Enclosure to

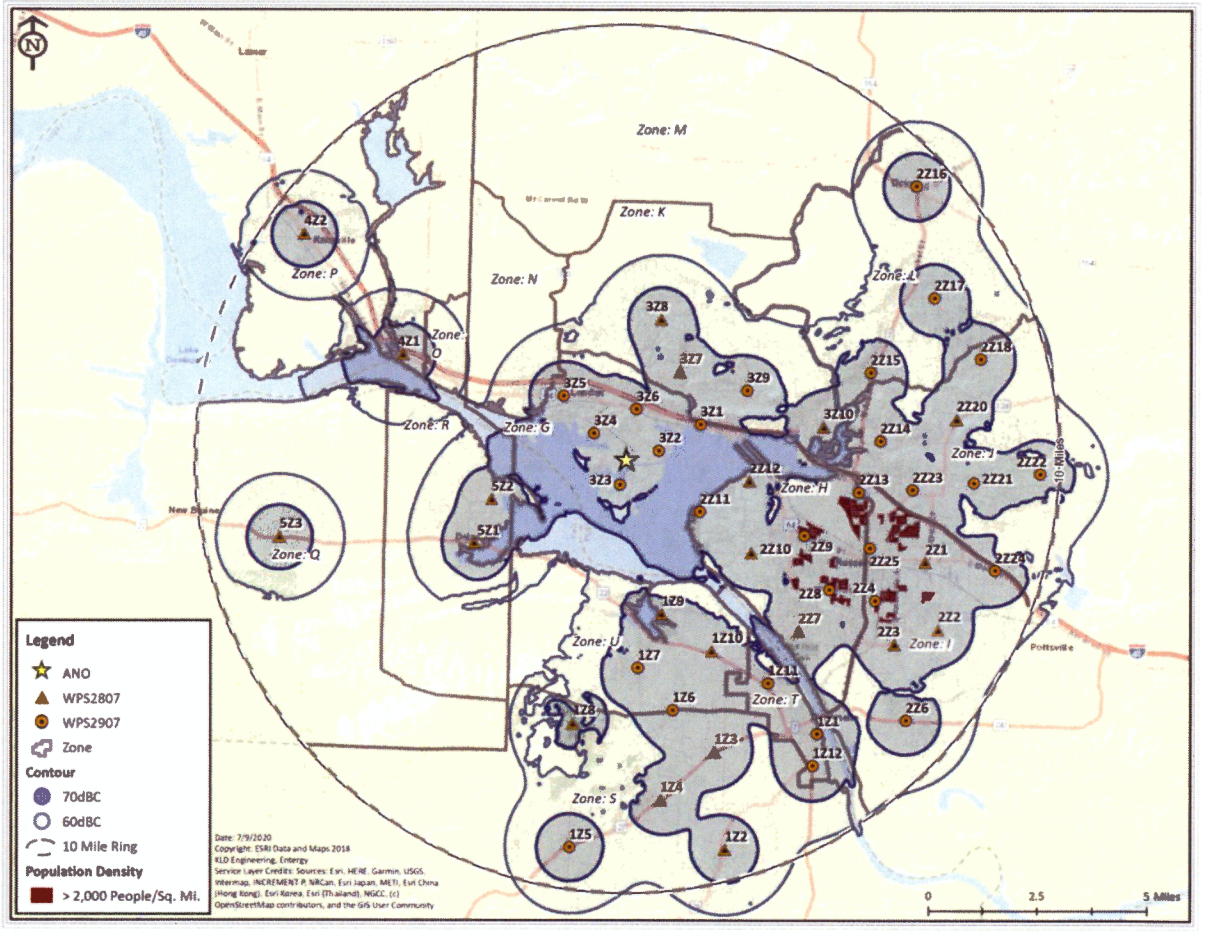
0CAN042104

Arkansas Nuclear One Alert and Notification System Design Report

KLD ENGINEERING, P.C.

ARKANSAS NUCLEAR ONE

Alert and Notification System (ANS) Design Report



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SIGNATURE LIST

My agency has reviewed the enclosed Alert and Notification (ANS) Design Report in its entirety. We find the report to be accurate and complete, and to be in agreement with our agency's emergency plans. My signature below is my attestation to such.

OSCAR MARTINEZ JR Digitally signed by OSCAR MARTINEZ JR
Date: 2020.12.14 08:26:07 -06'00'

FEMA Regional Representative (*Print/Signature*) **Date**

JOSH TOBEN 09/28/2020

Entergy Emergency Planning Representative (*Print/Signature*) **Date**

J. CHRIS MEYER 9.28.20

Arkansas Department of Health (*Print/Signature*) **Date**

REVISION HISTORY

Date	Revision #	Notes
3/5/1984	0	FEMA approval of original ANS for the ANO EPZ.
5/2009	1	Design report was updated to account for: • One-for-one replacement of 34 electromechanical sirens with Whelen and ATI electronic sirens without modifying or changing the control system, antennas and radio systems. • Results of an acoustical test following installation of the new sirens to demonstrate that the updated siren system meets the design objectives. • The Failure Mode and Effects Analysis (FMEA) of the completed siren system • Replacement of transmitters and radios for the tone alert system.
6/14/2011	2	Design report updated to correct siren GPS locations and siren coverage map
5/2016 2/2017	3	Design report was revised and supplemented to reflect the following changes: • One-for-one replacement of the 28 ATI sirens with Whelen 2900-7 series sirens. • Installation of an additional Whelen 2900-7 siren. • Results of the near-field tests indicate that the replacement of the 28 sirens provide a higher siren rated output. • Provide the Manufacturer's Technical Data, Operations and Troubleshooting Manual for the Whelen 2900-7 siren. • A replacement transmitter and replacement radios for the NOAA Tone Alert System.
9/2020	4	Design report was requested to update to include. • Update the siren coverage map using detailed SoundPLAN acoustical model and field testing of siren sound levels. • New guidance on report format and report content in FEMA Radiological Emergency Planning Program Manual dated December 2019.

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EXECUTIVE SUMMARY

The Arkansas Nuclear One (ANO) is located on a peninsula near the Town of Russellville in southwestern Pope County, Arkansas. The Emergency Planning Zone (EPZ) for ANO includes parts of Johnson, Logan, Pope, and Yell Counties. The permanent resident population for the EPZ is 52,871 people as per the 2010 U.S. Census.

The Alert and Notification System (ANS) for the ANO relies on the Siren Warning System (SWS) and the National Oceanic and Atmospheric Administration (NOAA) Tone Alert System as the primary means of alerting the public. Route alerting is used as the backup means to alert the residents around the failed or inoperable siren(s). Public information materials are distributed to the EPZ populace to inform people what to do if they hear sirens sounding or a loud tone from the activated NOAA Tone Alert Radios, and what radio stations to tune into for additional information.

The SWS consists of 50 omni-directional electronic sirens (21 Whelen WPS2807 sirens and 29 Whelen WPS2907 sirens). The location, model type and mounted height of each siren were input to SoundPLAN acoustic modeling software to estimate the audible level of the sirens throughout the 10-mile EPZ surrounding ANO. The SWS provides 60dBC coverage to 92.6% of the population within the EPZ and 70dBC coverage to the areas with population density exceeding 2,000 people per square mile. NOAA Tone Alert Radios are provided to residents of the 10-mile EPZ who live outside the 60dBC coverage or who have special needs. The radios are also provided to facilities within the 10-mile EPZ with significant population. The ANO tests the ANS routinely and has an extensive maintenance program in place to ensure continuous, reliable operation of the ANS. The ANS for ANO has had a reliability performance indicator of 100% for 2019. The reliability of the ANS has not dropped below 99% during the last decade of operation. Operators of the ANS are offered training as needed to ensure continued reliable operation of the system.

All siren batteries and control boxes are locked and mounted on the siren pole to prevent tampering. The siren activation equipment is installed at secure locations (the Arkansas Department of Health offices). The ANS system includes a DTMF encoder that requires key-lock activation to make it resistant to cyber-attack.

This ANS design report is an update to the last ANS report (Rev. 3 dated 2/2017) to update the siren coverage map using outputs from the detailed SoundPLAN acoustic model and field testing of siren sound levels, and to address the new guidance on ANS design report formatting and content documented in the December 2019 FEMA REP Program Manual.

1 Licensing Obligations

Title 10 of the Code of Federal Regulations (CFR) §50.47(b), item (5) and Title 44 of the CFR §350.5(a), item (5) state:

> "Procedures have been established for notification, by the licensee, of State and local response organizations and for notification of emergency personnel by all organizations; the content of initial and follow-up messages to response organizations and the public has been established; and means to provide early notification and clear instruction to the populace within the plume exposure pathway Emergency Planning Zone [EPZ] have been established."

The December 2019 FEMA Radiological Emergency Preparedness (REP) Program Manual states, "the alerting and notification of the public is a function of the state, local, tribal and territorial governments' emergency plans. An NPP [Nuclear Power Plant] applicant/licensee is required to demonstrate that the administrative and physical means are established for alerting the public and providing instructions, regardless of who implements the ANS [Alert and Notification System] capability. An applicant/licensee may install and maintain the ANS but the responsibility for the alerting and notifying the public, as well as the activation of the ANS, remains with the state, local, tribal and territorial governments."

This ANS design report describes the physical and administrative means established by Entergy to assist the states and counties in alerting and notifying the public in an emergency. Detail of the state and county actions can be found in the state and county radiological emergency plans.

As discussed in the December 2019 version of the FEMA REP Program Manual, the initial federal guidance on ANS provided in NUREG-0654/FEMA-REP-1, Rev. 1[1], Appendix 3 (1980) and FEMA-REP-10 ("Guidance for the Evaluation of Alert and Notification Systems for Nuclear Power Plants") (1985) "predated technology many citizens now take for granted (e.g., smartphones, social media, etc.)." As such, the FEMA REP Program Manual is now the recognized federal ANS guidance document as it "allows evaluators to account for new technologies, consider updated NRC/FEMA guidance, and incorporate REP lessons learned." This ANS design report adheres to the guidance of the latest FEMA REP Program Manual (December 2019), but does rely on data and information from the following additional guidance documents:

- NUREG-0654/FEMA-REP-1, Rev. 1[1] (1980) including Supplement 4 (2011)
- FEMA CPG 1-17, "Outdoor Warning Systems Guide" (1980)
- FEMA-REP-10 (1985)
- FEMA Technical Bulletin (Version 2.0) "Outdoor Warning Systems" (2006)
- NUREG-1022, Revision 3, "Event Report Guidelines 10 CFR 50.72 and 50 73 (2013)
- NEI 13-01, Revision 0, "Reportable Action Levels for Loss of Emergency Preparedness Capabilities"

Part V, Section B of the 2019 FEMA REP Program Manual discuss ANS design objectives. The minimum acceptable design objectives for coverage by an ANS – what the system must be able to do when speed is critical – include:

[1] This document is outdated, being replaced with Rev 2 in December 2019. One of the goals of Rev. 2 of this document and of the December 2019 revision of the FEMA REP Program Manual was to not mention specific technologies (i e , sirens) in reference to ANS Nonetheless, Rev 1 of this document does include valuable guidance on outdoor warning sirens

- The capability to provide both an alert signal and an informational or instructional message to the population in the EPZ within 15 minutes.
- The initial notification system will ensure direct coverage of essentially 100 percent of the population within 5 miles of the NPP site.
- Notification methods will be established to ensure coverage within 45 minutes of essentially 100 percent of the population in the EPZ who may not have received the initial notification including any special requirement exceptions (e.g., large water areas with transient boats or remote hiking trails).
- The capability of the ANS to cover essentially 100 percent of the population within the EPZ, regardless of failures. The corrective means/measures will be conducted within a reasonable time, with a recommended goal of 45 minutes. The use of a sequential failure model or "primary and backup" ANS model is acceptable. Other models, such as simultaneous or concurrent activation models, could be used.

All of these criteria are met by the ANS system in the Arkansas Nuclear One (ANO) EPZ, as discussed in the sections below.

2 Requirements

2.1 System Coverage

2 1.1 Population

The ANO site is located near the Town of Russellville in southwestern Pope County, Arkansas. The EPZ is located entirely within the State of Arkansas and consists of portions of four counties – Johnson, Logan, Pope, and Yell Counties. Figure 1 shows the location of ANO as well as the approximate 10-mile EPZ.

The permanent resident population in the EPZ is 52,871 people according to the 2010 Census. Table 1 summarizes the permanent resident population and population density in the EPZ, by Zone, for the last two decennial censuses conducted by the U.S. Census Bureau. As the data indicate, population in the EPZ has increased since 2000, with an increase of +3.8% for the 2-mile radius of the plant, +12.8% for those Zones within the 5-mile radius, and +13.6% for the EPZ as a whole.

A common method for displaying population around a nuclear power plant is by sector. The EPZ is divided up into one-mile increments and the sixteen cardinal and inter-cardinal wind directions, for a total of 160 sectors. The 2010 EPZ permanent resident population, by sector, is shown in Figure 2.

The federal guidance; FEMA-REP-10, "Guide for the Evaluation of Alert and Notification Systems for Nuclear Power Plants," indicates that sirens are in compliance with federal guidance if they meet either of the following conditions:

- "The expected siren sound pressure level generally exceeds 70dBC where the population exceeds 2,000 persons per square mile and 60dBC in other inhabited areas; or
- The expected siren sound pressure level generally exceeds the average measured summer daytime ambient sound pressure levels by 10dB (geographical areas with less than 2,000 persons per square mile)."

FEMA CPG 1-17, "Outdoor Warning Systems Guide" indicates that people typically mentally block out sounds that are not pertinent to what they are doing. In order to break the mental block, a warning sound

must be about 9dBC greater than ambient noise to capture the attention of the listener. This is the basis of the conservative 10dBC above ambient noise guidance. Ambient noise levels were not measured in the ANO EPZ; thus, 60dBC and 70dBC will be used as the criteria for siren sound levels in this report, depending on the population density in a given area

In order to determine whether 60dBC or 70dBC coverage is needed, population density was computed. There are many different methods for computing population density:

- Population density by radial distance – 2-mile radius, 5-mile radius, or the full approximate 10-mile EPZ
- Population density by county
- Population density by municipality

As shown in Table 2, these population densities differ significantly, underscoring the uneven distribution of population in the EPZ. Higher sound pressure levels are required in densely populated areas to overcome the higher ambient noise levels associated with a larger number of people and increased activity. Computing the population density by a large radial distance, or by county can distort population density by incorporating large land areas that are unpopulated or sparsely populated. This could result in the failure to adequately identify areas that need 70dBC coverage. For example, Table 2 indicates that the municipalities in the EPZ have population densities ranging from 211 to 1,303 people per square mile. However, when considering the population density for each county as a whole, it is considerably lower (ranging from 24 to 76 people per square mile).

The most refined method for computing population density is by census block. The U.S. Census Bureau divides the U.S. into census tracts. These census tracts are in turn divided into block groups, and block groups are comprised of multiple blocks. The census block is the finest level at which the U.S. Census Bureau aggregates detailed population data.

Census blocks vary in size from as small as a single city block to as large as an entire county. Given the variance in block size, there is the potential to have abnormally high population density for a block with a very small area. Similarly, a small neighborhood can have a population density exceeding 2,000 people per square mile but it may be the only community for miles. Assuming this neighborhood has 100 people living in an area of about 0.04 square miles (approximately 26 acres – 50 homes on ½ acre plots), the population density would exceed 2,000 people per square mile. However, if there are no surrounding neighborhoods, 100 people are not likely to generate enough background noise to warrant 70dBC coverage.

The last physical census in the United States was conducted in 2010 (the 2020 Census is ongoing, but data will not be released until March 31, 2021). Thus, the 2010 Census serves as the basis for all population estimates in this document. Each year in May, the U.S. Census Bureau releases projected populations for each state, county and municipality in the U.S. The latest available census population estimates, as of July 1, 2019, which were released in May 2020 (when this analysis documented in this report was started), from the U.S. Census Bureau were used to compute annual growth rates by county and municipality. These growth rates were then used to extrapolate the 2010 census population in the EPZ to 2020 at the

block level. For more information, please refer to the 2020 Evacuation Time Estimate (ETE) update[2] for ANO.

The following methodology was used to compute population density within the EPZ, by census block. Population block data was overlaid on the EPZ boundary using Geographic Information Systems (GIS) mapping software. The population density was computed by dividing the 2020 extrapolated population by the area of the block in square miles. Any block with a density exceeding 2,000 people per square mile was flagged (block color coded red) as high density as shown in Figure 3.

As discussed above, there is a possibility of isolated neighborhoods or extremely small census blocks being flagged with abnormally high population densities. While mathematically the population densities are correct, these anomalous census blocks do not represent densely populated areas that would have significant background noise warranting 70dB siren sound levels. Two steps were taken to remove these anomalous census blocks from the actual high population density areas:

1. A filter was applied which eliminates all flagged blocks that have a population less than 100 people or an area less than 0.02 square miles. This filter eliminates sparsely populated census blocks which are abnormally small and result in unrealistically high population densities. Figure 4 displays those blocks which are still flagged after applying this filter.
2. Each flagged census block with a population density exceeding 2,000 people per square mile was converted into a circle with an area of 1 square mile, centered at the center of the block. These 1 square mile circles were then overlaid with the census block data once again and the population density of the 1 square mile circle was recalculated. If the density exceeded 2,000 people per square mile, the block which the circle was centered at remained flagged as having a high population density. If the density of the circle fell below the threshold, the block the circle was centered at was removed from consideration. This filter eliminates isolated high population density neighborhoods that are surrounded by areas of low population density. Figure 5 shows an example of this filter applied to three census blocks in the EPZ. Both blocks shown in Step 1 are flagged as high population density blocks after applying Filter 1. However, when drawing the 1 square mile circles (Step 2.1) centered at the blocks, the population density (Step 2.2) is well below the 2,000 people per square mile threshold. As a result, both blocks are eliminated as high population density blocks (Step 2.3). Figure 6 shows the final blocks flagged as having population density exceeding 2,000 people per square mile in the EPZ after the two filters were applied.

2.1.2 Geographic Area

The ANO site is situated on a peninsula formed by Lake Dardanelle, which includes the Arkansas River and the former Illinois Bayou. The land within 5 miles of the plant is gently rolling and contains a number of ridge-valley configurations. The Arkansas River and Lake Dardanelle roughly bisect the ANO EPZ.

The meteorological information for each of the EPZ counties is described below.

Johnson County[3] is characterized by hot summers and cold winters, with an average high temperature of 90 degrees Fahrenheit (°F) in July and an average low temperature of 27°F in January. The average rainfall

[2] "Arkansas Nuclear One 2020 Population Update Analysis", KLD TR – 1167, dated September 19, 2020
[3] https //www bestplaces net/climate/county/arkansas/johnson

and snowfall in the county is 50 inches and 4 inches, respectively. The number of days with any measurable precipitation is 96. Johnson County is at an average elevation of 1,017 feet.

Logan County[4] is also characterized by hot summers and cold winters, with an average high temperature of 92°F in July and an average low temperature of 28°F in January. The average rainfall and snowfall in the county is 49 inches and 2 inches, respectively. The number of days with any measurable precipitation is 95. Logan County is at an average elevation of 678 feet.

Pope County[5] is also characterized by hot summers and cold winters, with an average high temperature of 91°F in July and an average low temperature of 28°F in January. The average rainfall and snowfall in the county is 50 inches and 4 inches, respectively. The number of days with any measurable precipitation is 101. Pope County is at an average elevation of 835 feet.

Yell County[6] is also characterized by hot summers and cold winters, with an average high temperature of 93°F in July and an average low temperature of 29°F in January. The average rainfall and snowfall in the county is 51 inches and 3 inches, respectively. The number of days with any measurable precipitation is 95. Yell County is at an average elevation of 626 feet.

Figure 1 identifies the municipal areas and major roads in the area, as well as the 15 Zones that comprise the approximate 10-mile EPZ. The Zones are color-coded based on the county they are in.

The National Oceanic and Atmospheric Administration (NOAA) commissioned a study[7] to summarize historical wind data from 1930 to 1996 in the United States. Wind data was aggregated for Fort Smith Regional Airport, which is the closest airport to ANO. The average wind speed at Fort Smith Regional Airport, based on the data gathered, ranges from a low of 6 miles per hour (mph) in July to a high of 8mph in January.

As shown in Figure 1 and listed in Table 2, there are 6 municipalities within the EPZ. Most of the municipalities are located adjacent to the Arkansas River and Lake Dardanelle. Beyond the population centers is sparsely populated rural farmland or undeveloped land.

The population centers in the ANO EPZ are connected by an extensive highway network. Interstate 40 and US Route 64 travel northwest-southeast through the EPZ. The major state highways servicing the EPZ include Arkansas State Routes 7, 22, 27, 28, 124, 164, 247, 315, 326, 331, 333 and 359. The primary railroads within the EPZ include Dardanelle and Russellville Railroad and Missouri Pacific Railroad .

2.1.3 Means

The physical means of alerting and notifying the public within the ANO 10-mile EPZ is the Emergency Warning System (EWS) that consists of a mixture of the Siren Warning System (SWS) and the NOAA Tone Alert System. The ANS is essentially designed to notify the individuals in the 10-mile EPZ within 15 minutes of the issuance of recommendations by the State of Arkansas for radiological emergencies at ANO. Local fire departments in the EPZ and route alerting are used as the backup method to alert the public to receive instructions, information, and necessary actions to be taken.

[4] https://www.bestplaces.net/climate/county/arkansas/logan
[5] https://www.bestplaces.net/climate/county/arkansas/pope
[6] https://www.bestplaces.net/climate/county/arkansas/yell
[7] https://www.ncdc.noaa.gov/sites/default/files/attachments/wind1996.pdf

2.1.4 Primary Methods

The primary ANS for ANO is the EWS as discussed above. The SWS is used to alert the more densely populated areas shown in Figure 7. Based on the population estimates discussed in Section 2.1.1, the SWS covers 92.6% of the population within the EPZ at 60dBC or higher. Those residents of the 10-mile EPZ who live outside the siren coverage area or who have special needs are alerted by NOAA Tone Alert Radios (TAR). NOAA TARs are also provided to the facilities within the 10-mile EPZ with significant population. These individuals and facilities are further discussed in Section 2.2.

The SWS relies on 50 Whelen omni-directional electronic sirens (21 WPS2807 sirens and 29 WPS2907 sirens). Of the 50 sirens, there are 2 sirens in Johnson County, 3 sirens in Logan County, 33 sirens in Pope County and 12 sirens in Yell County. All sirens are mounted at pole top, approximately 50 feet above the ground. The location, height and ID for each siren are presented in Table 3.

All of the sirens are radio-controlled and a DTMF (Dual Tone Multiple Frequency) encoder is required for activation. Sirens include a National Nuclear Attack signal that insists of an up-and-down scale tone. This three-minute continuous tone signal will be used to alert the populace to tune into NOAA TARs and local radio stations for emergency information (primary notification). Sirens also include a warning signal. This signal is used to alert the populace of not only a radiological incident, but also of natural disasters, especially tornado warnings.

The Arkansas Department of Health (ADH) maintains a database of addresses that are outside of the 60dBC siren coverage area. Each year a letter is sent to those addresses to verify if they have a NOAA TAR and if it is functioning. If they do not have a TAR or if the TAR is not functioning, they can request that ADH provide a TAR. The ADH also mails batteries to the TAR holders annually.

The NOAA Tone Alert System is operated in cooperation with the National Weather Service (NWS). When activated, a loud tone is emitted from the radio to alert the user. Following activation of the receivers, live or pre-recorded emergency messages are broadcast to instruct/notify the public. Section 3.1 below provides additional details of the EWS.

2.1.5 Backup Methods

Supplemental notification to the EPZ population is provided by local fire departments in the EPZ. In the event of siren or NOAA Tone Alert System failures, route alerting is implemented in the affected fire district(s) using truck sirens and Public Address (PA) systems for notification of residents around the failed or inoperable siren(s). The truck sirens serve as the backup alert method, while the announcements being made over the PA system serve as the backup notification method.

2.2 Population/Demographics

In addition to the permanent resident population detailed in Section 2.1.1, there are transients who may be visiting the EPZ for recreational purposes. Those people who live and recreate in the EPZ have already been considered as permanent residents to avoid double counting population.

According to the latest ETE study done for ANO (KLD TR-517, "Arkansas Nuclear One – Development of Evacuation Time Estimates," Rev. 1, dated December 2012), there could be as many as 11,745 transients in the EPZ at peak times. The transient estimate is based on data provided by county emergency management agencies.

There are 69 special facilities identified in the EPZ. These facilities include schools, universities, parks, campgrounds, golf courses, marinas, recreational areas, lodging facilities, major employers, medical facilities, and correctional facilities. The EWS is capable of alerting and notifying each of these special facilities. Nonetheless, the State has plans in place to notify each of these facilities individually as discussed below.

As per the Arkansas Comprehensive Emergency Management Plan (ARCEMP), Rev. 39, dated September 30, 2019, the State Department of Parks and Tourism will provide notification of the public within the park system; the State Game and Fish Commission and State Forestry Division will provide backup communications and personnel for notification purposes in remote forest areas, and on rivers and lakes; the ADH repeater system will alert the emergency response agencies and schools within the 10-mile EPZ through the Early Notification System (ENS) component of the EWS; and information contained in the Emergency Instruction Booklet[8] (EIB) is posted and/or placed in public locations within the 10-mile EPZ such as public buildings, state and national parks, recreational areas, tourist information centers and rest areas located on major highways, which are routinely visited by transient populations. Postings will be checked periodically and updated as needed. In addition, letters of agreement formalizing the emergency notification interfaces between Entergy and Arkansas Tech University in Russellville are kept on file in Entergy's offices.

None of the areas discussed above are considered exception areas. They can all be alerted and notified in a timely fashion.

Special provisions have been developed by ADH Nuclear Planning & Response Program (NP&RP) and Entergy for the alerting of identified handicapped individuals. A postage-prepaid, detachable postcard is provided in the annual mailing of the EIB for use by persons who may have special needs. This form is to be completed and then mailed to the ADH NP&RP office, and the information is subsequently provided to the appropriate local government. The individuals with special needs, depending upon their handicap, are notified appropriately. The notification may include door-to-door notification by law enforcement officers, neighbors, telephones, or tone activated NOAA TARs. Persons who are hearing impaired, or who require special notification are provided NOAA TARs free of charge. These receivers are also made available to the large businesses, hospitals, nursing homes, schools, day reception centers, and other applicable groups within the 10-mile EPZ.

According to American Community Survey 2014 – 2018 data[9], the percent of non-English speakers within the EPZ is approximately 0.56%. Given the small size of non-English speaking population, English is the only language used for notification.

2.3 Interoperability

The SWS is divided into 5 siren activation zones of relatively higher population density covering parts of the 10-mile EPZ, specifically: Yell County (1Z as Zone 1), the Russellville/Dover area and the Village of London in Pope County (2Z and 3Z), Johnson County (4Z), and Logan County (5Z). Each of these zones can be activated independently or in conjunction with other zones. All zones would be activated in the event of emergency at the ANO site.

[8] https://www.healthy.arkansas.gov/images/uploads/pdf/AR_NucOne20_ENGweb.pdf
[9] Additional details about language spoken at home can be found at the following website:
https://factfinder.census.gov/faces/affhelp/jsf/pages/metadata.xhtml?lang=en&type=table&id=table.en.ACS_17_5YR_B16004

The ADH has the sole ability to activate the SWS. There are three activation points – one primary and two backup points, as discussed in Section 3.1.3 and Section 3.3.1. The locations of the activation points are outlined in Table 4. All the activation points have backup power and two independent paths for activation signals to reach the sites. The SWS is activated by radio signal in the UHF (Ultra High Frequency) band which is transmitted by the primary/backup siren radio transmitter. The architecture of the SWS activation is discussed in detail in Section 3.1.3. The SWS activation is also made available to local governments for use in severe weather and other emergencies. Authorized officials may request siren activation for various zones in their jurisdictions.

The sirens are battery operated and are powered by four high capacity batteries. Battery charge is maintained by AC power through "smart" chargers to avoid overcharging. Sirens, depending on use, can keep operating up to 10 days without AC power. The ADH has mobile generator units that can be used in the event an AC power outage exceeds that length of time.

The NOAA TARs are activated by the NWS through a 300-watt transmitter with a 300-watt backup transmitter. The NWS is contacted by the ADH staff and informed of the intent to activate the EWS. The NWS is notified in advance of the sirens being activated such that, in conjunction with the siren activation, the NWS activates the NOAA tone which automatically turns the receivers on.

2.4 Operations

ANO maintains the capabilities to assess, classify, and declare an emergency condition within 15 minutes of the availability of indications to plant operators that an emergency action level has been exceeded. Emergency personnel are trained to promptly declare the emergency condition as soon as possible following identification of the appropriate emergency classification level. There are four emergency classification levels – Notification of Unusual Event, Alert, Site Area Emergency and General Emergency. The EWS within the 10-mile EPZ might be activated by ADH for a Site Area Emergency and will be activated for a General Emergency.

The final decisions to alert and notify the public by the EWS are the decisions of governmental officials. Initial notification is made to the state and local authorities within 15 minutes after declaring an emergency. An Emergency Action Authenticator is used to verify messages that are received over a non-secure system, such as commercial telephone system. The NRC is notified immediately following notification of state and local authorities and within 1 hour of the declared emergency.

The EWS can be fully activated from the ADH Emergency Communication Center (ECC), the alternate State Emergency Operations Facility (SEOF) or the ADH NP&RP office. Anytime the SWS is to be activated to notify the public, ADH NP&RP will take over operation of radio station KXRJ, 91.9 FM at Arkansas Tech University. ADH NP&RP has the capability to remotely take over broadcast of this station and provide the public with any emergency communications or protective actions that might become necessary. The detailed activation process is included in Appendix B.

2.5 Management/Administration

It is the responsibility of ADH to manage and oversee the EWS network. The NOAA radio program is administrated by ADH NP&RP and operated by NWS. The NWS is responsible for managing the weather radio transmitters nationwide.

2.6 Security and Privacy

2.6.1 Physical Security

All siren batteries and control boxes are pad locked and mounted on the siren pole to prevent tampering, and both AC and battery voltage can be monitored remotely. The siren activation equipment is installed at secure locations that are manned 24 hours per day. Entry into all activation points is limited to authorized personnel only. Additionally, all activation consoles are equipped with a physical keyed lock to prevent access to the activation keys.

2.6.2 Logical Security

To prevent cyber-attack, the actual activation of the EWS is accomplished by use of a DTMF encoder requiring key-lock activation. Details of either activation procedure are limited to a "Need-to-Know" basis for security reasons.

2.7 Maintenance/Repair

2.7 1 Preventative Maintenance

It is the responsibility of ADH NP&RP to perform the Preventive Maintenance (PM) on the SWS. On a quarterly basis, the PM is performed following the instructions listed in the ANO SWS Maintenance Plan (see Appendix C). During the scheduled PM, each siren may experience brief periods when it is not able to sound, but it is not taken out of service for more than a few minutes and could be returned to service immediately, if needed. As noted in the maintenance plan, a wide variety of inspections are performed at each siren site including verification that there is no vegetation growth that can obstruct sound propagation near the siren head; visual inspection of the pole, the antenna, the siren head, the cabinet and associated connections; verifying acceptable condition of the batteries and chargers; and running a silent test. In addition, the ADH performs the maintenance with contractor assisted items, such as crane rental for upper driver maintenance.

The ADH NP&RP also checks the operation of the control points and transceivers associated with the activation system on a routine basis. The operability of key components, for instance, is verified every weekday. Additionally, a contractor is used to measure the transceiver perimeters.

The ADH NP&RP mails information annually to every address within the 10-mile EPZ to provide the contact information for the request of the NOAA TARs. On a monthly basis, the ADH mails letters to the new residents within the 10-mile EPZ to notify them of the same information. Recipients of the NOAA TARs are tracked in a master database by the NP&RP staff as discussed in Section 2.1.4. Needed repair and/or replacement of the receivers identified as defective is also carried out by the NP&RP staff. All the holders of the NOAA TARs receive new batteries and instructions from the ADH annually.

2.7.2 Corrective Maintenance

Upon notification of a siren malfunction, the ADH determines if the failure(s) is reportable in accordance with 10CFR 50.72, and the noted siren malfunction is immediately serviced by an ADH NP&RP Electronics Technician and every attempt is made to return the unit to operation. If the siren is unavailable, the appropriate county is notified that the backup alert method – route alerting – will be required in the affected area until the unit is returned to service.

A siren that did not fully respond to the activation command signal during a valid test is considered as an activation failure and would not have provided adequate public alert. It would be reported as a siren

failure to FEMA and to ANO Emergency Planning (EP) personnel. A siren is considered out of service when it cannot receive, process, or sound the appropriate audible warning tone through the driver section.

When determination has been made that a SWS component is not responding appropriately to polling, such as low battery, AC voltage or related issues; or reports or concerns from the public indicating siren abnormal behavior, an on-site inspection and repair will be performed by an ADH NP&RP Electronics Technician. The Electronics Technician will follow the guidelines recommended in the manufacturer's operating and troubleshooting manuals (see Appendix D) to restore component functionality. The Electronics Technicians also meet routinely with the ADH Section Chief to identify any maintenance and/or performance trends. Trends are noted and corrective actions are implemented, if needed.

In addition, the ADH tests the siren control transmitters and consoles every weekday morning, when the state offices are open. If a problem is identified, the corresponding corrective action is immediately undertaken. The use of redundant transmitters and activation points minimizes the risk of a failure of the activation system.

2.8 Availability/Reliability

Appendix 4 of FEMA REP-10 specifies that the operability of a siren system is considered acceptable "when an average of 90% of the sirens (as determined by a simple average of all regularly conducted tests) can be demonstrated functional over the 12-month period immediately preceding the submittal of the design report."

The Nuclear Energy Institute (NEI) Regulatory Assessment Performance Indicator Guideline, NEI 99-02 Revision 7, specifies a minimum performance indicator threshold of 94% for ANS Reliability during the previous four quarters for plants operating in the normal regulatory response band.

The ANO SWS reliability data is reported to FEMA for review on a quarterly basis. According to the ADH, the ANO siren system has been operational since 1981 A review was completed over the past 10 years and it was determined that the successful siren performance has not dropped below 99% during that time. Table 5 shows the results of siren tests at ANO for the last 4 quarters. As shown, the siren performance in each quarter of 2019 was 100%.

2.9 Testing

The EWS is tested by ADH and NWS periodically to ensure its readiness. The testing includes functionality of sirens and of NOAA TARs.

The entire SWS is sounded weekly to reinforce public awareness of the system. This is not a silent or growl test, but either a 15-second or 1-minute audible test each Wednesday at 12:00 pm. Testing will not be performed if severe weather is present in the area or the state offices are closed. Under a verbal agreement with FEMA, the 1-minute audible test is performed on the 4th Wednesday of the month. The operation of each siren is verified once per month and the results are reported to FEMA. Due to the fact that the weekly audible test far exceeds the annual federal operability requirement, other types of audible tests are not conducted at the ANO.

In addition to the weekly audible test, sirens are polled for health maintenance at least once per month. The health of siren batteries is assessed by the ADH NP&RP Electronics Technician on a quarterly basis (see Section 2.7.1). Batteries are replaced at a frequency that exceeds the battery manufacturer's recommendations. The siren activation equipment is tested frequently (see Section 2.7 2). Special

observations may be conducted in the event of severe weather or high winds which might result in physical damage, such as identifying loose feed lines or pole damage. If any issues are identified during these observations, repairs will be undertaken using the ANO SWS Maintenance Plan in Appendix C.

The NOAA TAR activation is tested by the NWS and monitored by ADH NP&RP. The testing is performed each Wednesday between 11:00 am and 12:00 pm. If inclement weather persists, the testing will be performed the next clear day.

The current testing conducted by ADH exceeds the annual maintenance recommended by the NRC. This includes actions specifically designed for the ANO EWS. The testing records are kept in the ADH NP&RP office.

2.10 Responsibility

It is the responsibility of ADH NP&RP to perform or supervise maintenance on the entire EWS network (except for the NOAA radio system and local broadcast stations and radios) and to ensure that it is functioning properly. In general, the electronic component control and radio parts are maintained and repaired by ADH. The items requiring the use of a crane or other specialized equipment are maintained and repaired by contractors. The NOAA radio system is tested by the NWS and monitored by ADH NP&RP and by ANO EP personnel (see Section 2.9 and Section 4.3). A local contractor is responsible for maintenance and repair of the NOAA weather radio transmitters.

2.11 Training

It is the responsibilities of ADH NP&RP to identify organizations with a need for training and provide training and refresher training on a continuing basis. Refresher training shall be made available to emergency personnel at least annually. At a minimum, these emergency workers will have attended the FEMA REP Planning course. The training required for emergency personnel is discussed in Section 7.

2.12 Quality Assurance

The ADH maintains several procedures pertaining to the ANS, including procedures on activation, testing, maintenance, repair and reportability. These procedures are included in Appendices B and C. The records regarding the SWS testing and maintenance are maintained by ADH and routinely reviewed by ANO. Copies of the quarterly reports detailing siren system performance are also provided to ANO. Additionally, the ANO is provided the results of activation verification on a monthly basis.

In addition to these procedures above, the EWS is tested on a weekly basis as discussed in Section 2.9. Hence, the essential elements of the SWS activation are "practiced" weekly. These extensive exercises help to reduce errors during the operation.

The NOAA weather radio test data is not reported as the weekly test is not guaranteed due to the weather conditions The records of the NOAA radio system performance are not maintained as it is outside ADH's area of responsibility. However, the ADH notifies the NWS of service interruptions monitored (see Section 4.3) and provides assistance in resolving problems. As noted in Section 2.10, a local contractor is responsible for the maintenance and repair of the NOAA weather radio transmitters.

3 Description/Performance

3.1 Physical requirements

3.1.1 System Components

As discussed in Section 2.1.4, the siren system is comprised of 50 omni-directional electronic sirens. Figure 8 maps the sirens in the EPZ. The sirens are labeled with their identification number and are symbolized by siren model type. Table 3 lists each of the 50 sirens in the ANO EPZ. The table includes the siren identification number, the latitude and longitude of the siren, the siren model, the mounted height of the siren and location description.

WPS2807 and WPS2907 sirens can produce approximately 115.1dBC and 115.5dBC, respectively, at 100 feet along their centerline with operating frequencies between 500 and 630 Hz, based on the results of the near-field tests discussed in Section 4.1.

A WPS2807 or WPS2907 siren consists of a power supply (batteries), a control board, seven 400-watt audio drivers, seven audio amplifiers, and a radio transceiver for reception of control signals. The batteries, control board, amplifiers and transceiver are located in a sealed and locked enclosure. The siren drivers are pole mounted at approximately 50 feet above the ground. All sirens have multiple ground points and surge protection, including antenna feed lines.

Over the past 30 years, the ADH has issued numerous NOAA TARs of various models and manufacturers. Nevertheless, all the radio receivers must respond to the 1050 Hz alert tone and feature an audible warning. The ADH also provides models with a visual signal to alert deaf or hearing-impaired individuals. The NOAA TAR have a battery backup feature which allows the user to install batteries, such that the radio will work during a power outage. New batteries are issued annually to each of the NOAA TAR holders as discussed in Section 2.1.4 and Section 2.7.1.

3.1.2 User Interfaces

The WPS2800 and WPS2900 series sirens can be remotely activated by using an encoder and siren radio transmitter. The logical connection between the siren control components is further discussed in Section 3.1.3. The NOAA TARs are activated by a primary 300-watt transmitter. A secondary 300-watt backup transmitter would be used following a failure of the primary transmitter. Both primary and secondary backup transmitter sites are located on Mount Nebo, which is approximately 6 miles SSW of the ANO site. Entergy has provided backup generator capability for the transmitter site. Hot standby switching for auto-start of the backup transmitter and a backup generator with auto-start capability is also available and tested frequently.

3.1.3 Functional Block Diagrams

Figure 9 shows the logical connection of the components of the siren control system. As shown in the diagram, there are three different locations that can communicate with the primary and backup siren radio transmitters which in turn communicate with the siren sites via a utility microwave link or a leased line which is a circuit rented from a public carrier – AT&T in this case. The ADH Mobile Command Post can communicate with the primary and backup radio transmitters via radio line. The primary/backup siren radio transmitters activate sirens by UHF-FM radio signal. Section 2.3 further discusses the physical connections of the system and the interoperability.

3.2 Administrative Components

3.2.1 Organizational Responsibilities

The ADH ECC is the official 24-hours-per-day point of contact between the State and ANO for the initial notification of a radiological incident. In the event of an emergency, the operator of ANO is responsible for notifying the ADH ECC, Arkansas Department of Emergency Management (ADEM), and the warning points in Conway, Johnson, Logan, Pope and Yell Counties. The final decisions to alert and notify the public by the EWS are the decisions of governmental officials.

The responsibilities of ADH NP&RP include off-site emergency planning and response to emergencies involving ANO; the development and update of emergency response plans; the maintenance and operation of the EWS and the communication system used to notify state agencies and local governments of emergencies; the maintenance of equipment and supplies necessary to support emergency operations for state and local agencies; the development and training of emergency personnel who would respond to an emergency; and the distribution of emergency instructions to the public.

The primary means of notification and communication between ANO and the state and local governments will be via the ANO Dedicated Emergency Facsimile/Voice System (DEF/VS). In the event that the ANO DEF/VS is not operating properly, the operator of ANO will notify the ADH ECC directly by commercial telefax or by commercial telephone; and ADH, in turn, will notify the county warning points and ADEM using various means, such as the DEF/VS, ENS radio, ADEM radio, and/or commercial telephone. If both communication procedures outlined above fail, the operator of ANO will use commercial telephone to notify the ADEM which will, in turn, notify the ADH ECC. The communications link between the state and federal emergency response organizations is via the commercial telephone system, with the National Warning System (NAWAS) serving as the backup system.

3.2.2 Management

As noted in Section 2.6, the activation consoles are key locked and kept at secure locations to prevent the inadvertent systemwide activation, and the siren control system is configured in such a way that a systemwide inadvertent activation is very unlikely to occur. There are limited failure paths which will result in an inadvertent activation, such as included high voltage that shorts a control cable. In the event of an inadvertent siren activation, the ADH sends the notification to area broadcast stations and to appropriate 911 Centers to assure the public there is no emergency involving ANO. In an emergency involving ANO, this responsibility falls on which of the State's centers have "Command and Control". For other situations, it depends on the time of day. After hours notification falls to the ADH ECC if the radiological emergency response team is not activated.

If siren(s) are inadvertently sounded, the cancellation tones are not automatically sent to the siren(s) due to the time factor. In most cases, reports of spurious siren sounding come in the form of calls from the public to the appropriate 911 Center which then notifies the ADH. It is noted that the sirens in Arkansas are hard coded to sound for 3 minutes before shutting off. As such, the siren has most likely "timed out" when the incident is reported. When the ADH receives a report of inadvertent siren sounding, the first step is to gather the information of the inadvertent sounding reported, including the number of calls received, the generation location of the sound reported, the caller names and call back numbers. The ADH then will verify the existence of a siren in the reported activation area. If a siren is identified in the reported area, a repair technician will visit the site to ascertain the status of the siren, and attempt to determine if

there was an actual activation or if there were other noise sources that imitate a siren. Most reported siren sounds are in fact from other sources, for instance, emergency vehicle sirens.

3.3 Operational Components

3.3.1 Activation

As discussed previously in Section 2.3, the SWS is activated by ADH through the primary or secondary activation points. As shown in Table 4, the primary activation point for the SWS is located at the ADH ECC office that is manned 24 hours per day to accommodate day or night activation. One secondary activation point for the SWS is located in the SEOF which is co-located at the ANO site; another secondary activation point is located in the ADH NP&RP office. All the activation points have the ability to activate the entire SWS, but for events where ANO is not involved, such as severe weather, activation is usually conducted by ADH ECC or by ADH NP&RP.

The NWS is notified by the ADH staff in advance of the sirens being activated. The NWS in turn utilizes the primary/backup weather radio transmitter to transmit the NOAA tone which automatically turns the receivers on. Both primary and secondary backup transmitter sites are located on Mount Nebo, which is approximately 6 miles SSW of the ANO site.

3.3.2 Timing

According to ADH, when an emergency is declared at ANO, the ANO operator must notify state officials within 15 minutes. State officials can then notify the public of an emergency within 15 minutes by use of the EWS. The EWS activation will be conducted with a sense of urgency without undue delay. The sirens activate within seconds of the signal being sent from the controller. The NOAA tone is activated in conjunction with the siren activation. The backup method – route alerting – is capable of alerting and notifying the 10-mile EPZ population within 45 minutes (see Section 4.3 and Section 5).

There are no exception areas (rural, low population areas) in the EPZ that would require additional time to be alerted and notified.

3 3.3 Geo-Targeting

Individual sirens within the siren system can be activated to pinpoint a geographic location for alerts; however, this is not part of the standard alert procedure. NOAA radios cannot be individually sounded.

4 Verification

4.1 Coverage

ANO recently conducted an extensive acoustical study of the siren system, including detailed acoustical modeling and field testing of siren sound levels. The results of this study are summarized below.

Section 2.0 of FEMA Technical Bulletin (Version 2.0) "Outdoor Warning Systems" dated January 12, 2006 provides an extensive discussion of sound propagation. Below are some key points on sound taken from this guidance document:

- Sound travels in waves
- Sound decreases in loudness at greater distances from its source
- Refraction: Sound waves can refract or bend with differences in temperature and wind speed. The specific heat of the ground is higher than that of the air above it. Thus, during the day, the ground

is warm and temperature decreases as you move higher above the ground. This difference in temperature impacts the speed of sound waves as shown in Figure 10. The resulting shadow zone causes the audible level of the siren to be lower at the ground. The opposite happens in the evening when the ground releases its heat to the atmosphere resulting in higher temperatures the farther you get from the ground, as shown in Figure 11. This explains why sounds from the same source are louder at night than they are in the daytime.

- Ground Absorption: Soft ground such as grass covered soil or dense foliage can cause significant absorption of sound, thereby reducing perceived loudness of sound. Hard surfaces such as concrete, ice, or water can cause sound waves to reflect upwards and be perceived as louder as shown in Figure 12.
- Wind: Wind speed either adds or subtracts to the velocity of sound waves depending on whether the sound is moving upwind or downwind, resulting in refraction of sound waves. Wind speed also increases with height above the ground causing further refraction. The additive refraction of these two phenomena can result in a significant acoustical shadow zone in the upwind direction as shown in Figure 13.
- Diffraction: Sound waves can also be diffracted (bent upward or downward) by objects (buildings, trees) in the path between the source and the listener resulting in lower perceived loudness.

Figure 14 shows multiple potential factors that could impact the sound heard by a receiver from a source.

One way to deal with the complications that can impact the audible level of outdoor sirens is to use a sophisticated acoustic model that accounts for terrain and atmospheric conditions. Such a model, SoundPLAN, was used to predict the siren coverage in the ANO EPZ. The SoundPLAN software is a state-of-the-art acoustic model written by SoundPLAN, LLC (a German company) and distributed in the U.S. by Navcon Engineering Network in California. This software has been used to model the siren coverage for more than a dozen U.S. nuclear plants, including the Diablo Canyon Power Plant in California, which has one of the most difficult terrains of any U.S. plant in terms of siren coverage.

Modeling Inputs and Assumptions

The following inputs/assumptions were used in the acoustic modeling:

- Digital elevation data was provided by the United States Geological Survey (USGS) National Map Viewer[10]. A standard DEM[11] was downloaded with a resolution of 1/3 arc-second, which is an approximate grid spacing of 10 meters. This is more than adequate to model the terrain in the EPZ.
- Major bodies of water including the Arkansas River, Illinois Bayou and Lake Dardanelle were explicitly modeled in the analysis using GIS mapping software.
- Ground surface absorption was explicitly modeled. The software default value for ground surface absorption is 1 for all soft grounds such as fields or other grassy areas, and forests. The ground surface value was changed to 0 for major bodies of water to accurately depict the reflective properties of the hard surface.
- The siren locations and model type documented in Table 3 were input to the model.

[10] http://viewer.nationalmap.gov/basic/
[11] http://nationalmap.gov/3DEP/3dep_prodserv.html

- Acoustical tests were conducted on June 23 and June 24, 2020 to measure the sound levels output by sirens. The tests included seven near-field tests in accordance with ANSI S12.14, wherein a sound meter was aimed at the center of the siren horns from a bucket truck parallel with the siren horns at a distance of 100 feet. In addition to the near-field tests, far-field tests were conducted with siren meters on the ground at varying distances form the siren pole. Five WPS2907 sirens and two WPS2807 sirens were tested. Figure 15 presents the locations of the near-field and far-field test locations. The tests were conducted by acoustical expert – Dr. Bruce Ikelheimer – using Larson Davis Model 831 sound level meters – and were supervised by the ADH and Entergy personnel. Weather conditions during the tests were good, with low winds and no precipitation. The test results were analyzed and reported by Dr. Bruce Ikelheimer (see Appendix E). The results of the near-field tests are summarized in Table 6. Based on the overall average results, sound levels of 115.1dBC and 115.5dBC are adopted for WPS2807 and WPS2907 siren models, respectively. The ANSI S12.14 test sheets for the seven near-field tests which provide additional details on the test are included in Appendix E.
- The acoustical standard International Organization for Standardization (ISO) 9613-2[12] was used. ISO-9613-2 is a widely used standard for sound modeling and is accurate at predicting total coverage areas at extended distances from the source.
- The average daytime temperature, pressure and humidity were used to account for atmospheric conditions. These data were estimated as the 3-month average of June, July and August of 2019. The historical weather data was obtained from the Weather Underground website[13]. The location used was Hot Springs, which is located approximately 55 miles southeast of ANO. The atmospheric conditions used were:
    - Average temperature = 79.8°F (26.5°C)
    - Average relative humidity = 77.2%
    - Average air pressure = 29.4 inHg (995.2mbar)

As discussed in Section 3.1.2, the NOAA TARs are activated by the primary/secondary weather radio transmitter located in Mount Nebo. As per the latest county radiological emergency response plans, the NOAA weather radio primary/backup transmitter at Mount Nebo covers the following counties – Conway, Johnson, Perry, Pope and Yell. This has provided adequate coverage to the radio receivers within the 10-mile EPZ.

4.2 Population/Demographics

Based on the population density analysis using the 2020 population projections (see Section 2.1.1), the overall population density in the ANO EPZ is low. Only parts of Russellville have a population density exceeding 2,000 persons per square mile, as shown in Figure 6. As discussed in Section 2.1.1, federal guidance recommends siren coverage of at least 70dBC in areas where the population density exceeds 2,000 people per square mile, and 60dBC in all other areas. Also, as discussed in Section 1, the ANS should provide direct coverage of essentially 100 percent of the population within 5 miles of the NPP site.

Figure 7 maps the predicted siren coverage for the ANO EPZ output by the SoundPLAN software based on the inputs and assumptions discussed above. The map shows the 60dB and 70dB contours, as well as the high population density areas discussed in Section 2.1.1.

[12] https://www.iso.org/standard/20649.html
[13] https://www.wunderground.com/

As shown in the map, the 60dBC coverage covers the majority of the 10-mile EPZ. All the high population density areas flagged red in Figure 7 have adequate 70dB coverage. As discussed in Section 2.1.4, the ADH maintains a database of addresses that are outside the 60dBC siren coverage area. Letters are sent to those addresses annually to ensure NOAA TARs are available to those addresses to ensure completed coverage of the EPZ by the EWS.

4.3 Metrics

Sound levels during siren activation were measured in many locations as discussed in Section 4.1 and shown in Figure 15. These sound level measurements were used to calibrate the acoustical model and predict 60dBC and 70dBC of the siren system in the EPZ.

As discussed in Section 4.1, the NOAA TAR receivers within the 10-mile EPZ are fully covered by the NOAA weather radio primary/backup transmitter at Mount Nebo. According to the ADH, the NOAA radio signal strength has not been reported as an issue by any NOAA TAR holders. As discussed in Section 2.5, the NOAA radio program is operated by the NWS and administrated by the ADH NP&RP staff. The ADH retains several radio receivers in the ADH NP&RP office for constant monitoring. The NOAA radio system is also monitored by ANO EP personnel.

As per federal guidance, the primary ANS means should be capable of alerting and notifying the EPZ population within 15 minutes, and the backup means should be capable of alerting and notifying the EPZ population within 45 minutes. According to the ADH, the time for the EWS (primary method) activation and route alerting (backup method) process has been evaluated by FEMA several times during the bi-annual evaluated exercises, and the timeline has been acceptable. The time for actual physical activation of the ENS by pushing the button is a matter of seconds.

5 Availability/Reliability

As discussed in Section 2.12, the ADH maintains several procedures to provide detailed information of performing testing, maintenance, and record keeping for system maintenance/repair activities. The system testing, maintenance and siren malfunctions have been discussed in detail in Section 2.7 and in Section 2.9. Appendices B and C details the Quality Assurance procedures that are in place which have resulted in a 100% reliability score for the ANS in 2019 and reliability scores in excess of 99% for the past decade (see Section 2.8). The inadvertent activation of the SWS and the actions taken thereafter are discussed in Section 3.2.2.

As discussed in Section 4.3, the ability to meet the minimum activation time of 15 minutes has been successfully demonstrated in the bi-annual evaluated exercises, including the latest one on July 17, 2018. The evaluation details are reported in the After-Action Report/Improvement Plan published by FEMA.

6 Security and Privacy

The applications used to activate the SWS can only be accessed by authorized personnel with unique user IDs and passwords. Section 2.6 provides additional detail on the physical and cyber security of the ANS.

7 Training and Public Outreach

The ADH NP&RP is responsible for arranging the initial and continuing training for all staff members who are assigned to the ANO radiological emergency planning effort. The elements of training required for emergency personnel include the review of emergency classification levels, protective action advisories, methods of notification, notification procedures, procedures for dissemination of public information during a nuclear generating plant emergency, emergency notification forms, emergency staff positions and responsibilities, facility set-up, layout and equipment.

The public is instructed by the EIB to tune to NOAA TARs and local radio stations for emergency instructions when the sirens are activated. The local radio stations have the capability to broadcast emergency messages on a 24-hour basis to the general public. The EIB is available in both English and Spanish and can be accessed through the ADH website[14]. The booklet also includes contact information for emergency planning agencies should additional information on alert and notification or other emergency planning issues be needed.

In addition to the EIB, emergency information regarding notification procedures and those steps that should be taken in an emergency is included in the official telephone directory distributed within the 10-mile EPZ and is updated annually. Education and informational programs are offered annually to area civic and service organizations, including public and private schools. These programs include information on the EWS, evacuation routes, and designated care centers. An annual media workshop is conducted by ADH NP&RP to provide pre-incident information to the representatives of the Arkansas news media. The workshop provides information on notification, evacuation and planning efforts. The ADH NP&RP will also provide the news media with periodic releases containing information on any changes in notification, evacuation or planning efforts.

[14] https://www.healthy.arkansas.gov/programs-services/topics/nuclear-planning-and-response

SIGNATURE LIST

My agency has reviewed the enclosed Alert and Notification (ANS) Design Report in its entirety. We find the report to be accurate and complete, and to be in agreement with our agency's emergency plans. My signature below is my attestation to such.

FEMA Regional Representative (*Print/Signature*) Date

Entergy Emergency Planning Representative (*Print/Signature*) Date

Arkansas Department of Health (*Print/Signature*) Date

REVISION HISTORY

Date	Revision #	Notes
3/5/1984	0	FEMA approval of original ANS for the ANO EPZ.
5/2009	1	Design report was updated to account for: • One-for-one replacement of 34 electromechanical sirens with Whelen and ATI electronic sirens without modifying or changing the control system, antennas and radio systems. • Results of an acoustical test following installation of the new sirens to demonstrate that the updated siren system meets the design objectives. • The Failure Mode and Effects Analysis (FMEA) of the completed siren system. • Replacement of transmitters and radios for the tone alert system.
6/14/2011	2	Design report updated to correct siren GPS locations and siren coverage map.
5/2016 2/2017	3	Design report was revised and supplemented to reflect the following changes: • One-for-one replacement of the 28 ATI sirens with Whelen 2900-7 series sirens. • Installation of an additional Whelen 2900-7 siren. • Results of the near-field tests indicate that the replacement of the 28 sirens provide a higher siren rated output. • Provide the Manufacturer's Technical Data, Operations and Troubleshooting Manual for the Whelen 2900-7 siren. • A replacement transmitter and replacement radios for the NOAA Tone Alert System.
9/2020	4	Design report was requested to update to include: • Update the siren coverage map using detailed SoundPLAN acoustical model and field testing of siren sound levels. • New guidance on report format and report content in FEMA Radiological Emergency Planning Program Manual dated December 2019.

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EXECUTIVE SUMMARY

The Arkansas Nuclear One (ANO) is located on a peninsula near the Town of Russellville in southwestern Pope County, Arkansas. The Emergency Planning Zone (EPZ) for ANO includes parts of Johnson, Logan, Pope, and Yell Counties. The permanent resident population for the EPZ is 52,871 people as per the 2010 U.S. Census.

The Alert and Notification System (ANS) for the ANO relies on the Siren Warning System (SWS) and the National Oceanic and Atmospheric Administration (NOAA) Tone Alert System as the primary means of alerting the public. Route alerting is used as the backup means to alert the residents around the failed or inoperable siren(s). Public information materials are distributed to the EPZ populace to inform people what to do if they hear sirens sounding or a loud tone from the activated NOAA Tone Alert Radios, and what radio stations to tune into for additional information.

The SWS consists of 50 omni-directional electronic sirens (21 Whelen WPS2807 sirens and 29 Whelen WPS2907 sirens). The location, model type and mounted height of each siren were input to SoundPLAN acoustic modeling software to estimate the audible level of the sirens throughout the 10-mile EPZ surrounding ANO. The SWS provides 60dBC coverage to 92.6% of the population within the EPZ and 70dBC coverage to the areas with population density exceeding 2,000 people per square mile. NOAA Tone Alert Radios are provided to residents of the 10-mile EPZ who live outside the 60dBC coverage or who have special needs. The radios are also provided to facilities within the 10-mile EPZ with significant population. The ANO tests the ANS routinely and has an extensive maintenance program in place to ensure continuous, reliable operation of the ANS. The ANS for ANO has had a reliability performance indicator of 100% for 2019. The reliability of the ANS has not dropped below 99% during the last decade of operation. Operators of the ANS are offered training as needed to ensure continued reliable operation of the system.

All siren batteries and control boxes are locked and mounted on the siren pole to prevent tampering. The siren activation equipment is installed at secure locations (the Arkansas Department of Health offices). The ANS system includes a DTMF encoder that requires key-lock activation to make it resistant to cyber-attack.

This ANS design report is an update to the last ANS report (Rev. 3 dated 2/2017) to update the siren coverage map using outputs from the detailed SoundPLAN acoustic model and field testing of siren sound levels, and to address the new guidance on ANS design report formatting and content documented in the December 2019 FEMA REP Program Manual.

1 Licensing Obligations

Title 10 of the Code of Federal Regulations (CFR) §50.47(b), item (5) and Title 44 of the CFR §350.5(a), item (5) state:

> "Procedures have been established for notification, by the licensee, of State and local response organizations and for notification of emergency personnel by all organizations; the content of initial and follow-up messages to response organizations and the public has been established; and means to provide early notification and clear instruction to the populace within the plume exposure pathway Emergency Planning Zone [EPZ] have been established."

The December 2019 FEMA Radiological Emergency Preparedness (REP) Program Manual states, "the alerting and notification of the public is a function of the state, local, tribal and territorial governments' emergency plans. An NPP [Nuclear Power Plant] applicant/licensee is required to demonstrate that the administrative and physical means are established for alerting the public and providing instructions, regardless of who implements the ANS [Alert and Notification System] capability. An applicant/licensee may install and maintain the ANS but the responsibility for the alerting and notifying the public, as well as the activation of the ANS, remains with the state, local, tribal and territorial governments."

This ANS design report describes the physical and administrative means established by Entergy to assist the states and counties in alerting and notifying the public in an emergency. Detail of the state and county actions can be found in the state and county radiological emergency plans.

As discussed in the December 2019 version of the FEMA REP Program Manual, the initial federal guidance on ANS provided in NUREG-0654/FEMA-REP-1, Rev. 1[1], Appendix 3 (1980) and FEMA-REP-10 ("Guidance for the Evaluation of Alert and Notification Systems for Nuclear Power Plants") (1985) "predated technology many citizens now take for granted (e.g., smartphones, social media, etc.)." As such, the FEMA REP Program Manual is now the recognized federal ANS guidance document as it "allows evaluators to account for new technologies, consider updated NRC/FEMA guidance, and incorporate REP lessons learned." This ANS design report adheres to the guidance of the latest FEMA REP Program Manual (December 2019), but does rely on data and information from the following additional guidance documents:

- NUREG-0654/FEMA-REP-1, Rev. 1[1] (1980) including Supplement 4 (2011)
- FEMA CPG 1-17, "Outdoor Warning Systems Guide" (1980)
- FEMA-REP-10 (1985)
- FEMA Technical Bulletin (Version 2.0) "Outdoor Warning Systems" (2006)
- NUREG-1022, Revision 3, "Event Report Guidelines 10 CFR 50.72 and 50.73 (2013)
- NEI 13-01, Revision 0, "Reportable Action Levels for Loss of Emergency Preparedness Capabilities"

Part V, Section B of the 2019 FEMA REP Program Manual discuss ANS design objectives. The minimum acceptable design objectives for coverage by an ANS – what the system must be able to do when speed is critical – include:

[1] This document is outdated, being replaced with Rev 2 in December 2019 One of the goals of Rev 2 of this document and of the December 2019 revision of the FEMA REP Program Manual was to not mention specific technologies (i e , sirens) in reference to ANS Nonetheless, Rev 1 of this document does include valuable guidance on outdoor warning sirens

- The capability to provide both an alert signal and an informational or instructional message to the population in the EPZ within 15 minutes.
- The initial notification system will ensure direct coverage of essentially 100 percent of the population within 5 miles of the NPP site.
- Notification methods will be established to ensure coverage within 45 minutes of essentially 100 percent of the population in the EPZ who may not have received the initial notification including any special requirement exceptions (e.g., large water areas with transient boats or remote hiking trails).
- The capability of the ANS to cover essentially 100 percent of the population within the EPZ, regardless of failures. The corrective means/measures will be conducted within a reasonable time, with a recommended goal of 45 minutes. The use of a sequential failure model or "primary and backup" ANS model is acceptable. Other models, such as simultaneous or concurrent activation models, could be used.

All of these criteria are met by the ANS system in the Arkansas Nuclear One (ANO) EPZ, as discussed in the sections below.

2 Requirements

2.1 System Coverage

2.1.1 Population

The ANO site is located near the Town of Russellville in southwestern Pope County, Arkansas. The EPZ is located entirely within the State of Arkansas and consists of portions of four counties – Johnson, Logan, Pope, and Yell Counties. Figure 1 shows the location of ANO as well as the approximate 10-mile EPZ.

The permanent resident population in the EPZ is 52,871 people according to the 2010 Census. Table 1 summarizes the permanent resident population and population density in the EPZ, by Zone, for the last two decennial censuses conducted by the U.S. Census Bureau. As the data indicate, population in the EPZ has increased since 2000, with an increase of +3.8% for the 2-mile radius of the plant, +12.8% for those Zones within the 5-mile radius, and +13.6% for the EPZ as a whole.

A common method for displaying population around a nuclear power plant is by sector. The EPZ is divided up into one-mile increments and the sixteen cardinal and inter-cardinal wind directions, for a total of 160 sectors. The 2010 EPZ permanent resident population, by sector, is shown in Figure 2.

The federal guidance, FEMA-REP-10, "Guide for the Evaluation of Alert and Notification Systems for Nuclear Power Plants," indicates that sirens are in compliance with federal guidance if they meet either of the following conditions:

- "The expected siren sound pressure level generally exceeds 70dBC where the population exceeds 2,000 persons per square mile and 60dBC in other inhabited areas; or
- The expected siren sound pressure level generally exceeds the average measured summer daytime ambient sound pressure levels by 10dB (geographical areas with less than 2,000 persons per square mile)."

FEMA CPG 1-17, "Outdoor Warning Systems Guide" indicates that people typically mentally block out sounds that are not pertinent to what they are doing. In order to break the mental block, a warning sound

must be about 9dBC greater than ambient noise to capture the attention of the listener. This is the basis of the conservative 10dBC above ambient noise guidance. Ambient noise levels were not measured in the ANO EPZ; thus, 60dBC and 70dBC will be used as the criteria for siren sound levels in this report, depending on the population density in a given area.

In order to determine whether 60dBC or 70dBC coverage is needed, population density was computed. There are many different methods for computing population density:

- Population density by radial distance – 2-mile radius, 5-mile radius, or the full approximate 10-mile EPZ
- Population density by county
- Population density by municipality

As shown in Table 2, these population densities differ significantly, underscoring the uneven distribution of population in the EPZ. Higher sound pressure levels are required in densely populated areas to overcome the higher ambient noise levels associated with a larger number of people and increased activity. Computing the population density by a large radial distance, or by county can distort population density by incorporating large land areas that are unpopulated or sparsely populated. This could result in the failure to adequately identify areas that need 70dBC coverage. For example, Table 2 indicates that the municipalities in the EPZ have population densities ranging from 211 to 1,303 people per square mile. However, when considering the population density for each county as a whole, it is considerably lower (ranging from 24 to 76 people per square mile).

The most refined method for computing population density is by census block. The U.S. Census Bureau divides the U.S. into census tracts. These census tracts are in turn divided into block groups, and block groups are comprised of multiple blocks. The census block is the finest level at which the U.S. Census Bureau aggregates detailed population data.

Census blocks vary in size from as small as a single city block to as large as an entire county. Given the variance in block size, there is the potential to have abnormally high population density for a block with a very small area. Similarly, a small neighborhood can have a population density exceeding 2,000 people per square mile but it may be the only community for miles. Assuming this neighborhood has 100 people living in an area of about 0.04 square miles (approximately 26 acres – 50 homes on ½ acre plots), the population density would exceed 2,000 people per square mile. However, if there are no surrounding neighborhoods, 100 people are not likely to generate enough background noise to warrant 70dBC coverage.

The last physical census in the United States was conducted in 2010 (the 2020 Census is ongoing, but data will not be released until March 31, 2021). Thus, the 2010 Census serves as the basis for all population estimates in this document. Each year in May, the U.S. Census Bureau releases projected populations for each state, county and municipality in the U.S. The latest available census population estimates, as of July 1, 2019, which were released in May 2020 (when this analysis documented in this report was started), from the U.S. Census Bureau were used to compute annual growth rates by county and municipality. These growth rates were then used to extrapolate the 2010 census population in the EPZ to 2020 at the

block level. For more information, please refer to the 2020 Evacuation Time Estimate (ETE) update[2] for ANO.

The following methodology was used to compute population density within the EPZ, by census block. Population block data was overlaid on the EPZ boundary using Geographic Information Systems (GIS) mapping software. The population density was computed by dividing the 2020 extrapolated population by the area of the block in square miles. Any block with a density exceeding 2,000 people per square mile was flagged (block color coded red) as high density as shown in Figure 3.

As discussed above, there is a possibility of isolated neighborhoods or extremely small census blocks being flagged with abnormally high population densities. While mathematically the population densities are correct, these anomalous census blocks do not represent densely populated areas that would have significant background noise warranting 70dB siren sound levels. Two steps were taken to remove these anomalous census blocks from the actual high population density areas:

1. A filter was applied which eliminates all flagged blocks that have a population less than 100 people or an area less than 0.02 square miles. This filter eliminates sparsely populated census blocks which are abnormally small and result in unrealistically high population densities. Figure 4 displays those blocks which are still flagged after applying this filter.
2. Each flagged census block with a population density exceeding 2,000 people per square mile was converted into a circle with an area of 1 square mile, centered at the center of the block. These 1 square mile circles were then overlaid with the census block data once again and the population density of the 1 square mile circle was recalculated. If the density exceeded 2,000 people per square mile, the block which the circle was centered at remained flagged as having a high population density. If the density of the circle fell below the threshold, the block the circle was centered at was removed from consideration. This filter eliminates isolated high population density neighborhoods that are surrounded by areas of low population density. Figure 5 shows an example of this filter applied to three census blocks in the EPZ. Both blocks shown in Step 1 are flagged as high population density blocks after applying Filter 1. However, when drawing the 1 square mile circles (Step 2.1) centered at the blocks, the population density (Step 2.2) is well below the 2,000 people per square mile threshold. As a result, both blocks are eliminated as high population density blocks (Step 2.3). Figure 6 shows the final blocks flagged as having population density exceeding 2,000 people per square mile in the EPZ after the two filters were applied.

2.1.2 Geographic Area

The ANO site is situated on a peninsula formed by Lake Dardanelle, which includes the Arkansas River and the former Illinois Bayou. The land within 5 miles of the plant is gently rolling and contains a number of ridge-valley configurations. The Arkansas River and Lake Dardanelle roughly bisect the ANO EPZ.

The meteorological information for each of the EPZ counties is described below.

Johnson County[3] is characterized by hot summers and cold winters, with an average high temperature of 90 degrees Fahrenheit (°F) in July and an average low temperature of 27°F in January. The average rainfall

[2] "Arkansas Nuclear One 2020 Population Update Analysis", KLD TR – 1167, dated September 19, 2020
[3] https://www.bestplaces.net/climate/county/arkansas/johnson

and snowfall in the county is 50 inches and 4 inches, respectively. The number of days with any measurable precipitation is 96. Johnson County is at an average elevation of 1,017 feet.

Logan County[4] is also characterized by hot summers and cold winters, with an average high temperature of 92°F in July and an average low temperature of 28°F in January. The average rainfall and snowfall in the county is 49 inches and 2 inches, respectively. The number of days with any measurable precipitation is 95. Logan County is at an average elevation of 678 feet.

Pope County[5] is also characterized by hot summers and cold winters, with an average high temperature of 91°F in July and an average low temperature of 28°F in January. The average rainfall and snowfall in the county is 50 inches and 4 inches, respectively. The number of days with any measurable precipitation is 101. Pope County is at an average elevation of 835 feet.

Yell County[6] is also characterized by hot summers and cold winters, with an average high temperature of 93°F in July and an average low temperature of 29°F in January. The average rainfall and snowfall in the county is 51 inches and 3 inches, respectively. The number of days with any measurable precipitation is 95. Yell County is at an average elevation of 626 feet.

Figure 1 identifies the municipal areas and major roads in the area, as well as the 15 Zones that comprise the approximate 10-mile EPZ. The Zones are color-coded based on the county they are in.

The National Oceanic and Atmospheric Administration (NOAA) commissioned a study[7] to summarize historical wind data from 1930 to 1996 in the United States. Wind data was aggregated for Fort Smith Regional Airport, which is the closest airport to ANO. The average wind speed at Fort Smith Regional Airport, based on the data gathered, ranges from a low of 6 miles per hour (mph) in July to a high of 8mph in January.

As shown in Figure 1 and listed in Table 2, there are 6 municipalities within the EPZ. Most of the municipalities are located adjacent to the Arkansas River and Lake Dardanelle. Beyond the population centers is sparsely populated rural farmland or undeveloped land.

The population centers in the ANO EPZ are connected by an extensive highway network. Interstate 40 and US Route 64 travel northwest-southeast through the EPZ. The major state highways servicing the EPZ include Arkansas State Routes 7, 22, 27, 28, 124, 164, 247, 315, 326, 331, 333 and 359. The primary railroads within the EPZ include Dardanelle and Russellville Railroad and Missouri Pacific Railroad .

2.1.3 Means

The physical means of alerting and notifying the public within the ANO 10-mile EPZ is the Emergency Warning System (EWS) that consists of a mixture of the Siren Warning System (SWS) and the NOAA Tone Alert System. The ANS is essentially designed to notify the individuals in the 10-mile EPZ within 15 minutes of the issuance of recommendations by the State of Arkansas for radiological emergencies at ANO. Local fire departments in the EPZ and route alerting are used as the backup method to alert the public to receive instructions, information, and necessary actions to be taken.

[4] https //www bestplaces net/climate/county/arkansas/logan
[5] https://www bestplaces net/climate/county/arkansas/pope
[6] https //www bestplaces net/climate/county/arkansas/yell
[7] https://www ncdc noaa gov/sites/default/files/attachments/wind1996.pdf

2.1.4 Primary Methods

The primary ANS for ANO is the EWS as discussed above. The SWS is used to alert the more densely populated areas shown in Figure 7. Based on the population estimates discussed in Section 2.1.1, the SWS covers 92.6% of the population within the EPZ at 60dBC or higher. Those residents of the 10-mile EPZ who live outside the siren coverage area or who have special needs are alerted by NOAA Tone Alert Radios (TAR). NOAA TARs are also provided to the facilities within the 10-mile EPZ with significant population. These individuals and facilities are further discussed in Section 2.2.

The SWS relies on 50 Whelen omni-directional electronic sirens (21 WPS2807 sirens and 29 WPS2907 sirens). Of the 50 sirens, there are 2 sirens in Johnson County, 3 sirens in Logan County, 33 sirens in Pope County and 12 sirens in Yell County. All sirens are mounted at pole top, approximately 50 feet above the ground. The location, height and ID for each siren are presented in Table 3.

All of the sirens are radio-controlled and a DTMF (Dual Tone Multiple Frequency) encoder is required for activation. Sirens include a National Nuclear Attack signal that insists of an up-and-down scale tone. This three-minute continuous tone signal will be used to alert the populace to tune into NOAA TARs and local radio stations for emergency information (primary notification). Sirens also include a warning signal. This signal is used to alert the populace of not only a radiological incident, but also of natural disasters, especially tornado warnings.

The Arkansas Department of Health (ADH) maintains a database of addresses that are outside of the 60dBC siren coverage area. Each year a letter is sent to those addresses to verify if they have a NOAA TAR and if it is functioning. If they do not have a TAR or if the TAR is not functioning, they can request that ADH provide a TAR. The ADH also mails batteries to the TAR holders annually.

The NOAA Tone Alert System is operated in cooperation with the National Weather Service (NWS). When activated, a loud tone is emitted from the radio to alert the user. Following activation of the receivers, live or pre-recorded emergency messages are broadcast to instruct/notify the public. Section 3.1 below provides additional details of the EWS.

2.1.5 Backup Methods

Supplemental notification to the EPZ population is provided by local fire departments in the EPZ. In the event of siren or NOAA Tone Alert System failures, route alerting is implemented in the affected fire district(s) using truck sirens and Public Address (PA) systems for notification of residents around the failed or inoperable siren(s). The truck sirens serve as the backup alert method, while the announcements being made over the PA system serve as the backup notification method.

2.2 Population/Demographics

In addition to the permanent resident population detailed in Section 2.1.1, there are transients who may be visiting the EPZ for recreational purposes. Those people who live and recreate in the EPZ have already been considered as permanent residents to avoid double counting population.

According to the latest ETE study done for ANO (KLD TR-517, "Arkansas Nuclear One – Development of Evacuation Time Estimates," Rev. 1, dated December 2012), there could be as many as 11,745 transients in the EPZ at peak times. The transient estimate is based on data provided by county emergency management agencies.

There are 69 special facilities identified in the EPZ. These facilities include schools, universities, parks, campgrounds, golf courses, marinas, recreational areas, lodging facilities, major employers, medical facilities, and correctional facilities. The EWS is capable of alerting and notifying each of these special facilities. Nonetheless, the State has plans in place to notify each of these facilities individually as discussed below.

As per the Arkansas Comprehensive Emergency Management Plan (ARCEMP), Rev. 39, dated September 30, 2019, the State Department of Parks and Tourism will provide notification of the public within the park system; the State Game and Fish Commission and State Forestry Division will provide backup communications and personnel for notification purposes in remote forest areas, and on rivers and lakes; the ADH repeater system will alert the emergency response agencies and schools within the 10-mile EPZ through the Early Notification System (ENS) component of the EWS; and information contained in the Emergency Instruction Booklet[8] (EIB) is posted and/or placed in public locations within the 10-mile EPZ such as public buildings, state and national parks, recreational areas, tourist information centers and rest areas located on major highways, which are routinely visited by transient populations. Postings will be checked periodically and updated as needed. In addition, letters of agreement formalizing the emergency notification interfaces between Entergy and Arkansas Tech University in Russellville are kept on file in Entergy's offices.

None of the areas discussed above are considered exception areas. They can all be alerted and notified in a timely fashion.

Special provisions have been developed by ADH Nuclear Planning & Response Program (NP&RP) and Entergy for the alerting of identified handicapped individuals. A postage-prepaid, detachable postcard is provided in the annual mailing of the EIB for use by persons who may have special needs. This form is to be completed and then mailed to the ADH NP&RP office, and the information is subsequently provided to the appropriate local government. The individuals with special needs, depending upon their handicap, are notified appropriately. The notification may include door-to-door notification by law enforcement officers, neighbors, telephones, or tone activated NOAA TARs. Persons who are hearing impaired, or who require special notification are provided NOAA TARs free of charge. These receivers are also made available to the large businesses, hospitals, nursing homes, schools, day reception centers, and other applicable groups within the 10-mile EPZ.

According to American Community Survey 2014 – 2018 data[9], the percent of non-English speakers within the EPZ is approximately 0.56%. Given the small size of non-English speaking population, English is the only language used for notification.

2.3 Interoperability

The SWS is divided into 5 siren activation zones of relatively higher population density covering parts of the 10-mile EPZ, specifically: Yell County (1Z as Zone 1), the Russellville/Dover area and the Village of London in Pope County (2Z and 3Z), Johnson County (4Z), and Logan County (5Z). Each of these zones can be activated independently or in conjunction with other zones. All zones would be activated in the event of emergency at the ANO site.

[8] https://www.healthy.arkansas.gov/images/uploads/pdf/AR_NucOne20_ENGweb.pdf
[9] Additional details about language spoken at home can be found at the following website
https://factfinder.census.gov/faces/affhelp/jsf/pages/metadata.xhtml?lang=en&type=table&id=table.en.ACS_17_5YR_B16004

The ADH has the sole ability to activate the SWS. There are three activation points – one primary and two backup points, as discussed in Section 3.1.3 and Section 3.3.1. The locations of the activation points are outlined in Table 4. All the activation points have backup power and two independent paths for activation signals to reach the sites. The SWS is activated by radio signal in the UHF (Ultra High Frequency) band which is transmitted by the primary/backup siren radio transmitter. The architecture of the SWS activation is discussed in detail in Section 3.1.3. The SWS activation is also made available to local governments for use in severe weather and other emergencies. Authorized officials may request siren activation for various zones in their jurisdictions.

The sirens are battery operated and are powered by four high capacity batteries. Battery charge is maintained by AC power through "smart" chargers to avoid overcharging. Sirens, depending on use, can keep operating up to 10 days without AC power. The ADH has mobile generator units that can be used in the event an AC power outage exceeds that length of time.

The NOAA TARs are activated by the NWS through a 300-watt transmitter with a 300-watt backup transmitter. The NWS is contacted by the ADH staff and informed of the intent to activate the EWS. The NWS is notified in advance of the sirens being activated such that, in conjunction with the siren activation, the NWS activates the NOAA tone which automatically turns the receivers on.

2.4 Operations

ANO maintains the capabilities to assess, classify, and declare an emergency condition within 15 minutes of the availability of indications to plant operators that an emergency action level has been exceeded. Emergency personnel are trained to promptly declare the emergency condition as soon as possible following identification of the appropriate emergency classification level. There are four emergency classification levels – Notification of Unusual Event, Alert, Site Area Emergency and General Emergency. The EWS within the 10-mile EPZ might be activated by ADH for a Site Area Emergency and will be activated for a General Emergency.

The final decisions to alert and notify the public by the EWS are the decisions of governmental officials. Initial notification is made to the state and local authorities within 15 minutes after declaring an emergency. An Emergency Action Authenticator is used to verify messages that are received over a non-secure system, such as commercial telephone system. The NRC is notified immediately following notification of state and local authorities and within 1 hour of the declared emergency.

The EWS can be fully activated from the ADH Emergency Communication Center (ECC), the alternate State Emergency Operations Facility (SEOF) or the ADH NP&RP office. Anytime the SWS is to be activated to notify the public, ADH NP&RP will take over operation of radio station KXRJ, 91.9 FM at Arkansas Tech University. ADH NP&RP has the capability to remotely take over broadcast of this station and provide the public with any emergency communications or protective actions that might become necessary. The detailed activation process is included in Appendix B.

2.5 Management/Administration

It is the responsibility of ADH to manage and oversee the EWS network. The NOAA radio program is administrated by ADH NP&RP and operated by NWS. The NWS is responsible for managing the weather radio transmitters nationwide.

2.6 Security and Privacy

2.6.1 Physical Security

All siren batteries and control boxes are pad locked and mounted on the siren pole to prevent tampering, and both AC and battery voltage can be monitored remotely. The siren activation equipment is installed at secure locations that are manned 24 hours per day. Entry into all activation points is limited to authorized personnel only. Additionally, all activation consoles are equipped with a physical keyed lock to prevent access to the activation keys.

2.6.2 Logical Security

To prevent cyber-attack, the actual activation of the EWS is accomplished by use of a DTMF encoder requiring key-lock activation. Details of either activation procedure are limited to a "Need-to-Know" basis for security reasons.

2.7 Maintenance/Repair

2.7.1 Preventative Maintenance

It is the responsibility of ADH NP&RP to perform the Preventive Maintenance (PM) on the SWS. On a quarterly basis, the PM is performed following the instructions listed in the ANO SWS Maintenance Plan (see Appendix C). During the scheduled PM, each siren may experience brief periods when it is not able to sound, but it is not taken out of service for more than a few minutes and could be returned to service immediately, if needed. As noted in the maintenance plan, a wide variety of inspections are performed at each siren site including verification that there is no vegetation growth that can obstruct sound propagation near the siren head; visual inspection of the pole, the antenna, the siren head, the cabinet and associated connections; verifying acceptable condition of the batteries and chargers; and running a silent test. In addition, the ADH performs the maintenance with contractor assisted items, such as crane rental for upper driver maintenance.

The ADH NP&RP also checks the operation of the control points and transceivers associated with the activation system on a routine basis. The operability of key components, for instance, is verified every weekday. Additionally, a contractor is used to measure the transceiver perimeters.

The ADH NP&RP mails information annually to every address within the 10-mile EPZ to provide the contact information for the request of the NOAA TARs. On a monthly basis, the ADH mails letters to the new residents within the 10-mile EPZ to notify them of the same information. Recipients of the NOAA TARs are tracked in a master database by the NP&RP staff as discussed in Section 2.1.4. Needed repair and/or replacement of the receivers identified as defective is also carried out by the NP&RP staff. All the holders of the NOAA TARs receive new batteries and instructions from the ADH annually.

2.7.2 Corrective Maintenance

Upon notification of a siren malfunction, the ADH determines if the failure(s) is reportable in accordance with 10CFR 50.72, and the noted siren malfunction is immediately serviced by an ADH NP&RP Electronics Technician and every attempt is made to return the unit to operation. If the siren is unavailable, the appropriate county is notified that the backup alert method – route alerting – will be required in the affected area until the unit is returned to service.

A siren that did not fully respond to the activation command signal during a valid test is considered as an activation failure and would not have provided adequate public alert. It would be reported as a siren

failure to FEMA and to ANO Emergency Planning (EP) personnel. A siren is considered out of service when it cannot receive, process, or sound the appropriate audible warning tone through the driver section.

When determination has been made that a SWS component is not responding appropriately to polling, such as low battery, AC voltage or related issues; or reports or concerns from the public indicating siren abnormal behavior, an on-site inspection and repair will be performed by an ADH NP&RP Electronics Technician. The Electronics Technician will follow the guidelines recommended in the manufacturer's operating and troubleshooting manuals (see Appendix D) to restore component functionality. The Electronics Technicians also meet routinely with the ADH Section Chief to identify any maintenance and/or performance trends. Trends are noted and corrective actions are implemented, if needed.

In addition, the ADH tests the siren control transmitters and consoles every weekday morning, when the state offices are open. If a problem is identified, the corresponding corrective action is immediately undertaken. The use of redundant transmitters and activation points minimizes the risk of a failure of the activation system.

2.8 Availability/Reliability

Appendix 4 of FEMA REP-10 specifies that the operability of a siren system is considered acceptable "when an average of 90% of the sirens (as determined by a simple average of all regularly conducted tests) can be demonstrated functional over the 12-month period immediately preceding the submittal of the design report."

The Nuclear Energy Institute (NEI) Regulatory Assessment Performance Indicator Guideline, NEI 99-02 Revision 7, specifies a minimum performance indicator threshold of 94% for ANS Reliability during the previous four quarters for plants operating in the normal regulatory response band.

The ANO SWS reliability data is reported to FEMA for review on a quarterly basis. According to the ADH, the ANO siren system has been operational since 1981. A review was completed over the past 10 years and it was determined that the successful siren performance has not dropped below 99% during that time. Table 5 shows the results of siren tests at ANO for the last 4 quarters. As shown, the siren performance in each quarter of 2019 was 100%.

2.9 Testing

The EWS is tested by ADH and NWS periodically to ensure its readiness. The testing includes functionality of sirens and of NOAA TARs.

The entire SWS is sounded weekly to reinforce public awareness of the system. This is not a silent or growl test, but either a 15-second or 1-minute audible test each Wednesday at 12:00 pm. Testing will not be performed if severe weather is present in the area or the state offices are closed. Under a verbal agreement with FEMA, the 1-minute audible test is performed on the 4th Wednesday of the month. The operation of each siren is verified once per month and the results are reported to FEMA. Due to the fact that the weekly audible test far exceeds the annual federal operability requirement, other types of audible tests are not conducted at the ANO.

In addition to the weekly audible test, sirens are polled for health maintenance at least once per month. The health of siren batteries is assessed by the ADH NP&RP Electronics Technician on a quarterly basis (see Section 2.7.1). Batteries are replaced at a frequency that exceeds the battery manufacturer's recommendations. The siren activation equipment is tested frequently (see Section 2.7.2). Special

observations may be conducted in the event of severe weather or high winds which might result in physical damage, such as identifying loose feed lines or pole damage. If any issues are identified during these observations, repairs will be undertaken using the ANO SWS Maintenance Plan in Appendix C.

The NOAA TAR activation is tested by the NWS and monitored by ADH NP&RP. The testing is performed each Wednesday between 11:00 am and 12:00 pm. If inclement weather persists, the testing will be performed the next clear day.

The current testing conducted by ADH exceeds the annual maintenance recommended by the NRC. This includes actions specifically designed for the ANO EWS. The testing records are kept in the ADH NP&RP office.

2.10 Responsibility

It is the responsibility of ADH NP&RP to perform or supervise maintenance on the entire EWS network (except for the NOAA radio system and local broadcast stations and radios) and to ensure that it is functioning properly. In general, the electronic component control and radio parts are maintained and repaired by ADH. The items requiring the use of a crane or other specialized equipment are maintained and repaired by contractors. The NOAA radio system is tested by the NWS and monitored by ADH NP&RP and by ANO EP personnel (see Section 2.9 and Section 4.3). A local contractor is responsible for maintenance and repair of the NOAA weather radio transmitters.

2.11 Training

It is the responsibilities of ADH NP&RP to identify organizations with a need for training and provide training and refresher training on a continuing basis. Refresher training shall be made available to emergency personnel at least annually. At a minimum, these emergency workers will have attended the FEMA REP Planning course. The training required for emergency personnel is discussed in Section 7.

2.12 Quality Assurance

The ADH maintains several procedures pertaining to the ANS, including procedures on activation, testing, maintenance, repair and reportability. These procedures are included in Appendices B and C. The records regarding the SWS testing and maintenance are maintained by ADH and routinely reviewed by ANO. Copies of the quarterly reports detailing siren system performance are also provided to ANO. Additionally, the ANO is provided the results of activation verification on a monthly basis.

In addition to these procedures above, the EWS is tested on a weekly basis as discussed in Section 2.9. Hence, the essential elements of the SWS activation are "practiced" weekly. These extensive exercises help to reduce errors during the operation.

The NOAA weather radio test data is not reported as the weekly test is not guaranteed due to the weather conditions. The records of the NOAA radio system performance are not maintained as it is outside ADH's area of responsibility. However, the ADH notifies the NWS of service interruptions monitored (see Section 4.3) and provides assistance in resolving problems. As noted in Section 2.10, a local contractor is responsible for the maintenance and repair of the NOAA weather radio transmitters.

3 Description/Performance

3.1 Physical requirements

3.1.1 System Components

As discussed in Section 2.1.4, the siren system is comprised of 50 omni-directional electronic sirens. Figure 8 maps the sirens in the EPZ. The sirens are labeled with their identification number and are symbolized by siren model type. Table 3 lists each of the 50 sirens in the ANO EPZ. The table includes the siren identification number, the latitude and longitude of the siren, the siren model, the mounted height of the siren and location description.

WPS2807 and WPS2907 sirens can produce approximately 115.1dBC and 115.5dBC, respectively, at 100 feet along their centerline with operating frequencies between 500 and 630 Hz, based on the results of the near-field tests discussed in Section 4.1.

A WPS2807 or WPS2907 siren consists of a power supply (batteries), a control board, seven 400-watt audio drivers, seven audio amplifiers, and a radio transceiver for reception of control signals. The batteries, control board, amplifiers and transceiver are located in a sealed and locked enclosure. The siren drivers are pole mounted at approximately 50 feet above the ground. All sirens have multiple ground points and surge protection, including antenna feed lines.

Over the past 30 years, the ADH has issued numerous NOAA TARs of various models and manufacturers. Nevertheless, all the radio receivers must respond to the 1050 Hz alert tone and feature an audible warning. The ADH also provides models with a visual signal to alert deaf or hearing-impaired individuals. The NOAA TAR have a battery backup feature which allows the user to install batteries, such that the radio will work during a power outage. New batteries are issued annually to each of the NOAA TAR holders as discussed in Section 2.1.4 and Section 2.7.1.

3.1.2 User Interfaces

The WPS2800 and WPS2900 series sirens can be remotely activated by using an encoder and siren radio transmitter. The logical connection between the siren control components is further discussed in Section 3.1.3. The NOAA TARs are activated by a primary 300-watt transmitter. A secondary 300-watt backup transmitter would be used following a failure of the primary transmitter. Both primary and secondary backup transmitter sites are located on Mount Nebo, which is approximately 6 miles SSW of the ANO site. Entergy has provided backup generator capability for the transmitter site. Hot standby switching for auto-start of the backup transmitter and a backup generator with auto-start capability is also available and tested frequently.

3.1.3 Functional Block Diagrams

Figure 9 shows the logical connection of the components of the siren control system. As shown in the diagram, there are three different locations that can communicate with the primary and backup siren radio transmitters which in turn communicate with the siren sites via a utility microwave link or a leased line which is a circuit rented from a public carrier – AT&T in this case. The ADH Mobile Command Post can communicate with the primary and backup radio transmitters via radio line. The primary/backup siren radio transmitters activate sirens by UHF-FM radio signal. Section 2.3 further discusses the physical connections of the system and the interoperability.

3.2 Administrative Components

3.2.1 Organizational Responsibilities

The ADH ECC is the official 24-hours-per-day point of contact between the State and ANO for the initial notification of a radiological incident. In the event of an emergency, the operator of ANO is responsible for notifying the ADH ECC, Arkansas Department of Emergency Management (ADEM), and the warning points in Conway, Johnson, Logan, Pope and Yell Counties. The final decisions to alert and notify the public by the EWS are the decisions of governmental officials.

The responsibilities of ADH NP&RP include off-site emergency planning and response to emergencies involving ANO; the development and update of emergency response plans; the maintenance and operation of the EWS and the communication system used to notify state agencies and local governments of emergencies; the maintenance of equipment and supplies necessary to support emergency operations for state and local agencies; the development and training of emergency personnel who would respond to an emergency; and the distribution of emergency instructions to the public.

The primary means of notification and communication between ANO and the state and local governments will be via the ANO Dedicated Emergency Facsimile/Voice System (DEF/VS). In the event that the ANO DEF/VS is not operating properly, the operator of ANO will notify the ADH ECC directly by commercial telefax or by commercial telephone; and ADH, in turn, will notify the county warning points and ADEM using various means, such as the DEF/VS, ENS radio, ADEM radio, and/or commercial telephone. If both communication procedures outlined above fail, the operator of ANO will use commercial telephone to notify the ADEM which will, in turn, notify the ADH ECC. The communications link between the state and federal emergency response organizations is via the commercial telephone system, with the National Warning System (NAWAS) serving as the backup system.

3.2.2 Management

As noted in Section 2.6, the activation consoles are key locked and kept at secure locations to prevent the inadvertent systemwide activation, and the siren control system is configured in such a way that a systemwide inadvertent activation is very unlikely to occur. There are limited failure paths which will result in an inadvertent activation, such as included high voltage that shorts a control cable. In the event of an inadvertent siren activation, the ADH sends the notification to area broadcast stations and to appropriate 911 Centers to assure the public there is no emergency involving ANO. In an emergency involving ANO, this responsibility falls on which of the State's centers have "Command and Control". For other situations, it depends on the time of day. After hours notification falls to the ADH ECC if the radiological emergency response team is not activated.

If siren(s) are inadvertently sounded, the cancellation tones are not automatically sent to the siren(s) due to the time factor. In most cases, reports of spurious siren sounding come in the form of calls from the public to the appropriate 911 Center which then notifies the ADH. It is noted that the sirens in Arkansas are hard coded to sound for 3 minutes before shutting off. As such, the siren has most likely "timed out" when the incident is reported. When the ADH receives a report of inadvertent siren sounding, the first step is to gather the information of the inadvertent sounding reported, including the number of calls received, the generation location of the sound reported, the caller names and call back numbers. The ADH then will verify the existence of a siren in the reported activation area. If a siren is identified in the reported area, a repair technician will visit the site to ascertain the status of the siren, and attempt to determine if

there was an actual activation or if there were other noise sources that imitate a siren. Most reported siren sounds are in fact from other sources, for instance, emergency vehicle sirens.

3.3 Operational Components

3.3.1 Activation

As discussed previously in Section 2.3, the SWS is activated by ADH through the primary or secondary activation points. As shown in Table 4, the primary activation point for the SWS is located at the ADH ECC office that is manned 24 hours per day to accommodate day or night activation. One secondary activation point for the SWS is located in the SEOF which is co-located at the ANO site; another secondary activation point is located in the ADH NP&RP office. All the activation points have the ability to activate the entire SWS, but for events where ANO is not involved, such as severe weather, activation is usually conducted by ADH ECC or by ADH NP&RP.

The NWS is notified by the ADH staff in advance of the sirens being activated. The NWS in turn utilizes the primary/backup weather radio transmitter to transmit the NOAA tone which automatically turns the receivers on. Both primary and secondary backup transmitter sites are located on Mount Nebo, which is approximately 6 miles SSW of the ANO site.

3.3.2 Timing

According to ADH, when an emergency is declared at ANO, the ANO operator must notify state officials within 15 minutes. State officials can then notify the public of an emergency within 15 minutes by use of the EWS. The EWS activation will be conducted with a sense of urgency without undue delay. The sirens activate within seconds of the signal being sent from the controller. The NOAA tone is activated in conjunction with the siren activation. The backup method – route alerting – is capable of alerting and notifying the 10-mile EPZ population within 45 minutes (see Section 4.3 and Section 5).

There are no exception areas (rural, low population areas) in the EPZ that would require additional time to be alerted and notified.

3.3.3 Geo-Targeting

Individual sirens within the siren system can be activated to pinpoint a geographic location for alerts; however, this is not part of the standard alert procedure. NOAA radios cannot be individually sounded.

4 Verification

4.1 Coverage

ANO recently conducted an extensive acoustical study of the siren system, including detailed acoustical modeling and field testing of siren sound levels. The results of this study are summarized below.

Section 2.0 of FEMA Technical Bulletin (Version 2.0) "Outdoor Warning Systems" dated January 12, 2006 provides an extensive discussion of sound propagation. Below are some key points on sound taken from this guidance document:

- Sound travels in waves
- Sound decreases in loudness at greater distances from its source
- Refraction: Sound waves can refract or bend with differences in temperature and wind speed. The specific heat of the ground is higher than that of the air above it. Thus, during the day, the ground

is warm and temperature decreases as you move higher above the ground. This difference in temperature impacts the speed of sound waves as shown in Figure 10. The resulting shadow zone causes the audible level of the siren to be lower at the ground. The opposite happens in the evening when the ground releases its heat to the atmosphere resulting in higher temperatures the farther you get from the ground, as shown in Figure 11. This explains why sounds from the same source are louder at night than they are in the daytime.

- Ground Absorption: Soft ground such as grass covered soil or dense foliage can cause significant absorption of sound, thereby reducing perceived loudness of sound. Hard surfaces such as concrete, ice, or water can cause sound waves to reflect upwards and be perceived as louder as shown in Figure 12.
- Wind: Wind speed either adds or subtracts to the velocity of sound waves depending on whether the sound is moving upwind or downwind, resulting in refraction of sound waves. Wind speed also increases with height above the ground causing further refraction. The additive refraction of these two phenomena can result in a significant acoustical shadow zone in the upwind direction as shown in Figure 13.
- Diffraction: Sound waves can also be diffracted (bent upward or downward) by objects (buildings, trees) in the path between the source and the listener resulting in lower perceived loudness.

Figure 14 shows multiple potential factors that could impact the sound heard by a receiver from a source.

One way to deal with the complications that can impact the audible level of outdoor sirens is to use a sophisticated acoustic model that accounts for terrain and atmospheric conditions. Such a model, SoundPLAN, was used to predict the siren coverage in the ANO EPZ. The SoundPLAN software is a state-of-the-art acoustic model written by SoundPLAN, LLC (a German company) and distributed in the U.S. by Navcon Engineering Network in California. This software has been used to model the siren coverage for more than a dozen U.S. nuclear plants, including the Diablo Canyon Power Plant in California, which has one of the most difficult terrains of any U.S. plant in terms of siren coverage.

Modeling Inputs and Assumptions

The following inputs/assumptions were used in the acoustic modeling:

- Digital elevation data was provided by the United States Geological Survey (USGS) National Map Viewer[10]. A standard DEM[11] was downloaded with a resolution of 1/3 arc-second, which is an approximate grid spacing of 10 meters. This is more than adequate to model the terrain in the EPZ.
- Major bodies of water including the Arkansas River, Illinois Bayou and Lake Dardanelle were explicitly modeled in the analysis using GIS mapping software.
- Ground surface absorption was explicitly modeled. The software default value for ground surface absorption is 1 for all soft grounds such as fields or other grassy areas, and forests. The ground surface value was changed to 0 for major bodies of water to accurately depict the reflective properties of the hard surface.
- The siren locations and model type documented in Table 3 were input to the model.

[10] http://viewer.nationalmap.gov/basic/
[11] http://nationalmap.gov/3DEP/3dep_prodserv.html

- Acoustical tests were conducted on June 23 and June 24, 2020 to measure the sound levels output by sirens. The tests included seven near-field tests in accordance with ANSI S12.14, wherein a sound meter was aimed at the center of the siren horns from a bucket truck parallel with the siren horns at a distance of 100 feet. In addition to the near-field tests, far-field tests were conducted with siren meters on the ground at varying distances form the siren pole. Five WPS2907 sirens and two WPS2807 sirens were tested. Figure 15 presents the locations of the near-field and far-field test locations. The tests were conducted by acoustical expert – Dr. Bruce Ikelheimer – using Larson Davis Model 831 sound level meters – and were supervised by the ADH and Entergy personnel. Weather conditions during the tests were good, with low winds and no precipitation. The test results were analyzed and reported by Dr. Bruce Ikelheimer (see Appendix E). The results of the near-field tests are summarized in Table 6. Based on the overall average results, sound levels of 115.1dBC and 115.5dBC are adopted for WPS2807 and WPS2907 siren models, respectively. The ANSI S12.14 test sheets for the seven near-field tests which provide additional details on the test are included in Appendix E.
- The acoustical standard International Organization for Standardization (ISO) 9613-2[12] was used. ISO-9613-2 is a widely used standard for sound modeling and is accurate at predicting total coverage areas at extended distances from the source.
- The average daytime temperature, pressure and humidity were used to account for atmospheric conditions. These data were estimated as the 3-month average of June, July and August of 2019. The historical weather data was obtained from the Weather Underground website[13]. The location used was Hot Springs, which is located approximately 55 miles southeast of ANO. The atmospheric conditions used were:
    - Average temperature = 79.8°F (26.5°C)
    - Average relative humidity = 77.2%
    - Average air pressure = 29.4 inHg (995.2mbar)

As discussed in Section 3.1.2, the NOAA TARs are activated by the primary/secondary weather radio transmitter located in Mount Nebo. As per the latest county radiological emergency response plans, the NOAA weather radio primary/backup transmitter at Mount Nebo covers the following counties – Conway, Johnson, Perry, Pope and Yell. This has provided adequate coverage to the radio receivers within the 10-mile EPZ.

4.2 Population/Demographics

Based on the population density analysis using the 2020 population projections (see Section 2.1.1), the overall population density in the ANO EPZ is low. Only parts of Russellville have a population density exceeding 2,000 persons per square mile, as shown in Figure 6. As discussed in Section 2.1.1, federal guidance recommends siren coverage of at least 70dBC in areas where the population density exceeds 2,000 people per square mile, and 60dBC in all other areas. Also, as discussed in Section 1, the ANS should provide direct coverage of essentially 100 percent of the population within 5 miles of the NPP site.

Figure 7 maps the predicted siren coverage for the ANO EPZ output by the SoundPLAN software based on the inputs and assumptions discussed above. The map shows the 60dB and 70dB contours, as well as the high population density areas discussed in Section 2.1.1.

[12] https://www.iso.org/standard/20649.html
[13] https://www.wunderground.com/

As shown in the map, the 60dBC coverage covers the majority of the 10-mile EPZ. All the high population density areas flagged red in Figure 7 have adequate 70dB coverage. As discussed in Section 2.1.4, the ADH maintains a database of addresses that are outside the 60dBC siren coverage area. Letters are sent to those addresses annually to ensure NOAA TARs are available to those addresses to ensure completed coverage of the EPZ by the EWS.

4.3 Metrics

Sound levels during siren activation were measured in many locations as discussed in Section 4.1 and shown in Figure 15. These sound level measurements were used to calibrate the acoustical model and predict 60dBC and 70dBC of the siren system in the EPZ.

As discussed in Section 4.1, the NOAA TAR receivers within the 10-mile EPZ are fully covered by the NOAA weather radio primary/backup transmitter at Mount Nebo. According to the ADH, the NOAA radio signal strength has not been reported as an issue by any NOAA TAR holders. As discussed in Section 2.5, the NOAA radio program is operated by the NWS and administrated by the ADH NP&RP staff. The ADH retains several radio receivers in the ADH NP&RP office for constant monitoring. The NOAA radio system is also monitored by ANO EP personnel.

As per federal guidance, the primary ANS means should be capable of alerting and notifying the EPZ population within 15 minutes, and the backup means should be capable of alerting and notifying the EPZ population within 45 minutes. According to the ADH, the time for the EWS (primary method) activation and route alerting (backup method) process has been evaluated by FEMA several times during the bi-annual evaluated exercises, and the timeline has been acceptable. The time for actual physical activation of the ENS by pushing the button is a matter of seconds.

5 Availability/Reliability

As discussed in Section 2.12, the ADH maintains several procedures to provide detailed information of performing testing, maintenance, and record keeping for system maintenance/repair activities. The system testing, maintenance and siren malfunctions have been discussed in detail in Section 2.7 and in Section 2.9. Appendices B and C details the Quality Assurance procedures that are in place which have resulted in a 100% reliability score for the ANS in 2019 and reliability scores in excess of 99% for the past decade (see Section 2.8). The inadvertent activation of the SWS and the actions taken thereafter are discussed in Section 3.2.2.

As discussed in Section 4.3, the ability to meet the minimum activation time of 15 minutes has been successfully demonstrated in the bi-annual evaluated exercises, including the latest one on July 17, 2018. The evaluation details are reported in the After-Action Report/Improvement Plan published by FEMA.

6 Security and Privacy

The applications used to activate the SWS can only be accessed by authorized personnel with unique user IDs and passwords. Section 2.6 provides additional detail on the physical and cyber security of the ANS.

7 Training and Public Outreach

The ADH NP&RP is responsible for arranging the initial and continuing training for all staff members who are assigned to the ANO radiological emergency planning effort. The elements of training required for emergency personnel include the review of emergency classification levels, protective action advisories, methods of notification, notification procedures, procedures for dissemination of public information during a nuclear generating plant emergency, emergency notification forms, emergency staff positions and responsibilities, facility set-up, layout and equipment.

The public is instructed by the EIB to tune to NOAA TARs and local radio stations for emergency instructions when the sirens are activated. The local radio stations have the capability to broadcast emergency messages on a 24-hour basis to the general public. The EIB is available in both English and Spanish and can be accessed through the ADH website[14]. The booklet also includes contact information for emergency planning agencies should additional information on alert and notification or other emergency planning issues be needed.

In addition to the EIB, emergency information regarding notification procedures and those steps that should be taken in an emergency is included in the official telephone directory distributed within the 10-mile EPZ and is updated annually. Education and informational programs are offered annually to area civic and service organizations, including public and private schools. These programs include information on the EWS, evacuation routes, and designated care centers. An annual media workshop is conducted by ADH NP&RP to provide pre-incident information to the representatives of the Arkansas news media. The workshop provides information on notification, evacuation and planning efforts. The ADH NP&RP will also provide the news media with periodic releases containing information on any changes in notification, evacuation or planning efforts.

[14] https://www.healthy.arkansas.gov/programs-services/topics/nuclear-planning-and-response

Table 1. EPZ Population by Decennial Census

Zone	2000 Population	2010 Population	2000 Population Density (people per sq. mi)	2010 Population Density (people per sq. mi)
G	1,278	1,327	58	60
Total for Zones intersecting 2-mile Radius:	1,278	1,327	58	60
H	12,861	14,653	899	1,024
K	1,798	2,185	80	97
N	492	579	53	62
O	146	141	72	70
R	502	431	27	24
U	1,277	1,387	80	87
Total for Zones intersecting 5-mile Radius:	18,354	20,703	176	198
I	10,618	12,262	541	625
J	4,426	5,445	232	285
L	4,074	4,484	175	192
M	763	936	21	25
P	1,931	2,022	80	84
Q	398	464	12	14
S	1,739	2,133	47	58
T	4,228	4,422	1,371	1,434
EPZ TOTAL:	**46,531**	**52,871**	**155**	**176**

Table 2. Population Density Computed using Different Geographic Areas

Geographic Area	2010 Population	Area (sq. mi)	Population Density (people per sq. mi)
Radial Distance			
2-mile	1,003	12.57	80
5-mile	11,553	78.54	147
10-mile	52,869	314.16	168
Full EPZ	52,871	300.97	176
County			
Johnson	25,540	659.80	39
Logan	22,361	708.13	32
Pope	61,754	812.55	76
Yell	22,185	929.98	24
Municipality			
Dardanelle	4,747	3.64	1,303
Dover	1,379	2.83	488
Knoxville	733	3.19	230
London	1,040	3.18	327
Pottsville	2,783	13.19	211
Russellville	28,113	28.37	991

Table 3. Siren Details for the ANO EPZ

Siren ID #	Description from ADH	Siren Model	Location	Latitude	Longitude	Zone	County	Mounting Pole Height (m)
1Z1	1001 Whelen 29	WPS2907	Corner of Front St. and Market St.	35.21924	-93.15294	T	Yell	15.2
1Z2	1002 Whelen 28	WPS2807	Intersection of Hwy 28 and Arcadia Rd. Approx. 100 yds down Arcadia Rd.	35.18017	-93.18961	S	Yell	15.2
1Z3	1003 Whelen 28	WPS2807	1.9 miles south of Hwy 7 and Hwy 27 intersection on south side of Hwy 27.	35.21265	-93.19426	S	Yell	15.2
1Z4	1004 Whelen 28	WPS2807	3.7 miles south of Hwy 27 intersection on Hwy 27 north side of Hwy	35.19644	-93.21616	S	Yell	15.2
1Z5	1005 Whelen 29	WPS2907	Just off Hwy 27 at the intersection of Alpha Rd. (CR 40 and Hwy 27)	35.18037	-93.25319	S	Yell	15.2
1Z6	1006 Whelen 29	WPS2907	South side of Hwy 155, 2.6 miles west of intersection with Hwy 22.	35.22657	-93.21175	S	Yell	15.2
1Z7	1007 Whelen 29	WPS2907	Turn North off of Hwy 155 on Bethel Rd. (CR 64), then turn West on Haney Hollow Rd. (CR 913). Siren is at second driveway on right.	35.24049	-93.22641	U	Yell	15.2
1Z8	1008 Whelen 28	WPS2807	Mt. Nebo State Park at the intersection of Hwy 155 and Kentucky Rd.	35.22163	-93.25236	S	Yell	15.2
1Z9	1009 Whelen 28	WPS2807	At Bay Ridge Country Club, take Bay Ridge DR 1.2 miles from Hwy 22.	35.25855	-93.21677	U	Yell	15.2
1Z10	1010 Whelen 28	WPS2807	Located 2.8 miles from the intersection of Hwy 7 and Hwy 22 on the north side of Hwy 22.	35.24641	-93.19587	U	Yell	15.2
1Z11	1011 Whelen 29	WPS2907	Located at 2nd St. and Hwy 22 in south Dardanelle right of 2nd St.	35.236	-93.17313	T	Yell	15.2
1Z12	1012 Whelen 29	WPS2907	South side of Lower Danville Rd., 320 feet south of the intersection with S 5th St.	35.20859	-93.15462	T	Yell	15.2
2Z1	2001 Whelen 28	WPS2807	North Side of East 2nd St. 150 feet west of intersection of East 2nd St. and Verona.	35.27698	-93.10901	I	Pope	15.2

Siren ID #	Description from ADH	Siren Model	Location	Latitude	Longitude	Zone	County	Mounting Pole Height (m)
2Z2	2002 Whelen 28	WPS2807	At intersection of Elmira and Jimmy Lile Rd., siren is 0.1 miles south on Jimmy Lile Rd.	35.25449	-93.10342	I	Pope	15.2
2Z3	2003 Whelen 28	WPS2807	South of Hwy 7T 0.1 miles at corner of Bernice Cemetery.	35.24936	-93.12127	I	Pope	15.2
2Z4	2004 Whelen 29	WPS2907	Corner of East 16th and South Detroit on Oakland Heights School Grounds.	35.26415	-93.12967	I	Pope	15.2
2Z6	2006 Whelen 29	WPS2907	North side of Hwy 247 near New Hope 1.6 miles east of intersection with Hwy 7 South.	35.22414	-93.11605	I	Pope	15.2
2Z7	2007 Whelen 28	WPS2807	East side of Sheppa Rd. St. 0.3 miles north of intersection with Old Post Rd.	35.25344	-93.16099	H	Pope	15.2
2Z8	2008 Whelen 29	WPS2907	On Sequoyah Elementary School Grounds off 12th St. in Russellville.	35.26758	-93.14869	H	Pope	15.2
2Z9	2009 Whelen 29	WPS2907	In parking lot off Hwy 64 West ¼ block from intersection with South Cumberland.	35.28552	-93.15919	H	Pope	15.2
2Z10	2010 Whelen 28	WPS2807	North Side of Hwy 326 – 0.8 miles west of intersection with Skyline Drive.	35.27955	-93.18061	H	Pope	15.2
2Z11	2011 Whelen 29	WPS2907	At entrance to Lake Dardanelle State park on west side of Hwy 326, 2.3 miles southwest of intersection with U.S. Hwy 64.	35.29323	-93.2017	H	Pope	15.2
2Z12	2012 Whelen 28	WPS2807	West side of Hwy 326, 0.9 miles southeast of intersection with U.S. Hwy 64.	35.30352	-93.18168	H	Pope	15.2
2Z13	2013 Whelen 29	WPS2907	On Reasoner Ave. just off Hwy 7 North, 0.8 miles North of intersection of Hwy 124 and Hwy 7.	35.30037	-93.13682	I	Pope	15.2
2Z14	2014 Whelen 29	WPS2907	Take Shiloh Rd. East off Hwy 7, 0.4 miles, turn south on paved road and proceed 0.3 miles; siren is on east side of road.	35.31757	-93.12815	J	Pope	15.2

Siren ID #	Description from ADH	Siren Model	Location	Latitude	Longitude	Zone	County	Mounting Pole Height (m)
2Z15	2015 Whelen 29	WPS2907	0.1 miles north of Baker's Creek Bridge on west side of Hwy 7 at Country Club.	35.34038	-93.13262	L	Pope	15.2
2Z16	2016 Whelen 29	WPS2907	Just north of intersection of Hwy 7 and Hwy 27 in Dover.	35.40276	-93.11462	L	Pope	15.2
2Z17	2017 Whelen 29	WPS2907	North side of Morgan Rd. 0.7 miles east of intersection with Hwy 27.	35.36554	-93.10677	L	Pope	15.2
2Z18	2018 Whelen 29	WPS2907	East side of Roy Taylor Rd. 0.7 miles South of intersection with Morgan Rd.	35.34533	-93.08753	J	Pope	15.2
2Z20	2020 Whelen 28	WPS2807	East side of Hwy 124, 0.9 miles north of Shiloh Creek Bridge.	35.32504	-93.09692	J	Pope	15.2
2Z21	2021 Whelen 29	WPS2907	Proceed 0.6 miles east on Crow Mountain Rd. 1.8 miles south of intersection with Hwy 124, turn on Yukon Rd. for 0.3 miles; siren is on west side of road.	35.30396	-93.08957	J	Pope	15.2
2Z22	2022 Whelen 29	WPS2907	Proceed 2.3 miles east on Crow mountain Rd. from intersection with Hwy 124, turn north on Sherman Acres Rd. and proceed 0.2 miles and turn east on Gravel Rd. and go 0.2 miles. Siren is on south side of Gravel Rd.	35.30726	-93.06265	J	Pope	15.2
2Z23	2023 Whelen 29	WPS2907	North side of Hwy 124 in curve 0.4 miles north of I-40 overpass.	35.30136	-93.11459	J	Pope	15.2
2Z24	2024 Whelen 29	WPS2907	South side of Hwy 64 East at Hagan's Datsun 0.8 miles east of I-40 interchange or intersection of Hwy 64 and Hwy 331.	35.27466	-93.08059	I	Pope	15.2
2Z25	2025 Whelen 29	WPS2907	At Dare's Car Wash corner of North Boston and East "E" St. in Russellville	35.2817	-93.13209	I	Pope	15.2
3Z1	3001 Whelen 29	WPS2907	North side of Hwy 64, 0.5 mile east of intersection with Hwy 333.	35.32245	-93.20183	G	Pope	15.2

Siren ID #	Description from ADH	Siren Model	Location	Latitude	Longitude	Zone	County	Mounting Pole Height (m)
3Z2	3002 Whelen 29	WPS2907	North side of Hwy 333 in curve 1 mile from intersection with Hwy 64.	35.31349	-93.21891	G	Pope	15.2
3Z3	3003 Whelen 29	WPS2907	South of Arkansas Nuclear One, 1 mile from intersection of Bunker Hill Rd.	35.30193	-93.23453	G	Pope	15.2
3Z4	3004 Whelen 29	WPS2907	East side of Flatwood Ln 0.5 mile from intersection of Hwy 333.	35.31901	-93.24541	G	Pope	15.2
3Z5	3005 Whelen 29	WPS2907	On south side of Hwy 64 in London 0.2 mile west of Hwy 333 intersection.	35.33134	-93.2582	G	Pope	15.2
3Z6	3006 Whelen 29	WPS2907	On south side of U.S. Hwy 64, 1.0 mile west of intersection with Robertson Ln. and Hwy 333.	35.32721	-93.2284	G	Pope	15.2
3Z7	3007 Whelen 28	WPS2807	East side of Mill Creek Rd. 1.3 miles north of intersection with Hwy 64.	35.33982	-93.21062	K	Pope	15.2
3Z8	3008 Whelen 28	WPS2807	North side of Mill Creek Rd. 2.9 miles from intersection of Hwy 64.	35.35714	-93.21851	K	Pope	15.2
3Z9	3009 Whelen 29	WPS2907	North side of Pleasant View Rd. 1.5 miles east of intersection with Mill Creek Rd.	35.33402	-93.18326	K	Pope	15.2
3Z10	3010 Whelen 28	WPS2807	North side of Pleasant View Rd. 1.0 miles west of intersection with Hwy 7.	35.32197	-93.15181	K	Pope	15.2
4Z1	4001 Whelen 28	WPS2807	In Piney Community 4 miles west of London on U.S. Hwy 64.	35.34428	-93.32532	P	Johnson	15.2
4Z2	4002 Whelen 28	WPS2807	Knoxville City Limits in front of Knoxville Elementary School.	35.38404	-93.36616	P	Johnson	15.2
5Z1	5001 Whelen 28	WPS2807	South side of Hwy 22 at Yell-Logan County Line, 0.1 mile east of intersection of Hwy 22 and Hwy 393.	35.28161	-93.29453	R	Logan	15.2
5Z2	5002 Whelen 28	WPS2807	Right off Hwy 22 on Hwy 393, 1.5 miles toward Delaware Park.	35.29633	-93.28739	R	Logan	15.2
5Z3	5003 Whelen 28	WPS2807	Four miles west of Delaware on Hwy 22 on the right side of the road.	35.28272	-93.37439	Q	Logan	15.2

Table 4. SWS Activation Points for ANO Site

ACTIVATION POINT	PHYSICAL ADDRESS
Primary Point – ADH ECC	4815 West Markham, Little Rock, AR 72205
Secondary Backup Point – SEOF	1448 AR-333, Russellville, AR 72802
Secondary Backup Point – ADH NP&RP	305 S Knoxville Ave, Russellville, AR 72801

Table 5. Siren System Reliability

Quarter - Year	Total Siren Tests	Successful Siren Tests	% Successful Test
Q4 - 2019	147	147	100.00%
Q3 - 2019	147	147	100.00%
Q2 - 2019	147	147	100.00%
Q1 - 2019	147	147	100.00%

Table 6 Summary of Near-Field Acoustical Test Results

Siren Model	Siren	Average (dBC)	Maximum (dBC)
WPS2807	1Z9*	107.4	110.7
	5Z2	115.1	118.6
Overall Average		**115.1**	**118.6**
WPS2907	2Z14	113.1	116.6
	1Z11	114.3	118.5
	3Z4	116.9	120.3
	3Z5	116.1	119.2
	2Z13	117.2	120.3
Overall Average		**115.5**	**119.0**

* According to Entergy, the siren head of Siren 1Z9 was damaged before the near-field test was performed It was repaired after the acoustical test

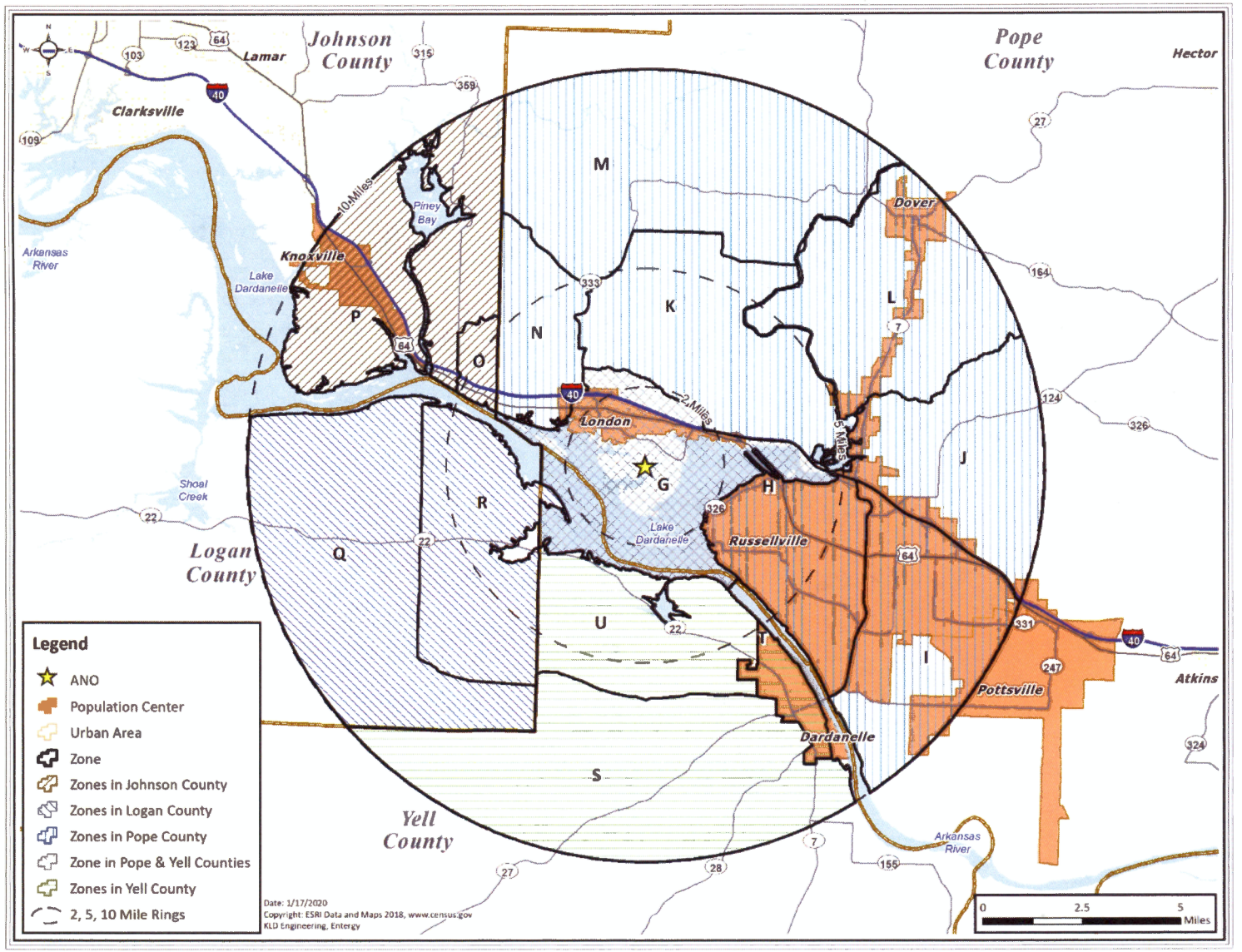
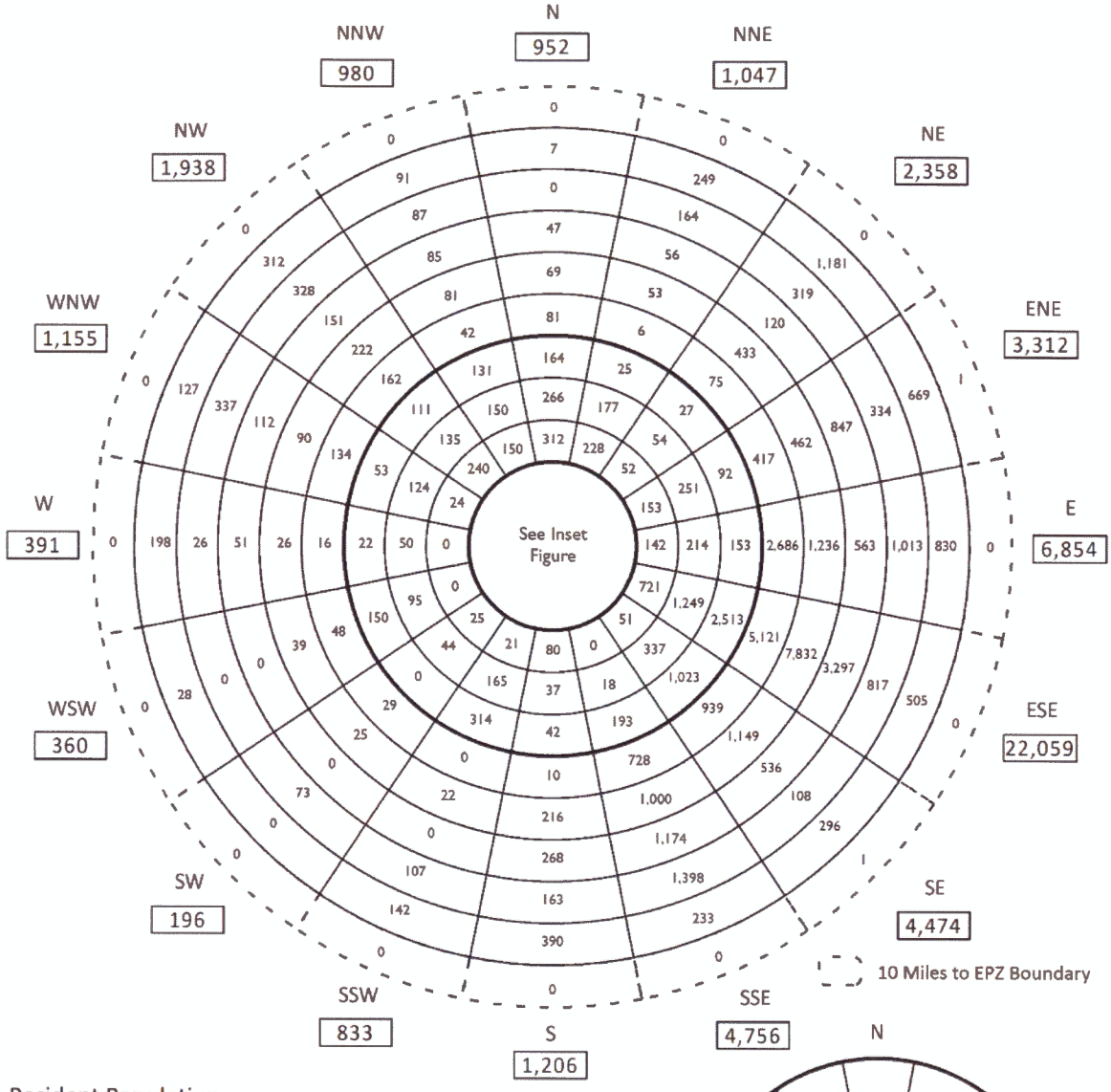
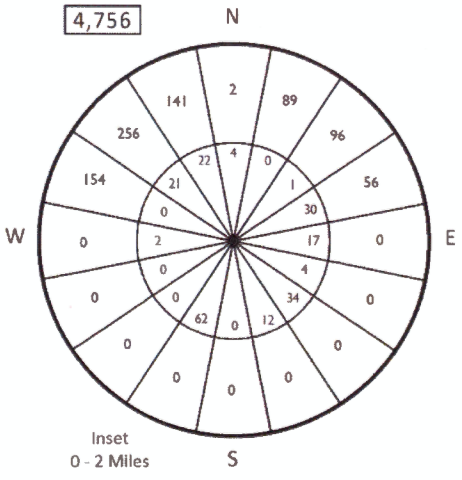


Figure 1. Site Location





Resident Population

Miles	Subtotal by Ring	Cumulative Total
0 - 1	209	209
1 - 2	794	1,003
2 - 3	2,199	3,202
3 - 4	3,366	6,568
4 - 5	5,013	11,581
5 - 6	10,494	22,075
6 - 7	12,955	35,030
7 - 8	7,307	42,337
8 - 9	5,274	47,611
9 - 10	5,258	52,869
10 - EPZ	2	52,871
	Total:	52,871

Figure 2. Permanent Resident Population by Sector for the ANO EPZ

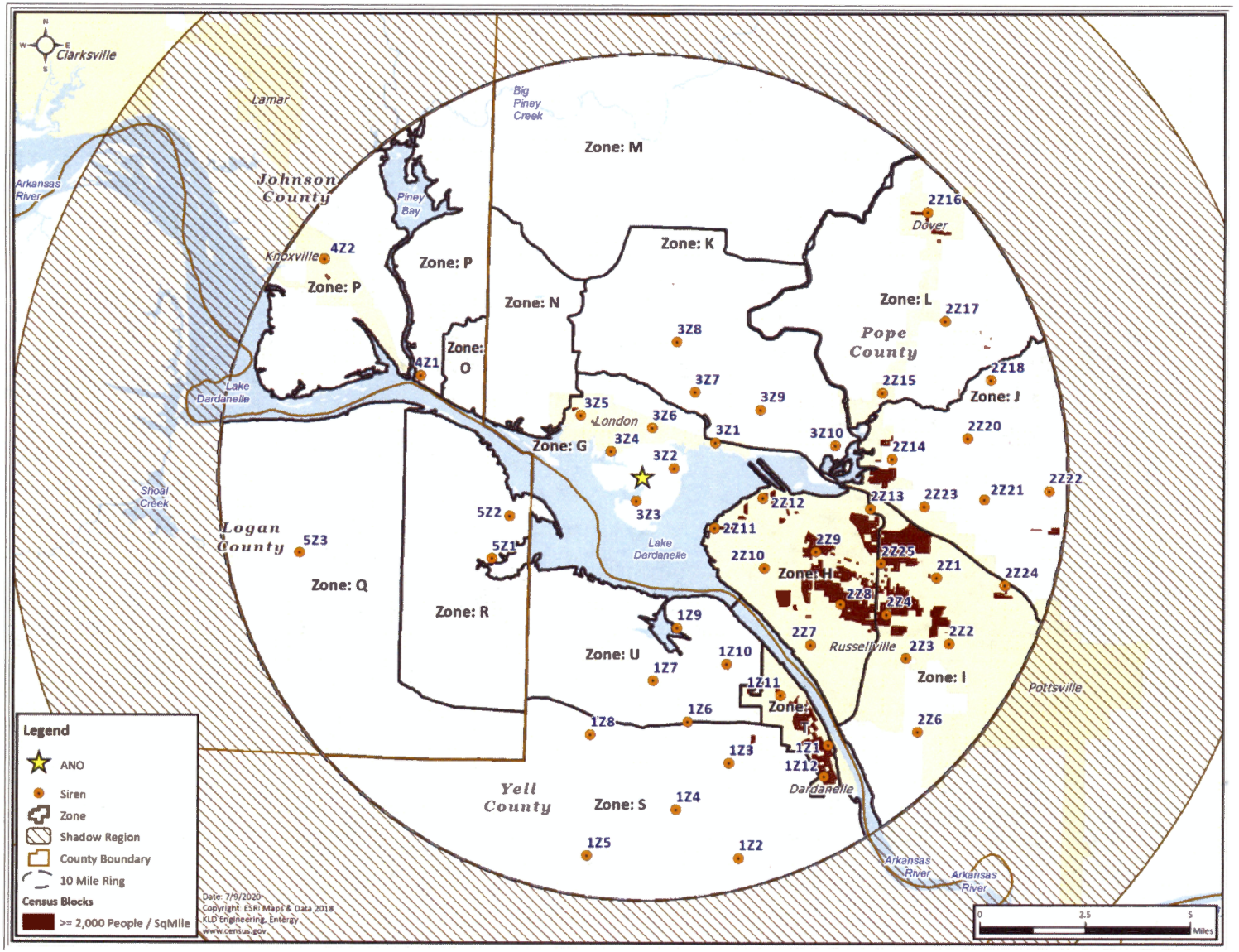


Figure 3. Census Blocks with Population Density Exceeding 2,000 People per Square Mile

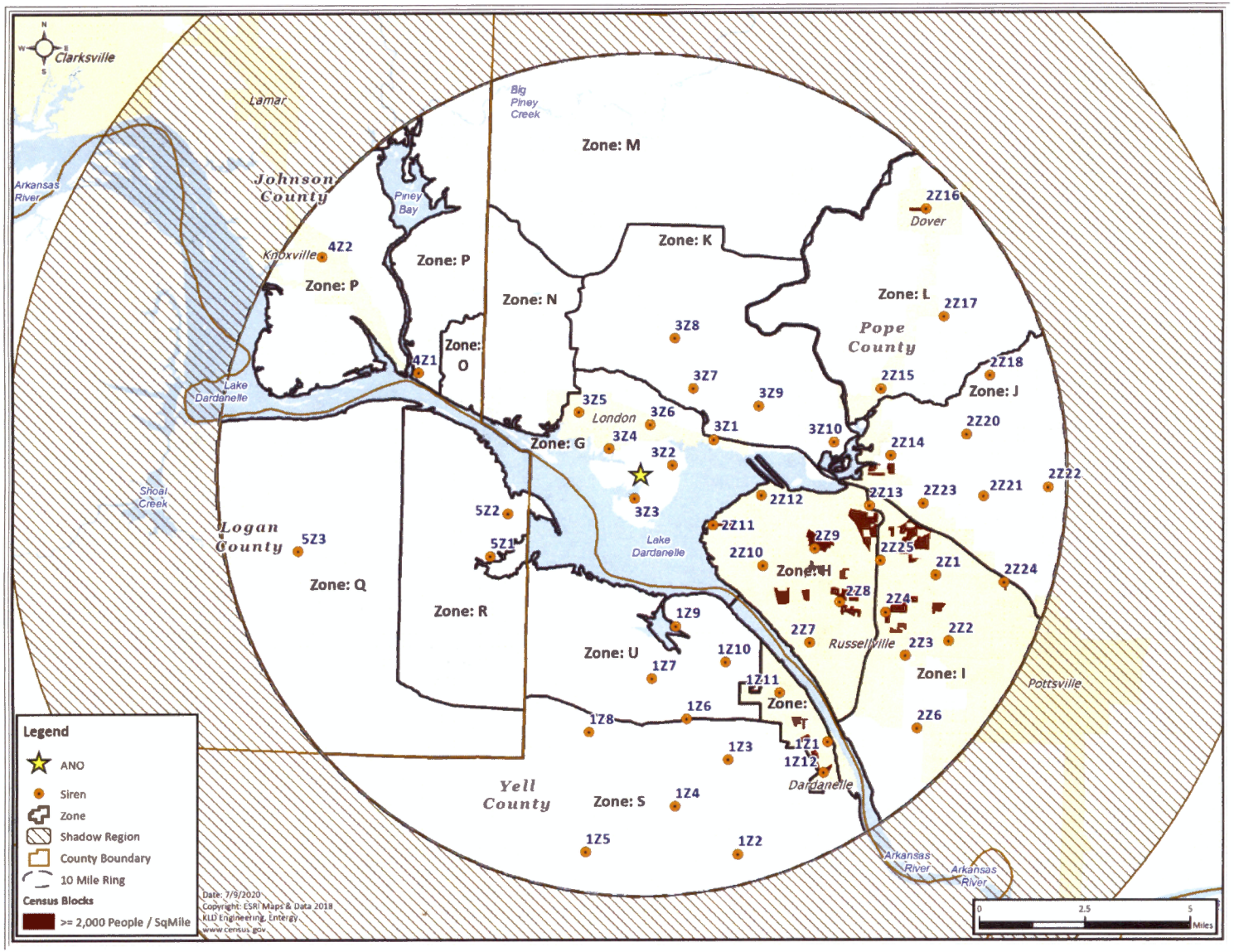


Figure 4. Census Blocks with Population Density Exceeding 2,000 People per Square Mile (Filter 1 Applied)

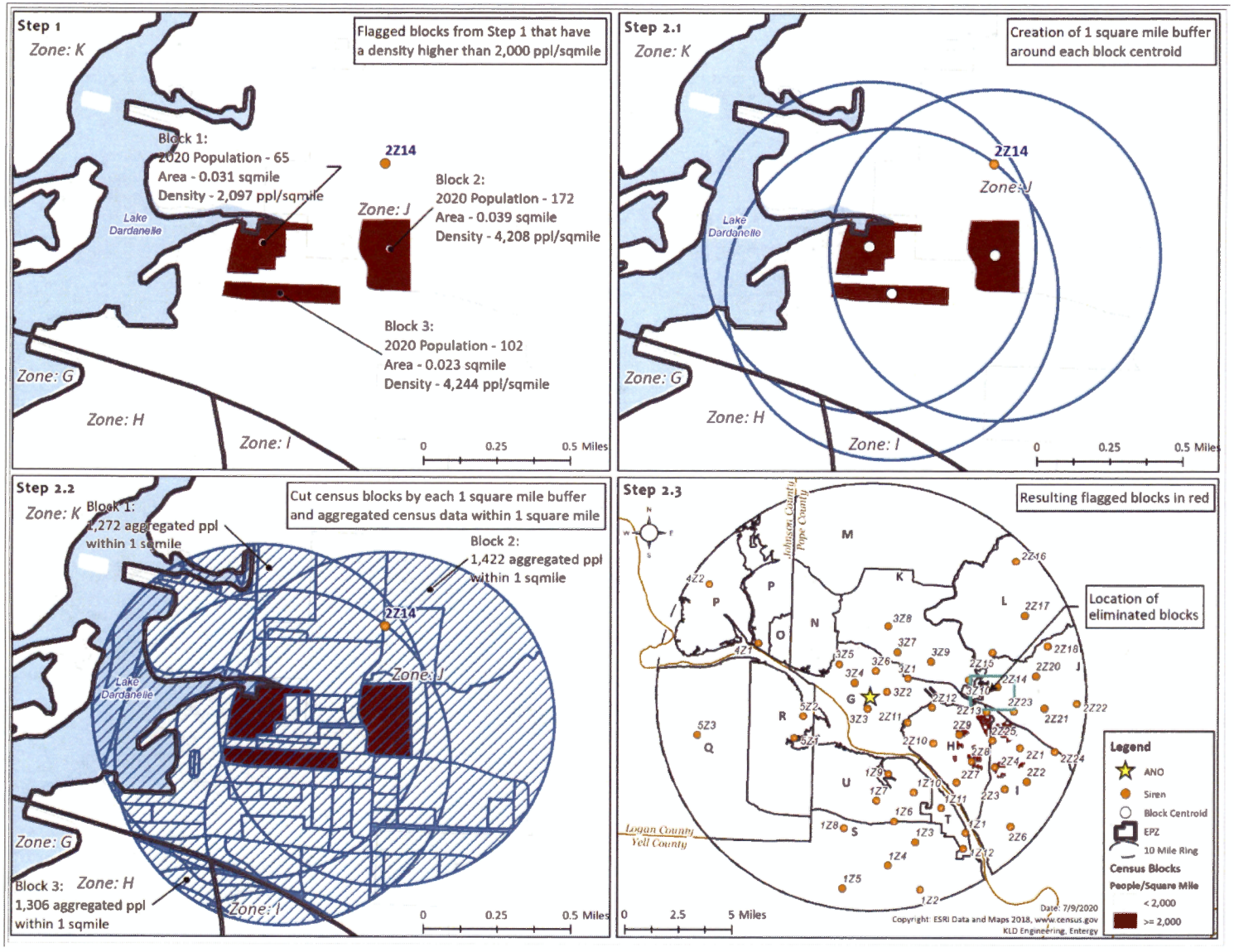


Figure 5. Applying Filter 2 to Eliminate Isolated Neighborhoods from High Population Density Consideration

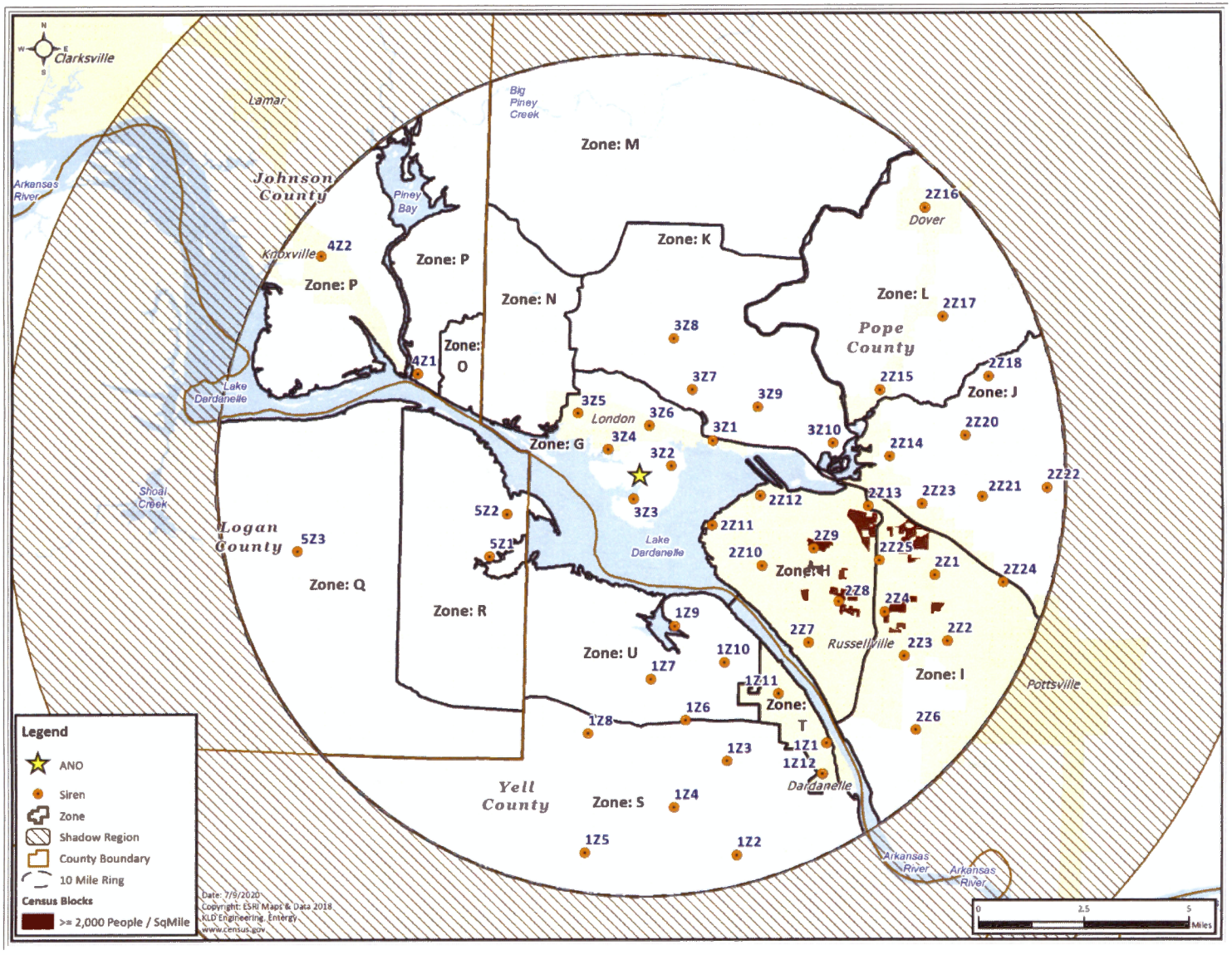


Figure 6. Final Census Blocks with Population Density Exceeding 2,000 People per Square Mile after Applying Filters

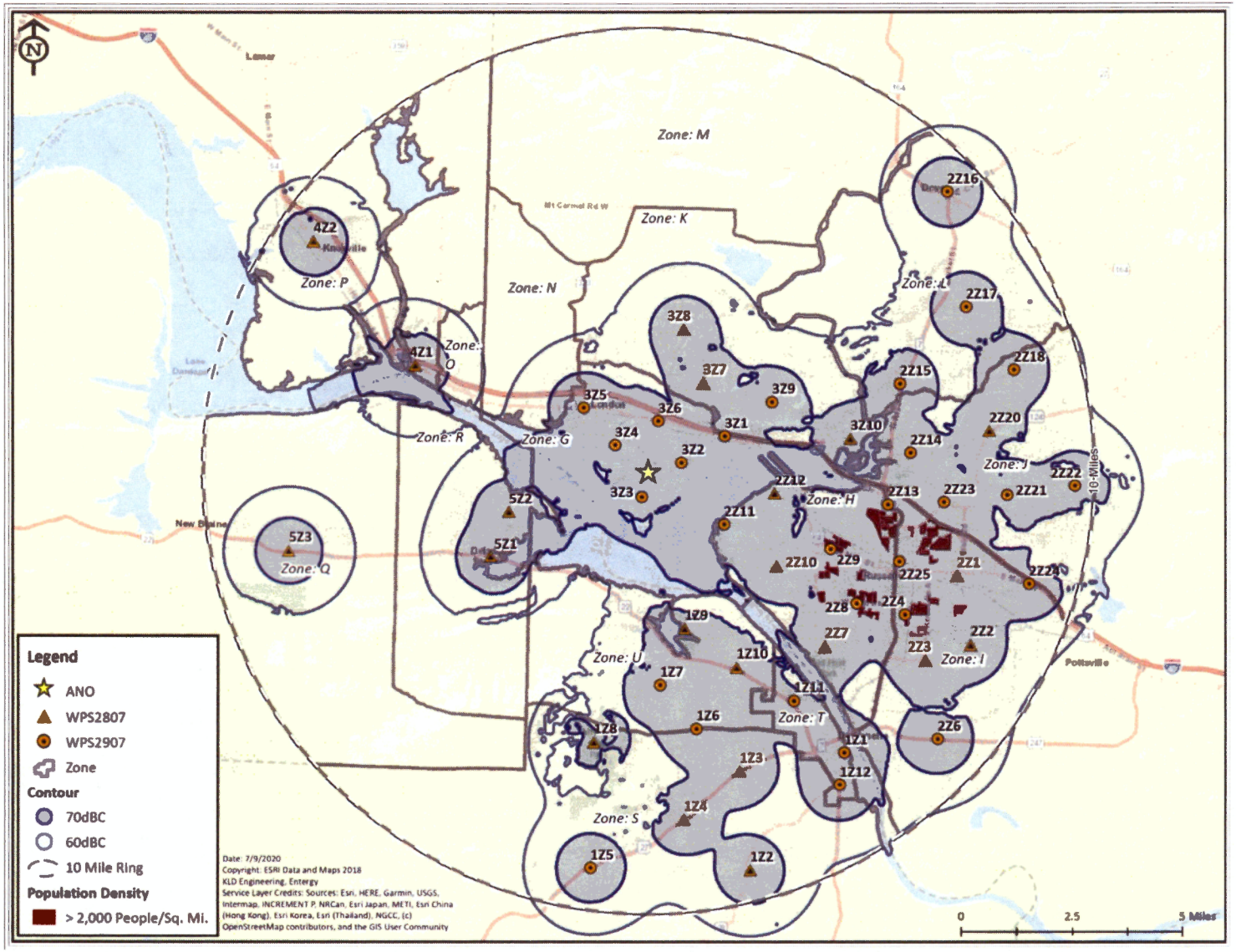


Figure 7. Siren Coverage Map for the ANO EPZ

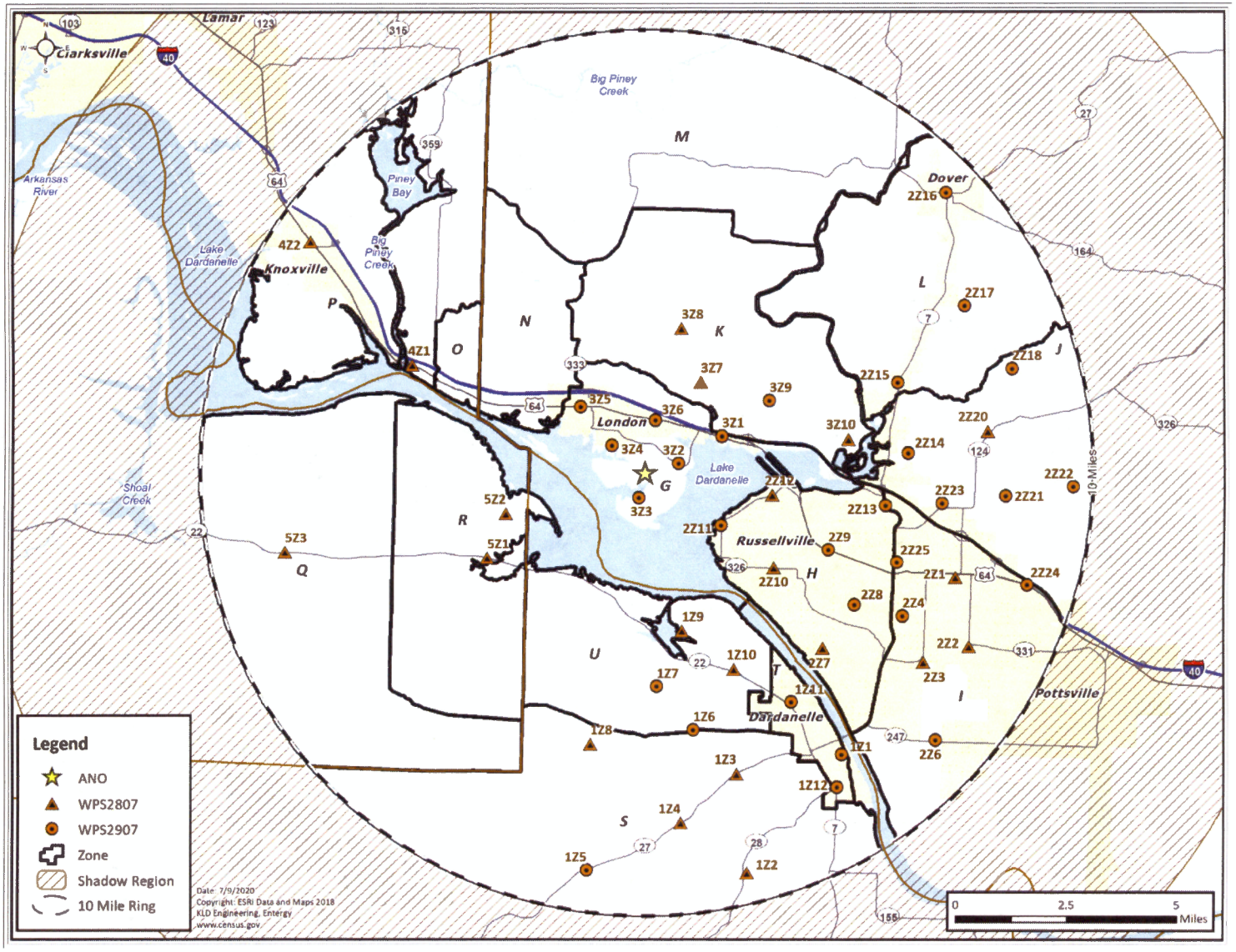


Figure 8. Siren System within the ANO EPZ

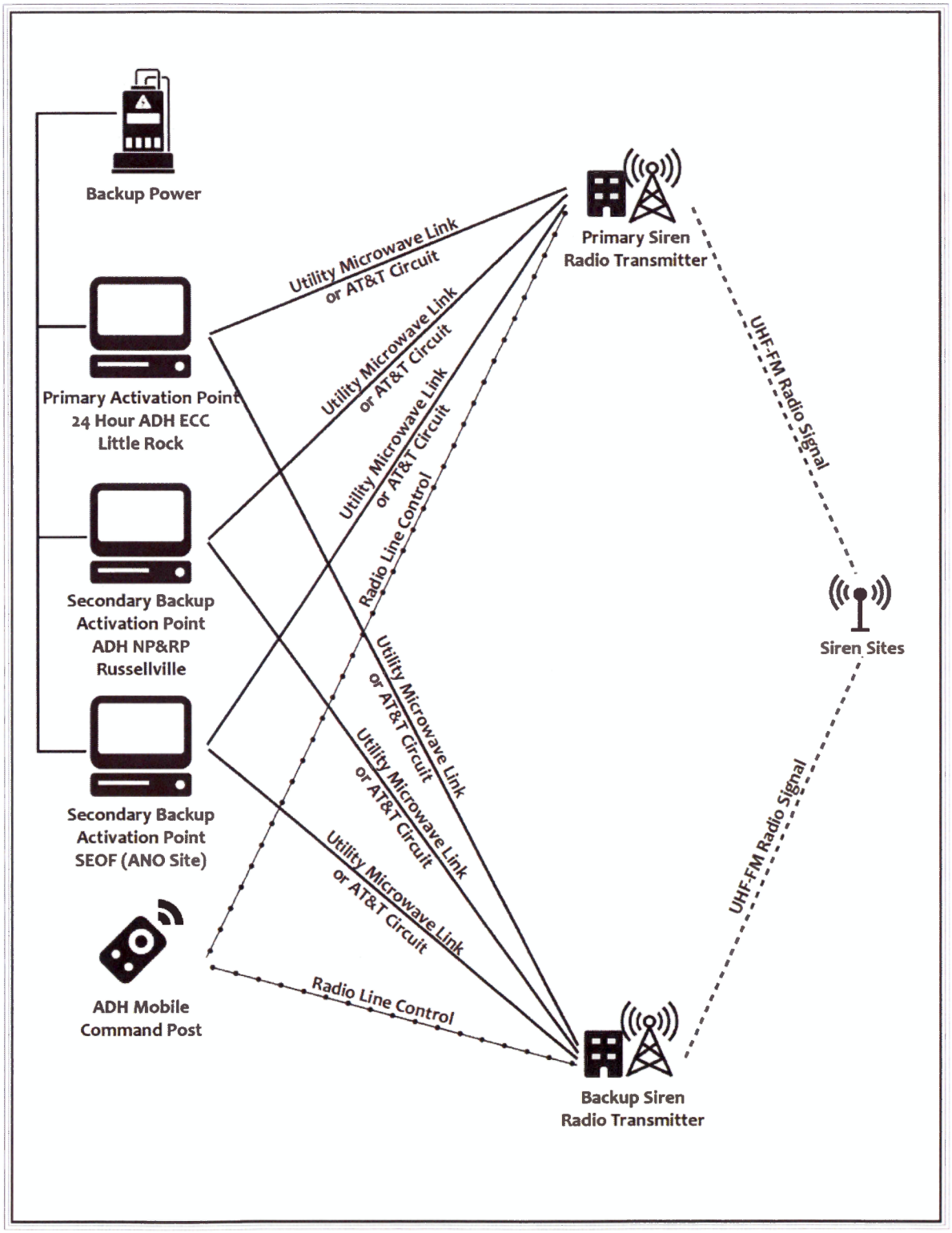


Figure 9. Control System Layout for the ANO ANS Siren System

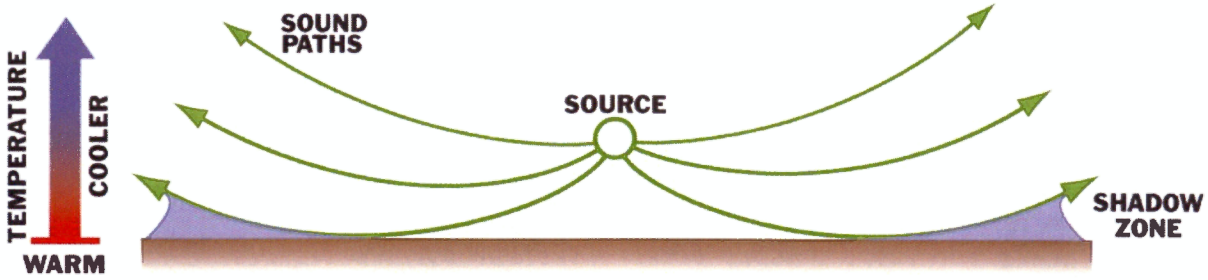


Figure 10. Sound Transmission in Temperature Lapse Conditions

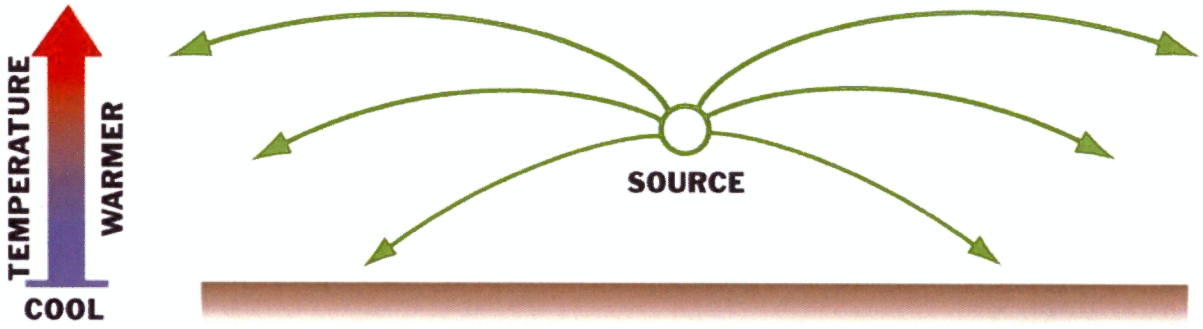


Figure 11. Sound Transmission in Temperature Inversion Conditions

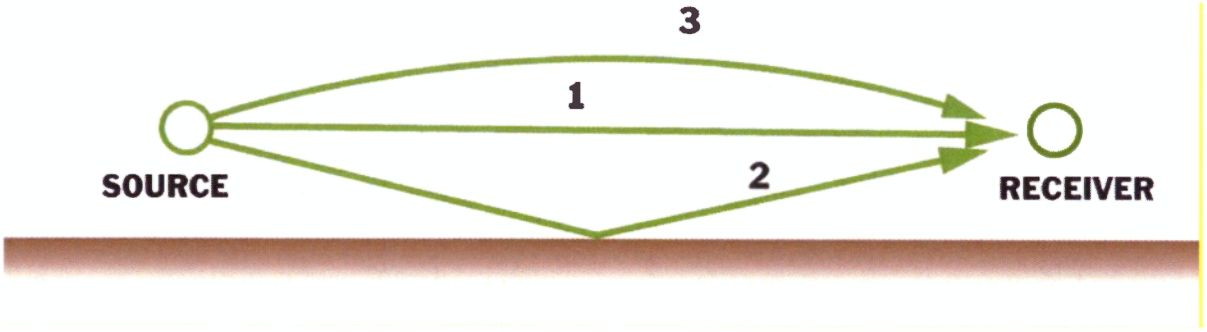


Figure 12. Outdoor Sound Propagation near the Ground

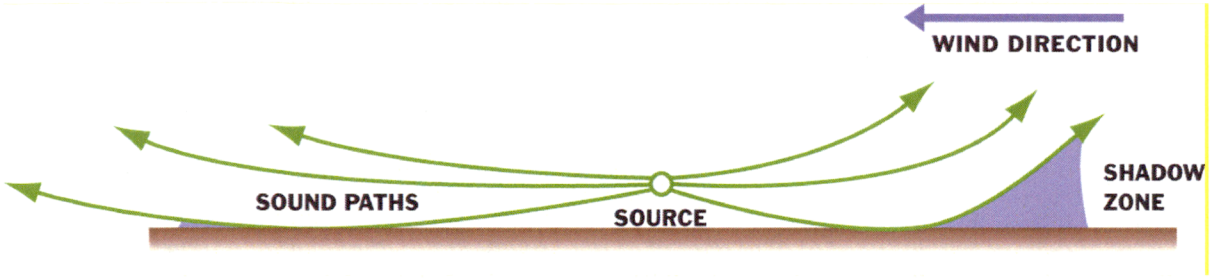


Figure 13. Upwind Sound Propagation

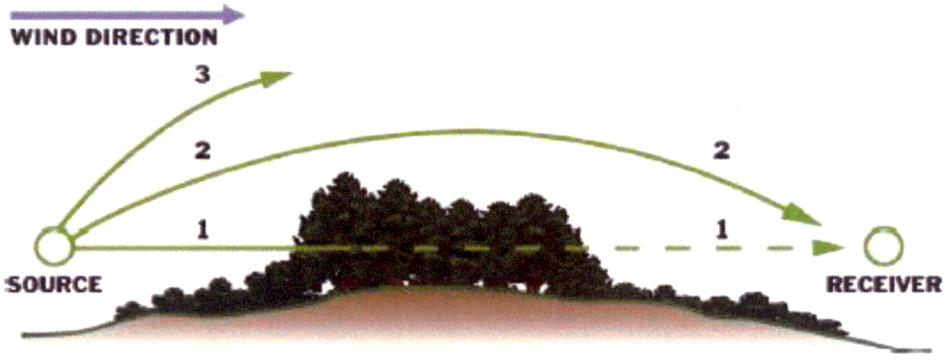


Figure 14. Downwind Sound Propagation with Terrain and Vegetation Effects

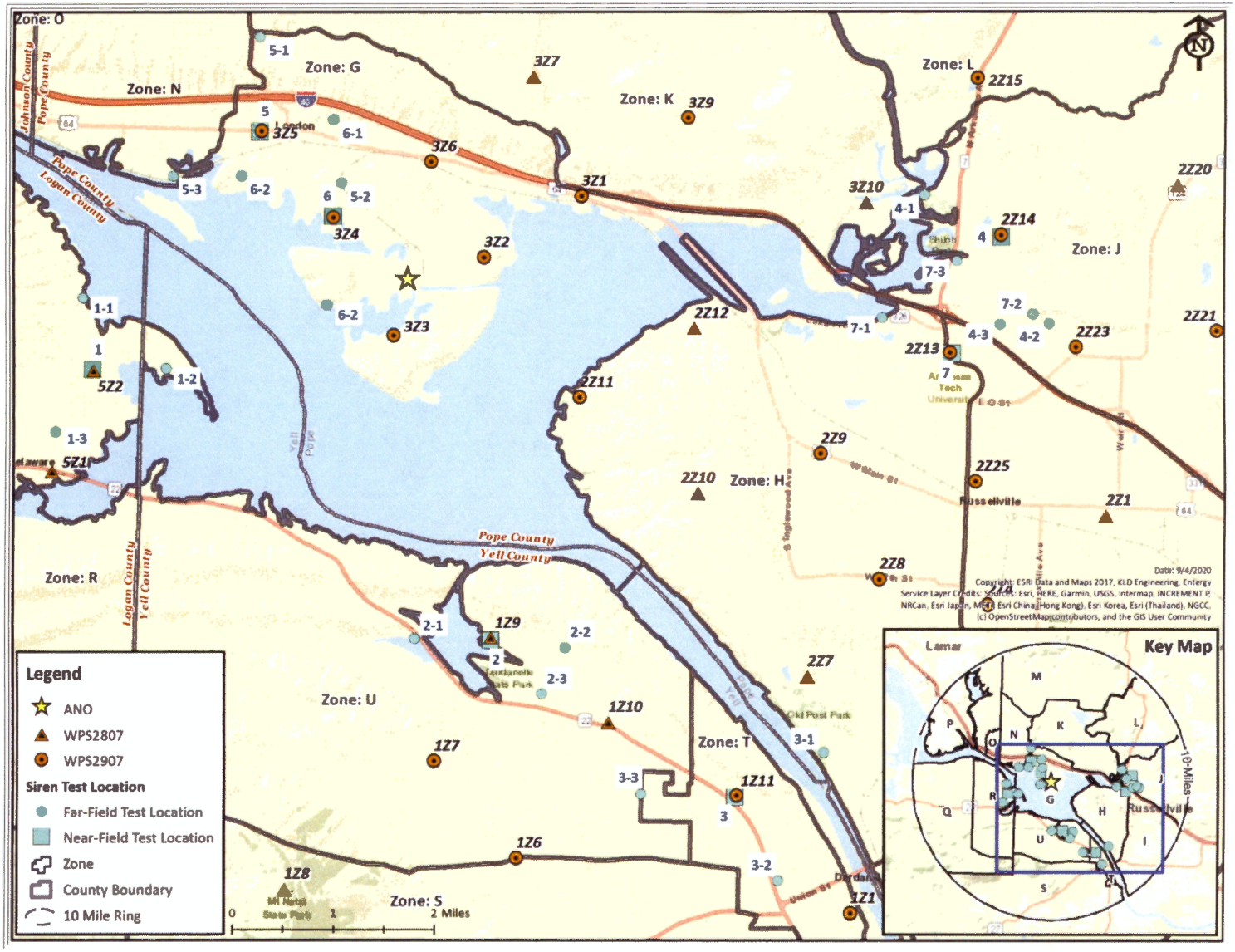


Figure 15. Near-Field and Far-Field Test Locations

REFERENCES

1. American National Standards Institute, Inc. (ANSI) S1.4-1983, "Specification for Sound Level Meters"
2. ANSI S12.14-1992, "Methods for the Field Measurements of the Sound Output of Audible Public Warning Devices Installed at Fixed Locations Outdoors"
3. ANSI S12.18-1994, "Procedures for Outdoor Measurements of Sound Pressure Level"
4. ANSI S1.43-1997, "Specifications for Integrating - Averaging Sound Level Meters"
5. ANSI S1.26-2014, "Method for Calculation of the Absorption of Sound by the Atmosphere"
6. "Arkansas Nuclear One – Upgraded Public Alert and Notification System Design Report Update", May 2016
7. Entergy Operations, Inc., "Supplement to Arkansas Nuclear One – Upgraded Public Alert and Notification System Design Report Update", February 2017
8. Arkansas Department of Health (ADH), "Arkansas Nuclear One Siren Warning System Maintenance Plan", September 15, 2020
9. Arkansas State Emergency Operations Facility (SEOF), "Rapid Warning System Activation Checklist", March 2020
10. Entergy Operations, Inc., "Arkansas Nuclear One Emergency Plan" Rev. 39, November 2014
11. Arkansas Division of Emergency Management (ADEM), "Arkansas Comprehensive Emergency Management Plan", Revised, September 30, 2019
12. Federal Emergency Management Agency (FEMA) CPG 1-17, "Outdoor Warning Systems Guide", March 1, 1980
13. FEMA-REP-10, "Guide for the Evaluation of Alert and Notification Systems for Nuclear Power Plants", November 1985.
14. FEMA Technical Bulletin (Version 2.0), "Outdoor Warning Systems", January 12, 2006
15. FEMA, "Radiological Emergency Preparedness Program Manual" (FEMA P-1028), December 2019
16. Johnson County Department of Emergency Management, "Johnson County Radiological Emergency Response Plan", Rev. 5.2, July 2019
17. Logan County Office of Emergency Management, "Logan County Radiological Emergency Response Plan", Rev. 5.2, July 2019
18. Pope County Office of Emergency Management, "Pope County Radiological Emergency Response Plan", Rev. 5.2, July 2019
19. Yell County Office of Emergency Management, "Yell County Radiological Emergency Response Plan", Rev. 5.2, July 2019
20. International Organization for Standardization (ISO) 9613, "Acoustics - Attenuation of Sound during Propagation Outdoors" 1993
21. KLD Engineering, P.C. (KLD), Technical Report 517, "Arkansas Nuclear One Development of Evacuation Time Estimates", Rev. 1, December 2012

22. KLD, Technical Report 1167, "Arkansas Nuclear One 2020 Population Update Analysis", September 19, 2020

23. Nuclear Energy Institute (NEI) 99-02 Rev. 7, "Regulatory Assessment Performance Indicator Guideline", August 31, 2013

24. Nuclear Regulatory Commission (NRC), 10 CFR 50.47, "Emergency Plans"

25. NRC, 10 CFR Appendix E to Part 50, "Emergency Planning and Preparedness for Production and Utilization Facilities"

APPENDIX A

Compliance with Federal Regulations and Guidance

A. Compliance with Federal Regulations and Guidance

Table A-1 is a crosswalk to show compliance of this design report with federal guidance and regulations. The criteria in the left column of Table A-1 are taken verbatim from Part V: REP Program Alert and Notification System Guidance, Section C. "ANS Evaluation Report Guidance" of the December 2019 revision of the FEMA REP Program Manual. The references in the right column of Table A-1 are the sections, figures and tables from the design report wherein the criteria from the FEMA REP Program Manual are addressed.

Table A-1. Regulations Crosswalk

Criteria	Section(s) where Requirement is Met
a. Introduction of the ANS Evaluation Report	
Title Page	
The Title Page must contain basic information about the report such as the name of the report and date of the report, name of the nuclear power plant, and applicable revision number.	Cover Page
Signature Page	
The Signature Page has signatures of responsible officials attesting to the accuracy, completeness, and concurrence of information included within the ANS evaluation report. Since alert and notification is a key component of offsite planning and is part of the state, local, territorial, or tribal government(s) radiological emergency plan approval under 44 CFR 350, the responsible official from the state, at a minimum, must sign. No ANS design, plan, or revision may be considered by FEMA without the state's concurrence. Other signatories could include responsible officials or representatives from the utility emergency preparedness, the local or county emergency management agency, the state, local, territorial, or tribal government(s) emergency management, and the FEMA Region.	Signature List
Revision History	
The Revision History is a summary of the current version, as well as a history of past revisions. This is typically shown as a table with each past revision number and an associated summary outlining the change in each version.	Revision History
Table of Contents	
The Table of Contents outlines all sections of the report; any additional information should be included as annexes or appendices.	Table of Contents
Executive Summary	
The Executive Summary provides a short overview that describes the overall physical and administrative features and functions of the ANS. If the ANS evaluation report is an update to a previous version, it should also include a summary of the changes from the previous version.	Executive Summary

b. **Body of the ANS Evaluation Report**	
Below are points of review that should be addressed in the body of the ANS evaluation report for each type of system used. The ANS evaluation report is divided into two main sections: the ANS plan, where the administrative means and emergency planning aspects of the system is addressed; and the design report, where the physical means and technical components of the system are detailed. Depending on the type of system, some headings may be more relevant or need more information than others.	The ANS Plan portion of the FEMA Evaluation Report will be completed by FEMA based on their review of the county and state plans. This report is the Design Report. This appendix will help FEMA review the Design Report ensuring that all necessary criteria have been addressed.
Licensing obligations *(if any)*	
NRC licensing agreements address having a functional ANS and can include specific requirements unique to a particular licensee and/or state, local, territory, and/or tribal government organization. Any obligations or concessions contained within the licensing agreement should be included.	Section 1
Requirements	Section 2
• **System Coverage**	Section 2.1
◦ Population – Description or characterization of the population required to be alerted across a geographical area.	Section 2.1.1, Figure 1 through Figure 6, Table 1, and Table 2
◦ Geographical Area – Description of the geographical area intended for each systems' coverage.	Section 2.1.2, Figure 1 and Table 2
◦ Means – Description of the type of system to be used.	Section 2.1.3
◦ Primary Methods – Description of the methods to be used to alert and notify the population in the geographic area, both described above.	Sections 2.1.4 and 3.1, Table 3
◦ Backup Methods – Description of the methods to correct or compensate for failures (including total failure) for any segment of the population that did not receive the alert and/or notification.	Sections 2.1.5 and 3.3.3
• **Population/Demographics** – Description of population groups (e.g., transient populations, those with access/functional needs, non-English speakers, etc.), including any special requirements.	Section 2.2
• **Interoperability** – Description of how the system interfaces with other systems and how that interface is accomplished, if applicable.	Section 2.3, Figure 9, Table 4
• **Operation** – Description of all operational requirements.	Section 2.4 and Appendix B
• **Management/Administration** – Identify and describe the organizations and/or individuals responsible for management and oversight of the system, or the administration of third party agreements with	Section 2.5

vendors.	
• **Security/Privacy**	Section 2.6
◦ Physical Security – Description of physical security requirements, such as prevention of unauthorized access to systems and the components necessary to operate it	Section 2.6.1
◦ Logical Security – Description of logical security (cyber-security) requirements, such as prevention of unauthorized or malicious access to the system, or accidental or malicious actions resulting in denial of service and other cyber-security.	Section 2.6.2
• **Maintenance/Repair**	Section 2.7
◦ Preventative maintenance – Identify and describe routine and periodic maintenance requirements.	Section 2.7.1 and Appendix C
◦ Corrective maintenance – Identify and describe procedures and resources for correcting areas requiring improvement.	Section 2.7.2 and Appendix D
• **Availability/Reliability** – Identify and describe reliability and availability requirements. The NRC requires greater than 94 percent availability, or the elimination of all critical single-point failure modes. These requirements may include system operation in all weather conditions typical for local climate.	Section 2.8 and Table 5
• **Testing** - Identify and describe how system performance, availability and reliability is tested and verified on a periodic basis, including how often and the frequency and method of testing, and what aspects of the system are actually tested. Not all systems lend themselves to full operational testing. In those instances, passive testing, actual event verification, and inspection may be considered. Identify how the results of periodic and as-needed testing are recorded, preserved, and made available for inspection.	Section 2.9 and Appendix C
• **Responsibility** - Identify the individual(s) responsible for system maintenance, testing, and repair.	Sections 2.9, 2.10 and 3.2.1
• **Training** – Identify and describe initial and ongoing training requirements for all associated personnel.	Sections 2.11 and 7
• **Quality Assurance** - Identify and describe a comprehensive, ongoing quality assurance program that may include testing, record-keeping, internal and external inspections, and exercises.	Sections 2.7, 2.8, 2.9, 2.12, 4.3 and 5, Table 5, Appendices B and C
Description/Performance	Section 3
• **Physical components**	Section 3.1
◦ System components – Description of the major parts of each system being employed.	Section 3.1.1, Figure 8, Table 3
◦ User interfaces – The device, system, or physical equipment used to activate or control the ANS and its locations.	Sections 2.3, 3.1.2 and 3.3.1, Figure 9, Table 4
◦ Functional block diagrams – A diagram used to describe each logical and physical connection of components and systems.	Sections 2.3 and 3.1.3, Figure 9
• **Administrative components**	Section 3.2
◦ Organizational responsibilities – Description of established roles and responsibilities for operation,	Sections 2.9, 2.10, and 3.2.1

planning, maintenance, and testing of the ANS under discussion.	
◦ Management – Description of the controls used to ensure the proper use of ANS and implementation of any corrective actions.	Section 3.2.2
• **Operational components**	Section 3.3
◦ Activation – Description of location(s), access, and processes for activating ANS.	Sections 2.3, 3.1.2 and 3.3.1, Figure 9, Table 4
◦ Timing – Description of how long it takes to activate the system—after determining the need to activate ANS—and length of time between initiation of the system and when the alert and notification is received by the public.	Sections 3.3.2 and 4.3
◦ Geo-Targeting – Description of the system limits in its ability to a select a geographic location.	Section 3.3.3
Verification	
Documents that the system or approach meets the design report requirements identified above. The need to verify applies to implementation of both new and modified systems and approaches. Information provided here should objectively demonstrate that the system or approach meets the stated requirements, which can be verified by tests, inspections, demonstrations, analyses, studies, or any other applicable method. Each of the requirements identified should have a description of the corresponding verification process.	Section 4
• **Coverage** – The coverage (extent or reach) of the ANS can be verified through modeling of the ANS medium (e.g., radio, tone alerts, visual alerts, etc.) using existing accepted sources and databases, empirical data through testing, or other recognized means of verification.	Section 4.1, Figure 10 through Figure 15, Table 6, Appendix E
• **Population/Demographics** – Population and demographics information may be verified by identifying credible sources used for the population data. Credible sources may include census data, city or county records, local/tribal organization records, etc.	Sections 2.1.1 and 4.2 – 2010 Census data extrapolated to 2020 for permanent residents and employees, transient data provided by county and state emergency management agencies, Figure 7
• **Metrics** – Identification of the method(s), standard(s), or precedent(s) used to determine success or failure to meet the design objectives.	Section 4.3
Availability/Reliability	
Description of how failures are detected and tracked/trended, how the system is tested and maintained, and how vulnerabilities are identified, mitigated, and reported.	Sections 2.7, 2.8, 2.9, 4.3 and 5

Security and Privacy	
Description of the supporting information and data.	Sections 2.6 and 6
Training and Public Outreach	
Description of the training required for applicable stakeholders of the ANS, including training for personnel who operate and maintain the ANS; also a description of the public education and outreach activities. An informed population is far more likely to understand and respond appropriately to notifications and take action in emergency situations.	Section 7
c. Attachments	
Additional information, such as maps, diagrams, and/or references, which support the efficient evaluation of an ANS, should be included.	Not applicable

APPENDIX B

ANO EWS Activation Procedures

RAPID WARNING SYSTEM ACTIVATION

(Pre-Activation of SEOF)

CHECKLIST

THIS CHECKLIST IS FOR USE FOR *IMMEDIATE* ACTIVATION OF THE EMERGENCY WARNING SYSTEM FOR GENERAL EMERGENCY CLASSIFICATIONS *PRIOR* TO ACTIVATION OF THE RADIOLOGICAL EMERGENCY RESPONSE TEAM.

TIME: DATE: EC#:
OPERATOR/SDO:

1. [ ] (ANP ONLY) IF A STAFF DUTY OFFICER IS PRESENT, CONTACT ADH COMCENTER VIA HOT LINE OR DEV/VS AND INFORM THE COMCENTER OPERATOR THAT ANP IS ASSUMING OPERATION CONTROL OF ACTIVATION OF THE WARNING SYSTEM.

   NOTE: THE ADH COMCENTER OPERATOR WILL BE RESPONSIBLE FOR THE ACTIONS IN THIS CHECKLIST UNLESS NOTIFIED TO THE CONTRARY BY ANP SDO)

ACTIVATION OF SIRENS AND TONE ALERT RADIOS MUST OCCUR WITHIN 15 MINUTES OF NOTIFICATION - DO NOT DELAY

2. [ ] USING THE "RECOMMENDED PROTECTIVE ACTIONS - EVACUATION" INFORMATION FROM THE "EC" FORM, TRANSFER THE ZONES TO BE EVACUATED TO THE "GOLD" EVACUATION MESSAGE FORM (S)

3. [ ] USING THE "RECOMMENDED PROTECTIVE ACTIONS - SHELTER" INFORMATION FROM THE "EC" FORM, TRANSFER THE ZONES TO BE SHELTERED TO THE "GREEN" SHELTERING MESSAGE FORM (S)

4. [ ] USING THE DEF/VS FAX, TRANSMIT ALL APPROPRIATE MESSAGE FORMS TO THE NATIONAL WEATHER SERVICE.

5. [ ] VERIFY RECEPTION OF THE MESSAGE FORMS BY THE NATIONAL WEATHER SERVICE VIA NAWAS.

TIME THIS SECTION COMPLETED: _____

6. [ ] USING THE ZETRON CONSOLE:

   A. ARM CONSOLE USING KEY
   B. SELECT "SIREN" NET
   C. SELECT "KXRJ ON"
   D. PRESS "PAGE SAFETY"

RAPID WARNING SYSTEM ACTIVATION

(Pre-Activation of SEOF)

CHECKLIST

THIS CHECKLIST IS FOR USE FOR *IMMEDIATE* ACTIVATION OF THE EMERGENCY WARNING SYSTEM FOR GENERAL EMERGENCY CLASSIFICATIONS *PRIOR* TO ACTIVATION OF THE RADIOLOGICAL EMERGENCY RESPONSE TEAM.

7. [ ] USING ENS, TRANSMIT (IN A FILL-IN-THE-BLANK METHOD) ALL APPROPRIATE MESSAGES TO RUSSELLVILLE AREA BROADCAST STATIONS.

   AFTER HOURS SEE ATTACHMENT #1.

8. [ ] USING THE ZETRON CONSOLE:

   A. ARM CONSOLE USING KEY
   B. SELECT "SIREN NET F1"
   C. SELECT "ENS RADIO"
   D. PRESS "PAGE SAFETY"
   E. WAIT 10 SECONDS
   F. PRESS THE "TRANSMIT" BUTTON AND READ THE FOLLOWING MESSAGE

   "THIS IS THE ARKANSAS DEPARTMENT OF HEALTH....ATTENTION ALL BROADCAST STATIONS....PLEASE LOCATE YOUR GOLD AND GREEN MESSAGE FORMS AND STAND BY FOR AN EMERGENCY MESSAGE,...REPEATING...ALL BROADCAST STATIONS, PLEASE LOCATE YOUR GOLD AND GREEN MESSAGE FORMS AND STANDBY FOR AN EMERGENCY MESSAGE"

9. [ ] WAIT 1 MINUTE FOR STATIONS TO LOCATE FORMS

10. [ ] USING THE ZETRON CONSOLE:

    A. SELECT **"SIREN NET F1"**
    B. SELECT "ENS RADIO"
    C. PRESS "PAGE SAFETY"
    D. WAIT 10 SECONDS
    E. PRESS THE "TRANSMIT" BUTTON AND READ THE FOLLOWING MESSAGE

    "THIS IS THE ARKANSAS DEPARTMENT OF HEALTH.... ATTENTION ALL BROADCAST STATIONS, PLEASE FILL OUT AND CHECK THE NOTED INFORMATION ON YOUR "GOLD" EVACUATION MESSAGE." **(READ SLOWLY AND CLEARLY EACH APPROPRIATE BLANK, THEN REPEAT FOR THE GREEN MESSAGE)** "PLEASE FILL OUT AND CHECK THE NOTED INFORMATION ON YOUR "GREEN" SHELTERING FORM. EAS TONE ACTIVATION IS REQUESTED, THE SIREN WARNING SYSTEM WILL SOUND MOMENTARILY"

RAPID WARNING SYSTEM ACTIVATION

(Pre-Activation of SEOF)

CHECKLIST

THIS CHECKLIST IS FOR USE FOR *IMMEDIATE* ACTIVATION OF THE EMERGENCY WARNING SYSTEM FOR GENERAL EMERGENCY CLASSIFICATIONS *PRIOR* TO ACTIVATION OF THE RADIOLOGICAL EMERGENCY RESPONSE TEAM.

TIME THIS SECTION COMPLETED _____

11. [ ] ACTIVATE THE SIREN WARNING SYSTEM IN ALL ZONES

12. [ ] USING THE ZETRON CONSOLE:

    A. SELECT "SIREN" NET
    B. SELECT "ALERT ALL ZONES"
    C. PRESS "PAGE SAFETY"
    D. DO NOT CANCEL, SIRENS WILL SOUND FOR 3 MINUTES!

TIME THIS SECTION COMPLETED:_____

13. [ ] CONFIRM RECEPTION OF MESSAGES BY THE FOLLOWING RADIO STATIONS:

[ ]	KCJC	RUSSELLVILLE	(479) 968-6816
[ ]	KMTC	RUSSELLVILLE	(478) 968-7400
[ ]	KXRJ (ATU)	RUSSELLVILLE	(479) 968-0222
		Or (479) 317-7127 or	(479) 968-0583

NOTE: IF ANY STATION(S) FAILED TO RECEIVE MESSAGE(S) VIA ENS, READ THEM IN A FILL-IN-THE-BLANK METHOD.

14. [ ] (LITTLE ROCK ECC ONLY) NOTIFY ANY COUNTY WARNING POINTS WHICH FAILED TO RESPOND TO THE ROLL CALL CONDUCTED BY ANO (ANO WILL NOTIFY ADH OF ANY STATIONS WHICH FAIL TO RESPOND TO THE NOTIFICATION ROLL CALL)

[ ]	POPE COUNTY	(479) 890-6914
[ ]	JOHNSON COUNTY	(479) 754-2200
[ ]	LOGAN COUNTY	(479) 963-6800
[ ]	YELL COUNTY	(479) 495-4881
[ ]	CONWAY COUNTY	(501) 215-4911
[ ]	ADEM (STATE EOC)	(501) 683-6705

15. [ ] (LITTLE ROCK ECC ONLY) COMMENCE CHECKLIST FOR NOTIFICATION AND ACTIVATION OF RADIOLOGICAL EMERGENCY RESPONSE TEAM

16. [ ] (ANP ONLY) COMMENCE CHECKLIST FOR SDO / LGL SEOF PRE-ACTIVATION.

RAPID WARNING SYSTEM ACTIVATION

(Pre-Activation of SEOF)

CHECKLIST

THIS CHECKLIST IS FOR USE FOR *IMMEDIATE* ACTIVATION OF THE EMERGENCY WARNING SYSTEM FOR GENERAL EMERGENCY CLASSIFICATIONS *PRIOR* TO ACTIVATION OF THE RADIOLOGICAL EMERGENCY RESPONSE TEAM.

TIME THIS SECTION COMPLETED _____

*** END ***

LOCAL BROADCAST STATIONS
AFTER HOURS RECALL

Radio stations in the Russellville area may not be manned after normal business hours or on weekends. These stations have agreed to recall their staff upon notification. This notification will be done by calling until ONE person from each station has been reached.

EAB Radio Group

Name & Numbers	Attempt 1	Attempt 2	Attempt 3	Result
Aaron Elmore Home (479) 890-0508 Studio Numbers (479) 968-6816 (479) 968-6821				
Johnny Story Studio Numbers (479) 968-6816 (479) 968-6821				
KMTC Radio Melissa Krueger Studio Number (479) 968-7400				
KXRJ AIU Radio (May Not Respond If No One is There) (479)-968-0222 Or (479)-317-7127 Or (479)-968-0583				

APPENDIX C

ANO SWS Testing and Maintenance Procedures

Arkansas Nuclear One Siren Warning System Maintenance Plan

Created 7/16/2008
Rev. Date 9/15/2020

Siren Site Maintenance Plan

Siren #:_____ Tech: _____ Date:_____

Perform the following inspections/tests and record condition/results:

NOTE: Ensure the use of proper PPE

NOTE: Take photo (s) of siren damage as needed.

	Check the Following:	Completed	COMMENTS/REPAIRS PERFORMED
1	Record siren number. Technician's name & date in spaces provided above.		
2	Check Trees and Vegetation around Cabinet, Antenna and Horns. So as not to damage or affect sirens function, e.g. trees near horns, cannot access controls.		
3	Check Pole for damage, e.g. leaning, sinking, severe oxidation, ground rods missing, loose or cut.		
4	Check Radio Antenna for damage, e.g. missing, elements missing.		
5	Check for upper horn damage.		
6	Check Cabinet for damage, e.g. door seals, severe dents or distortion, lock broken, water or insect intrusion.		
7	Check Electronics for damage, e.g. loose connections, corrosion, chafing of wires, heat discoloration & surge suppressor.		
8	Check Batteries for damage, e.g. terminal corrosion, casing distortion, heat discoloration **-PERFORM LOAD TEST-**		
9	Check the Power Drop for damage, e.g. weather head not sealed, splices exposed, cables frayed, cable insulation damaged, disconnect malfunction.		
10	Check and record battery voltage.		Voltage =_____ VDC
11	Monitor Battery voltage while running a silent test. Ensure battery voltage goes no lower than 21 VDC.		
12	Plug in charger - watch for charger to come on & current meter to rise.		
13	Run Silent Test. Check that all amplifier LED's are on and all components are turned on.		

NOTE: ADDITIONAL COMMENTS ON BACK

	Arkansas Nuclear One Siren Warning System Maintenance Plan

NOTE NATURE OF REPAIR: (Parts replaced, Possible cause of the problem)

NOTE IF ADDITIONAL ACTION(S) IS REQUIRED: (Driver replacement, Battery change)

WHELEN®
ENGINEERING COMPANY INC.
51 Winthrop Road
Chester, Connecticut 06412-0684
Phone. (800) 63SIREN
Phone: (860) 526-9504
Fax: (860) 526-4784
Internet: www.whelen.com
Sales e-mail: iowsales@whelen.com
Customer Service e-mail: iowserv@whelen.com

Mass Notification

WPS-2800 SERIES HIGH POWER VOICE & SIREN SYSTEM

Operating and Troubleshooting Manual

For warranty information regarding this product, visit **www.whelen.com/warranty**

Form No 13580C (100710)

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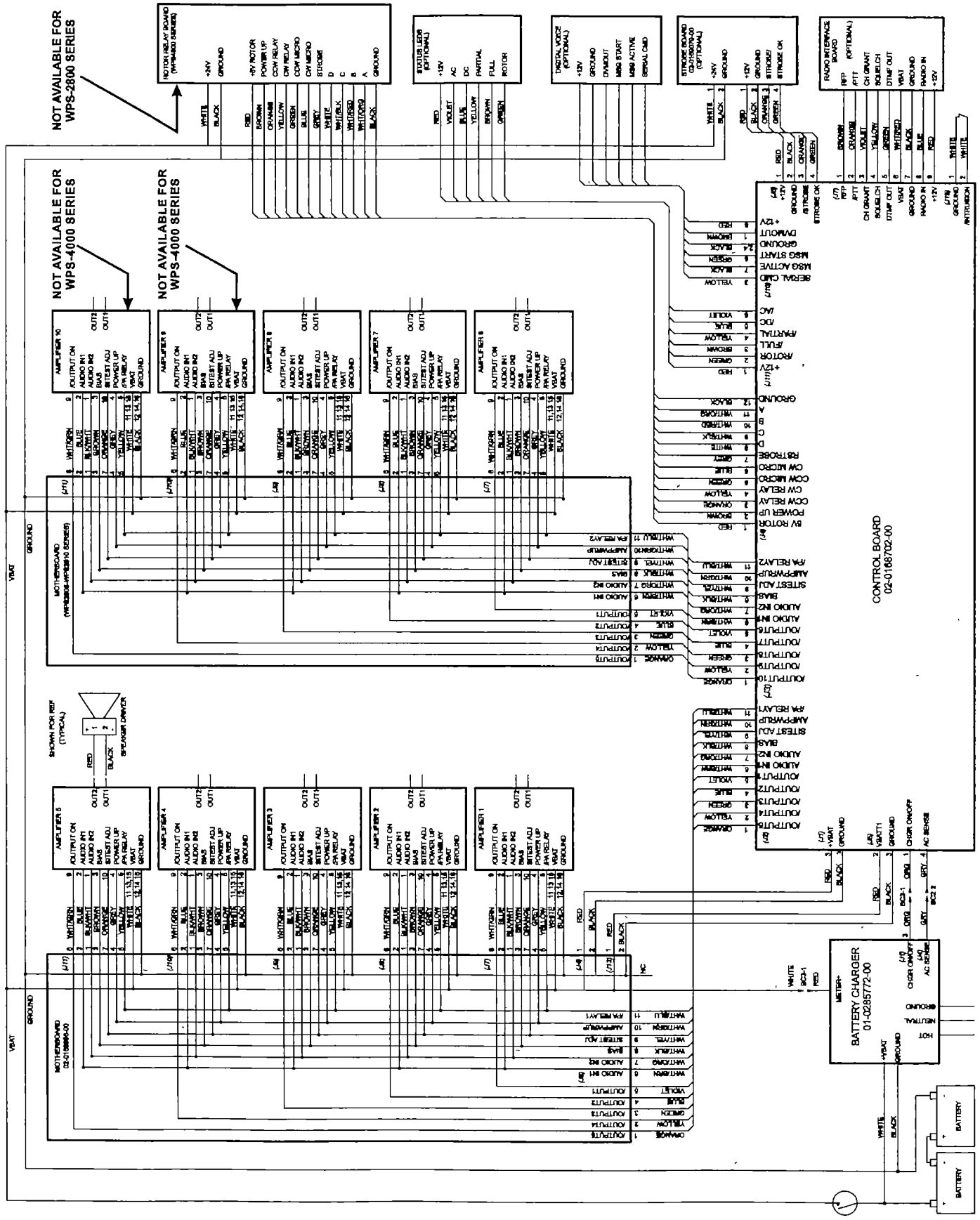
Illustrations

Fig. 1: Station Wiring Diagram



Section I: Overview of System Components

a) Station Component Locations

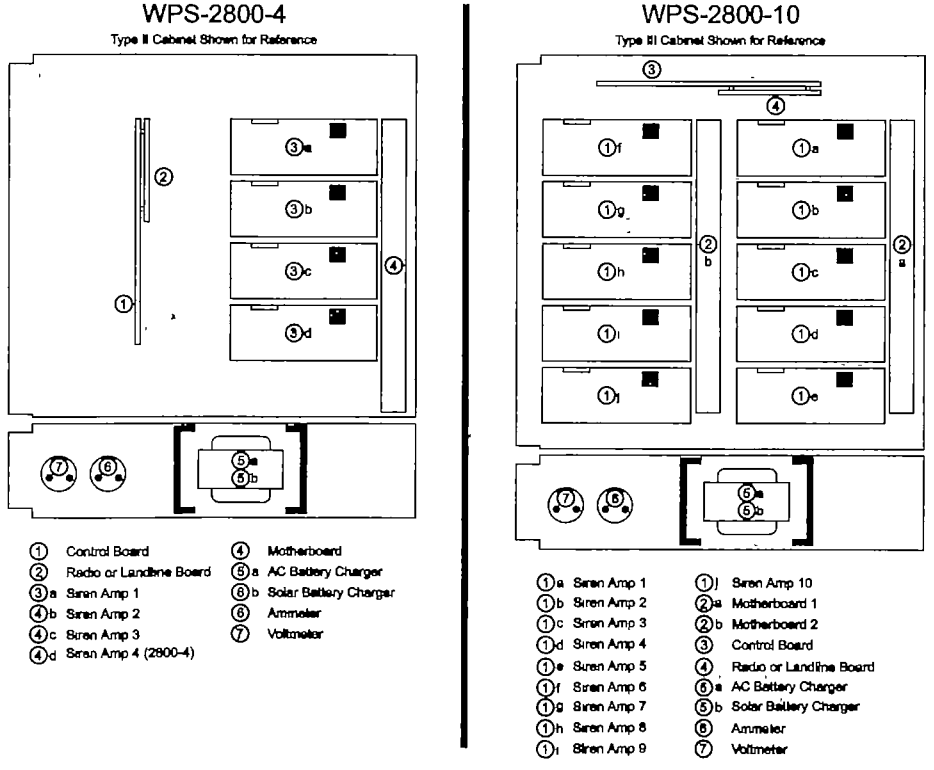
The WPS-2800 High-Power Voice and Siren System is comprised of 10 basic models:

Model	Driver Info	Cabinet
WPS-2800-1	One (1), 400 Watt Driver	Type II
WPS-2800-2	Two (2), 400 Watt Drivers	Type II
WPS-2800-3	Three (3), 400 Watt Drivers	Type II
WPS-2800-4	Four (4), 400 Watt Drivers	Type II
WPS-2800-5	Five (5), 400 Watt Drivers	Type II
WPS-2800-6	Six (6), 400 Watt Drivers	Type II
WPS-2800-6A	Six (6), 400 Watt Drivers	Type III
WPS-2800-7	Seven (7), 400 Watt Drivers	Type III
WPS-2800-8	Eight (8), 400 Watt Drivers	Type III
WPS-2800-9	Nine (9), 400 Watt Drivers	Type III
WPS-2800-10	Ten (10), 400 Watt Drivers	Type III

Each system essentially functions in the same manner as do the others. This manual will provide the necessary information to properly operate, program and diagnose this system regardless of specific model. If information relevant to a specific model is required, it shall be presented and noted as such.

The 2800 series systems are comprised of several major components common to all models, although quantities of some components will vary from model to model.

Fig. 2: Siren Cabinet Door Components



b) Station Components Defined

Control Board - **This component (located on the inside of the upper cabinet door) controls the key functions of the WPS4000 system including:**

Tone Generation	**Remote Activation**
Event Timing	**Rotor Control**
Remote Station Status Reporting* (encoding)	**Local Control**
System Diagnostics (incl. SI TEST®)*	

*** optional equipment**

The control board contains a microphone jack for public address and a serial port to allow connection of a palm computer (hereafter referred to as a PalmPC) to the remote station. The control board is also the location of the diagnostic LED's.

Siren Amps - **These components (located on the inside of the upper cabinet door) receive the desired tone or message generated by the control board, amplify it and deliver it to the siren driver.**

Siren Driver - **This component (located in the speaker assembly) produces the desired audible tone or voice message.**

Radio or Landline Board (Optional) - **This component (located on the inside of the upper cabinet door) receives signals from either the antenna or landline and delivers them to the control board for processing. Through the use of the included radio, the station is also capable of transmitting status information back to the control center.**

Motherboard - **This component (located on the inside of the upper cabinet door) distributes Battery Voltage and signals to all system components that require this voltage. The motherboard is fused @10 Amps to protect all connected components EXCEPT for the siren amplifiers and the rotor (they contain their own fuse). The 2nd motherboard (WPS4000-8 only) is also fused @10 Amps. The Motherboard also distributes signals between the amplifiers and the control board.**

AC Battery Charger - **This component (located on the inside of the lower cabinet door) uses 110 VAC (or 220 VAC) single-phase service to maintain the stations batteries at their proper voltages.**

Solar Regulator (optional) **- This component (located on the inside of the lower cabinet door) uses electrical energy collected by a pole-mounted solar panel to maintain the station batteries at their proper voltages.**

Ammeter **- This component (located on the inside of the lower cabinet door) provides a visual indication for the charge current flowing into the batteries from the charger or regulator.**

Voltmeter **- This component (located on the inside of the lower cabinet door) provides a visual indication of the DC voltage across the batteries.**

Auxiliary Control Status Board (optional) **- This component (located on the right inside wall of the upper cabinet) is wired to remote switches to facilitate remote operation of a specific siren station.**

Batteries **- These components (located on the inside of the lower cabinet) provide the 28VDC necessary for the system to operate.**

Battery Disconnect Switch **- This component (located on the rear inside wall of the upper cabinet) allows all system batteries to be completely disconnected from the system. NOTE: This switch does not disconnect the batteries from the battery charger or regulator.**

Antenna Poly Phaser (optional) **- This component suppresses high-voltage (static) charges that could be present on the antenna.**

Antenna (optional) **- This component (located on the utility pole) is capable of either receiving signals broadcast from the control center (one-way) or can both transmit and receive signals to and from the control center (two-way), depending how the system was ordered.**

Solar Panel (optional) **- This component (located on the utility pole) collects solar energy, converts it to electrical energy and delivers it to the Solar Regulator to maintain the station batteries at their proper voltage.**

Strobe Control Board (optional) **- This component (located on the rear inside wall of the upper cabinet) is a user-defined device that controls a pole-mounted strobe light. This light can be configured to activate during specific conditions (example: when any tone or message is generated).**

Intrusion Alarm (optional) **- This sensor (located on the door jam of the upper cabinet door) detects the opening of the cabinet door. If the station is equipped with this option, the alarm is configured to transmit a signal back to the control center.**

Section II: System Operations

a) Remote Operations

Remote operation of a WPS-2800 series siren involves transmitting signals from the control center to the desired station. This is accomplished by using either an encoder and transmitter or, if the station is so equipped, using an auxiliary control status board that has been wired to switches/controls at the control center. Remote operation is beyond the scope of this document and will therefore not be addressed. If your system is equipped with an encoder, please refer to the encoder operating manual for information regarding remote operation. If your station has been wired to use the auxiliary control status board, refer to the reference materials provided by the electrical engineer or installer.

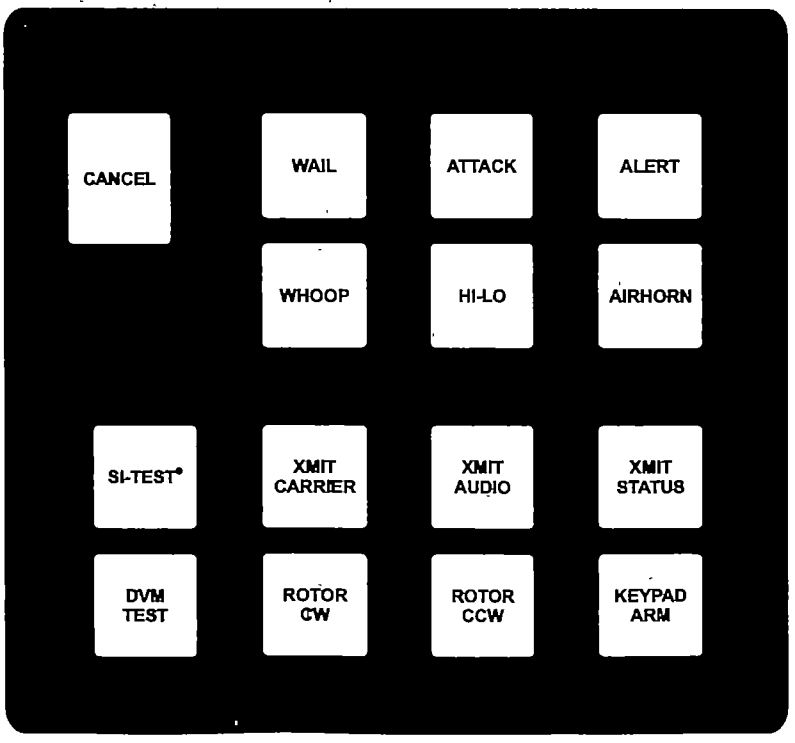
b) Local Operations

Local operation is accomplished through the control panel on the front of the station cabinet. The functions of these controls are as follows:

Cancel	**Abruptly stops siren tones without the normal "ramp down" found in several tones. Helpful in the event of an accidental tone activation.**
Wail	**Produces a slow rise and fall tone.**
Attack	**Produces a faster rise and fall tone (used for designated Civil Defense National Attack tone).**
Alert	**A steady tone (Civil Defense alert).**
Whoop	**A repetitive rise-only tone.**
Hi-Low	**An alternating two-tone sound.**
Air Horn	**A pulsing air horn sound.**
SI TEST®	**Initiates SI TEST® tone and the optional diagnostic SI TEST® routine.**
Xmit Carrier	**Actuates remote station radio transmitter PTT circuit. When tone squelch is used with the transmitter, the transmit function is used when adjusting tone squelch modulation.**

Xmit Audio	**For use with remote station radio transceiver, causes transmission of DTMF tone via RF link for tone modulation adjustment. The transmit tone level is adjusted with the transmit audio potentiometer located on the controller board (see "Fig. 4: System LED Diagnostic Indicators" page 28).**
Xmit Status	**Transmits station status information and battery voltage to the control center.**
DVM Test	**Activates the Digital Voice Message (DVM) assigned to the test procedure in the configuration software.**
Rotor CW	**No function with 2800-series equipment.**
Rotor CCW	**No function with 2800-series equipment.**
Keypad Arm	**Enables local station operation via keypad. Once pressed, the keypad remains active until either a) another keypad button is pressed, or b) 60 seconds have elapsed, whichever comes first. The Keypad Arm button must be pressed each time a keypad button is to be pressed. Note that the Cancel button is always enabled and does not require Keypad Arm to be pressed.**

Fig. 3: Station Control Panel



Section III: Understanding Station Addressing

Every Siren Station in a given area code has its own, unique "Station Address". This address allows the user to select an individual or a group of stations. As stated elsewhere in this manual, a valid station address can be any number from 0000 to 9999. This allows for 10,000 unique addresses; a staggering number of stations to keep track of. Although it is logistically impossible to have that many stations in a single area code, it does illustrate the importance of a sensible, intuitive numbering convention for station addresses. This section will outline two types of conventions

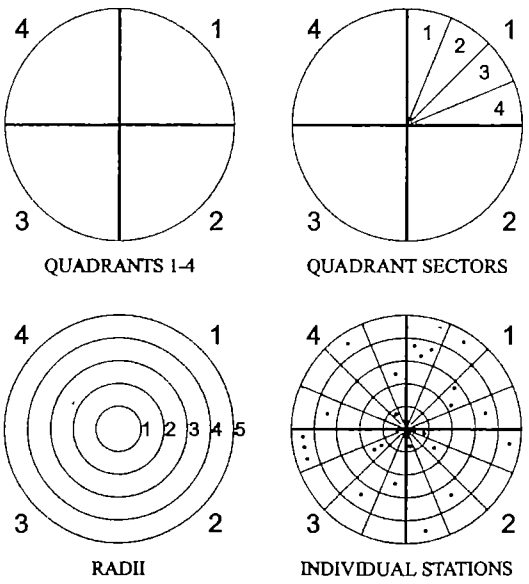
Central Point Source: Quadrant, Sector, Radial & Station

Frequently, warning systems are used to notify the public of emergency situations that may occur from a single, centralized location. Typically, siren stations would be located throughout a 360° area surrounding this location for a specified distance from the source. In this scenario, the Central Point Source convention would be well suited.

For illustration purposes, assume the siren stations are installed within a 5 mile radius of the Central Point. As such, a Quadrant, Sector, Radial & Station numbering convention would allow the selection of any of the following:

- **any siren station**
- **all siren stations**
- **any one of four sectors**
- **any one of 5 radii within the sectors**

The area of coverage in this system, a circle, is divided into 4 quadrants. Each quadrant is then divided into 4 sectors. Each sector is further divided into 5 segments or radii emanating from the center of this siren system.



In this system, a stations address is structured as follows:

Digit	Allocation
1	Quadrant (1 to 4)
2	Sector (1 to 4)
3	Radii (1 to 5)
4	Individual station within a radian

Here are some sample activations to further illustrate this concept.

Sample 1:

A station with address 1354 would be located in:

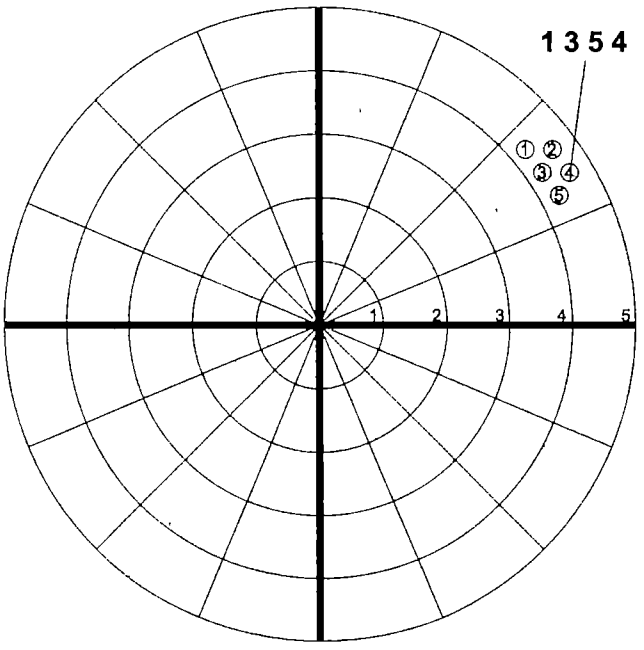
Quadrant: 1

Sector: 3 of Quadrant 1

Radial: 5

Station: 4

If an operator selects station 1-3-5-4, only that station will be selected, as shown.



SINGLE STATION SELECTION
STATION 1354

Sample 2:

If the activation of a group of remote stations within a whole segment of a radius within a quadrant and sector is desired, the fourth digit address is substituted with a "Wild Card", the "#" pound sign.

An address selection of 1 - 3 - 4 - # would activate the system as follows:

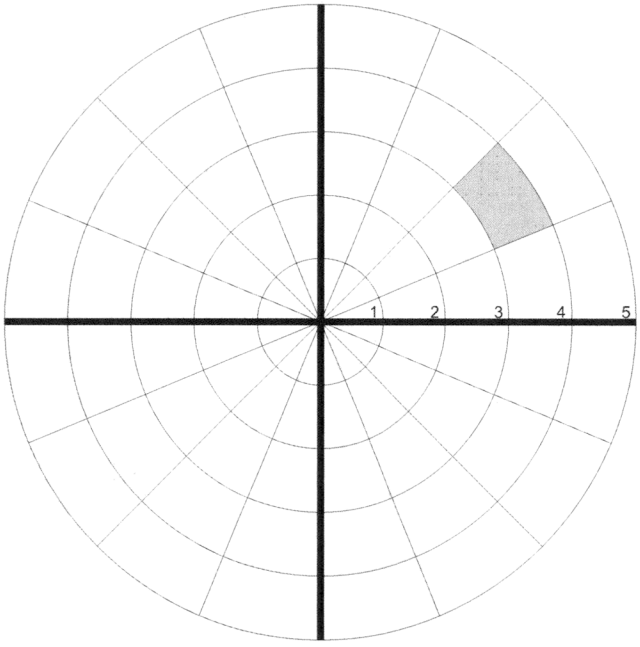
Quadrant: **1**

Sector: **3 of Quadrant 1**

Radial: **4**

Station: **# All stations defined by above**

This selection is shown below.



GROUP SELECTION-RADIAL SECTOR
GROUP 134#

Sample 3:

Selection of an entire sector can be accomplished by using the following address:

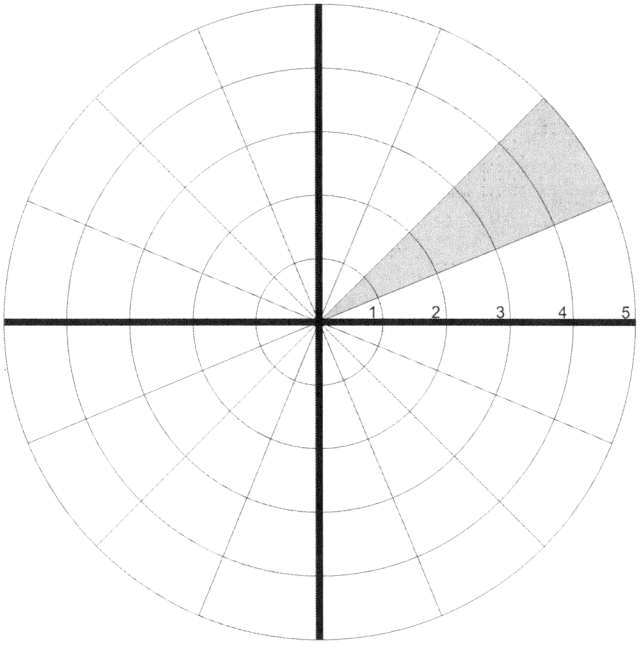
Quadrant: 1

Sector: 3 of Quadrant 1

Radial: # All radial 1 - 3

Station: # All stations defined by above

In selecting a sector, the first two digits of the address are set for the sector address, for example 1 - 3 (Quadrant 1 - Sector 3). The third and fourth digits are substituted with a # (Wild Card). Therefore, the address to select all stations in sector 1-3 is 1 - 3 - # - #. This selection is represented below.



GROUP SELECTION-SUB-SECTOR
GROUP13##

Sample 4:

The selection of a complete quadrant can be achieved by using the following address:

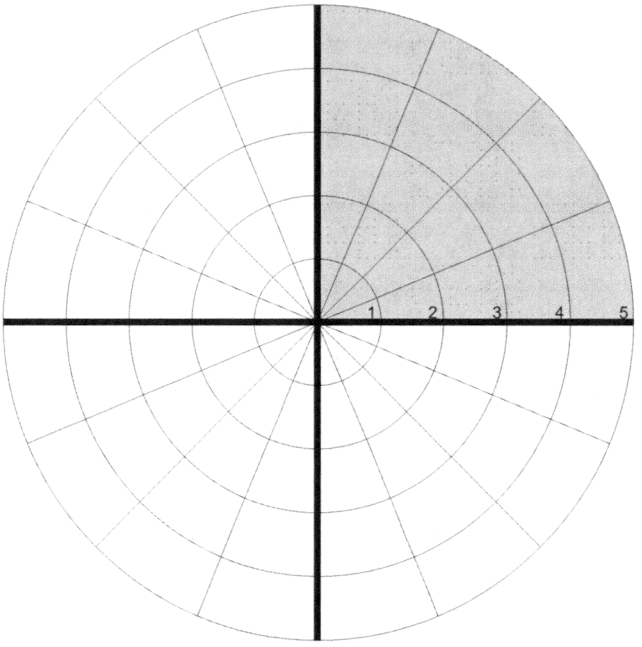
Quadrant: **1**

Sector: **# All sectors of Quadrant 1**

Radial: **# All radials in all sectors of Quadrant 1**

Station: **# All stations defined by above**

When selecting a quadrant, the first digit designates the Quadrant (1). the second, third and fourth digits are replaced with Wild Cards (#,#,#). Therefore, the address for selecting all stations in quadrant 1 is 1 - # - # - # as illustrated below.



GROUP SELECTION-QUADRANT
GROUP###

Sample 5:

All stations in a system may be accessed by using the Wild Card (#) for all address numbers. The address would be # - # - # - #.

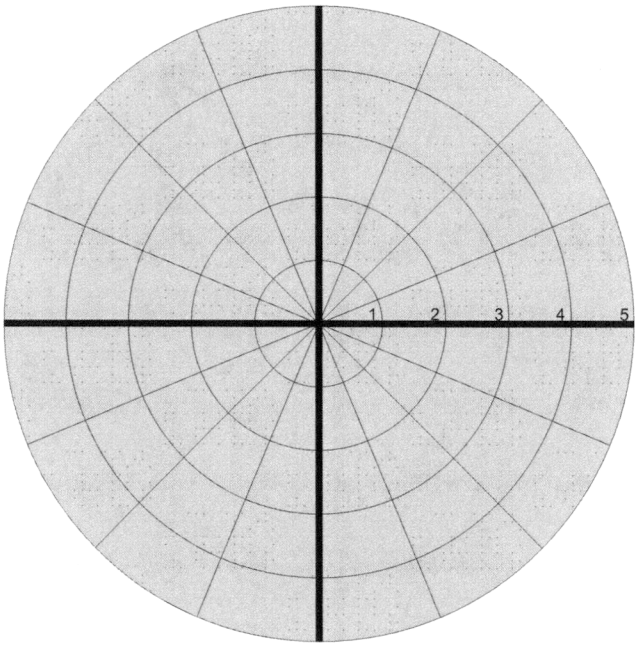
Quadrant: **# All Quadrants**

Sector: **# All sectors of all Quadrant**

Radial: **# All radials of all sectors of all Quadrants**

Station: **# All stations defined by above**

This "All Call" is illustrated as shown.



GROUP SELECTION-"ALL-CALL"
GROUP ####

Governmental: County, City & Station

For this next type of address structure, assume that the siren system in question is used primarily for tornado warnings throughout a major population center. This center encompasses three counties with each county having no more than ten cities. Two cities contain more than 50 high-power voice and siren stations.

The following represents a Governmental System 4-digit address configuration, allowing activation by "All Call", county group activations, city group activations and individual station activations:

```
X          X          X          X
:          :          :..........:..... Individual Siren Station (0 - 9)
:          :
:          :.......................... City (0 - 9)*
:
:.......................................... County (0 - 9)
```

***One digit could also be reserved for unincorporated areas.**

An address of 2 - 5 - 4 - 5 would indicate the following individual station:

Siren Station 45, in City 5, in County 2.

The WIld Card (#) permits the use of several different types of group activations. Three samples follow:

Sample 1: County Activation (1 - # - # - #)
All Siren Stations in all Cities in County 1 will be activated by this transmission.

Sample 2: City Activation (1 - 5 - # - #)
All Siren Stations in City 5 of County 1 will be activated by this transmission.

Sample 3: System All Call (# - # - # - #)
All Siren Stations in all Cities in all Counties will be activated by this transmission.

Section IV: Troubleshooting

Audio Loss

If after activating the siren there is no audio output, perform the following procedure step by step. This procedure will require a digital multimeter.

1. **Locate the Audio Presence LED on the controller board (see "Fig. 4: System LED Diagnostic Indicators" on page 28). When audio is present on the board, this LED will be on.**

2. **Activate the WAIL siren tone from the control panel on the siren cabinet. Confirm that the Audio Presence LED is on. If this LED is not on *or* if it turns off quickly, measure the battery voltage. The siren will not activate if battery voltage drops below 19 VDC. Be sure to measure the battery voltage at the same time you activate the siren. The batteries may show a good float voltage while they are not under load, but upon activation, the battery voltage may drop below 19 VDC if their capacity is low. Note that when the siren shuts down and the load is removed from the batteries, the voltage may rapidly return to 25 VDC or more. If this condition is occurring, the batteries will need to be replaced. If the voltages are in the normal range, proceed to step 3.**

3. **Locate connector J2 on the control board. With your multimeter set to AC volts, measure across pins 6 and 7 (White with Orange stripe and White with Brown stripe). With the siren tone running, 5 VAC should be present. *If no voltage is present, the controller board is probably at fault.***
   NOTE: Confirm that the audio presence LED is on while performing these measurements. It indicates that the siren controller is still activated. If the specified voltages are present, proceed to step 4.

4. **With the siren tone still active, measure across pin 1 (Blue wire) and pin 2 (Black w/ White trace) on each of the siren amplifiers. 5 VAC should be present at each amplifier. If so, proceed to step 5. If no voltage is measured, this is indicitive of a wiring problem between the controller board and the siren amplifiers. Check the wiring between these components**

5. **Remove the Red siren driver lead from each siren amplifier. Press "Cancel" on the control panel and then press "Wail". Measure across the output of each amplifier (White Weco connector) with the siren driver disconnected. 70 VAC should be measured. If this voltage leve is measured, proceed to step 6. If this voltage level is not found and 5 VAC was measured at the input, proceed to step 7.**

6. **Set your meter to measure resistance at its lowest scale. Measure across each of the speaker drivers, making sure that at least one wire of each driver is removed from the power amplifier (or else the transformer in the amp is being measured as well). Each driver should have a DC resistance of approximately 3 Ohms +/- .3 Ohms. If a resistance value outside of this range is found, contact factory.**

7. Set your meter to measure DC Volts. Connect the negative lead of your meter to ground (one of the solid black wires in the multi-position connector on the amplifier is a good ground source). With a siren tone activated, measure the following wires for the following voltages (approximately):

Grey	6 VDC
Brown	5 VDC
Solid White (all)	24 VDC

AC Battery Charger

The AC-powered battery charger has two charging modes: Equalization Mode and Float Charge Mode. The charger is in equalization mode when AC power is first applied; the charger will stay in equalization mode until the battery voltage reaches approximately 31.5 VDC. Once the battery voltage reaches that point, the charger will switch to float voltage mode. In that mode it will charge the batteries to the appropriate voltage relative to the temperature or the batteries (25 to 29 VDC).

The AC battery charger contains two circuit boards positioned on either side of the large transformer. One of these boards contains a single, green LED, while the other board contains a pair of LED's, one green and one yellow. This pair of LED's provides diagnostic information for the battery charger. The following chart defines their various diagnostic states.

Solar Regulator

The following procedure can be performed to confirm proper operation of the solar regulator:

1. Disconnect the solar panel from the charger. With a DC voltmeter, measure the voltage across the wires coming from the solar panel. The voltage should be greater than 32 VDC (NOTE: The solar panel must be in direct sunlight).
2. Reconnect the solar panel to the charger. Monitor the battery voltage with the cabinet voltmeter. The float voltage will vary between 25 to 30 VDC, depending on battery temperature. When the solar regulator is charging, the DC LED on the circuit board will be on. During normal operation the charger will cycle on and off.

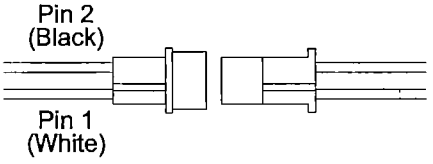
The float voltage will vary with battery temperature. The following is a brief description of the normal charging cycle:

If the float voltage for the current temperature of the batteries is 26 VDC, the regulator will turn on at 26 VDC (LED will come on) and it will charge the batteries to 28 VDC. Once the battery voltage reaches 28 VDC, the regulator will turn off (LED will go off), and the battery voltage will be allowed to drop to 26 VDC. The cycle would then repeat itself. If the float voltage was 27 VDC, it would cycle from 27 VDC to 29 VDC.

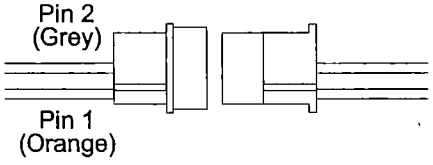
	Green LED	Yellow LED
OFF	Not Working	Normal Condition
FLASHING	Serial Communications Failed	No Thermistor or Thermistor is bad
ON	Charger Operating Properly	Equalization voltage mode

When AC power is applied to the battery charger, the following voltages should be measured on the wires coming off the charger:

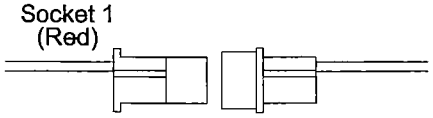
Note: Refer to "Fig. 1: Station Wiring Diagram" page 3.



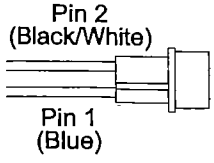
(BC-1)Two-Position Connector -
Charger output wires (25 to 32 VDC)



(BC-2)Three-Position Connector -
19 VDC from Grey to Ground
(Black wire in BC-1)



(BC-3)Two-Position Connector -
Battery Voltage to ground
(Black wire in BC-1) *Note:Only when the siren is powered up.; this is sourced from the siren motherboard.*



(BC-4)Two-Position Connector -
No Connection / Not Used

Digital Voice

1. **Remove all amplifier fuses.**
2. **Install an 8 ohm speaker at amplifier audio input connector pins 1 and 2 (Blue and Black w/White wires) in the 16 position connector.**
3. **Select a siren tone by pressing one of the controls on the front panel.**
4. **If the tone can be heard through the speaker, press the DVM-Test control to play the predesignated message.**

Partial or Full Diagnostic Failure

This procedure is to be used if the Partial or Full diagnostic LED (located on the controller board) indicates that a problem has been detected. A Partial indication means that at least one speaker and/or amplifier is operational. A Full indication means that all speakers and amplifiers are operational. ***NOTE: In order for a good Full indicator to be valid, a good Partial indicator must also be present).***

1. **Connect the PalmPC to the siren station *via* the com port on the front of the siren cabinet control panel.**
2. **Display the "Status" screen on the PalmPC.**
3. **Press the SI TEST® control on the front control panel.**
4. **Each amplifier contains a red LED that is visible on the front of the control panel. Note if all the LED's are on. Tap the "Update Status" button on the PalmPC and note which amp is displaying an error.**
5. **Open the front panel and swap the speaker driver wires from the amplifier that indicated a failure, with an amplifier with a lit LED. For example: if the LED for amplifier 1 is the only LED not on, install amplifier 1 speaker wires onto amplifier 2 and install amplifier 2 speaker wires onto amplifier 1. This will diagnose if it is the speaker or the amplifier that has failed. You may also measure the DC resistance of the speaker driver with your ohm meter. Be sure that the speaker driver wires are disconnected from the amp prior to measuring. A good driver will read 3 ohms +/- .3 ohms.**

Section V: Maintenance

Although The WPS-2800 is of a dependable, solid-state design, periodic activation, field inspection and preventive maintenance is recommended to insure the maximum performance of each station.

Frequency of Testing and Activation

A system of twice-monthly activation and confirmation, combined with a quarterly service and preventive maintenance is recommended to help insure the successful performance of a station. Increasing the frequency of testing will support and improve a station's test record.

Stations located in environmentally adverse locations will require inspection and preventive maintenance at more frequent intervals than just discussed. Stations should always be inspected following severe storms.

If a station is activated by remote control (landline or radio), the twice-monthly activation should be performed using the remote control link.

The twice-monthly activation of a station can be confirmed by several different methods, depending upon the options selected with each Whelen System.

Local Site Confirmation

For a basic station activated at the cabinet, or by landline or radio, have an observer confirm that the station activated audibly. The observer should report successful as well as failed station tests. Station Performance Logs should be maintained. It is important to understand that audible confirmation alone is not assurance that the station is operating at 100% power. This requires inspecting the station in greater detail.

Stations may be optionally equipped with counters that advance upon radio or tone generator activation. These counters do not confirm total operation or the final expected output of an outdoor warning device.

If a station is equipped with SI TEST® diagnostics (optional), the station's activation may be confirmed using SI TEST® or full power siren mode. Following an activation, SI TEST® displays its information on control board mounted LED's or through a LED display board visible on the right side of the cabinet. Fig. 17 shows the location and function of the LED's on the control board. The cabinet mounted display board LED's will confirm the following (from Left to Right):

Red	**AC Power**
Yellow	**DC Power at minimum proper operating level**
Red	**Partial Amplifier and Speaker Driver Operation**
Green	**Full Amplifier and Speaker Driver Operation**
? Red	**Rotor Operation**

Following activation and observation the results should be noted in the performance log. Any indication of incomplete operation presented by the LED indicators should prompt IMMEDIATE service attention.

The SI TEST® system retains information until cleared by a specific command.

The SI TEST® information stored at the station, if not cleared, will update itself automatically with subsequent SI TEST® activations.

Remote Monitoring and Confirmation

Stations equipped with the optional Whelen COMM/STAT™ Command and Status Monitoring control, allow remote monitoring of status as well as confirmation of system activation. COMM/STAT™ returns the results of a remote station activation (both SI TEST® and siren warning mode) in a DTMF encoded format via radio link.

Remote monitoring by RF link eliminates the necessity of physically visiting a station to confirm an activation.

Following the activation of a station, a "Status Request" may be sent to that station by DTMF encoded radio command. Diagnostic SI TEST® information is then presented to the status encoder at the station, converted into DTMF code and transmitted back to the control center, where one of several COMM/STAT™ base station products will convert the DTMF code into meaningful information.

Quarterly Maintenance

Developing a quarterly inspection and preventive maintenance program for an outdoor warning station requires a thorough understanding of all the elements and expectations of the system. The following section provides an overview and basic guideline for quarterly station inspection and preventive maintenance program for the sample station.

Visual Siren Station Physical Inspection

- **Observe the speaker cluster, siren cabinet and AC Service for any signs of damage or loose mounting hardware (Some shrinkage of a newly treated utility pole may occur in the first several years following installation, requiring the tightening of mounting hardware.**

- **Check all conduit for watertight connection and entrance into the siren cabinet.**

- **Inspect the AC Service for damage, blown fuses, degraded (corroded) power connections and integrity of the lightning arrestor.**

- **Inspect the grounding system for AC Service, Siren Cabinet and pole top equipment. Verify connections and acceptability of earth ground.**

- **Observe the pole for any shifting and/or leaning. Poles that are not plumb will not properly direct alerting sounds.**

- **Examine entire station for any signs of vandalism or forced entry.**

Siren Cabinet and Components

- **Inspect AC Outlet, fuse and surge suppression equipment. Examine system for infiltration of foreign material(s), rodents or other pests.**

- **Inspect and, if necessary, clean all drain holes and vent screens.**

- **Inspect battery terminal connections and clean if necessary. Re-apply silicone coating to battery terminals if necessary. Observe battery voltage with siren in inactive state (AC power must be on to station, otherwise station must be powered up to observe meter).**

- **Examine all wiring harnesses for chafing. Verify wiring terminations for tightness and wiring connections for proper electrical connections. Replace and correct any corroded or marginal connections. Inspect antenna for proper connection.**

Speaker Assembly and Pole Top Equipment

NOTE: Any examination of Pole Top equipment should be performed with the station audibly disabled.

- **Inspect speaker for blockage by rodents, pests or other foreign material. Clean if necessary. Inspect any wiring cables or harnesses for chafing. Inspect the siren driver compartment for infiltration of foreign materials, rodents or pests. Clean if necessary. Confirm that the driver compartment will allow for water or moisture drainage. Inspect speaker wiring connections for any sign of corrosion.**

- **Verify tightness of all mounting hardware.**
- **Check all wiring terminations and connections.**
- **Verify lubrication of the rotor gear train. The recommended inspection interval is initially 6 months. Following the initial two inspections, the owner may determine if a longer inspection interval is acceptable. Varying weather conditions will affect this interval. Many stations are located in areas of the country where an annual inspection/ lubrication interval is acceptable.**

Station Performance Testing

NOTE: Depending on local conditions and station options selected, the station may be tested on or off line. Off line testing of the station involves disconnecting the speaker drivers from the siren amplifiers, so as not to disturb the public when verifying tone generator operation. A complete test must, however, include the testing of the siren amplifier operation. This can be accomplished inaudibly on units equipped with SI TEST®. Other units must be audibly tested.

A basic routine, verifying the performance and operation of the sample station previously described, would be as follows:

1. **Local and Remote Activation -**

   Activation of each remote station function by local control and remote control. With amplifiers on and off line as needed. An examination of each activation function will also facilitate a verification of related and subsequent system module activations and electrical connections that would be caused by an activation command. Also confirm function time outs (ex.: does the Alert signal time out at three minutes as per user specification?).

2. **Response to Station Address and All Call address programming -**

   Control Center reception and activation on SI TEST® or non-tone activation, for individual station address and All Call address selection.

3. **Public Address -**

   With the station on line, activation of PA for both local and remote control, verifying PA Audio path and proper set up level of volume. Verify AC drop out on PA.

4. **Siren Amplifiers -**

   Inspect for complete operation with speaker drivers (observe LED's).

5. **SI TEST® Station Analysis -**

Observe and confirm diagnostic status of:
AC
DC
Partial Amplifier & Speaker Driver Operation (disable one amplifier to confirm this test).
Full Amplifier & Speaker Driver Operation
NOTE: Verify AC drop out during SI TEST® mode.

6. **Battery Charger Operation -**

Observe for proper charging operation.
Verify AC drop out in PA or SI TEST® mode.

7. **Batteries -**

Verify voltage stability under load.
Perform a load test.

8. **Status Encoder -**

Perform a diagnostic SI TEST® of the station.
Compare status information with observations made locally at the station.
Disable one speaker and verify that the "Full" LED indicator is off.
Disable AC and verify that the "AC" LED indicator is off.
Compare battery voltage return status with observed and measured battery voltage.

9. **Transmitter -**

Check status encoder DTMF tone level modulation with transmitter.
Check transmitter set up.
Verify power output and SWR.

NOTE:On concluding any examination of a station where connectors have been opened and closed , a final radio test by either SI TEST® or full power should be performed and the results observed for a complete successful test. The PA audio path should also be audibly verified by sending PA and broadcast a voice message.

The following is a sample form that may be used for quarterly inspection and maintenance.

MAINTENANCE CHECK LIST

Station #:_____ **Siren Address:**_____

Installation Date:____/____/____ **Inspection Date:**_____

Inspector:_____

PHYSICAL INSPECTION:

	OK	NOT OK	COMMENT
Mounting Hardware	___	_____	_____
Speaker Assembly	___	_____	_____
AC Service	___	_____	_____
Proper Grounding	___	_____	_____
Solar Panels*	___	_____	_____
Antenna*	___	_____	_____
Conduit Connections	___	_____	_____
Siren Case Assembly	___	_____	_____
Batteries	___	_____	_____
Components Secure	___	_____	_____
Harnesses	___	_____	_____

LOCAL OPERATIONAL TESTING

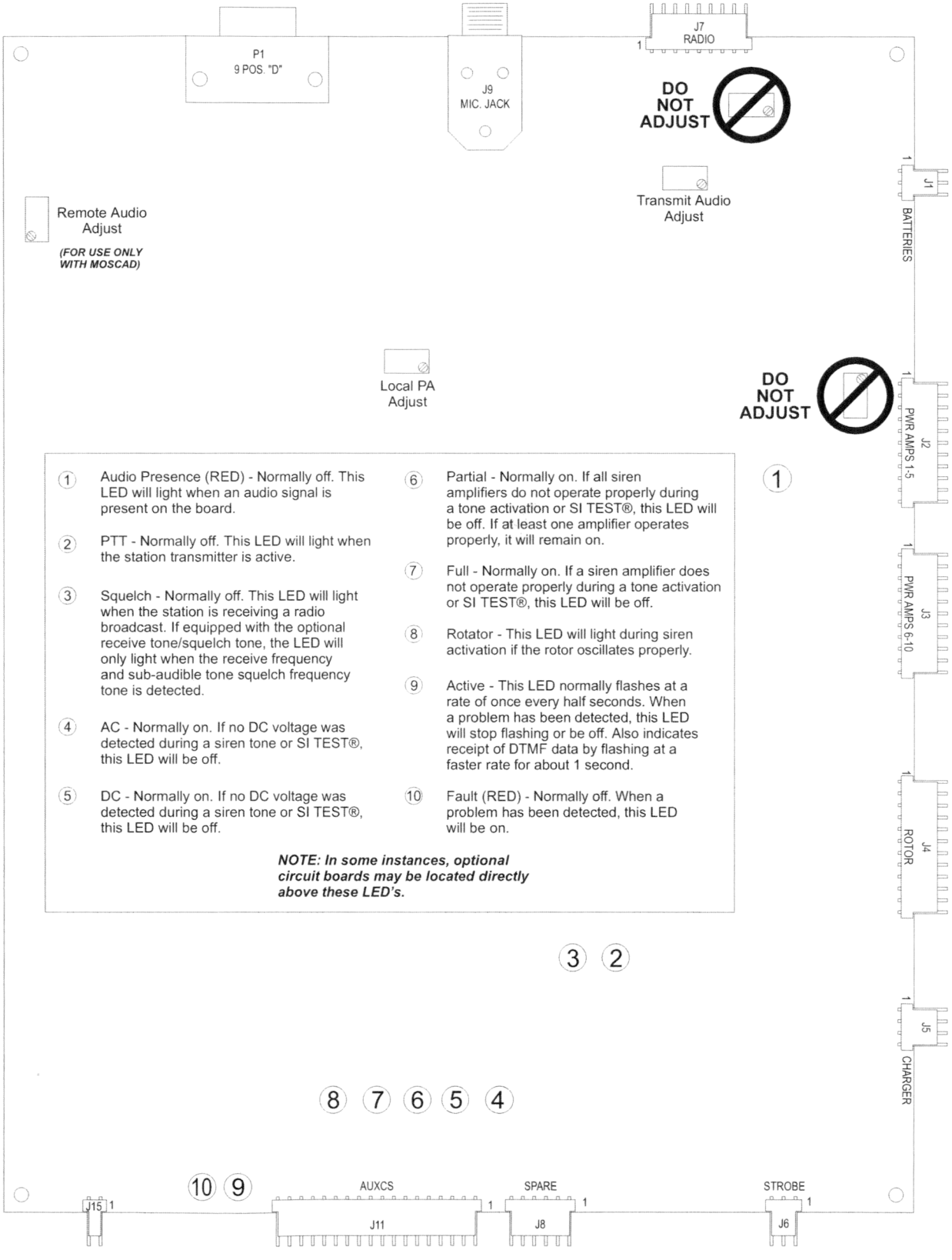
Battery Voltage	___	_____	_____
Manual Test:			
Clear	___	_____	_____
Wail	___	_____	_____
Attack	___	_____	_____
Alert	___	_____	_____
Airhorn	___	_____	_____
Hi-Lo	___	_____	_____
Whoop	___	_____	_____
Clockwise	___	_____	_____
Counter Clockwise	___	_____	_____
(SI TEST®):*	___	_____	_____
AC LED	___	_____	_____
DC LED	___	_____	_____
Partial LED	___	_____	_____
Full LED	___	_____	_____
Rotor LED	___	_____	_____
Timer Set LED	___	_____	_____
Audio Present LED	___	_____	_____
Microphone	___	_____	_____
Mic Volume	___	_____	_____

MAINTENANCE CHECK LIST
(continued)

	OK	NOT OK	COMMENT
Radio*:			
Squelch Control	___	_____	_____
Sensitivity	___	_____	_____
Antenna Tuned*	___	_____	_____
Transmit LED	___	_____	_____
Remote Activation:			
Clear	___	_____	_____
Wail	___	_____	_____
Attack	___	_____	_____
Alert	___	_____	_____
Public Address	___	_____	_____
Airhorn	___	_____	_____
Hi-Lo	___	_____	_____
Whoop	___	_____	_____
Wail / 5 Sec.	___	_____	_____
All Call	___	_____	_____
Speaker LEDs:			
1	___	_____	_____
2	___	_____	_____
3	___	_____	_____
4	___	_____	_____
5	___	_____	_____
6	___	_____	_____
7	___	_____	_____
8	___	_____	_____
9	___	_____	_____
10	___	_____	_____
SI TEST®:			
AC	___	_____	_____
DC	___	_____	_____
Partial	___	_____	_____
Full	___	_____	_____
Status Request	___	_____	_____
Intrusion*	___	_____	_____

*Optional

Fig. 4: System LED Diagnostic Indicators



1. Audio Presence (RED) - Normally off. This LED will light when an audio signal is present on the board.
2. PTT - Normally off. This LED will light when the station transmitter is active.
3. Squelch - Normally off. This LED will light when the station is receiving a radio broadcast. If equipped with the optional receive tone/squelch tone, the LED will only light when the receive frequency and sub-audible tone squelch frequency tone is detected.
4. AC - Normally on. If no DC voltage was detected during a siren tone or SI TEST®, this LED will be off.
5. DC - Normally on. If no DC voltage was detected during a siren tone or SI TEST®, this LED will be off.
6. Partial - Normally on. If all siren amplifiers do not operate properly during a tone activation or SI TEST®, this LED will be off. If at least one amplifier operates properly, it will remain on.
7. Full - Normally on. If a siren amplifier does not operate properly during a tone activation or SI TEST®, this LED will be off.
8. Rotator - This LED will light during siren activation if the rotor oscillates properly.
9. Active - This LED normally flashes at a rate of once every half seconds. When a problem has been detected, this LED will stop flashing or be off. Also indicates receipt of DTMF data by flashing at a faster rate for about 1 second.
10. Fault (RED) - Normally off. When a problem has been detected, this LED will be on.

NOTE: In some instances, optional circuit boards may be located directly above these LED's.

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⚠ **WARNING:** This product can expose you to chemicals including Methylene Chloride which is known to the State of California to cause cancer, and Bisphenol A, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

WPS-2900 SERIES HIGH POWER VOICE & SIREN SYSTEM

OPERATING & TROUBLESHOOTING MANUAL

Mass Notification

Form No.13948F (050911)

For warranty information regarding this product, visit **www.whelen.com/warranty**

Table Of Contents

Illustrations

IMPORTANT! THIS MANUAL ASSUMES THE READER/TECHNICIAN HAS AN INTERMEDIATE TO ADVANCED LEVEL OF PROFESSIONAL TRAINING IN THE FIELD OF ELECTRONICS.

Fig. 1a: Station Wiring Diagram (designations)

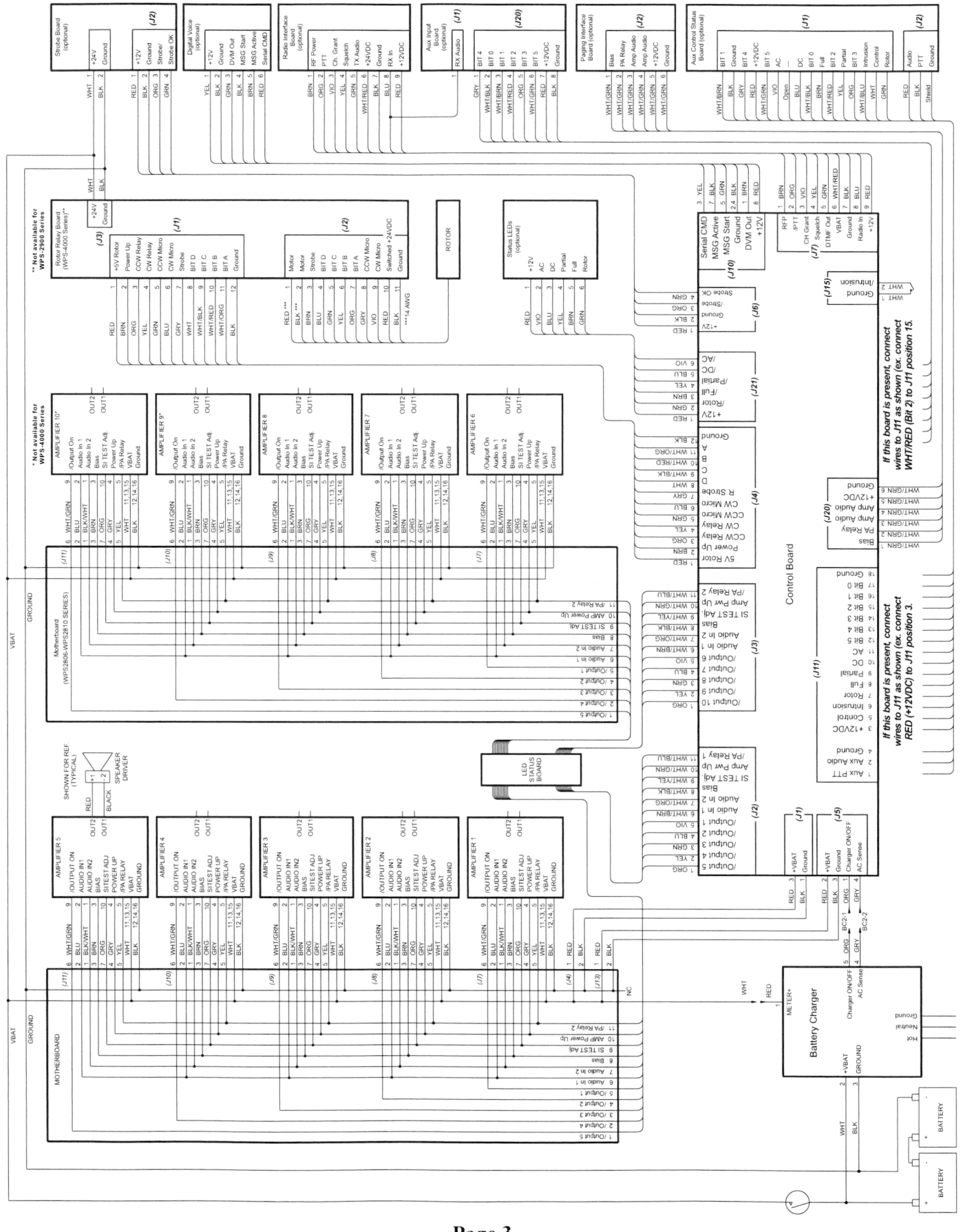
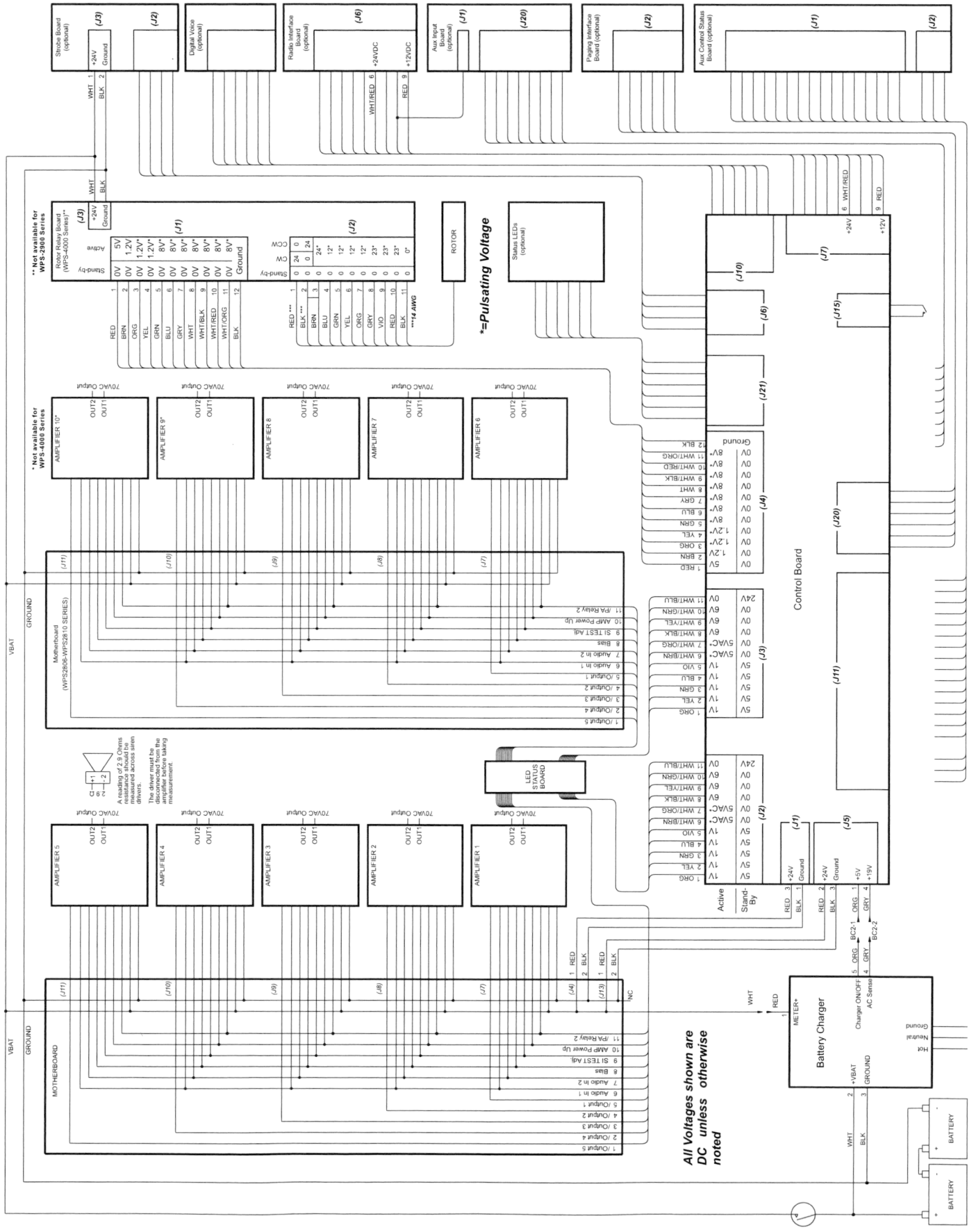


Fig. 1b: Station Wiring Diagram (voltages)



Section I: Overview of System Components

a) Station Component Locations

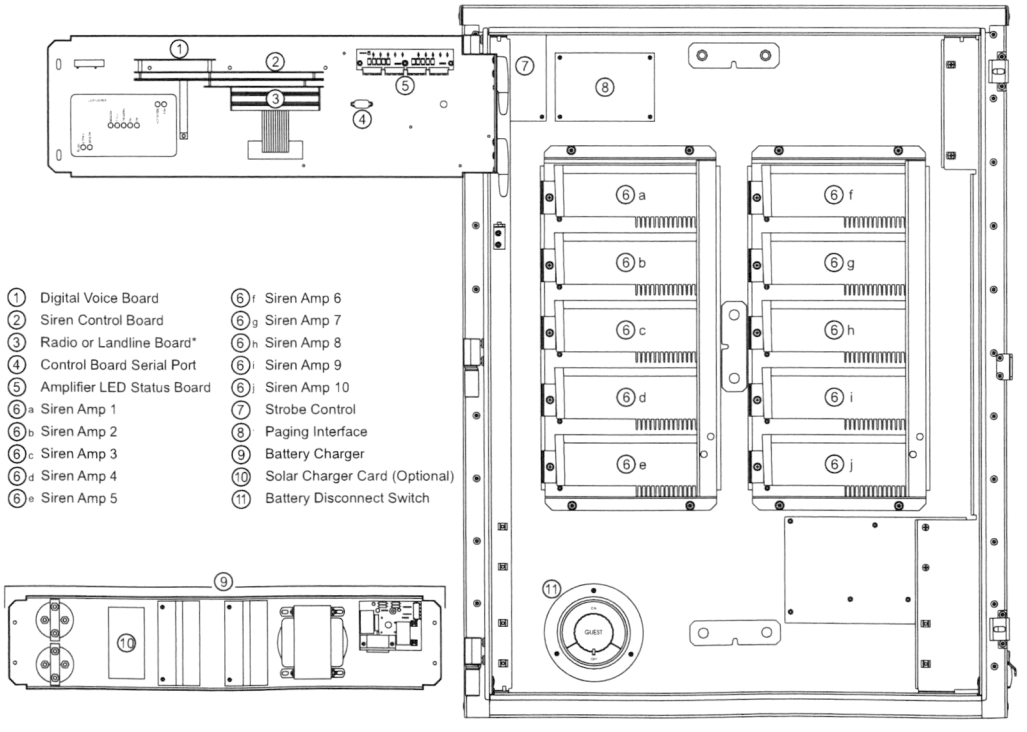
The WPS-2900 High-Power Voice and Siren System is comprised of 10 basic models:

Model	Driver Info	Cabinet
WPS-2900-1	One (1), 400 Watt Driver	Type II
WPS-2900-2	Two (2), 400 Watt Drivers	Type II
WPS-2900-3	Three (3), 400 Watt Drivers	Type II
WPS-2900-4	Four (4), 400 Watt Drivers	Type II
WPS-2900-5	Five (5), 400 Watt Drivers	Type II
WPS-2900-6	Six (6), 400 Watt Drivers	Type II
WPS-2900-6A	Six (6), 400 Watt Drivers	Type III
WPS-2900-7	Seven (7), 400 Watt Drivers	Type III
WPS-2900-8	Eight (8), 400 Watt Drivers	Type III
WPS-2900-9	Nine (9), 400 Watt Drivers	Type III
WPS-2900-10	Ten (10), 400 Watt Drivers	Type III

Each system essentially functions in the same manner as do the others. This manual will provide the necessary information to properly operate, program and diagnose this system regardless of specific model. If information relevant to a specific model is required, it shall be presented and noted as such.

The 2900 series systems are comprised of several major components common to all models, although quantities of some components will vary from model to model.

Fig. 2: Siren Cabinet Door Components



b) Station Components Defined

Control Board **- This component (located on the inside of the upper cabinet door) controls the key functions of the WPS2900 system including:**

Tone Generation
Event Timing
Remote Station Status Reporting* (encoding)
System Diagnostics (incl. SI TEST®)
Remote Activation
Rotor Control
Local Control

The control board contains a microphone jack for public address and a serial port to allow connection of our Siren Diagnostic Programming Tool Software (hereafter referred to as SDPTS) to the remote station. The control board is also the location of the diagnostic LED's.

Siren Amps **- These components (located on the inside of the upper cabinet door) receive the desired tone or message generated by the control board, amplify it and deliver it to the siren driver.**

Siren Driver **- This component (located in the speaker assembly) produces the desired audible tone or voice message.**

Radio or Landline Board (Optional) **- This component (located on the inside of the upper cabinet door) receives signals from either the antenna or landline and delivers them to the control board for processing. Through the use of the included radio, the station is also capable of transmitting status information back to the control center.**

Motherboard **- This component (located on the inside of the upper cabinet door) distributes Battery Voltage and signals to all system components that require this voltage. The motherboard is fused @10 Amps to protect all connected components EXCEPT for the siren amplifiers and the rotor (they contain their own fuse). The 2nd motherboard (WPS2900-6 thru WPS2900-10) is also fused @10 Amps. The Motherboard also distributes signals between the amplifiers and the control board.**

AC Battery Charger **- This component (located on the inside of the lower cabinet door) uses 110 VAC (or 220 VAC) single-phase service to maintain the stations batteries at their proper voltages.**

Solar Regulator (optional) **- This component (located on the inside of the lower cabinet door) uses electrical energy collected by a pole-mounted solar panel to maintain the station batteries at their proper voltages.**

Ammeter **- This component (located on the inside of the lower cabinet door) provides a visual indication for the charge current flowing into the batteries from the charger or regulator.**

Voltmeter **- This component (located on the inside of the lower cabinet door) provides a visual indication of the DC voltage across the batteries.**

Auxiliary Control Status Board (optional) **- This component (located on the right inside wall of the upper cabinet) is wired to remote switches to facilitate remote operation of a specific siren station.**

Auxiliary Input Control (optional) **- This component (located below the "Radio/Landline Board" on the rear inside wall of the upper cabinet) is wired to remote switches to facilitate limited remote operation of a siren station. In contrast to the Auxiliary Control Status Board, the Auxiliary Input Control Board does not offer feedback capabilities and is limited to the following remote activation commands:**

- **All Siren Tones**
- **Cancel**
- **SI TEST®**
- **Digital Voice Messages 1 thru 4**

Batteries **- These components (located on the inside of the lower cabinet) provide the 28VDC necessary for the system to operate.**

Battery Disconnect Switch **- This component (located on the rear inside wall of the upper cabinet) allows all system batteries to be completely disconnected from the system. NOTE: This switch does not disconnect the batteries from the battery charger or regulator.**

Antenna Poly Phaser (optional) **- This component suppresses high-voltage (static) charges that could be present on the antenna.**

Antenna (optional) **- This component (located on the utility pole) is capable of either receiving signals broadcast from the control center (one-way) or can both transmit and receive signals to and from the control center (two-way), depending how the system was ordered.**

Solar Panel (optional) **- This component (located on the utility pole) collects solar energy, converts it to electrical energy and delivers it to the Solar Regulator to maintain the station batteries at their proper voltage.**

Strobe Control Board (optional) **- This component (located on the rear inside wall of the upper cabinet) is a user-defined device that controls a pole-mounted strobe light. This light can be configured to activate during specific conditions (example: when any tone or message is generated).**

Intrusion Alarm (optional) **- This sensor (located on the door jam of the upper cabinet door) detects the opening of the cabinet door. If the station is equipped with this option, the alarm is configured to transmit a signal back to the control center.**

Paging Interface (optional) **- This component (located below the "Strobe Control Board" on the rear inside wall of the upper cabinet) is a user-defined device that serves as an interface between the siren cabinet and an existing, in-house public address system. This board has an output relay with a 1 Amp rated closure that can be used for a "Push To Talk" function.**

Section II: System Operations

a) Remote Operations

Remote operation of a WPS-2900 series siren involves transmitting signals from the control center to the desired station. This is accomplished by using either an encoder and transmitter or, if the station is so equipped, using an auxiliary control status board that has been wired to switches/controls at the control center. Remote operation is beyond the scope of this document and will therefore not be addressed. If your system is equipped with an encoder, please refer to the encoder operating manual for information regarding remote operation. If your station has been wired to use the auxiliary control status board, refer to the reference materials provided by the electrical engineer or installer.

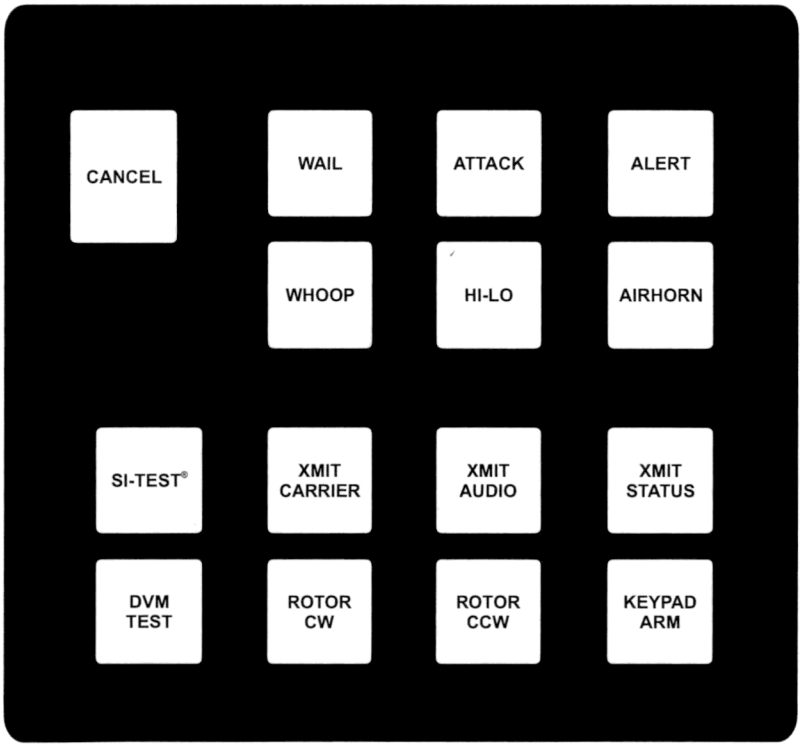
b) Local Operations

Local operation is accomplished through the control panel on the front of the station cabinet. The functions of these controls are as follows:

Cancel	**Abruptly stops siren tones without the normal "ramp down" found in several tones. Helpful in the event of an accidental tone activation.**
Wail	**Produces a slow rise and fall tone.**
Attack	**Produces a faster rise and fall tone (used for designated Civil Defense National Attack tone).**
Alert	**A steady tone (Civil Defense alert).**
Whoop	**A repetitive rise-only tone.**
Hi-Low	**An alternating two-tone sound.**
Air Horn	**A pulsing air horn sound.**
SI TEST®	**Initiates SI TEST® tone and the optional diagnostic SI TEST® routine.**
Xmit Carrier	**Actuates remote station radio transmitter PTT circuit. When tone squelch is used with the transmitter, the transmit function is used when adjusting tone squelch modulation.**

Xmit Audio	**For use with remote station radio transceiver, causes transmission of DTMF tone via RF link for tone modulation adjustment.**
Xmit Status	**Transmits station status information and battery voltage to the control center.**
DVM Test	**Activates the Digital Voice Message (DVM) assigned to the test procedure in the configuration software.**
Rotor CW	**No function with 2900-series equipment.**
Rotor CCW	**No function with 2900-series equipment.**
Keypad Arm	**Enables local station operation via keypad. Once pressed, the keypad remains active until either a) another keypad button is pressed, or b) 60 seconds have elapsed, whichever comes first. The Keypad Arm button must be pressed each time a keypad button is to be pressed. Note that the Cancel button is always enabled and does not require Keypad Arm to be pressed.**

Fig. 3: Station Control Panel



Section III: Understanding Station Addressing

Every Siren Station in a given area code has its own, unique "Station Address". This address allows the user to select an individual or a group of stations. As stated elsewhere in this manual, a valid station address can be any number from 0000 to 9999. This allows for 10,000 unique addresses; a staggering number of stations to keep track of. Although it is logistically impossible to have that many stations in a single area code, it does illustrate the importance of a sensible, intuitive numbering convention for station addresses. This section will outline two types of conventions

Central Point Source: Quadrant, Sector, Radial & Station

Frequently, warning systems are used to notify the public of emergency situations that may occur from a single, centralized location. Typically, siren stations would be located throughout a 360° area surrounding this location for a specified distance from the source. In this scenario, the Central Point Source convention would be well suited.

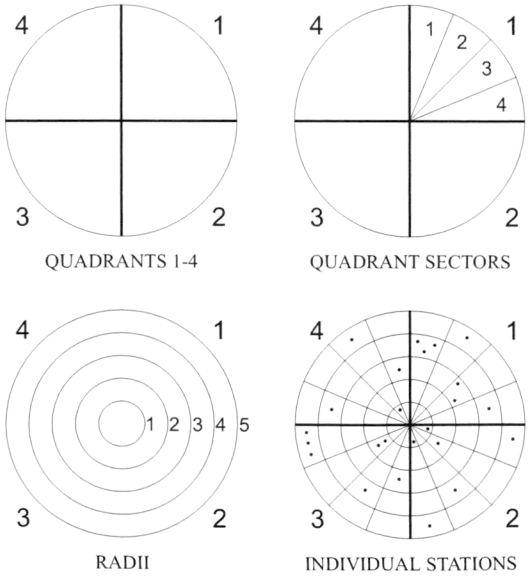
For illustration purposes, assume the siren stations are installed within a 5 mile radius of the Central Point. As such, a Quadrant, Sector, Radial & Station numbering convention would allow the selection of any of the following:

- **any siren station**
- **all siren stations**
- **any one of four sectors**
- **any one of 5 radii within the sectors**

The area of coverage in this system, a circle, is divided into 4 quadrants. Each quadrant is then divided into 4 sectors. Each sector is further divided into 5 segments or radii emanating from the center of this siren system.

Fig. 4:

Central Point Source Divisions



In this system, a stations address is structured as follows:

Digit	Allocation
1	Quadrant (1 to 4)
2	Sector (1 to 4)
3	Radii (1 to 5)
4	Individual station within a radian

Here are some sample activations to further illustrate this concept.

Sample 1:

A station with address 1354 would be located in:

Quadrant: 1

Sector: 3 of Quadrant 1

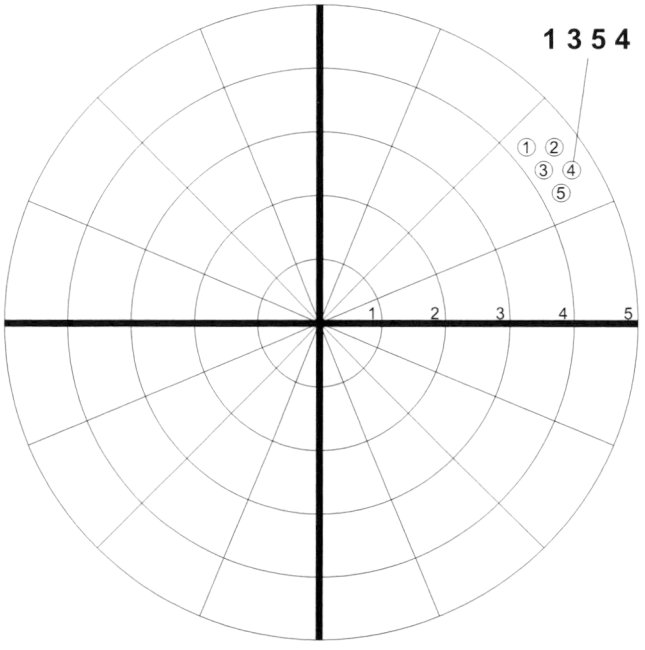
Radial: 5

Station: 4

If an operator selects station 1-3-5-4, only that station will be selected, as shown.

Fig. 5:

Single Station Selection



SINGLE STATION SELECTION
STATION 1354

Sample 2:

If the activation of a group of remote stations within a whole segment of a radius within a quadrant and sector is desired, the fourth digit address is substituted with a "Wild Card", the "#" pound sign.

An address selection of 1 - 3 - 4 - # would activate the system as follows:

Quadrant: **1**

Sector: **3 of Quadrant 1**

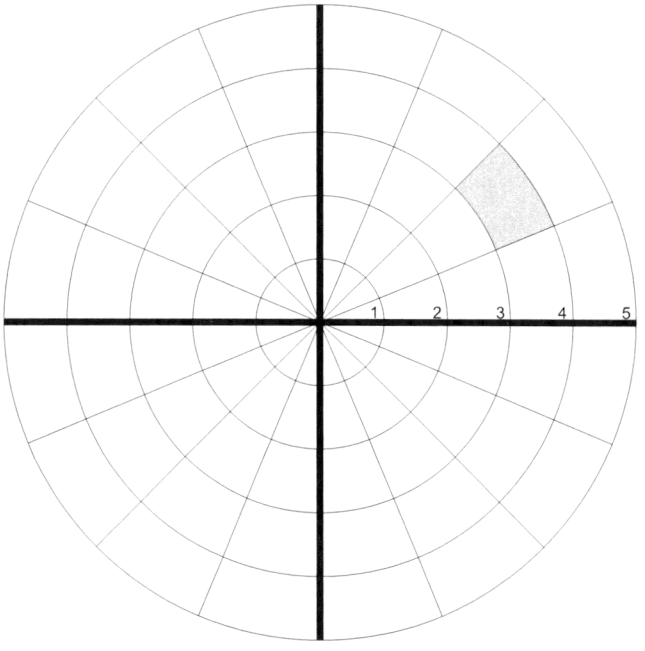
Radial: **4**

Station: **# All stations defined by above**

This selection is shown below.

Fig. 6:

Group Selection - Radial Sector



GROUP SELECTION-RADIAL SECTOR
GROUP 134#

Sample 3:

Selection of an entire sector can be accomplished by using the following address:

Quadrant: **1**

Sector: **3 of Quadrant 1**

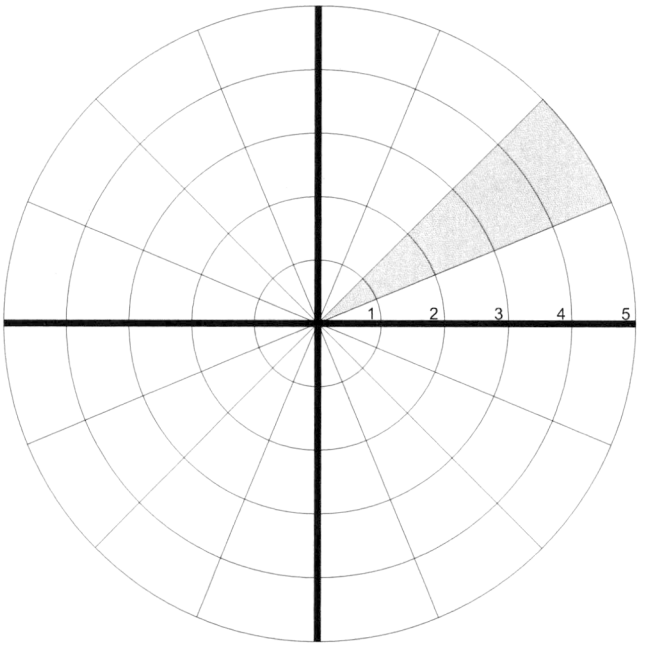
Radial: **# All radial 1 - 3**

Station: **# All stations defined by above**

In selecting a sector, the first two digits of the address are set for the sector address, for example 1 - 3 (Quadrant 1 - Sector 3). The third and fourth digits are substituted with a # (Wild Card). Therefore, the address to select all stations in sector 1-3 is 1 - 3 - # - #. This selection is represented below.

Fig. 7:

Group Selection - Sub Sector



GROUP SELECTION-SUB-SECTOR
GROUP13##

Sample 4:

The selection of a complete quadrant can be achieved by using the following address:

Quadrant: 1

Sector: # All sectors of Quadrant 1

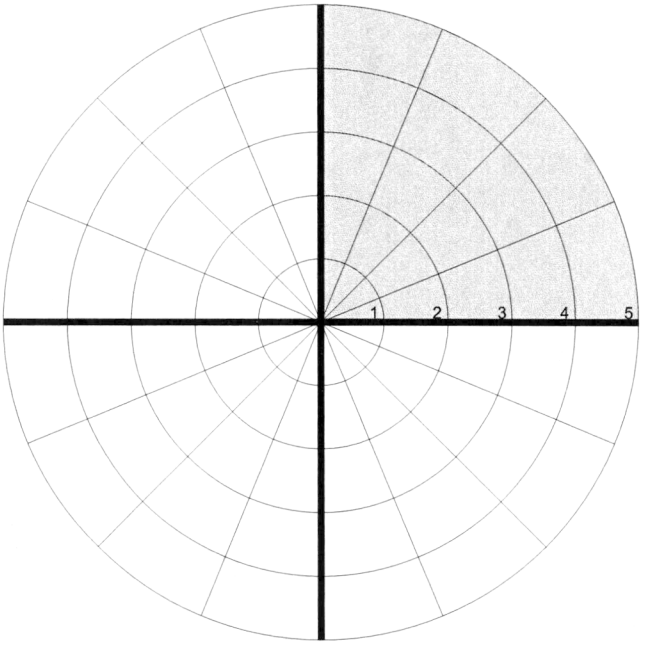
Radial: # All radials in all sectors of Quadrant 1

Station: # All stations defined by above

When selecting a quadrant, the first digit designates the Quadrant (1). the second, third and fourth digits are replaced with Wild Cards (#,#,#). Therefore, the address for selecting all stations in quadrant 1 is 1 - # - # - # as illustrated below.

Fig. 8:

Group Selection - Quadrant



GROUP SELECTION-QUADRANT
GROUP###

Sample 5:

All stations in a system may be accessed by using the Wild Card (#) for all address numbers. The address would be # - # - # - #.

Quadrant: **# All Quadrants**

Sector: **# All sectors of all Quadrant**

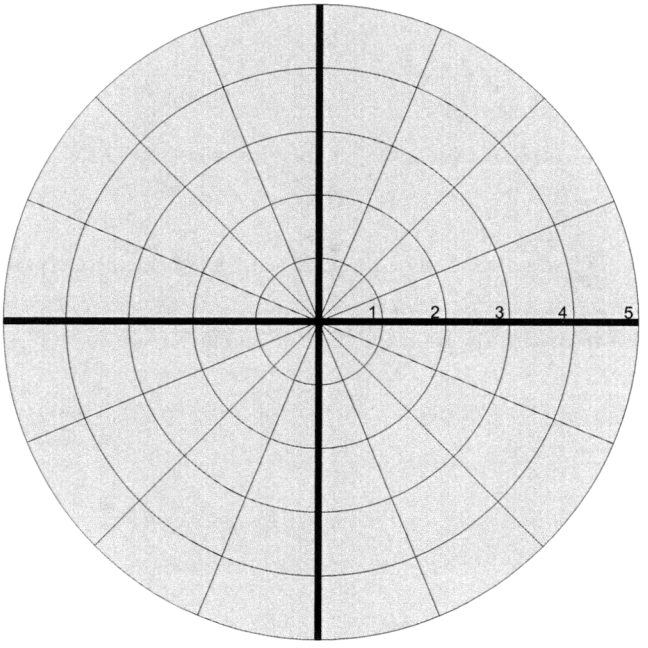
Radial: **# All radials of all sectors of all Quadrants**

Station: **# All stations defined by above**

This "All Call" is illustrated as shown.

Fig. 9:

Group Selection - All-Call



GROUP SELECTION-"ALL-CALL"
GROUP ####

Governmental: County, City & Station

For this next type of address structure, assume that the siren system in question is used primarily for tornado warnings throughout a major population center. This center encompasses three counties with each county having no more than ten cities. Two cities contain more than 50 high-power voice and siren stations.

The following represents a Governmental System 4-digit address configuration, allowing activation by "All Call", county group activations, city group activations and individual station activations:

```
X          X          X          X
:          :          :..........:.......... Individual Siren Station (00 - 99)
:          :
:          :..................................... City (0 - 9)*
:
:.............................................. County (0 - 9)
```

***One digit could also be reserved for unincorporated areas.**

An address of 2 - 5 - 4 - 5 would indicate the following individual station:

Siren Station 45, in City 5, in County 2.

The WIld Card (#) permits the use of several different types of group activations. Three samples follow:

Sample 1: County Activation (1 - # - # - #)
All Siren Stations in all Cities in County 1 will be activated by this transmission.

Sample 2: City Activation (1 - 5 - # - #)
All Siren Stations in City 5 of County 1 will be activated by this transmission.

Sample 3: System All Call (# - # - # - #)
All Siren Stations in all Cities in all Counties will be activated by this transmission.

Section IV: Troubleshooting

Audio Loss

If after activating the siren there is no audio output, perform the following procedure step by step. This procedure will require a digital multimeter.

1. **Locate the Audio Presence LED on the controller board (see "Fig. 11: System LED Diagnostic Indicators" on page 29). When audio is present on the board, this LED will be on.**

2. **Activate the WAIL siren tone from the control panel on the siren cabinet. Confirm that the Audio Presence LED is on. If this LED is not on *or* if it turns off quickly, measure the battery voltage. The siren will not activate if battery voltage drops below 19 VDC. Be sure to measure the battery voltage at the same time you activate the siren. The batteries may show a good float voltage while they are not under load, but upon activation, the battery voltage may drop below 19 VDC if their capacity is low. Note that when the siren shuts down and the load is removed from the batteries, the voltage may rapidly return to 25 VDC or more. If this condition is occurring, the batteries will need to be replaced. If the voltages are in the normal range, proceed to step 3.**

3. **Locate connector J2 on the control board. With your multimeter set to AC volts, measure across pins 6 and 7 (White with Orange stripe and White with Brown stripe). With the siren tone running, 5 VAC should be present. *If no voltage is present, the controller board is probably at fault.***
   NOTE: Confirm that the audio presence LED is on while performing these measurements. It indicates that the siren controller is still activated. If the specified voltages are present, proceed to step 4.

4. **With the siren tone still active, measure across pin 1 (Blue wire) and pin 2 (Black w/ White trace) on each of the siren amplifiers. 5 VAC should be present at each amplifier. If so, proceed to step 5. If no voltage is measured, this is indicitive of a wiring problem between the controller board and the siren amplifiers. Check the wiring between these components**

5. **Remove the Red siren driver lead from each siren amplifier. Press "Cancel" on the control panel and then press "Wail". Measure across the output of each amplifier (White Weco connector) with the siren driver disconnected. 70 VAC should be measured. If this voltage level is measured, proceed to step 6. If this voltage level is not found and 5 VAC was measured at the input, proceed to step 7.**

6. **Set your meter to measure resistance at its lowest scale. Measure across each of the speaker drivers, making sure that at least one wire of each driver is removed from the power amplifier (or else the transformer in the amp is being measured as well). Each driver should have a DC resistance of approximately 3 Ohms +/- .3 Ohms. If a resistance value outside of this range is found, contact factory.**

7. **Set your meter to measure DC Volts. Connect the negative lead of your meter to ground (one of the solid black wires in the multi-position connector on the amplifier is a good ground source). With a siren tone activated, measure the following wires for the following voltages (approximately):**

Grey	**6 VDC**
Brown	**5 VDC**
Solid White (all)	**24 VDC**

AC Battery Charger

The AC-powered battery charger has two charging modes: Equalization Mode and Float Charge Mode. The charger is in equalization mode when AC power is first applied; the charger will stay in equalization mode until the battery voltage reaches approximately 30VDC. Once the battery voltage reaches that point, the charger will switch to float voltage mode. In that mode it will charge the batteries to the appropriate voltage relative to the temperature of the batteries (25 to 29VDC).

The AC battery charger contains three circuit boards. The filter board contains a single, green LED, while two charging boards each contain a pair of LED's, one green and one yellow. This pair of LED's provides diagnostic information for the battery charger. The following chart defines their various diagnostic states.

Charging Board	Green LED	Yellow LED
OFF	Not Working	Normal Condition
ON	Charger Operating Properly	Equalization voltage mode
Filter Board		
OFF	No AC voltage present	*Not Applicable*
ON	AC voltage is present	*Not Applicable*

Solar Regulator

The following procedure can be performed to confirm proper operation of the solar regulator:

1. **Disconnect the solar panel from the charger. With a DC voltmeter, measure the voltage across the wires coming from the solar panel. The voltage should be greater than 32 VDC (NOTE: The solar panel must be in direct sunlight).**
2. **Reconnect the solar panel to the charger. Monitor the battery voltage with the cabinet voltmeter. The float voltage will vary between 25 to 30 VDC, depending on battery temperature. When the solar regulator is charging, the DC LED on the circuit board will be on. During normal operation the charger will cycle on and off.**

The float voltage will vary with battery temperature. The following is a brief description of the normal charging cycle:

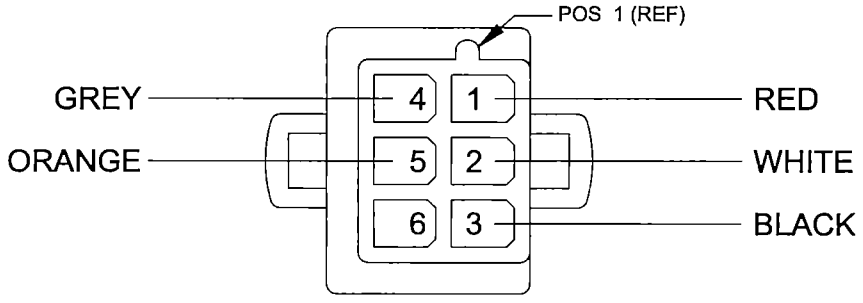
If the float voltage for the current temperature of the batteries is 26 VDC, the regulator will turn on at 26 VDC (LED will come on) and it will charge the batteries to 28 VDC. Once the battery voltage reaches 28 VDC, the regulator will turn off (LED will go off), and the battery voltage will be allowed to drop to 26 VDC. The cycle would then repeat itself. If the float voltage was 27 VDC, it would cycle from 27 VDC to 29 VDC.

When AC power is applied to the battery charger, the following voltages should be measured on the wires coming off the charger:

Note: Refer to "Fig. 1a: Station Wiring Diagram (designations)" page 3.

Fig. 10:

Solar Regulator Connector Pin-outs



REAR VIEW OF PIN HOUSING

Pin Position 1	RED - Battery Voltage to Ground (BLK wire in BC-1) Note: Voltage present only when siren is powered up.; this is sourced from the siren motherboard
Pin Position 2	WHITE - Charger output wires (25 to 31 VDC)
Pin Position 3	BLACK - Charger output wires (25 to 31 VDC)
Pin Position 4	GREY - 19VDC from GREY to Ground (BLK wire in BC-1)
Pin Position 5	ORANGE - 5VDC from ORANGE to Ground (BLK wire in BC-1)
Pin Position 6	Not Used

Digital Voice

1. Remove all amplifier fuses.
2. Install an 8 ohm speaker at amplifier audio input connector pins 1 and 2 (Blue and Black w/White wires) in the 16 position connector.
3. Select a siren tone by pressing one of the controls on the front panel.
4. If the tone can be heard through the speaker, press the DVM-Test control to play the predesignated message.

Partial or Full Diagnostic Failure

This procedure is to be used if the Partial or Full diagnostic LED (located on the controller board) indicates that a problem has been detected. A Partial indication means that at least one speaker and/or amplifier is operational. A Full indication means that all speakers and amplifiers are operational. *NOTE: In order for a good Full indicator to be valid, a good Partial indicator must also be present).*

1. Connect the SDPTS to the siren station *via* the com port on the front of the siren cabinet control panel.
2. Display the "Status" screen on the SDPTS.
3. Press the SI TEST® control on the front control panel.
4. Each amplifier contains a red LED that is visible on the front of the control panel. Note if all the LED's are on. Tap the "Update Status" button on the SDPTS and note which amp is displaying an error.
5. Open the front panel and swap the speaker driver wires from the amplifier that indicated a failure, with an amplifier with a lit LED. For example: if the LED for amplifier 1 is the only LED not on, install amplifier 1 speaker wires onto amplifier 2 and install amplifier 2 speaker wires onto amplifier 1. This will diagnose if it is the speaker or the amplifier that has failed. You may also measure the DC resistance of the speaker driver with your ohm meter. Be sure that the speaker driver wires are disconnected from the amp prior to measuring. A good driver will read 3 ohms +/- .3 ohms.

Section V: Maintenance

Although The WPS-2900 is of a dependable, solid-state design, periodic activation, field inspection and preventive maintenance is recommended to insure the maximum performance of each station.

Frequency of Testing and Activation

A system of twice-monthly activation and confirmation, combined with a quarterly service and preventive maintenance is recommended to help insure the successful performance of a station. Increasing the frequency of testing will support and improve a station's test record.

Stations located in environmentally adverse locations will require inspection and preventive maintenance at more frequent intervals than just discussed.

IMPORTANT! STATIONS SHOULD ALWAYS BE INSPECTED IMMEDIATELY FOLLOWING SEVERE STORMS.

If a station is activated by remote control (landline or radio), the twice-monthly activation should be performed using the remote control link.

The twice-monthly activation of a station can be confirmed by several different methods, depending upon the options selected with each Whelen System.

Local Site Confirmation

For a basic station activated at the cabinet, or by landline or radio, have an observer confirm that the station activated audibly. The observer should report successful as well as failed station tests. Station Performance Logs should be maintained. It is important to understand that audible confirmation alone is not assurance that the station is operating at 100% power. This requires inspecting the station in greater detail.

Stations may be optionally equipped with counters that advance upon radio or tone generator activation. These counters do not confirm total operation or the final expected output of an outdoor warning device.

If a station is equipped with the "Status Display" option, full power station activation can be visually confirmed from outside the siren cabinet. This diagnostic display, located on the right side of the cabinet, will indicate the following:

(from left to right)

Red	**indicates the presence of AC power (if equipped with an AC Battery Charger)**
Yellow	**indicates the presence of DC power at minimum operating level (at least 19VDC)**
Red	**indicates partial amplifier/driver function**
Green	**indicates full amplifier/driver function**
Red	**indicates rotor operation (WPS-4000 systems only)**

This diagnostic function is enabled by either a full power siren tone activation or by performing a SI TEST®.

The same information is available on the control board LED numbers 4 - 8. The "Status" option is not required for the on-board LED's to function.

Following activation and observation, the results should be noted in the performance log. Any indication of incomplete operation presented by the LED indicators should prompt IMMEDIATE service attention.

The system retains diagnostic information until cleared by a specific command.

The diagnostic information stored at the station, if not cleared, will update itself automatically with subsequent SI TEST® or siren tone activations.

Remote Monitoring and Confirmation

Stations equipped with the optional Whelen COMM/STAT™ Command and Status Monitoring control, allow remote monitoring of status as well as confirmation of system activation. COMM/STAT™ returns the results of a remote station activation (both SI TEST® and siren warning mode) in a DTMF encoded format via radio link.

Remote monitoring by RF link eliminates the necessity of physically visiting a station to confirm an activation.

Following the activation of a station, a "Status Request" may be sent to that station by DTMF encoded radio command. Diagnostic information is then presented to the status encoder at the station, converted into DTMF code and transmitted back to the control center, where one of several COMM/STAT™ base station products will convert the DTMF code into meaningful information.

Quarterly Maintenance

Developing a quarterly inspection and preventive maintenance program for an outdoor warning station requires a thorough understanding of all the elements and expectations of the system. The following section provides an overview and basic guideline for quarterly station inspection and preventive maintenance program for the sample station.

Visual Siren Station Physical Inspection

- **Observe the speaker cluster, siren cabinet and AC Service for any signs of damage or loose mounting hardware (Some shrinkage of a newly treated utility pole may occur in the first several years following installation, requiring the tightening of mounting hardware.**

- **Check all conduit for watertight connection and entrance into the siren cabinet.**

- **Inspect the AC Service for damage, blown fuses, degraded (corroded) power connections and integrity of the lightning arrestor.**

- **Inspect the grounding system for AC Service, Siren Cabinet and pole top equipment. Verify connections and acceptability of earth ground.**

- **Observe the pole for any shifting and/or leaning. Poles that are not plumb will not properly direct alerting sounds.**

- **Examine entire station for any signs of vandalism or forced entry.**

Siren Cabinet and Components

- **Inspect AC Outlet, fuse and surge suppression equipment. Examine system for infiltration of foreign material(s), rodents, insects or other pests.**

- **Inspect and, if necessary, clean all drain holes and vent screens.**

- **Inspect battery terminal connections and clean if necessary. Re-apply silicone coating to battery terminals if necessary. Observe battery voltage with siren in inactive state (AC power must be on to station, otherwise station must be powered up to observe meter).**

- **Examine all wiring harnesses for chafing. Verify wiring terminations for tightness and wiring connections for proper electrical connections. Replace and correct any corroded or marginal connections. Inspect antenna for proper connection.**

Speaker Assembly and Pole Top Equipment

NOTE: Any examination of Pole Top equipment should be performed with the station audibly disabled.

- **Inspect speaker for blockage by rodents, pests, insects or other foreign material. Clean if necessary. Inspect any wiring cables or harnesses for chafing. Inspect the siren driver compartment for infiltration of foreign materials, rodents or pests. Clean if necessary. Confirm that the driver compartment will allow for water or moisture drainage. Inspect speaker wiring connections for any sign of corrosion.**

- **Verify tightness of all mounting hardware.**
- **Check all wiring terminations and connections.**

Station Performance Testing

NOTE: Depending on local conditions and station options selected, the station may be tested on or off line. Off line testing of the station involves disconnecting the speaker drivers from the siren amplifiers, so as not to disturb the public when verifying tone generator operation. A complete test must, however, include the testing of the siren amplifier operation. This can be accomplished inaudibly using the SI TEST® command.

A basic routine, verifying the performance and operation of the sample station previously described, would be as follows:

1. **Local and Remote Activation -**
   Activation of each remote station function by local control and remote control. With amplifiers on and off line as needed. An examination of each activation function will also facilitate a verification of related and subsequent system module activations and electrical connections that would be caused by an activation command. Also confirm function time outs (ex.: does the Alert signal time out at three minutes as per user specification?).

2. **Response to Station Address and All Call address programming -**
   Control Center reception and activation on SI TEST® or non-tone activation, for individual station address and All Call address selection.

3. **Public Address -**
   With the station on line, activation of PA for both local and remote control, verifying PA Audio path and proper set up level of volume.

4. **Siren Amplifiers -**
   Inspect for complete operation with speaker drivers (observe LED's).

5. **SI TEST® Station Analysis -**
   Observe and confirm diagnostic status of:
   AC
   DC
   Partial Amplifier & Speaker Driver Operation (disable one amplifier to confirm this test).
   Full Amplifier & Speaker Driver Operation
   NOTE: Verify AC drop out during SI TEST® mode.

6. **Battery Charger Operation -**
   Observe for proper charging operation.
   Verify AC drop out in PA or SI TEST® mode.

7. **Batteries -**
Verify voltage stability under load.
Perform a load test.

8. **Status Encoder -**
Perform a diagnostic SI TEST® of the station.
Compare status information with observations made locally at the station.
Disable one speaker and verify that the "Full" LED indicator is off.
Disable AC and verify that the "AC" LED indicator is off.
Compare battery voltage return status with observed and measured battery voltage.

9. **Transmitter -**
Check status encoder DTMF tone level modulation with transmitter.

Wide Band		Narrow Band	
With CTCSS	3.1 kHz deviation	With CTCSS	1 8 kHz deviation
Without CTCSS	2.5 kHz deviation	Without CTCSS	1.5 kHz deviation

Check transmitter set up.
Verify power output and SWR.

NOTE:On concluding any examination of a station where connectors have been opened and closed , a final radio test by either SI TEST® or full power should be performed and the results observed for a complete successful test. The PA audio path should also be audibly verified by sending PA and broadcast a voice message.

The following is a sample form that may be used for quarterly inspection and maintenance.

MAINTENANCE CHECK LIST

Station #:_____ **Siren Address:**_____

Installation Date:____/____/____ **Inspection Date:**_____

Inspector:_____

PHYSICAL INSPECTION:

	OK	NOT OK	COMMENT
Mounting Hardware			
Speaker Assembly			
AC Service			
Proper Grounding			
Solar Panels*			
Antenna*			
Conduit Connections			
Siren Case Assembly			
Batteries			
Components Secure			
Harnesses			

LOCAL OPERATIONAL TESTING:

Battery Voltage (Stand-by)			
Battery Voltage (Under Load)			
Manual Test:			
Clear			
Wail			
Attack			
Alert			
Airhorn			
Hi/Low			
Whoop			
Clockwise			
Counter-Clockwise			
SI TEST®			
AC LED			
DC LED			
Partial LED			
Full LED			
Rotor LED			
Timer Set LED			
Audio Present LED			
Microphone			
Mic Volume			

*Optional

MAINTENANCE CHECK LIST
(continued)

	OK	NOT OK	COMMENT
Radio*:			
Squelch Control	_____	_____	_____
Sensitivity	_____	_____	_____
Antenna Tuned*	_____	_____	_____
Transmit LED	_____	_____	_____
Remote Activation:			
Clear	_____	_____	_____
Wail	_____	_____	_____
Attack	_____	_____	_____
Alert	_____	_____	_____
Public Address	_____	_____	_____
Airhorn	_____	_____	_____
Hi/Low	_____	_____	_____
Whoop	_____	_____	_____
Wail / 5 Sec.	_____	_____	_____
All Call	_____	_____	_____
Speaker LEDs:			
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____
5	_____	_____	_____
6	_____	_____	_____
7	_____	_____	_____
8	_____	_____	_____
9	_____	_____	_____
10	_____	_____	_____
Status:			
AC	_____	_____	_____
DC	_____	_____	_____
Partial	_____	_____	_____
Full	_____	_____	_____
Status Request	_____	_____	_____
Intrusion*	_____	_____	_____

***Optional**

Fig. 11: System LED Diagnostic Indicators

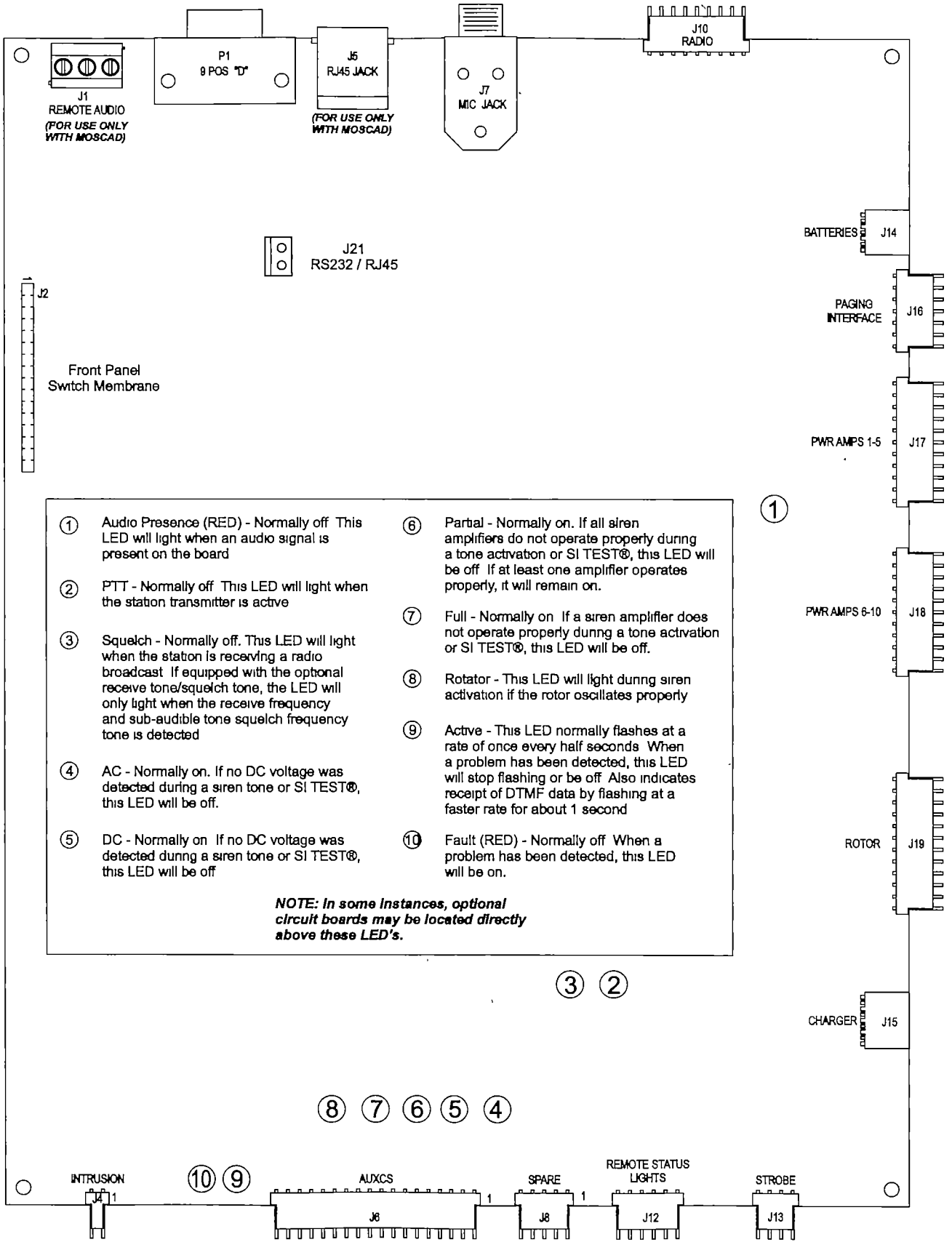
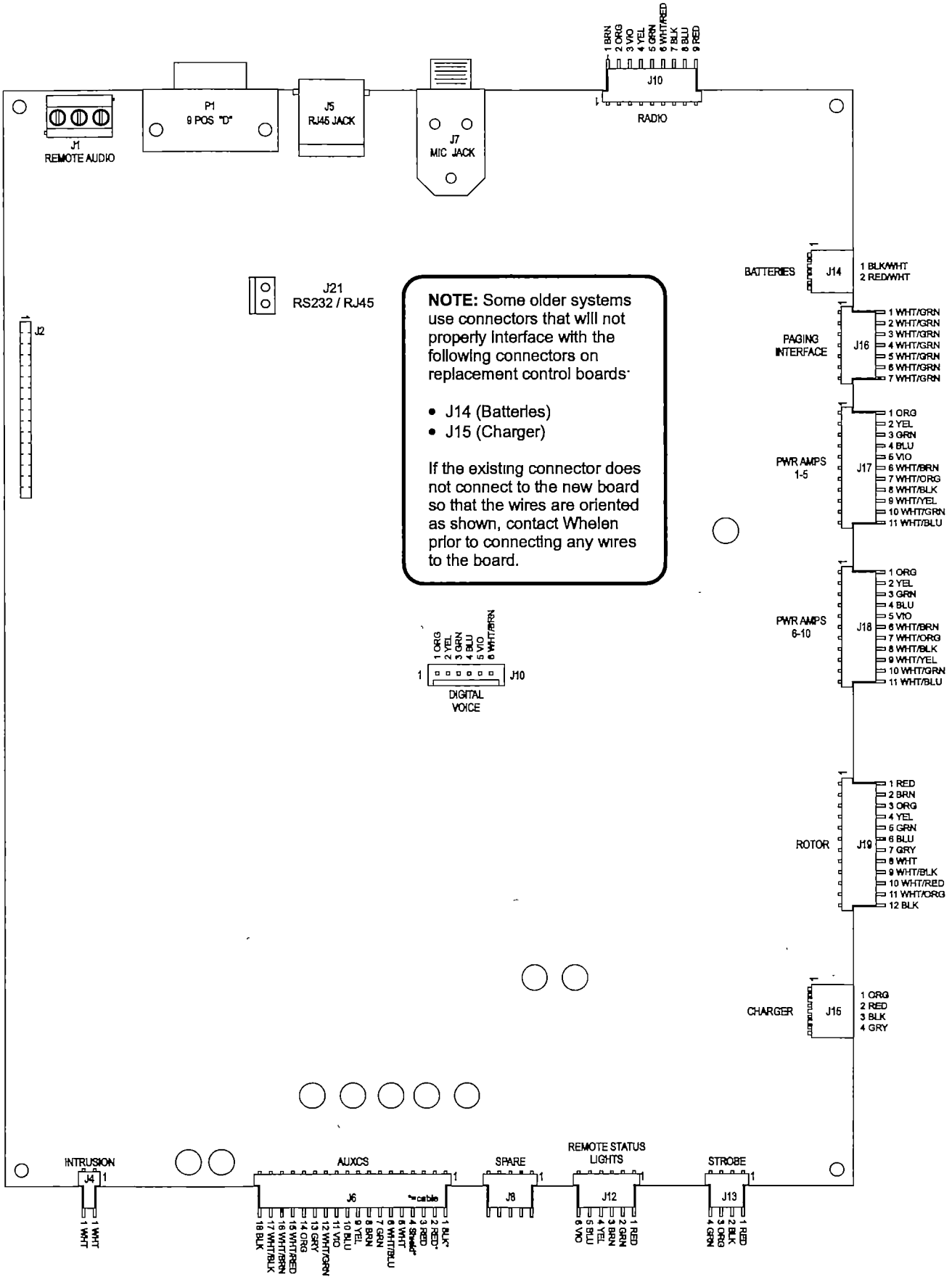


Fig. 12: Control Board Wire Colors



APPENDIX E

Siren Test Result Report

Results from Near and Far-Field Tests of the Outdoor Warning System Near Arkansas Nuclear One

25 Sept 2020

FINAL REPORT

Prepared by:

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Project Summary

Acoustic Analytics was contracted by KLD Engineering, P.C. (KLD) to help perform near-field and far-field acoustical tests of Arkansas Nuclear One's (ANO) outdoor warning system. Testing was conducted on July 23rd and July 24th, 2020. During that period two types of tests were conducted. The first were near-field ANSI S12.14 tests designed to accurately ascertain the output levels of the sirens. The other, far-field tests were conducted simultaneously to the ANSI S12.14 tests and measured the received sound level in the community, thousands of feet away from the siren. For all tests, the sirens were sounded for one minute, with background noise data collected before and after each sounding at all locations. Seven sirens were tested in total, with two Whelen Model WPS2807 sirens and five Whelen Model WPS2907 sirens. All sirens have a pure tone alert signal with a frequency of about 560 Hz.

The ANSI S12.14 measurements were performed using a microphone raised to the height of the siren (approximately 50 feet above ground) with a bucket truck. The microphone was positioned 100 feet from the siren and moved slowly during the test. Once all seven sirens were tested, data from similar siren types were combined to determine the expected output for each siren type, displayed in Table 1. In this table, the 'Maximum Level' is the single highest one-second sample, and the 'Average Level' is the arithmetic average of all the one-second samples collected during the siren sounding (about 60 in total). All values are reported using C-weighted values as per FEMA guidelines[1]. More details about C-weighting can be found in Appendix A.

Table 1. ANSI S12.14 final test results

Siren	Maximum Level (dBC)	Average Level (dBC)
WPS2907	119.0	115.5
WPS2807	118.6	115.1

For the far-field tests, sound level meters were set to collect data for at least ten minutes before the sirens sounded and continued collecting data for at least ten minutes after the sirens stopped. Meter placement was selected to provide safe, accessible locations for the testers in positions that were expected to have low background noise levels. They were also located in places that initial modeling (based on manufacturer data) predicted would receive siren levels up to 70 dBC. One meter failed to collect any data for two of the tests and in four instances the tests collected unexpectedly high levels of background noise. The rest of the meters collected valid data. The results showed that, for the fifteen valid data points collected, four reported received maximum siren levels above 70 dBC, with the rest reporting levels below 70 dBC.

[1] FEMA-REP-10, "Guide for the Evaluation of Alert and Notification Systems for Nuclear Power Plants", November 1985.

Testing Procedure

Acoustic Analytics and KLD collected acoustic data from seven sirens around ANO, with two different types of tests. The first was a near-field ANSI S12.14 test to ascertain the output level of the sirens, and the second was a far-field test to confirm received sound levels in the surrounding community.

Near-Field ANSI S12.14 Test Procedure

The ANSI S12.14 standard defines the method for testing omni-directional sirens. The siren sound measurements are performed using a microphone raised to the height of the siren, positioned 100 feet from the siren. KLD provided all of the acoustical testing equipment for this test and Entergy provided a lift truck capable of reaching the required height for the test.

All of the acoustical data were collected using Larson Davis 831 Sound Level Meters[2] (SLM). The SLMs were programmed to record acoustical data at one-second intervals, collecting slow C-weighted sound levels and one-third octave band levels. Each SLM had its calibration checked before and after each test, with at least 30 seconds of calibration tone recorded between each test. The siren sounding lasted for one minute for each test.

In addition to the elevated microphone extended from the bucket truck, an additional microphone was calibrated and used to determine the maximum sound level experienced on the ground. This measurement was conducted by walking an SLM radially outward from the siren pole during the siren test. Distance from the pole was recorded along with the maximum sound level. This measurement is performed to ensure that the sound levels received at the ground do not exceed recommendations from the Committee on Hearing, Bioacoustics, and Biomechanics of the National Academy of Sciences. These recommendations suggest that no person should be subjected to sound levels above 123 dBC[3].

Weather data were measured locally during the siren tests with a Kestrel Model 4500 Weather Meter. This weather meter is capable of recording wind speed, direction, temperature, and relative humidity. For each siren test, the weather meter was positioned close to the siren, mounted approximately 5 feet above ground level. Results from these measurements are recorded on the ANSI S12.14 datasheets.

Far-Field siren sound test procedure

The testing methodology used to measure the far-field siren sound closely follow the ANSI Standard S12.9 Part 3[4]. This is the governing standard for collecting data from a specific source such as the sound from an outdoor warning system.

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[2] Larson Davis, "Model 831 Sound Level Meter Operation Manual", 2006.

[3] FEMA CPG 1-17, "Outdoor Warning Systems Guide", 1980

[4] ANSI S12.9 Part 3 (R2008), "Quantities and Procedures for Descriptions and Measurement of Environmental Sounds. Part 3: Short-term measurements with an observer present", 2008

For these tests, Larson Davis 831 SLMs were used to collect the acoustic data and Kestrel 5500 Weather Meters were used to collect the weather data. For each measurement location, the SLM was mounted on a tripod with the microphone approximately 5 feet above the ground. The SLMs were programmed to record acoustical data at one-second intervals, collecting slow C-weighted sound levels and one-third octave band levels. Each SLM had its calibration checked before and after each test, with at least 30 seconds of calibration tone recorded between each test. The weather stations were mounted on a tripod close to the SLM and programmed to collect the wind speed, direction, temperature, and relative humidity during the test. The siren sounding lasted for one minute for each test.

The observers present recorded the position of the meters relative to all major features, including building and changes in the local terrain. The observers also collected notes during the tests, identifying specific noise or weather events that occurred during the testing. Weather conditions during the test were written down, as were the observed sound levels before, during, and after the sirens sounded. Any significant sounds noticed during the test were also written down. The meters were set to begin recording at least ten minutes before the siren sounding and were left running for at least ten minutes after the siren test ended to collect background noise levels. These procedures were handed out to all test participants, and a copy is provided in Appendix B.

Frequency Analysis

Frequency analysis of the siren signal is a useful tool in the system analysis. One of the SLMs used for the ANSI S12.14 test had the capability of recording high-quality audio file samples. These audio files were then analyzed using the analysis software, Audacity[5]. This software performs a Fast Fourier Transform on the audio signal to determine the frequency content. Figure 1 has a sample frequency spectra for the siren signal as measured from the bucket truck, 100 feet from siren 3Z4. In this plot, the frequency is on a logarithmic scale on the x-axis, and the amplitude is in dB is on the y-axis. Note that the y-axes on this plot is *not* calibrated, but is useful in determining where the maximum frequency occurs. All sirens measured has the same frequency content, with a maximum level at approximately 560 Hz indicative of a pure tone signal.

[5] https://www.audacityteam.org/

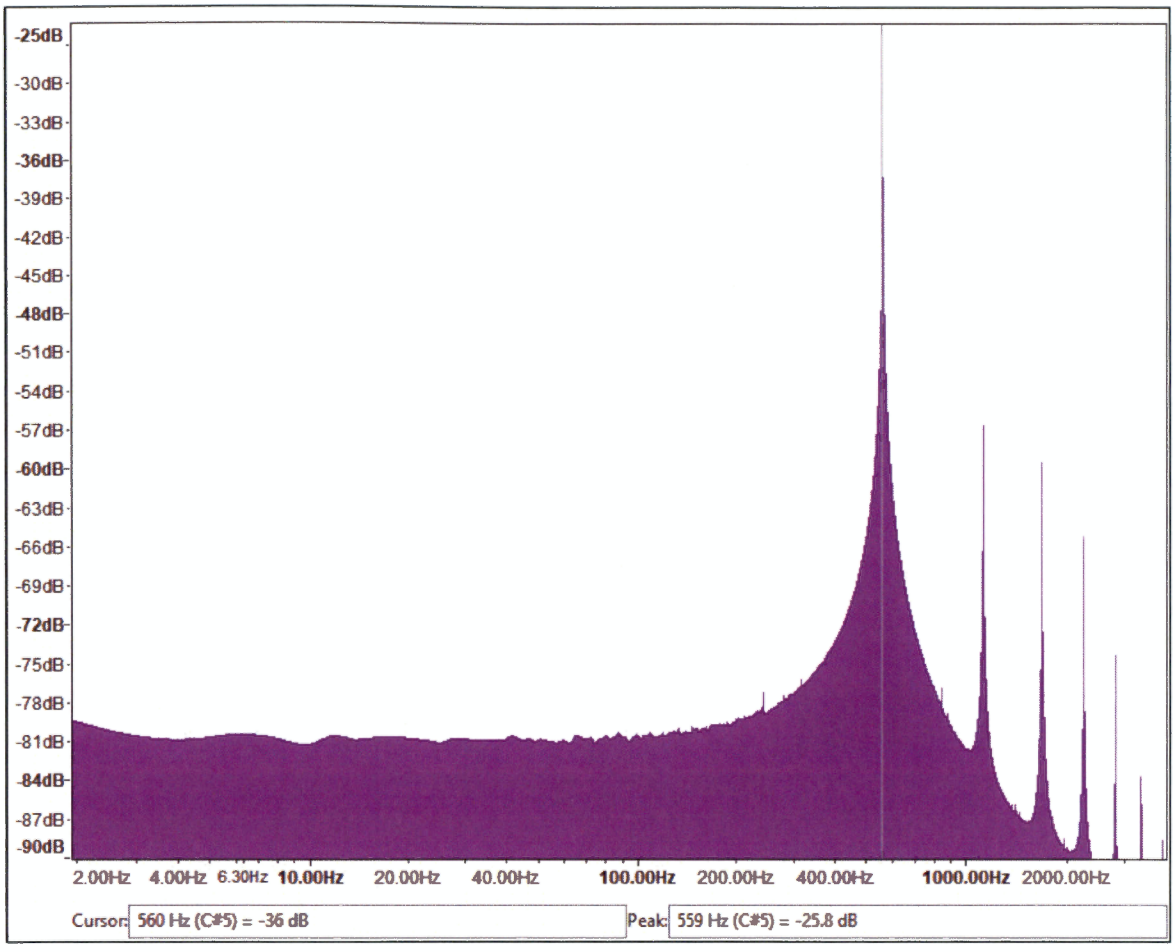


Figure 1. Frequency spectra of the Federal Signal 2001-130 siren as measured in the field

Another method of analyzing the frequency content of the siren sounds is to look at the One-Third Octave Bands collected by the SLMs. One-Third Octave Band analysis divides the sound into individual frequency bands, with three bands to every octave (or doubling of frequency). Since the frequency of these sirens is approximately 560 Hz, that falls between the 500 Hz and 630 Hz One-Third Octave Bands. This can be seen in the plots of the One-Third Octave Band spectra in Figure 2 with the two peaks at the appropriate frequencies. In this figure, the frequency is on the x-axis, plotted logarithmically, and the amplitude of the siren signal is on the y-axis in dB. In this plot the y-axis *is* from calibrated data, so the values are accurate.

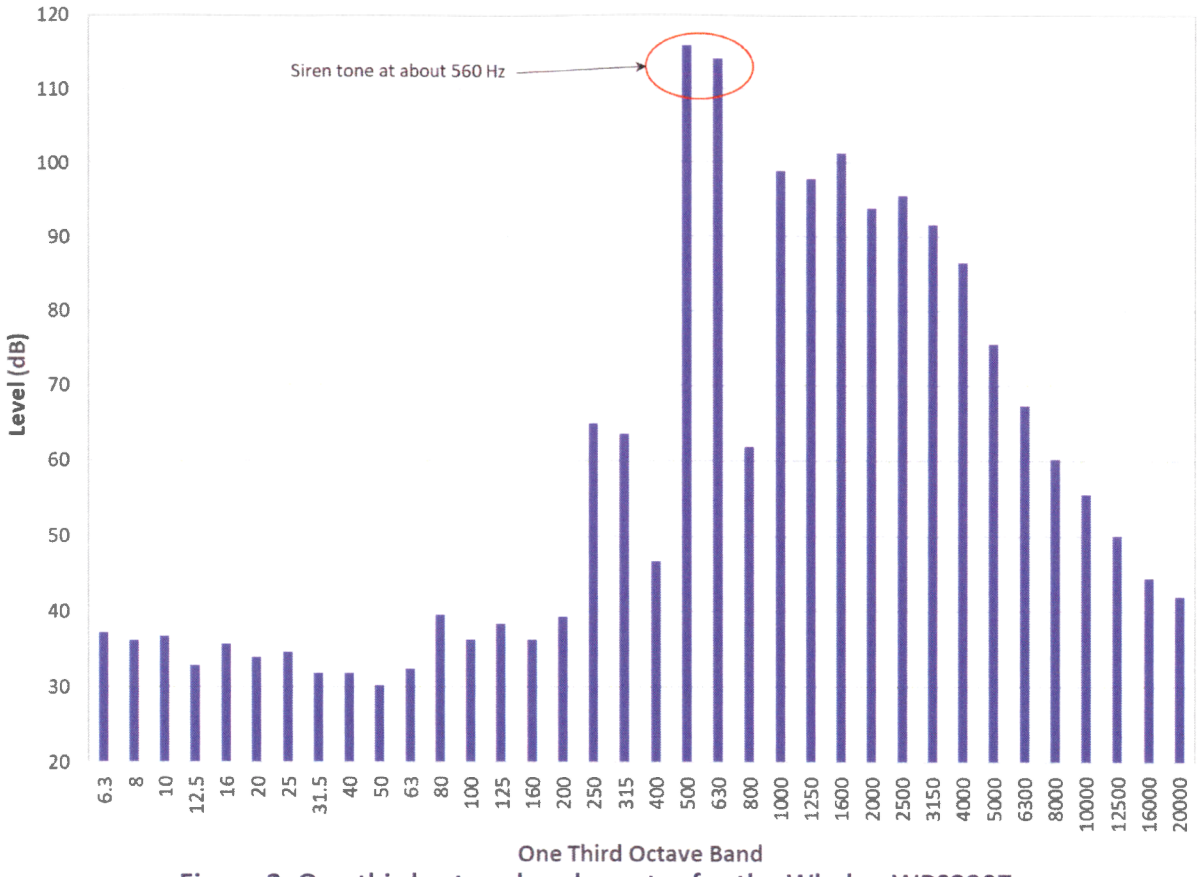


Figure 2. One third octave band spectra for the Whelen WPS2907

Siren Test Results

Seven different sirens were measured over two days, with three sirens measured on June 23rd, 2020 and four measured on June 24th, 2020. At each siren, a bucket truck was used to complete the ANSI S12.14 measurement. Results from all of these tests are provided below in Table 2. Simultaneously, three SLMs were placed in the far-field for each test, identified as ANO 01, ANO 02, and ANO 03. These locations were selected close to the estimated 70 dBC sound contour from each siren (based on initial manufacturer data). The tabulated results from these tests are provided in Table 3. For Table 2 and Table 3, the 'Maximum Level' is the single highest one-second sample collected during the test and the 'Average Level' is the arithmetic average of all one-second samples during a siren sounding (approximately 60 in all). The 'L10 Level' on Table 3 is the top 10th percentile of the data. This means that the received sound level was at that level or higher for 10 percent of the siren sounding, or approximately 6 seconds.

When reporting the data from the far-field meters, Acoustic Analytics has plotted two different acoustic metrics. The first is the C-weighted value. However, because of the way that the C-weighted levels are computed they often include elements that have nothing to do with the siren signal itself. Therefore, the combined 500 Hz and 630 Hz One-Third Octave Bands were also computed. This will often clearly show the siren signal even when the C-weight does not. The

combined value is much better at accurately representing the received output from the siren at these far-field locations and this is the value reported on Table 3.

To be certain that a measured signal is attributable to a siren (as opposed to just some other background noise), the measured signal must be at least 10 dB above the background noise. If the siren signal is not 10 dB above the background noise, the received siren level can only be estimated. For these situations, the level is denoted by the less-than symbol (<) to show that the siren signal is less than the value provided on the table. This happened to 4 measurements as shown in Table 3. More details about each siren test, including data collection sheets, ANSI S12.14 sheets, and graphs of the acoustic time histories for the collected data are provided in the next section.

Table 2. Results from all ANSI S12.14 tests

Siren	Model	Maximum Level (dBC)	Average Level (dBC)
2Z14	WPS2907	116.6	113.1
1Z11	WPS2907	118.5	114.3
1Z9 *	WPS2807	110.7	107.4
5Z2	WPS2807	118.6	115.1
3Z4	WPS2907	120.3	116.9
3Z5	WPS2907	119.2	116.1
2Z13	WPS2907	120.3	117.2

* Siren 1Z9 had lower than expected output levels.

Table 3. Far-field Test Results

Siren 2Z14				Siren 1Z11			
Meter	Maximum Level (dB)	L10 Level (dB)	Average Level (dB)	Meter	Maximum Level (dB)	L10 Level (dB)	Average Level (dB)
ANO 01	58.2	55.4	52.1	ANO 01	<67	<49	<45
ANO 02	73.7	67.4	61.8	ANO 02	67.4	64.4	58.6
ANO 03	72.7	68.6	61.6	ANO 03	< 59	<57	< 53

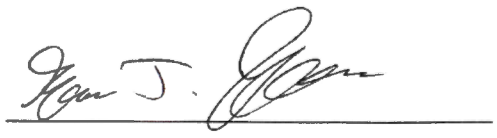
Siren 1Z9				Siren 5Z2			
Meter	Maximum Level (dB)	L10 Level (dB)	Average Level (dB)	Meter	Maximum Level (dB)	L10 Level (dB)	Average Level (dB)
ANO 01	-	-	-	ANO 01	58.7	57.5	52.7
ANO 02	58.6	56.5	52.1	ANO 02	77.1	75.5	70.2
ANO 03	70.1	68.8	61.6	ANO 03	67.9	66.3	62.3

Siren 3Z4				Siren 3Z5			
Meter	Maximum Level (dB)	L10 Level (dB)	Average Level (dB)	Meter	Maximum Level (dB)	L10 Level (dB)	Average Level (dB)
ANO 01	69.7	68.1	63.6	ANO 01	-	-	-
ANO 02	66.7	65.3	60.6	ANO 02	59.5	54.3	52.1
ANO 03	47.8	46.5	43.9	ANO 03	61.0	58.6	55.1

Siren 2Z13			
Meter	Maximum Level (dB)	L10 Level (dB)	Average Level (dB)
ANO 01	< 72	< 69	< 65
ANO 02	60.7	59.1	56.3
ANO 03	< 53	< 52	< 50

Summary

Acoustic Analytics, with the help of KLD and Entergy, conducted a successful acoustical test of the full outdoor warning system for the ANO outdoor warning system over the two day period from June 23rd to June 24th 2020. Data were collected from seven different sirens representing two different models. Weather conditions during the test were good, with low winds and no precipitation as measured by weather stations used duing the testing. Five SLMs were used for each siren test. Two SLM was used for near-field ANSI S12.14 measurements and three SLMs were used for far-field measurements. Of the 35 different sets of acoustical data collected over the week, two samples were lost due to equipment malfunction and four experienced elevated background noise levels that made it impossible to determinine the siren level.



Bruce Ikelheimer, President of Acoustic Analytics

Detailed Data from All Field Measurements

This section contains all of the detailed data from the field measurements including graphs, photos, and data sheets. It is useful as a reference for looking at specific siren tests. The data is organized by siren, with the ANSI S12.14 test provided first, followed by the data collected by the far-field SLMs. They are also provided in the order that the testing occurred. Table 4 provides the date, siren, and GPS location for all of the far-field test locations, with more information provided in each section.

Table 4. Date and location of far-field measurements

June 23rd, 2020					
Siren 2Z14, Model Whelen WPS2907			**Siren 1Z11, Model Whelen WPS2907**		
Meter ID	**Latitude**	**Longitude**	**Meter ID**	**Latitude**	**Longitude**
ANO 01	35.323279	-93.141710	ANO 01	35.242431	-93.157977
ANO 02	35.304833	-93.119475	ANO 02	35.236126	-93.189973
ANO 03	35.304651	-93.128141	ANO 03	35.223787	-93.165692
Siren 1Z9, Model Whelen WPS2807					
Meter ID	**Latitude**	**Longitude**			
ANO 01	35.258326	-93.230217			
ANO 02	35.250495	-93.207652			
ANO 03	35.257309	-93.203675			
June 24th, 2020					
Siren 5Z2, Model Whelen WPS2807			**Siren 3Z4, Model Whelen WPS2907**		
Meter ID	**Latitude**	**Longitude**	**Meter ID**	**Latitude**	**Longitude**
ANO 01	35.306951	-93.289443	ANO 01	35.333159	-93.245631
ANO 02	35.296799	-93.274475	ANO 02	35.324876	-93.261671
ANO 03	35.287405	-93.294007	ANO 03	35.306421	-93.246369
Siren 3Z5, Model Whelen WPS2907			**Siren 2Z13, Model Whelen WPS2907**		
Meter ID	**Latitude**	**Longitude**	**Meter ID**	**Latitude**	**Longitude**
ANO 01	35.324739	-93.273720	ANO 01	35.305384	-93.148826
ANO 02	35.324037	-93.244078	ANO 02	35.306214	-93.122389
ANO 03	35.345280	-93.258734	ANO 03	35.313796	-93.135871

Field Measurements of Siren 2Z14

Siren 2Z14, a Whelen model WPS2907 siren, was measured on June 23rd, 2020 at approximately 9:50 am. This siren is located across the street from the Darby Lane Baptist Church in Russelville, AR. This siren is mounted on top of an approximately 50 foot wooden pole. Far-field SLM ANO 01 was placed to the north-west of the siren and SLMs 02 and 03 were placed south-east and south of the siren, respectively. This is shown below in Figure 3. The ANSI S12.14 data sheet form this test is provided in Figure 4, with a photo of the siren in Figure 5 and the time history of the measured sound level in Figure 6.

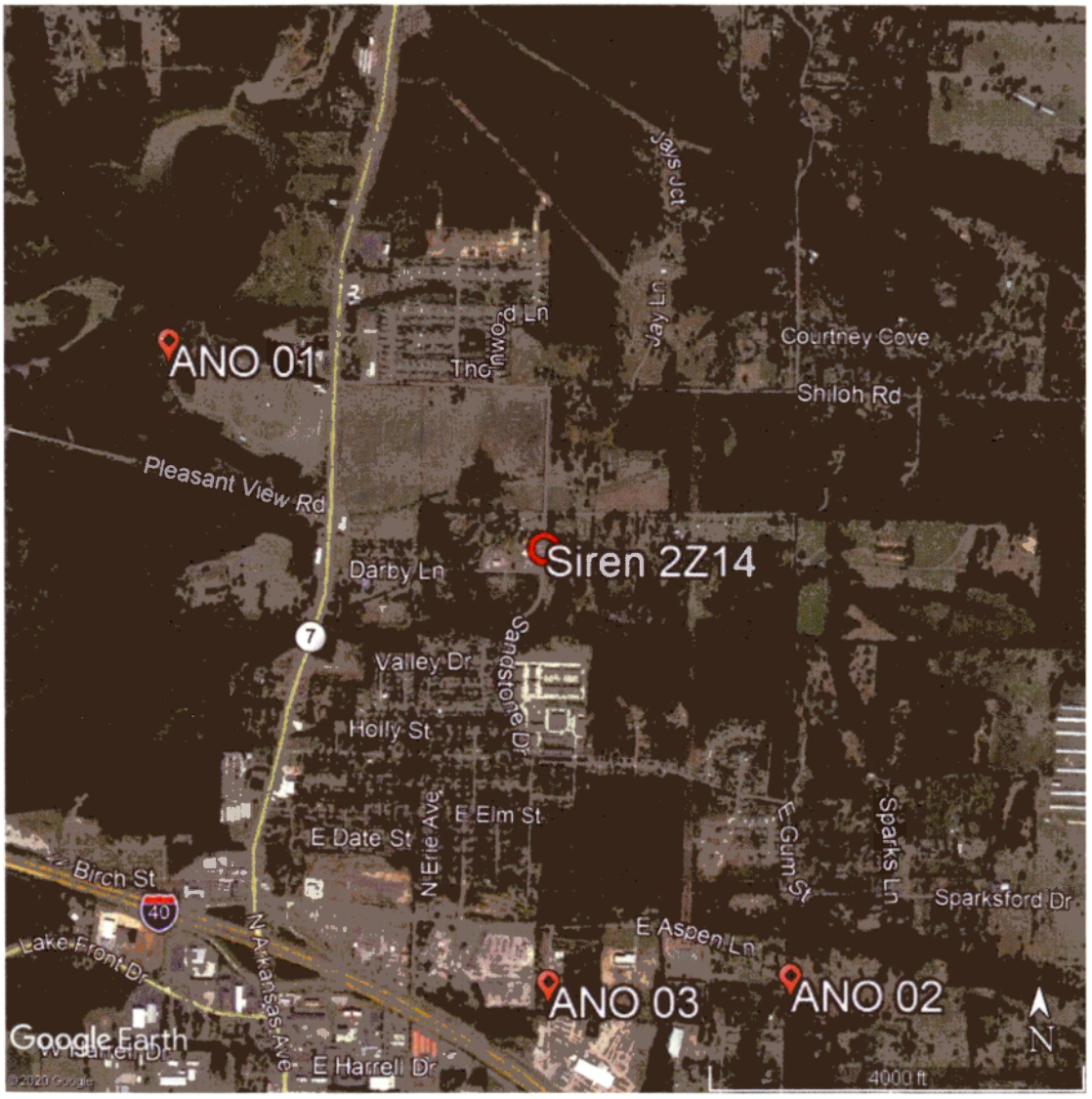


Figure 3. Position of siren 2Z14 relative to the far-field SLMs

Siren Sound Output Measurement per ANSI S12.14
Data Sheet

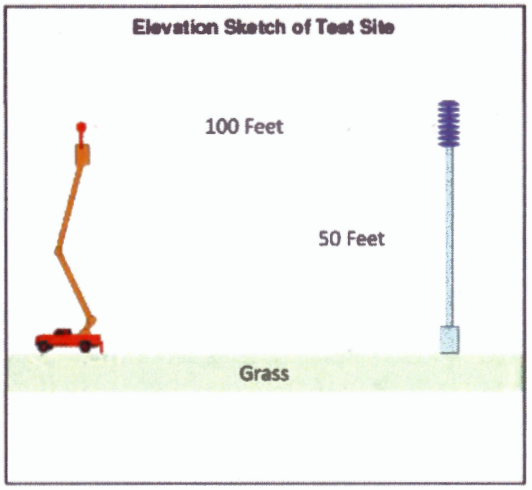
Siren Mfg: Whelen Model No: WPS2907 S/N: _____

Description: In situ measurement of ANO siren 2Z14

Meas. Loc. Across the road from a church along the side of a road

Date: 6/23/20 Time: 9:50 am By: Bruce I. Title: _____

Temp 82 °F Wind speed: 5.6 mph Wind Dir: 320 Clouds 100 % Precip. (Y/N)? N



Mfg rec'd mtg. height: 50 feet Actual height: 52 feet Method: Laser Power correct (Y/N)? _____

Ground type & cover between siren and meas. loc. Grass

Deviations from test procedure: None

SLM Mfg:	LD	Model No:	831	S/N	3174	Pri Cal Date:	3/11/20
Filter Mfg:		Model No:		S/N		Pri Cal Date:	
Calib Mfg:	LD	Model No:	Cal200	S/N	15674	Pri Cal Date:	6/19/20

Field Calibration: Before 94.0 dBC After 94.0 dBC

Max ambient: Before 60 dBC slow After 57 dBC slow

Microphone SN: 311593

Preamp SN: 51309

	Base Line Position	Secondary Position (if used)
Siren Sound:	Alert	Alert
MXSCL (max dBC, slow):	116.6	
Average SCL, dBC slow:	113.1	
Max 1/3 octave band, Hz:	500 Hz & 630 Hz	
MXSCL in max 1/3 octave band, dBC slow:	116.5	
Average SCL in max 1/3 octave band, dBC slow:	112.8	
Bystander MXSCL, dBC slow	111	XXX
Dist of bystander MXSCL from mount, feet	53	XXX

Other pertinent information: _____

Figure 4. ANSI S12.14 Data Sheet for Siren 2Z14

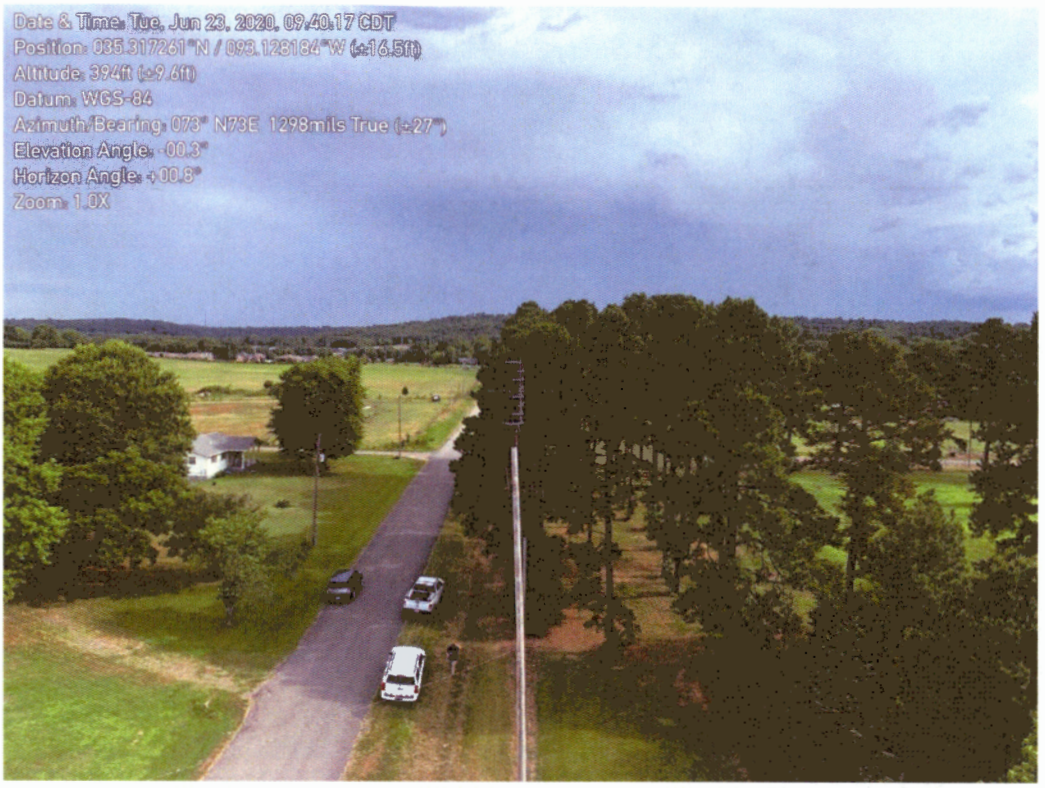


Figure 5. Photo from the bucket truck, looking at siren 2Z14

Figure 6. Time history of the received sound from siren 2Z14 as measured from the bucket truck

Far-Field Measurement of Siren 2Z14 from Sound Leve Meter ANO 01

SLM ANO 01 was placed by the water in Pleasant View Park. Figure 7 shows the time history for siren 2Z14, with the siren signal clearly evident above the background noise by at least 10 dB in the combined 500 Hz and 630 Hz signal. Background noise levels in this area were in the 55 dBC to 58 dB range. Figure 8 has the data collection sheet for this meter.

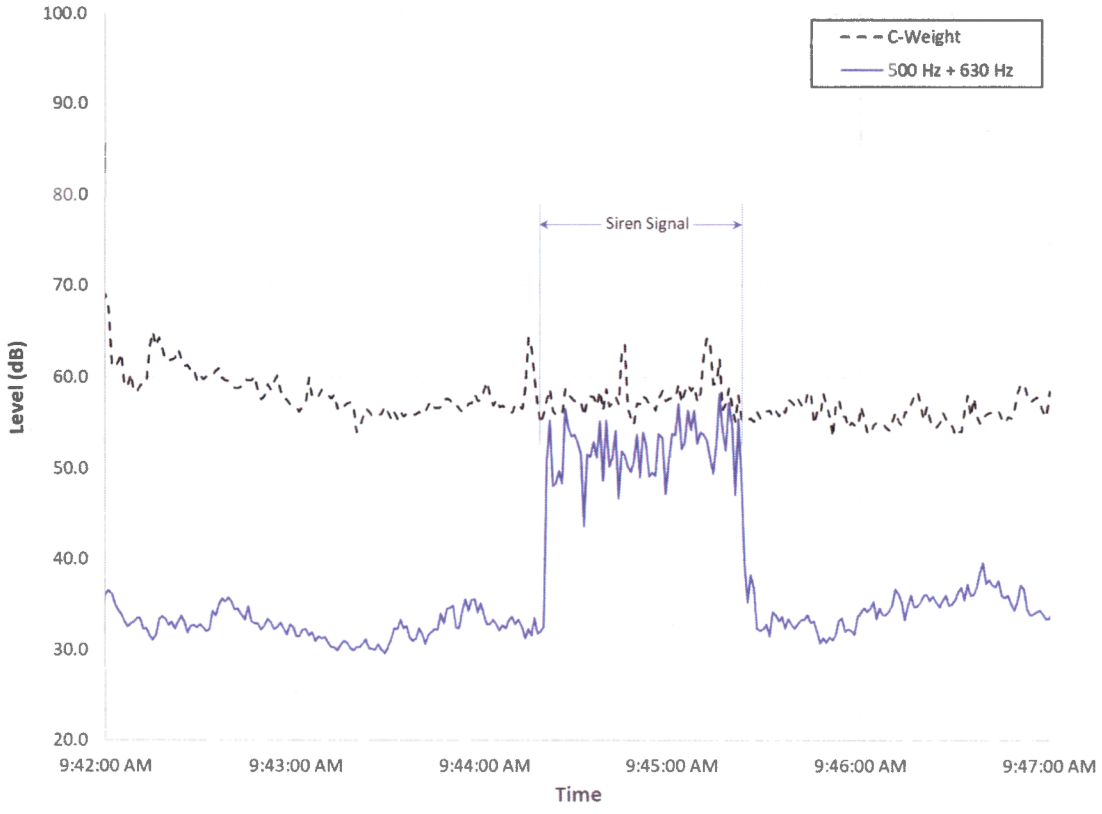


Figure 7. Time history from SLM ANO 01 for siren 2Z14

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 6/22/20 Time: 4:50 pm

SLM Model: LD 831 SLM Serial Number: 3558

Preamp SN: 58506 Microphone SN: 310089

Tester's Name: Danielle Mallon

GPS Coordinates: -93.14171 West 35.323379 North

Checked Battery? Yes No

Checked Clock? Yes No

Memory Checked? Yes No

Calibration level before test: 94.0 dBC

30 second calibration tone recorded before test? Yes No

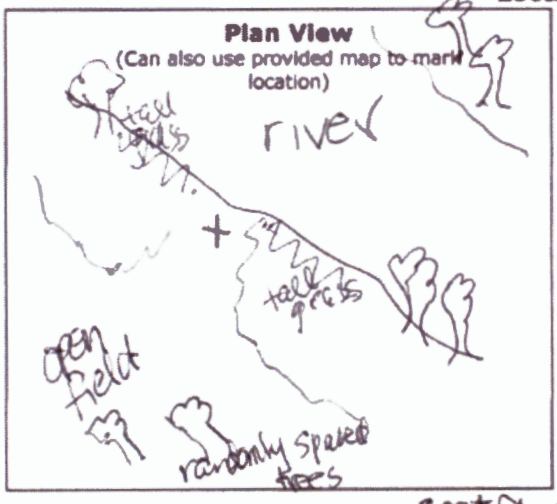
Calibration level after test: 94.1 dBC

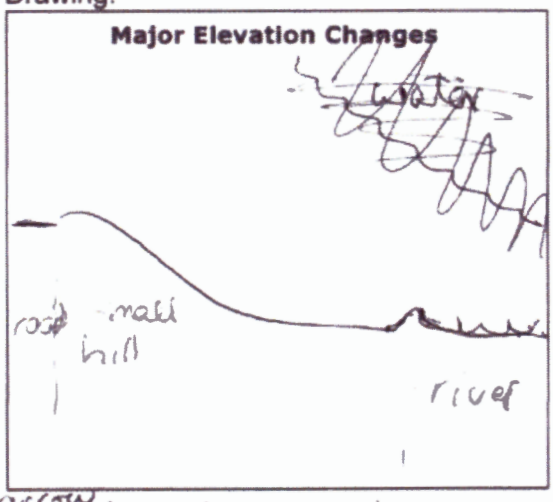
30 second calibration tone recorded after test? Yes No

Calibrator Model: Cal 200 Calibrator SN: 15674

----------To be filled in be by the field crew at the site----------

Location Drawing:





Measurement Location description: 300ft to dirt narrow road in park, next to river, in grass field clearing.

Microphone height: 5 ft. Wind Dir: N 353 deg.

Photos Taken? Yes No Wind Spd: 5 mph

Meter Recording? Yes No Temp: [illegible] °F

Weather Station on and wind cover removed? Yes No

Ambient noise level before test: [illegible] dBC

Maximum level observed during the test: 64.4 dBC 67.1 when siren not sounding.

Could you hear the sirens? Yes No

Ambient noise level after test: 58 dBC

Notes about test (including background noise and noise intrusions during the test):
bugs-cicadas, birds, etc-lots of birds, boats motors in distance. occasionally passin hammering in distance across river

Tester's Signature: Danielle Mallon

Figure 8. Data collection sheet for SLM ANO 01 for siren 2Z14

Far-Field Measurement of Siren 2Z14 from Sound Leve Meter ANO 02

SLM ANO 02 was placed by the side of Sparksfor Dr. south of its intersection with E. Aspen Ln. Figure 9 shows the time history for siren 2Z14. Here the combined 500 Hz and 630 Hz siren signal is clearly evident above the background noise by over 10 dB. Also evident in this time history are the passing of cars – shown as sudden spikes in the received noise level. Figure 10 shows the data collection sheet for this test.

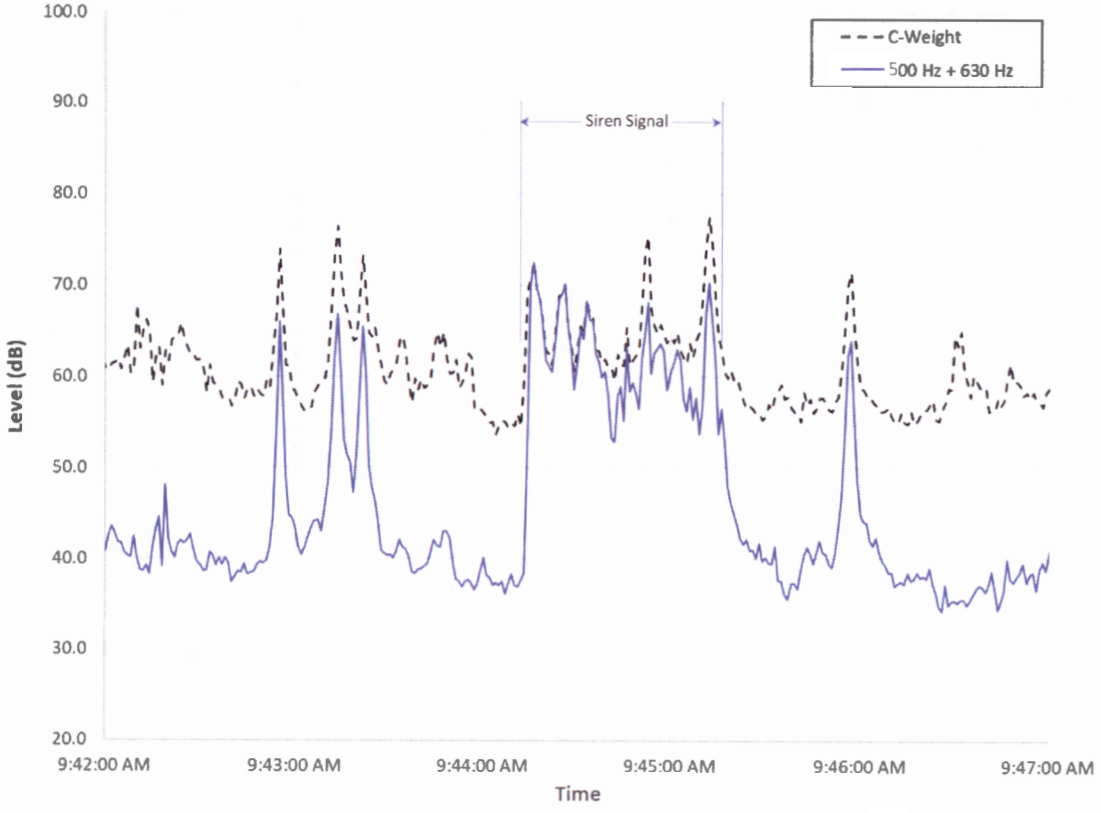


Figure 9. Time history from SLM ANO 02 for siren 2Z14

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 6/22/20 Time: 9:00 pm

SLM Model: LD 831 SLM Serial Number: 3397

Preamp SN: 51240 Microphone SN: 307776

Tester's Name: Efe Tuner

GPS Coordinates: 35.30 West -93.12 North

Checked Battery? Yes No

Checked Clock? Yes No

Memory Checked? Yes No

Calibration level before test: 94.0 dBC

30 second calibration tone recorded before test? Yes No

Calibration level after test: 94.1 dBC

30 second calibration tone recorded after test? Yes No

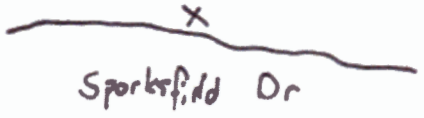
Calibrator Model: Cal 200 Calibrator SN: 15674

----------To be filled in be by the field crew at the site----------

Location Drawing:

Plan View
(Can also use provided map to mark location)

Major Elevation Changes



Measurement Location description: Open field on Sportsfield Dr

Microphone height: 5 ft. Wind Dir: NW 312 deg.

Photos Taken? Yes No Wind Spd: 1.1 mph

Meter Recording? Yes No Temp: 81.4 °F

Weather Station on and wind cover removed? Yes No

Ambient noise level before test: 56.9 dBC

Maximum level observed during the test: 67 dBC with car passing around 72

Could you hear the sirens? Yes No

Ambient noise level after test: 58 dBC

Notes about test (including background noise and noise intrusions during the test):

Tester's Signature: EfeT.

Figure 10. Data collection sheet for SLM ANO 02 for siren 2Z14

Far-Field Measurement of Siren 2Z14 from Sound Leve Meter ANO 03

SLM ANO 03 was placed by the side of Steel City Ln, about halfway down the road. Figure 11 shows the time history, with the combined 500 Hz and 630 Hz siren signal is clearly visible above the background noise. Background noise before and after the test was approximately 65 dBC. The data sheet for this test is shown in Figure 12.

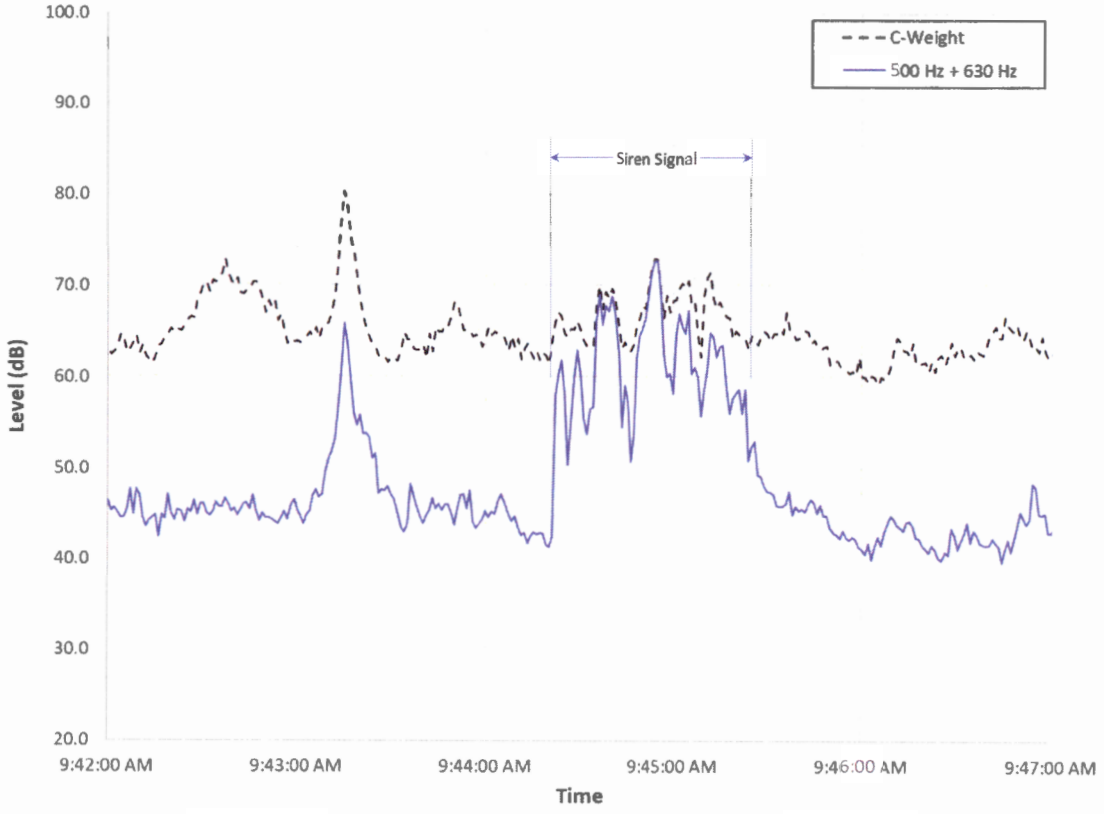


Figure 11. Time history from SLM ANO 03 for siren 2Z14

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 5/22/20 Time: 9:00 pm

SLM Model: LD 831 SLM Serial Number: 4278

Preamp SN: 19136 Microphone SN: 307396

Tester's Name: Zhuoxing (Amy) Jiang

GPS Coordinates: ~~-93.294007~~ West ~~35.287405~~ North

-93.126141 W 35.304651 N

Checked Battery? (Yes) No

Checked Clock? (Yes) No

Memory Checked? (Yes) No

Calibration level before test: 94 dBC

30 second calibration tone recorded before test? (Yes) No

Calibration level after test: 94.1 dBC

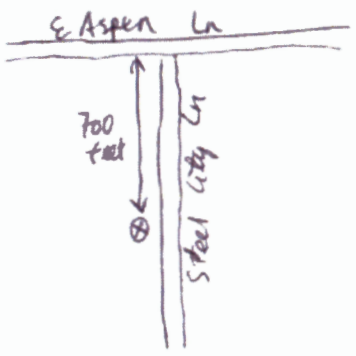
30 second calibration tone recorded after test? (Yes) No

Calibrator Model: Cal 200 Calibrator SN: 15674

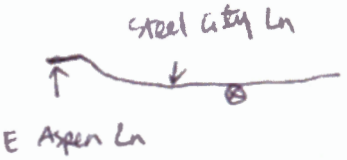
----------To be filled in be by the field crew at the site----------

Location Drawing:

Plan View
(Can also use provided map to mark location)



Major Elevation Changes



Measurement Location description: 700 feet south of E Aspen Ln & Steel City Ln

Microphone height: 5.0 ft. Wind Dir: 325 deg.

Photos Taken? (Yes) No Wind Spd: 2.4 mph

Meter Recording? Yes No Temp: 84.0 °F

Weather Station on and wind cover removed? (Yes) No

Ambient noise level before test: 66 dBC

Maximum level observed during the test: 73.7 dBC

Could you hear the sirens? (Yes) No

Ambient noise level after test: 64 dBC

Notes about test (including background noise and noise intrusions during the test):
This site is near interstate 40. The traffic noise is not loud, but I can hear it.

Tester's Signature: Zhuoxing Jiang

Figure 12. Data collection sheet for SLM ANO 03 for siren 2Z14

Field Measurements of Siren 1Z11

Siren 1Z11, a Whelen model WPS2907 siren, was measured on June 23rd, 2020 at approximately 10:50 am. This siren is located by the corner of N. 2nd St. and East St. in Dardenelle, AR. This siren is mounted on top of an approximately 50 foot wooden pole. Far-field SLM ANO 01 was placed to the north-east of the siren, SLMs 02 was placed to the west of the siren, and 03 was placed south-east of the siren. This is shown below in Figure 13. The ANSI S12.14 data sheet for this test is shown in Figure 14, with a photo of the siren in Figure 15 and the measured time history of the test in Figure 16.

Figure 13 Position of siren 1Z11 relative to the far-field SLMs

Siren Sound Output Measurement per ANSI S12.14
Data Sheet

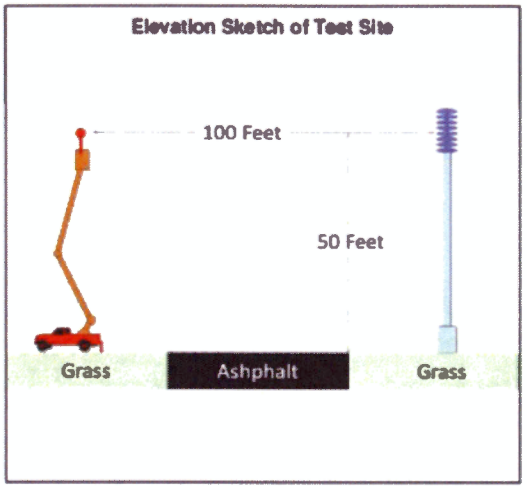
Siren Mfg: Whelen Model No: WPS2907 S/N: _____

Description: In situ measurement of ANO siren 1Z11

Meas. Loc. Measurement is across a small road from the siren, close to a day care facility.

Date: 6/23/20 Time: 10:50 am By: Bruce I. Title: _____

Temp 84 °F Wind speed: 0 mph Wind Dir: - Clouds 100 % Precip. (Y/N)? N



Mfg rec'd mtg. height: 50 feet Actual height: 52 feet Method: Laser Power correct (Y/N)? _____

Ground type & cover between siren and meas. loc. Grass and asphalt

Deviations from test procedure: None

SLM Mfg: LD Model No: 831 S/N 3174 Pri Cal Date: 3/11/20

Filter Mfg: _____ Model No: _____ S/N _____ Pri Cal Date: _____

Calib Mfg: LD Model No: Cal200 S/N 15674 Pri Cal Date: 6/19/20

Field Calibration: Before 93.9 dBC After 94.0 dBC

Max ambient: Before 65 dBC slow After 65 dBC slow

Microphone SN: 311593

Preamp SN: 51309

	Base Line Position	Secondary Position (if used)
Siren Sound:	Alert	Alert
MXSCL (max dBC, slow):	118.5	
Average SCL, dBC slow:	114.3	
Max 1/3 octave band, Hz:	500 Hz & 630 Hz	
MXSCL in max 1/3 octave band, dBC slow:	118.5	
Average SCL in max 1/3 octave band, dBC slow:	114.2	
Bystander MXSCL, dBC slow	113	XXX
Dist of bystander MXSCL from mount, feet	92' and 35'	XXX

Other pertinent information: _____

Figure 14 ANSI S12.14 Data Sheet for Siren 1Z11

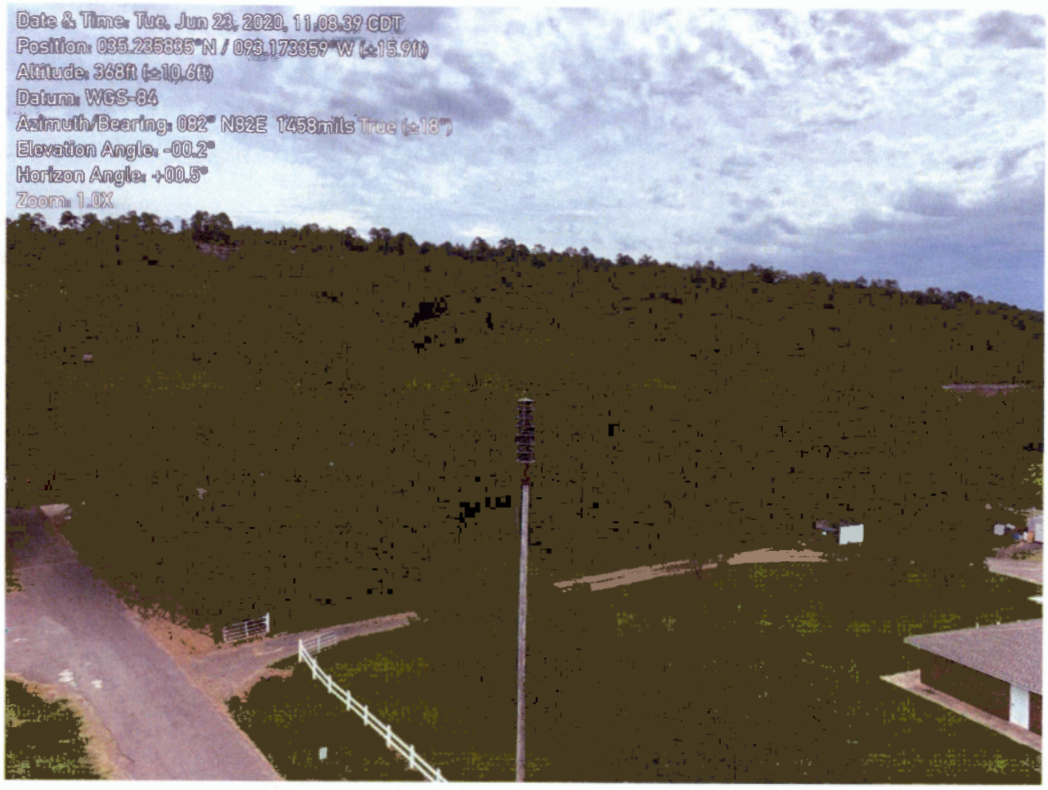


Figure 15. Photo from the bucket truck, looking at siren 1Z11

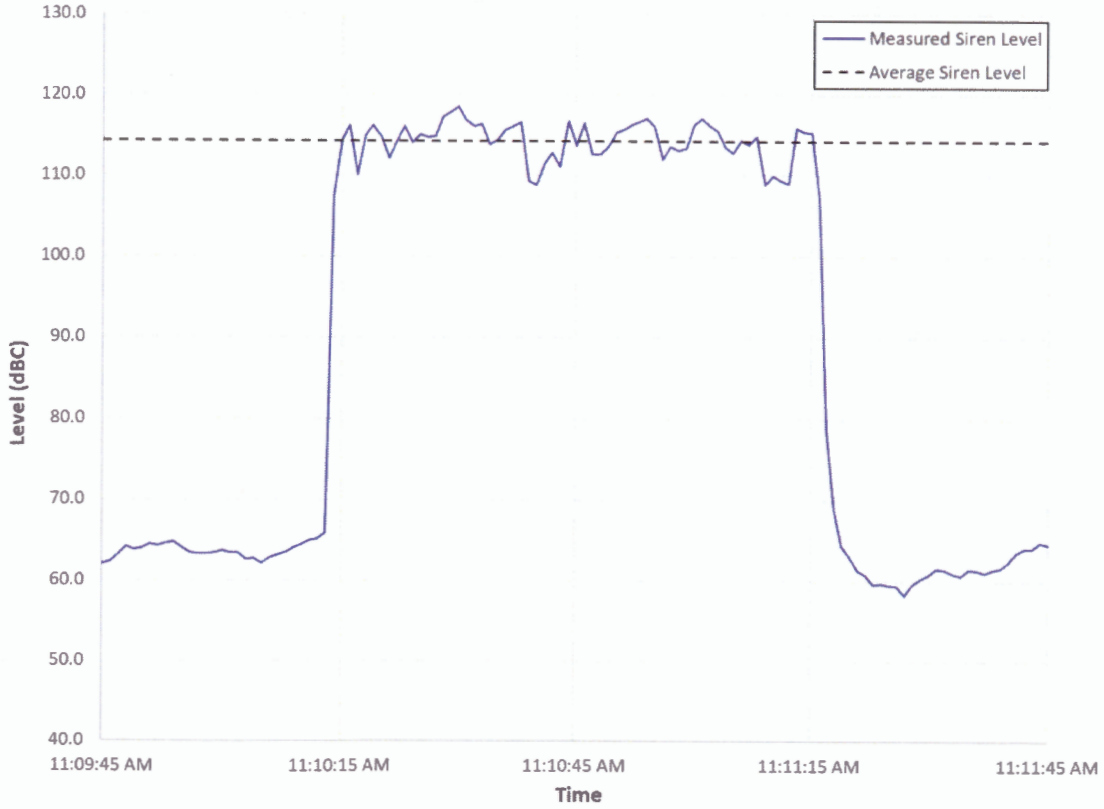


Figure 16. Time history of the received sound from siren 1Z11 as measured from the bucket truck

Far-Field Measurement of Siren 1Z11 from Sound Leve Meter ANO 01

SLM ANO 01 was placed close to a boat ramp at the end of Old Post Park Rd. The time history from this measurement is shown in Figure 17. In this case there is no evidence of the siren in the C-weight, while it does appear that there is siren signal in the 500 Hz and 630 Hz signal. However, because that level is not consistently 10 dB above the background, it is not possible to determine what portion of that signal comes from the siren and what is from the background noise. The data sheet for this test is shown in Figure 18.

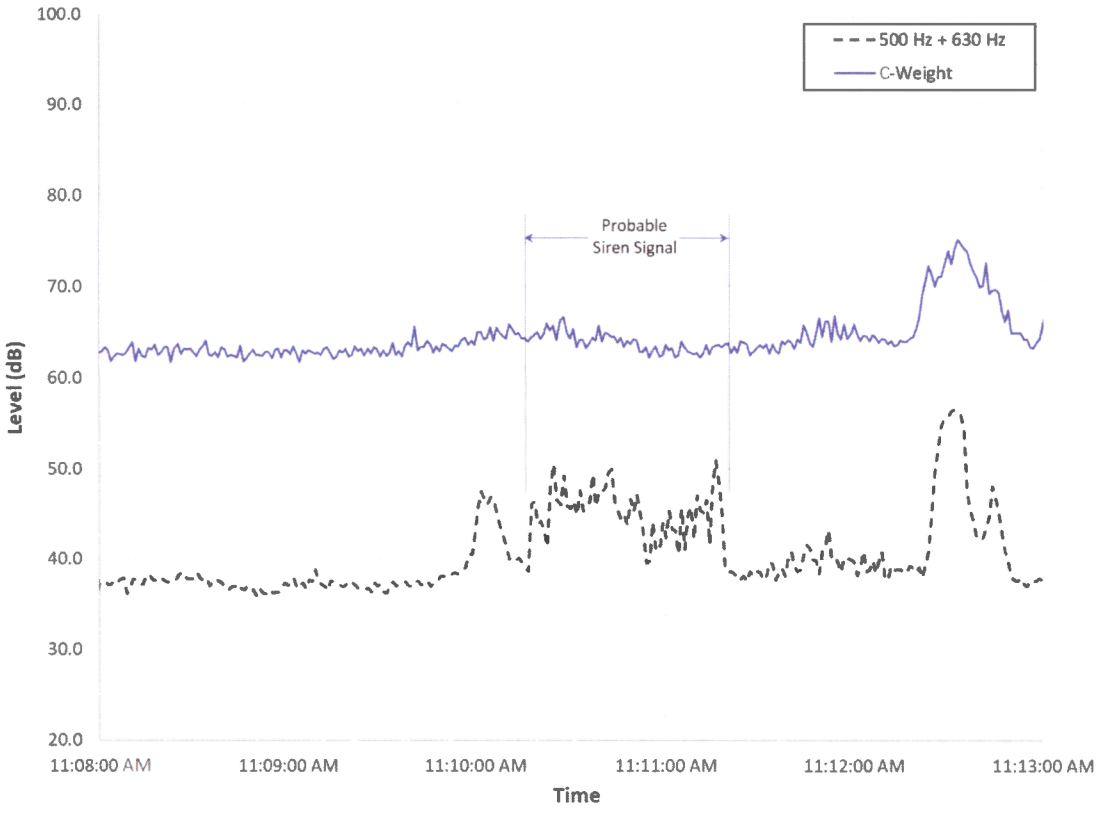


Figure 17. Time history from SML ANO 01 for siren 1Z11

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 6/23/20 Time: 10:00 am

SLM Model: LD 831 SLM Serial Number: 3558

Preamp SN: 58506 Microphone SN: 310089

Tester's Name: Danielle Mallon

GPS Coordinates: -93.157977 West 35.242431 North

Checked Battery? (Yes) No

Checked Clock? (Yes) No

Memory Checked? (Yes) No

Calibration level before test: 94.1 dBC

30 second calibration tone recorded before test? (Yes) No

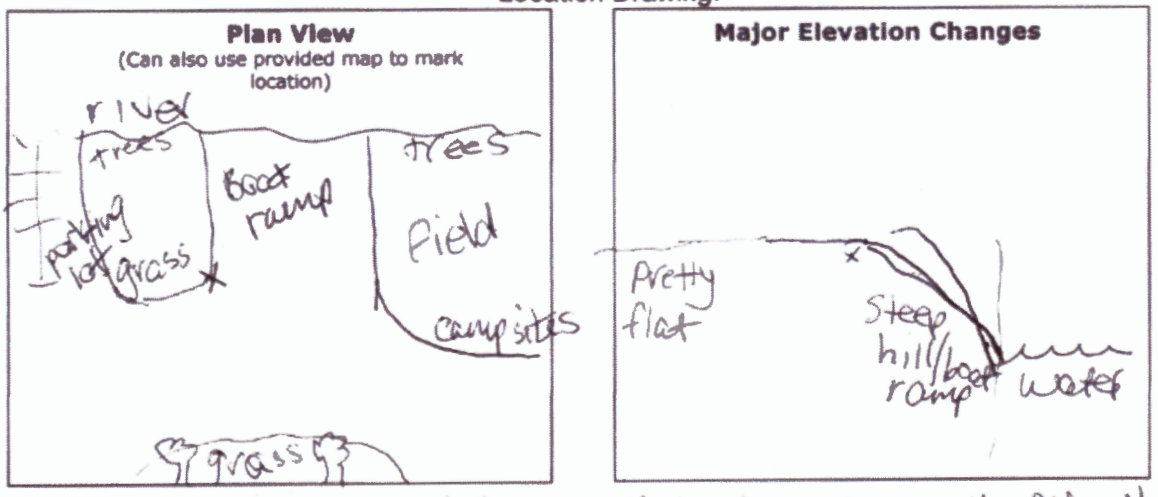
Calibration level after test: 94.1 dBC

30 second calibration tone recorded after test? (Yes) No

Calibrator Model: Cal 200 Calibrator SN: 15674

----------To be filled in be by the field crew at the site----------

Location Drawing:



Measurement Location description: at the top of the boat ramp, on the side of the rd/pavement.

Microphone height: 5 ft. a few ft from sign posts. Wind Dir: W 240 deg.

Photos Taken? (Yes) No Wind Spd: 2.5 mph

Meter Recording? (Yes) No Temp: 85 °F

Weather Station on and wind cover removed? (Yes) No

Ambient noise level before test: 63 dBC 75 (car)

Maximum level observed during the test: 65.2 dBC not while siren going off.

Could you hear the sirens? (Yes) No

Ambient noise level after test: 63 dBC

Notes about test (including background noise and noise intrusions during the test): Bugs, Cicadas etc. Birds Chirping ~~[illegible]~~ car turning down boat ramp & idling + turning around for 1st siren starting. ~5 cars driving by. construction truck beeping & engine noise in distance

Tester's Signature: Danielle Mallon

Figure 18. Data collection sheet for SLM ANO 01 for siren 1Z11

Far-Field Measurement of Siren 1Z11 from Sound Leve Meter ANO 02

SLM ANO 02 was positioned close to the intersection of Rte 51 and Hillside Dr. The time history from this test is shown in Figure 19, with the comined 500 Hz and 630 Hz siren signal clearly evident above the background level. Background levels at this location was around 55 dBC. The test data sheet is provided in Figure 20.

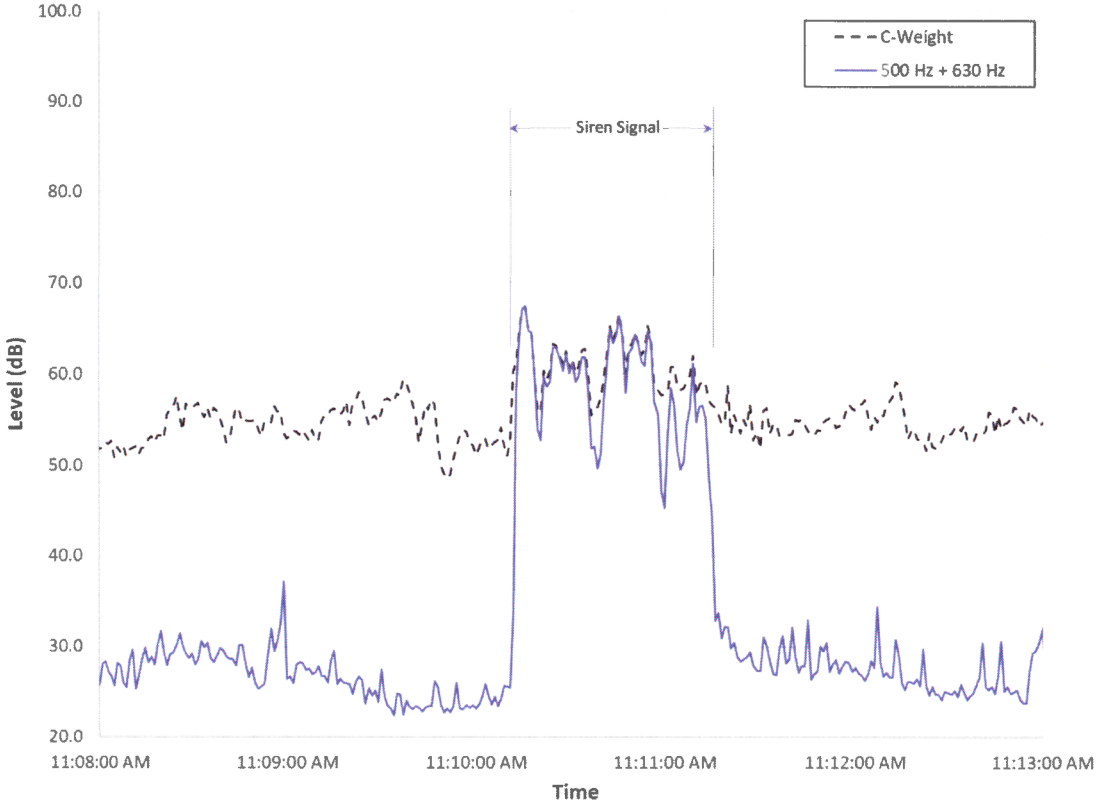


Figure 19. Time history from SLM ANO 02 for siren 1Z11

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 06/22/2020 Time: 10:44

SLM Model: LD 831 SLM Serial Number: 3397

Preamp SN: 51240 Microphone SN: 307776

Tester's Name: Efe Juncer

GPS Coordinates: 35.23 West -93.19 North

Checked Battery? Yes No

Checked Clock? Yes No

Memory Checked? Yes No

Calibration level before test: 94.1 dBC

30 second calibration tone recorded before test? (Yes) No

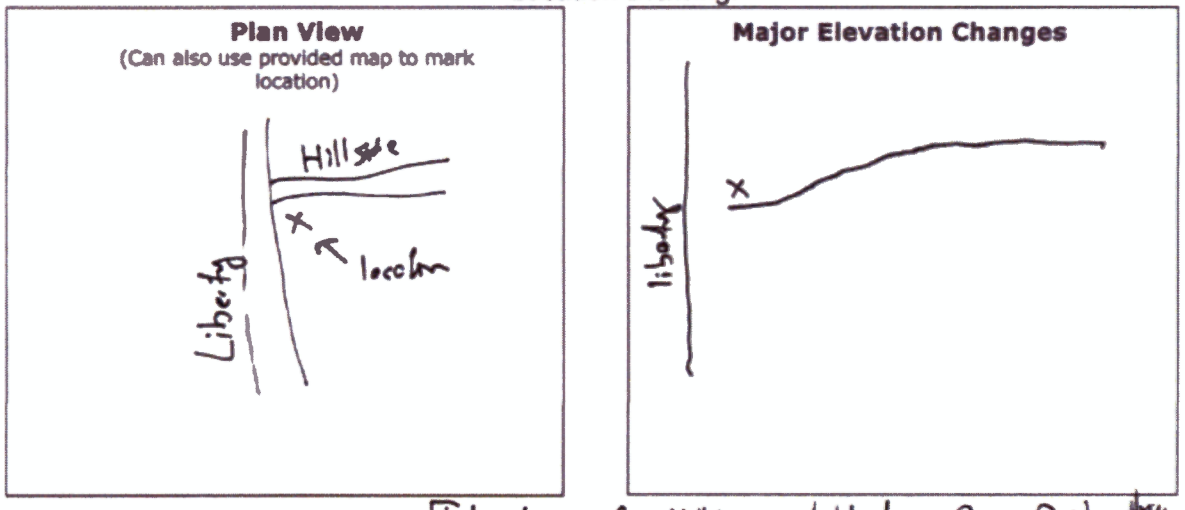
Calibration level after test: 94.0 dBC

30 second calibration tone recorded after test? (Yes) No

Calibrator Model: Cal 200 Calibrator SN: 15674

----------To be filled in be by the field crew at the site----------

Location Drawing:



Measurement Location description: Intersection of Hillside and Liberty - Open field -

Microphone height: 5 ft.

Photos Taken? (Yes) No

Meter Recording? (Yes) No

Wind Dir: SSW 170° deg.

Wind Spd: 3.1 mph

Temp: 82.8 °F

Weather Station on and wind cover removed? (Yes) No

Ambient noise level before test: 55 dBC

Maximum level observed during the test: 67 dBC

Could you hear the sirens? (Yes) No

Ambient noise level after test: 54 dBC

10:47:41

Siren Start: 22:23

Siren End: 23:23

Notes about test (including background noise and noise intrusions during the test):

Only birds Chirping during test

Tester's Signature: EJZ

Figure 20. Data collection sheet for SLM ANO 02 for siren 1Z11

Far-Field Measurement of Siren 1Z11 from Sound Leve Meter ANO 03

SLM ANO 03 was located in a large parking lot close to the busy road Rt. 22. Unfortunately because of the busy road, the elevated background noise made it almost impossible to identify the siren signal in the time history (shown in Figure 21). Background levels in this location were in the low 60s dBC. The data sheet for this test is shown in Figure 22.

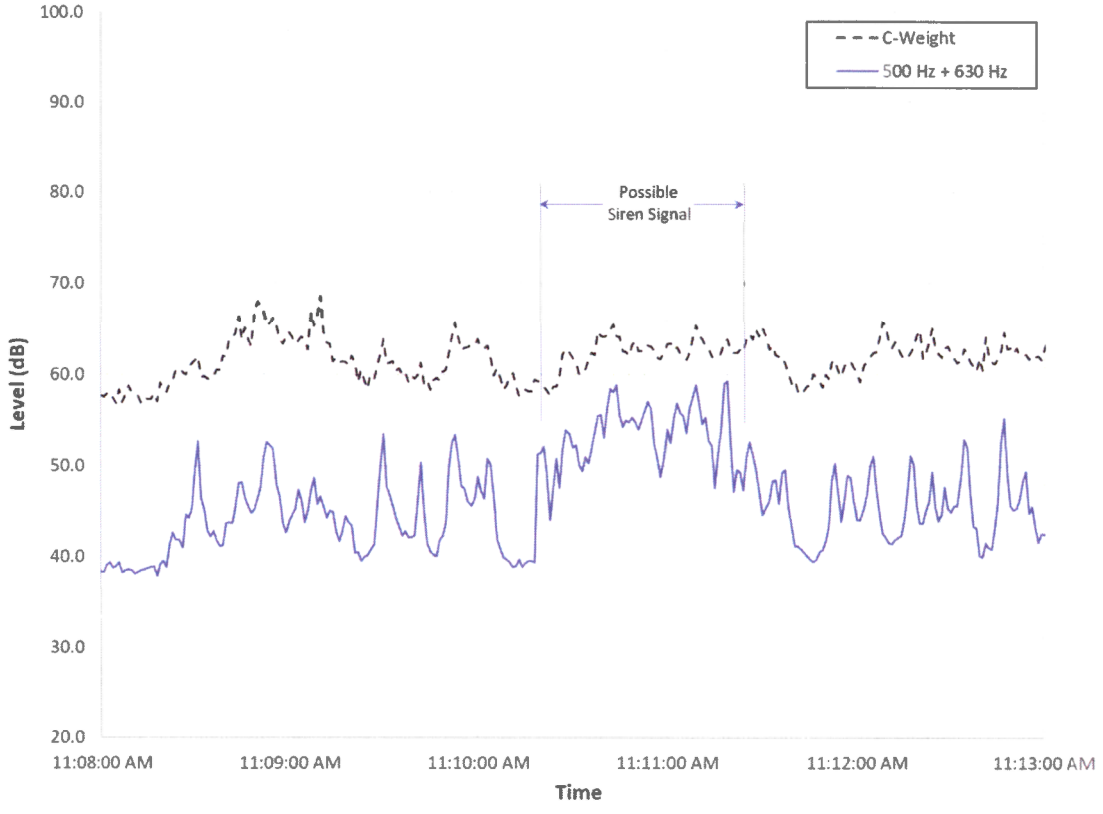


Figure 21. Time history from SLM ANO 03 for siren 1Z11

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 6/23/2020 Time: 10:30 am

SLM Model: LD 831 SLM Serial Number: 4278

Preamp SN: 19136 Microphone SN: 307396

Tester's Name: Zhuoxing (Amy) Jiang

GPS Coordinates: -93.165698 West 35.223787 North

Checked Battery? (Yes) No

Checked Clock? (Yes) No

Memory Checked? (Yes) No

Calibration level before test: 94.1 dBC

30 second calibration tone recorded before test? (Yes) No

Calibration level after test: 94.1 dBC

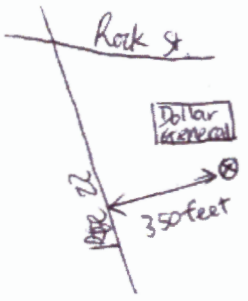
30 second calibration tone recorded after test? (Yes) No

Calibrator Model: Cal 200 Calibrator SN: 15674

----------To be filled in be by the field crew at the site----------

Location Drawing:

Plan View
(Can also use provided map to mark location)



Major Elevation Changes

no major elevation changes

Measurement Location description: 350 feet east of Rte 22

Microphone height: 50 ft. Wind Dir: 205 deg.

Photos Taken? (Yes) No Wind Spd: 0 mph

Meter Recording? (Yes) No Temp: 88.5 °F

Weather Station on and wind cover removed? (Yes) No

Ambient noise level before test: 64 dBC

Maximum level observed during the test: 66.2 dBC

Could you hear the sirens? (Yes) No

Ambient noise level after test: 63 dBC

Notes about test (including background noise and noise intrusions during the test):
This site is close to a major road (Rte 22). Vehicles pass by every 2-3 seconds

Tester's Signature: Zhuoxing Jiang

Figure 22. Data collection sheet for SLM ANO 03 for siren 1Z11

Field Measurements of Siren 1Z9

Siren 1Z9, a Whelen model WPS2807 siren, was measured on June 23rd, 2020 at approximately 12:00 pm. This siren is located on Bay Ridge Dr. in Dardenelle, AR, next to the Lion's Den Golf Course. This siren is mounted on top of an approximately 50 foot wooden pole. Far-field SLM ANO 01 was placed to the west of the siren, SLMs 02 was placed to the south-east of the siren, and 03 was placed east of the siren. This is shown below in Figure 23. The measured output from this test were significantly lower than other similar models of siren suggesting there may be a maintenance issue with this particular siren. After the testing Acoustic Analytics learned that the siren had, in fact, suffered damage (possibly from a lightning strike) and was repaired shortly after the testing was completed. The ANSI S12.14 data sheet is provided in Figure 24, with a photo of the siren in Figure 25 and the measured time history in Figure 26.

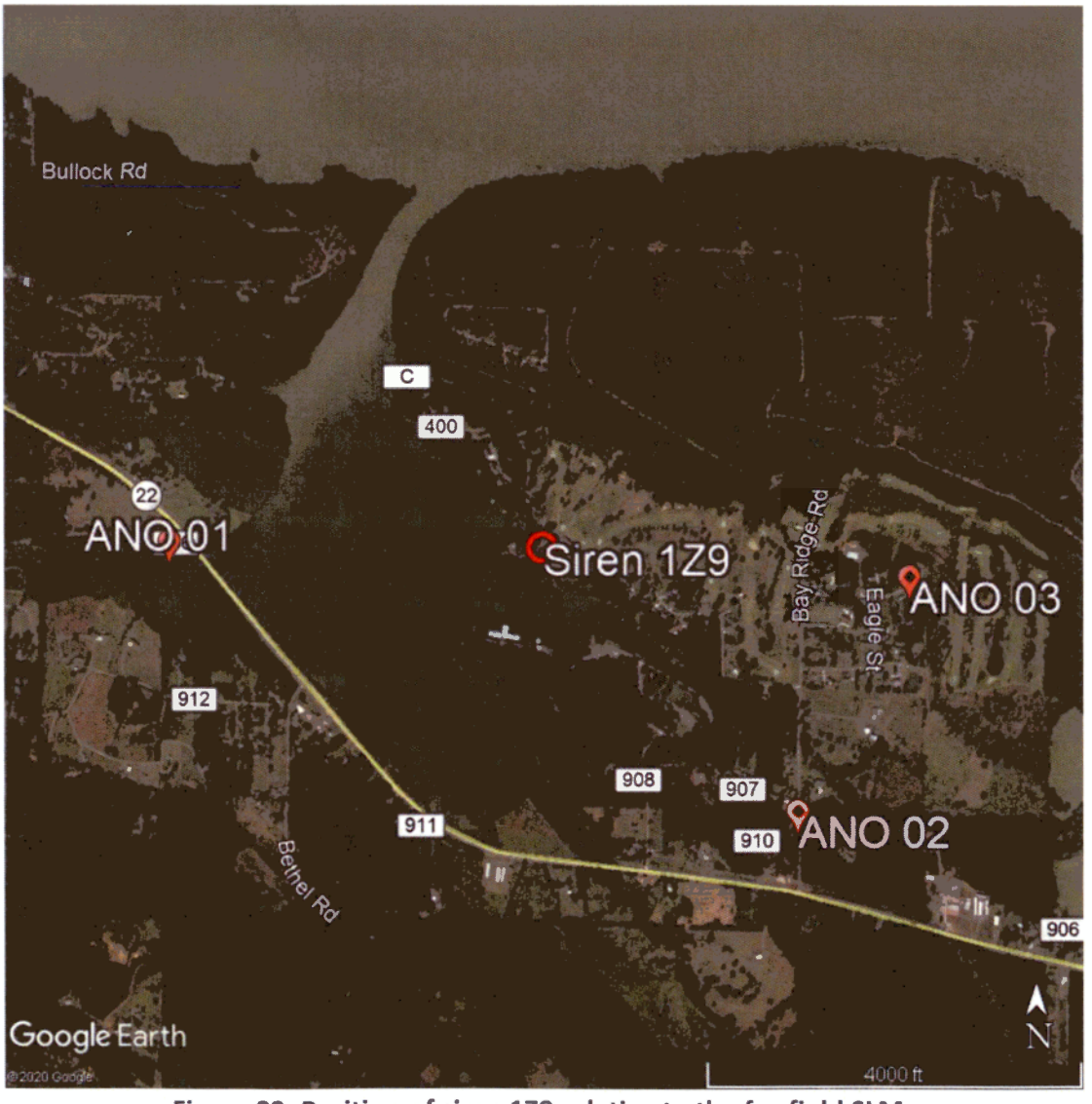


Figure 23. Position of siren 1Z9 relative to the far-field SLMs

Siren Sound Output Measurement per ANSI S12.14
Data Sheet

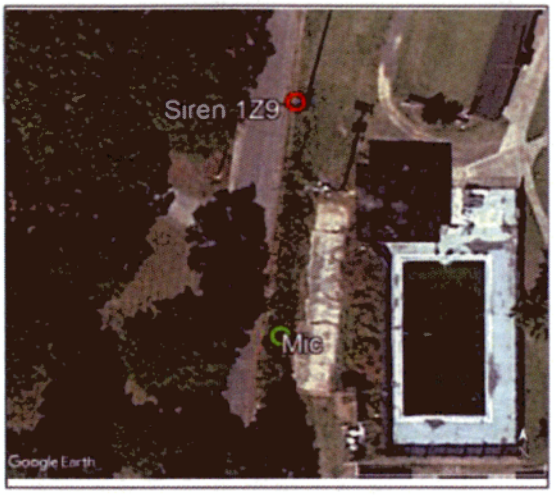
Siren Mfg: Whelen Model No: WPS2807 S/N: _____

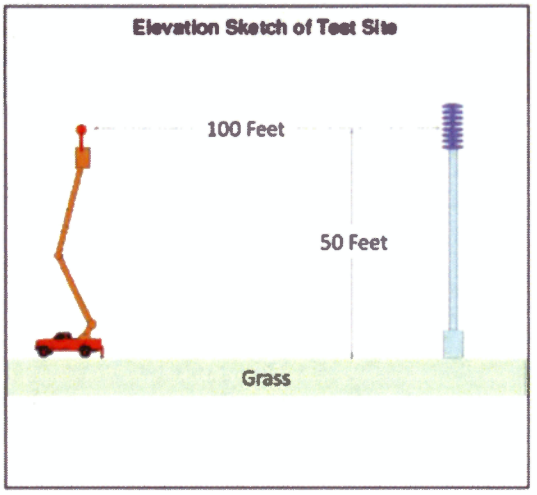
Description: In situ measurement of ANO siren 1Z9

Meas. Loc. Measurement along the side of a road next to a golf course

Date: 6/23/20 Time: 12:00 pm By: Bruce I. Title: _____

Temp 88 °F Wind speed: 0 mph Wind Dir: - Clouds 100 % Precip. (Y/N)? N





Mfg rec'd mtg. height: 50 feet Actual height: 52 feet Method: Laser Power correct (Y/N)? _____

Ground type & cover between siren and meas. loc. Grass

Deviations from test procedure: There appeared to be some repairs or modification to this siren. One of the bird screens was a different size than the others.

SLM Mfg:	LD	Model No:	831	S/N	3174	Pri Cal Date:	3/11/20
Filter Mfg:		Model No:		S/N		Pri Cal Date:	
Calib Mfg:	LD	Model No:	Cal200	S/N	15674	Pri Cal Date:	6/19/20

Field Calibration: Before 94.0 dBC After 94.0 dBC

Max ambient: Before 53 dBC slow After 56 dBC slow

Microphone SN: 311593
Preamp SN: 51309

	Base Line Position	Secondary Position (if used)
Siren Sound:	Alert	Alert
MXSCL (max dBC, slow):	110.7	
Average SCL, dBC slow:	107.4	
Max 1/3 octave band, Hz:	500 Hz & 630 Hz	
MXSCL in max 1/3 octave band, dBC slow:	110.9*	
Average SCL in max 1/3 octave band, dBC slow:	107.3	
Bystander MXSCL, dBC slow	119	XXX
Dist of bystander MXSCL from mount, feet	52	XXX

Other pertinent information: * The fact that the 500 Hz & 630 Hz appears higher than the C-weighted level is an artifact of the sound level meter's processing and is within the experimental error.

Figure 24. ANSI S12.14 Data Sheet for Siren 1Z9

Figure 25. Photo from the bucket truck, looking at siren 1Z9

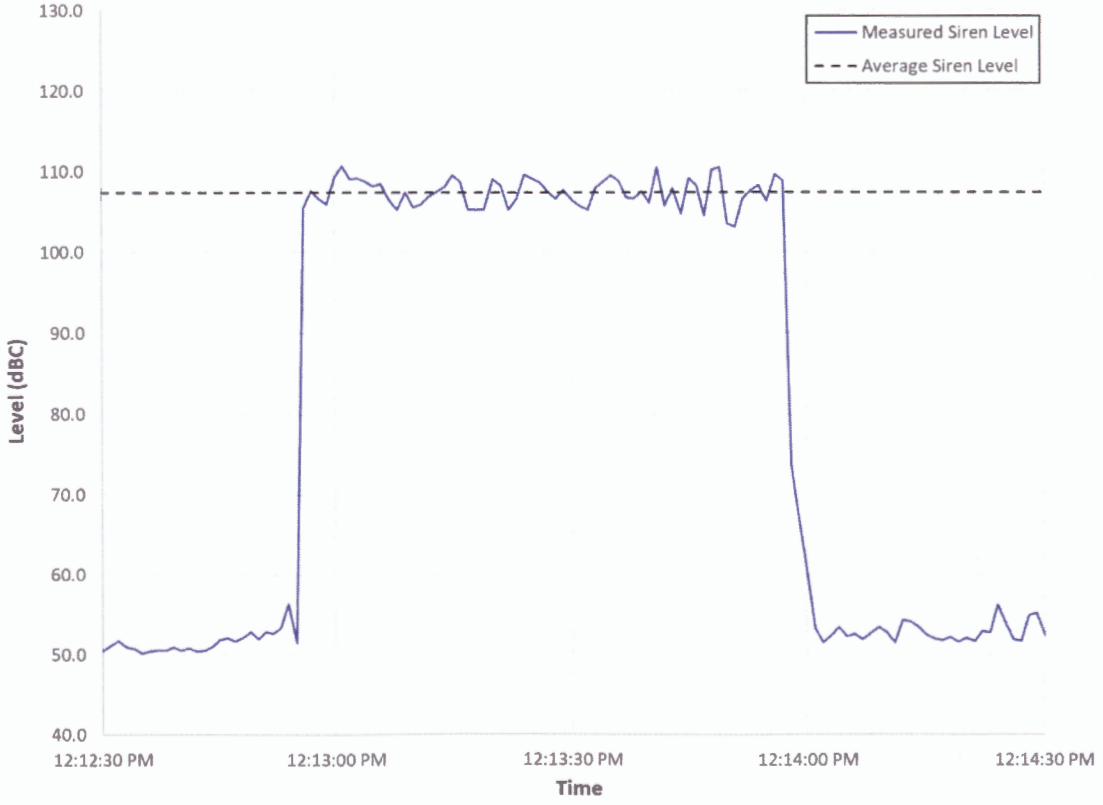


Figure 26. Time history of the received sound from siren 1Z9 as measured from the bucket truck

Far-Field Measurement of Siren 1Z9 from Sound Leve Meter ANO 01

This SLM was placed close to the intersection of Rte. 406 and Rte. 22. Because of an equipment malfunction, no data was collected from SLM ANO 01 for this siren.

Far-Field Measurement of Siren 1Z9 from Sound Leve Meter ANO 02

This SLM was placed at the intersection of Bay Ridge Rd. and Marina Rd. The time history from this tests is shown in Figure 27, with the data sheet provided in Figure 28. As identified in the data sheet (and as is clearly obvious in the time history), three cars passed by the meter during the siren sounding. This briefly artificially elevates the received sound level and does not accurately represent the siren signal. Therefore, those portions of the data were removed when computing the siren characteristics. Despite the intrusion of the cars, the siren signal is clearly evident above the background noise, which is in the low 60 dBC range for this location.

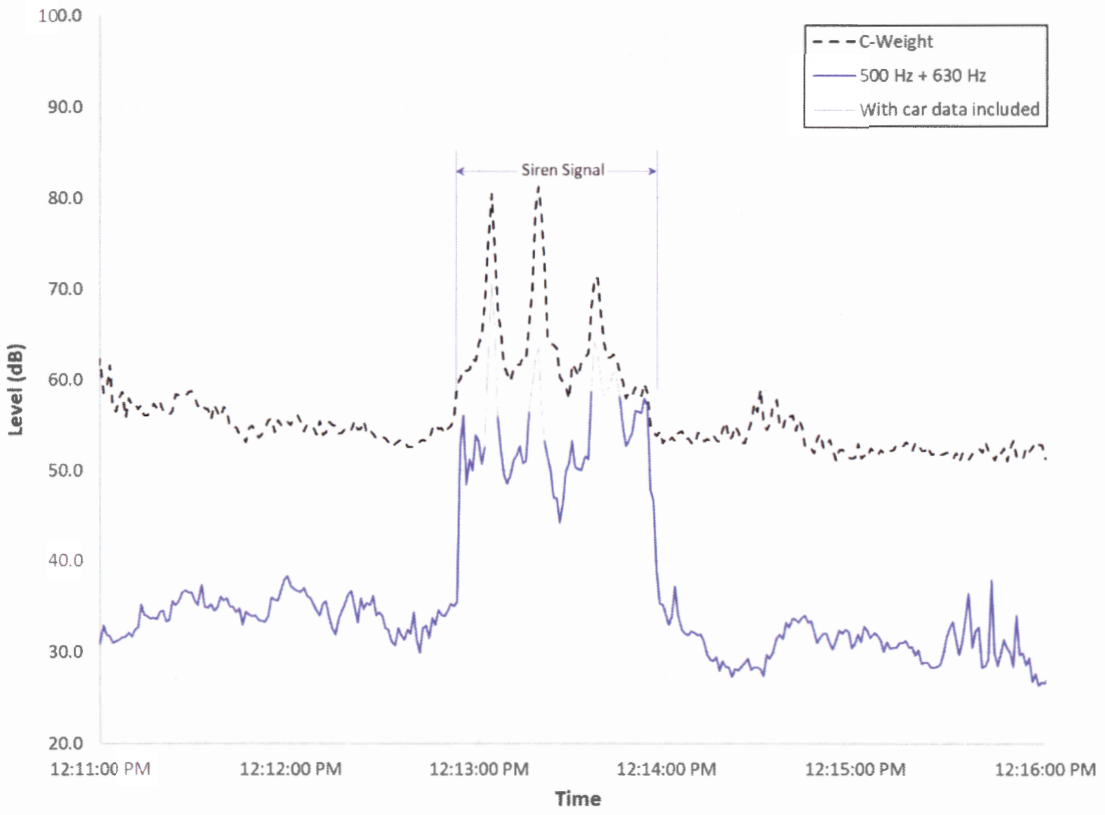


Figure 27. Time history from SLM ANO 02 for siren 1Z9

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 06/23/2029 Time: 12:00

SLM Model: LD 831 SLM Serial Number: 3397

Preamp SN: 51240 Microphone SN: 307776

Tester's Name: Efe Tuncer

GPS Coordinates: 35.25 West -93.21 North

Checked Battery? Yes No

Checked Clock? Yes No

Memory Checked? Yes No

Calibration level before test: 94.0 dBC

30 second calibration tone recorded before test? Yes No

Calibration level after test: 94.0 dBC

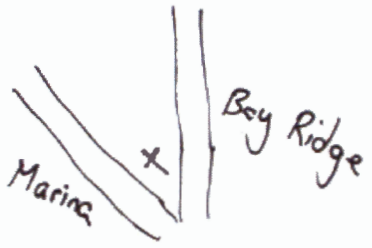
30 second calibration tone recorded after test? Yes No

Calibrator Model: Cal 200 Calibrator SN: 15674

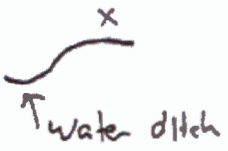
----------To be filled in be by the field crew at the site----------

Location Drawing:

Plan View
(Can also use provided map to mark location)



Major Elevation Changes



Measurement Location description: Residential Area - at the intersection of Marina and Bay Ridge

Microphone height: 5 ft. Wind Dir: NW 312 deg.

Photos Taken? Yes No Wind Spd: 0 mph

Meter Recording? Yes No Temp: 85.6 °F

Weather Station on and wind cover removed? Yes No

Ambient noise level before test: 56 dBC

Maximum level observed during the test: 65 dBC 81 at one point because of a car

Could you hear the sirens? Yes No

Ambient noise level after test: 54 dBC

Notes about test (including background noise and noise intrusions during the test): Birds and very light traffic 3 cars passed during the 1 min test.

Tester's Signature: EJZ

Figure 28. Data collection sheet for SLM ANO 02 for siren 1Z9

Far-Field Measurement of Siren 1Z9 from Sound Leve Meter ANO 03

This SLM was in a cul-de-sac at the end of Birdie St. The siren signal is clearly evident above the background noise shown in the time history in Figure 29. Background noise levels in this location were in the low 60 dBC range. The data sheet for this test is provided in Figure 30.

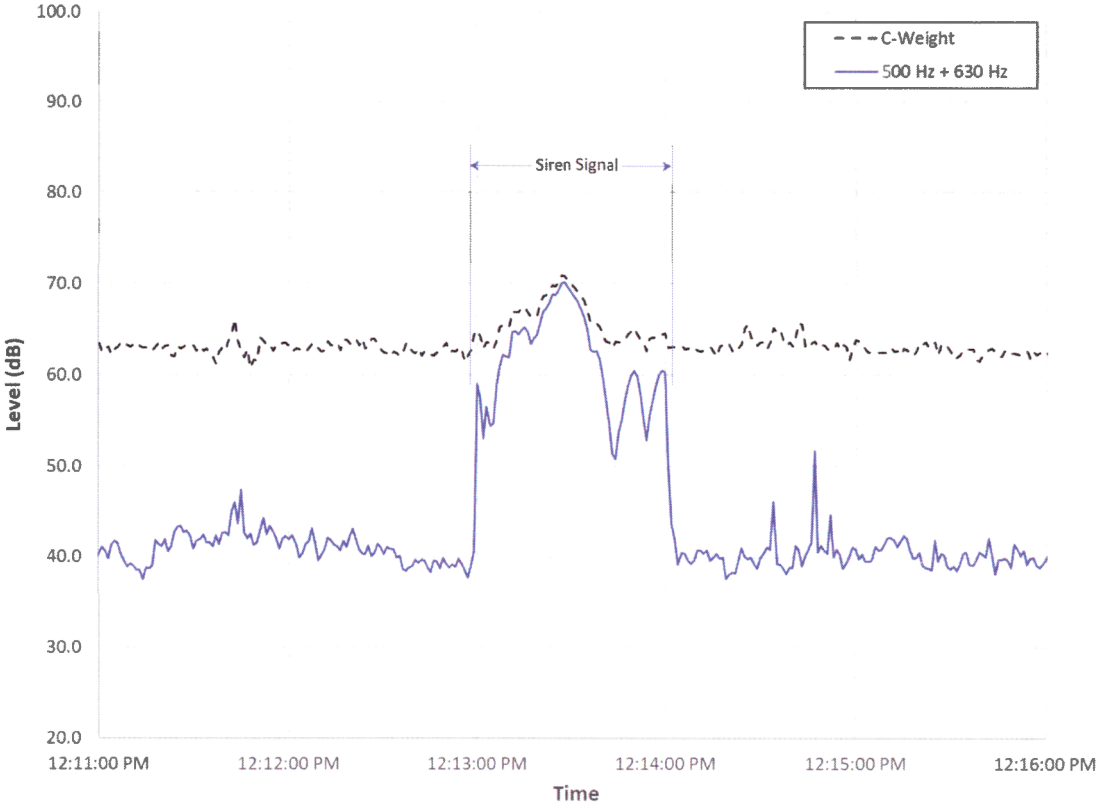


Figure 29. Time history from SLM ANO 03 for siren 1Z9

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 6/23/2020 Time: 12:00

SLM Model: LD 831 SLM Serial Number: 4278

Preamp SN: 19136 Microphone SN: 307396

Tester's Name: Zhuoxing (Amy) Jiang

GPS Coordinates: -93.203675 West 35.257309 North

Checked Battery? (Yes) No

Checked Clock? (Yes) No

Memory Checked? (Yes) No

Calibration level before test: 94.1 dBC

30 second calibration tone recorded before test? (Yes) No

Calibration level after test: 94.1 dBC

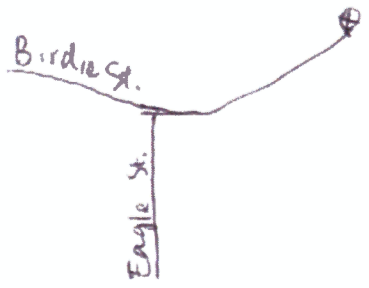
30 second calibration tone recorded after test? (Yes) No

Calibrator Model: Cal 200 Calibrator SN: 15674

----------To be filled in be by the field crew at the site----------

Location Drawing:

Plan View
(Can also use provided map to mark location)



Major Elevation Changes

no major elevation changes

Measurement Location description: The end of Birdie St. located in a golf course

Microphone height: 5.0 ft. Wind Dir: 299 deg. neighborha

Photos Taken? (Yes) No Wind Spd: 1.1 mph

Meter Recording? Yes No Temp: 85.1 °F

Weather Station on and wind cover removed? (Yes) No

Ambient noise level before test: 65 dBC

Maximum level observed during the test: 70.9 dBC

Could you hear the sirens? (Yes) No

Ambient noise level after test: 64 dBC

Notes about test (including background noise and noise intrusions during the test):
Some neighbor nearby is cutting trees, however, it is not loud at my test site.

Tester's Signature: Zhuoxing Jiang

Figure 30. Data collection sheet for SLM ANO 03 for siren 1Z9

Field Measurements of Siren 5Z2

Siren 5Z2, a Whelen model WPS2807 siren, was measured on June 24th, 2020 at approximately 8:40 am. This siren is located on Rt. 393 between Oak Rd. and Riverside Dr. in Illinois Township, AR. This siren is mounted on top of an approximately 50 foot wooden pole. Far-field SLM ANO 01 was placed to the north of the siren, SLMs 02 was placed to the east of the siren, and 03 was placed south-west of the siren. This is shown below in Figure 31.

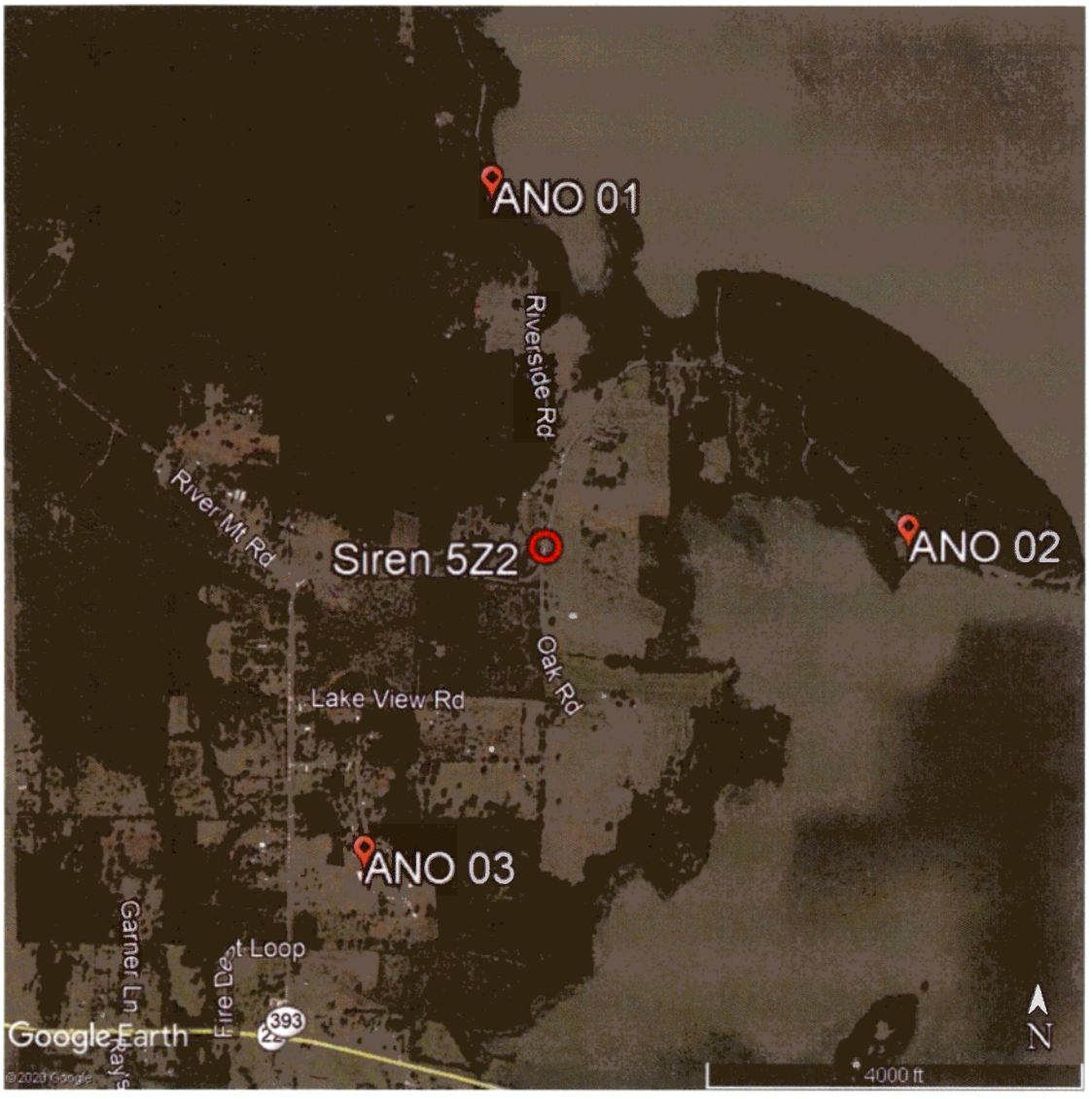


Figure 31. Position of siren 5Z2 relative to the far-field SLMs

Siren Sound Output Measurement per ANSI S12.14
Data Sheet

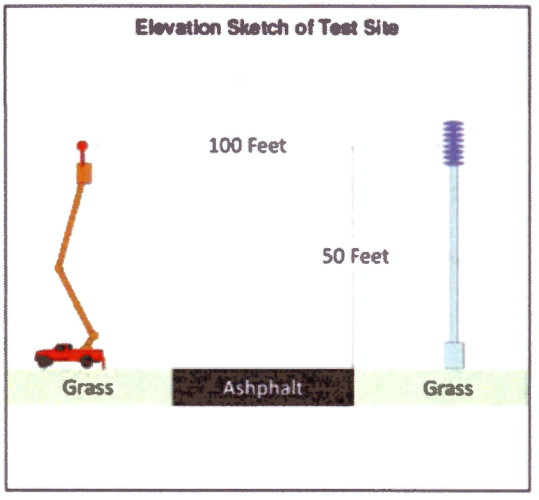
Siren Mfg: Whelen Model No: WPS2807 S/N: _____

Description: In situ measurement of ANO siren 5Z2

Meas. Loc. Measurement across a road near a farm.

Date: 6/24/20 Time: 8:40 am By: Bruce I. Title: _____

Temp 78 °F Wind speed: 2.5 mph Wind Dir: 100 Clouds 0 % Precip. (Y/N)? N



Mfg rec'd mtg. height: 50 feet Actual height: 47 feet Method: Laser Power correct (Y/N)? _____

Ground type & cover between siren and meas. loc. Grass and asphalt

Deviations from test procedure: _____

SLM Mfg:	LD	Model No:	831	S/N	3174	Pri Cal Date:	3/11/20
Filter Mfg:		Model No:		S/N		Pri Cal Date:	
Calib Mfg:	LD	Model No:	Cal200	S/N	15674	Pri Cal Date:	6/19/20
Field Calibration: Before	94.0 dBC			After	94.0 dBC		
Max ambient: Before	52	dBC slow		After	56	dBC slow	

Microphone SN: 311593
Preamp SN: 51309

	Base Line Position	Secondary Position (if used)
Siren Sound:	Alert	Alert
MXSCL (max dBC, slow):	118.6	
Average SCL, dBC slow:	115.1	
Max 1/3 octave band, Hz:	500 Hz & 630 Hz	
MXSCL in max 1/3 octave band, dBC slow:	118.6	
Average SCL in max 1/3 octave band, dBC slow:	104.6	
Bystander MXSCL, dBC slow	116	XXX
Dist of bystander MXSCL from mount, feet	47	XXX

Other pertinent information: _____

Figure 32. ANSI S12.14 Data Sheet for Siren 5Z2

Figure 33. Photo from the bucket truck, looking at siren 5Z2

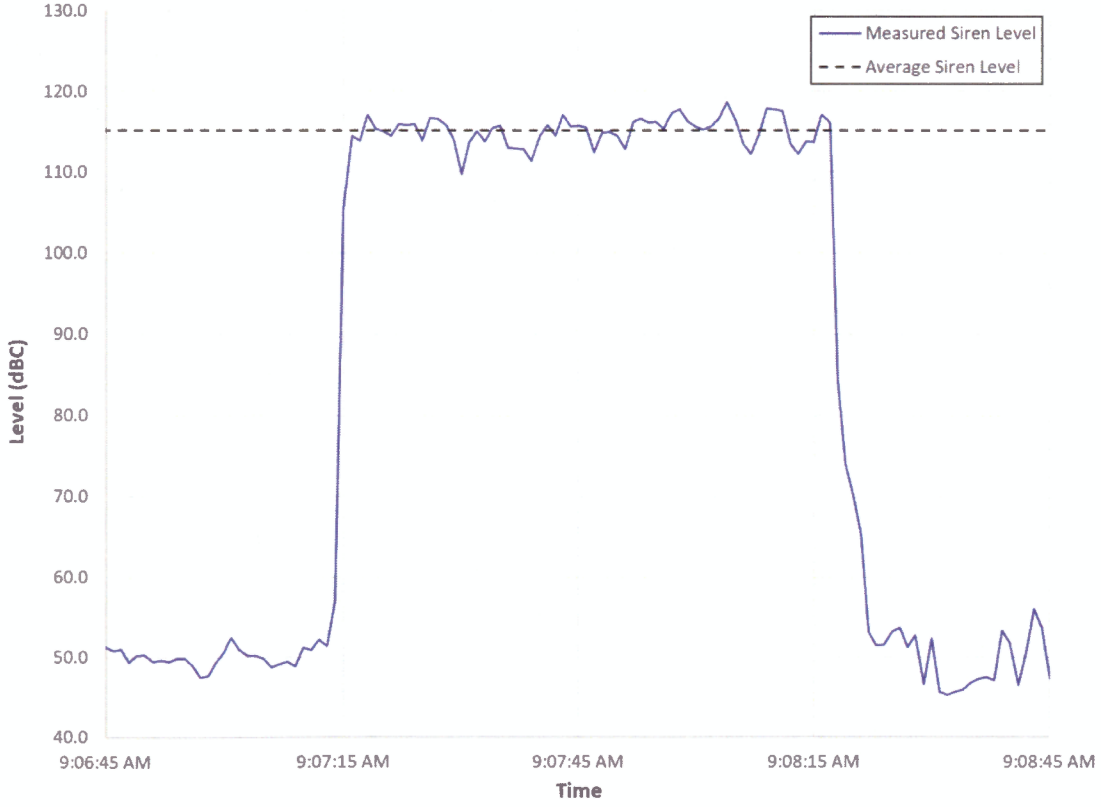


Figure 34. Time history of the received sound from siren 5Z2 as measured from the bucket truck

Far-Field Measurement of Siren 5Z2 from Sound Leve Meter ANO 01

Ths SLM was placed on the side of the road on Riverside Rd. The siren signal is clearly evident in the time history provided in Figure 35. Background noise levels in this location were in the mid 50 dBC range. The data sheet for this test is provided in Figure 36.

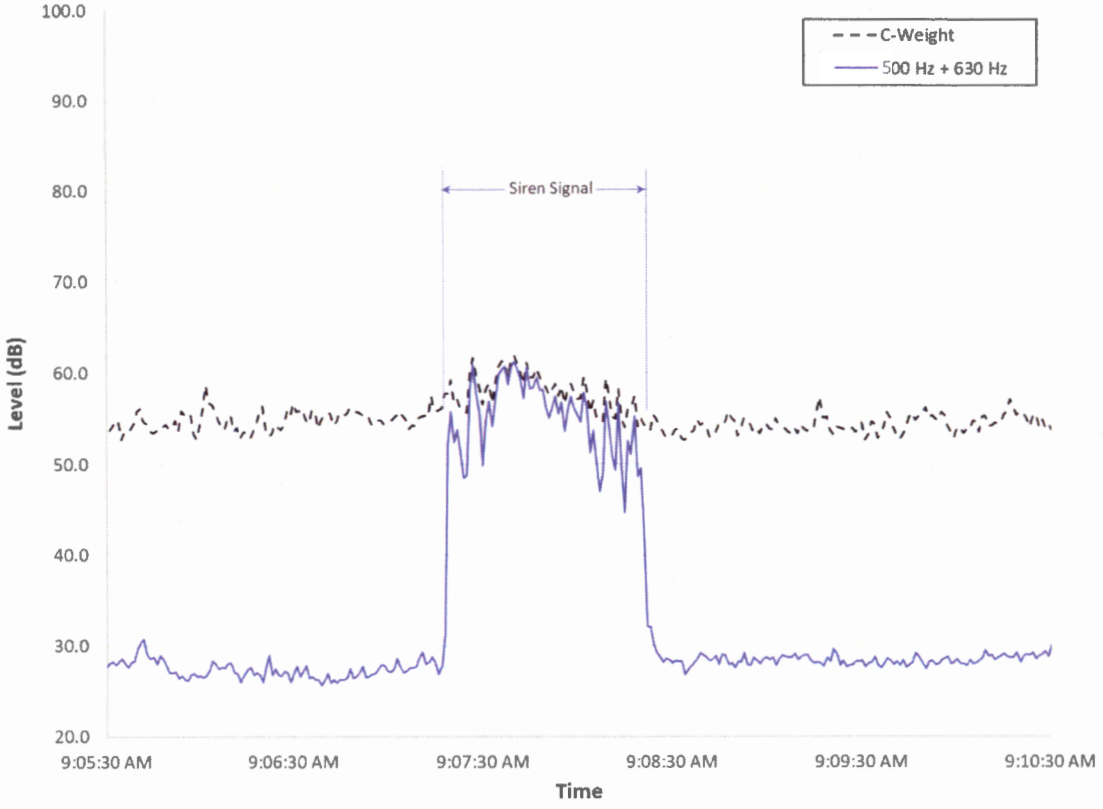


Figure 35. Time history from SLM ANO 01 for siren 5Z2

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 6/29/20 Time: 7:30 am

SLM Model: LD 831 SLM Serial Number: 3558

Preamp SN: 58506 Microphone SN: 310089

Tester's Name: Danielle Mallon

GPS Coordinates: -93.289443 West 35.306951 North

Checked Battery? (Yes) No

Checked Clock? (Yes) No

Memory Checked? (Yes) No

Calibration level before test: 94.1 dBC

30 second calibration tone recorded before test? (Yes) No

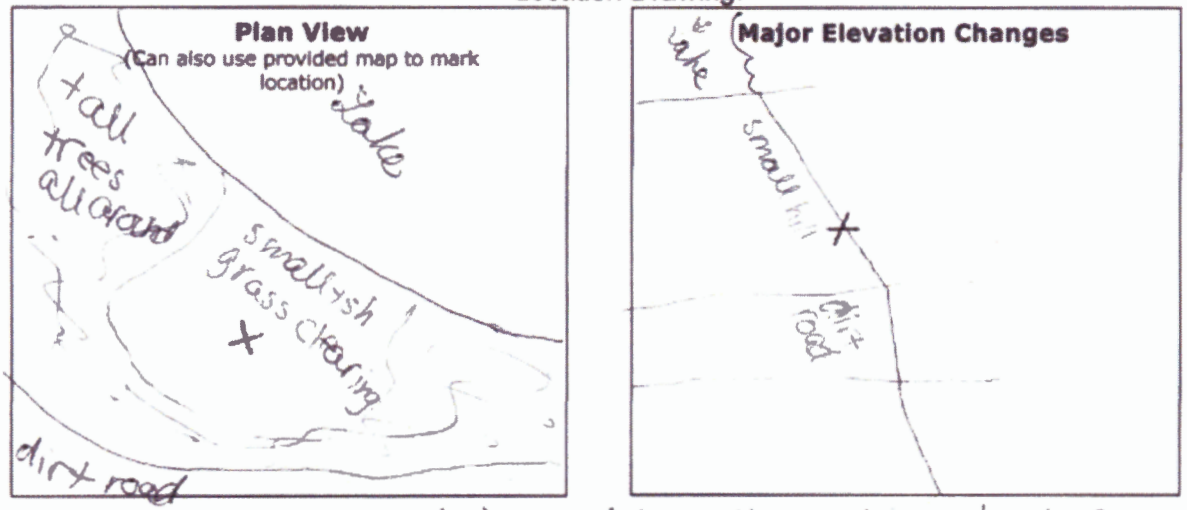
Calibration level after test: 94.0 dBC

30 second calibration tone recorded after test? (Yes) No

Calibrator Model: Cal 200 Calibrator SN: 15674

----------To be filled in be by the field crew at the site----------

Location Drawing:



Measurement Location description: between lake + dirt road, in a clearing around all of the trees

Microphone height: 5 ft.

Photos Taken? (Yes) No

Meter Recording? (Yes) No

Wind Dir: E101 deg.

Wind Spd: 1.8 mph

Temp: 76 °F

Weather Station on and wind cover removed? (Yes) No

Ambient noise level before test: 53 dBC

Maximum level observed during the test: 62.5 dBC

Could you hear the sirens? (Yes) No

Ambient noise level after test: 53 dBC

Notes about test (including background noise and noise intrusions during the test): lots of birds chirping + bugs. Entergy truck pulling up ~10 min.

Tester's Signature: Danielle Mallon

Figure 36. Data collection sheet for SLM ANO 01 for siren 5Z2

Far-Field Measurement of Siren 5Z2 from Sound Leve Meter ANO 02

This SLM was placed in the Delaware Park Public Use Area. The time history for this SLM is provided in Figure 37, with the siren signal clearly rises above the background noise. From the data sheet shown in Figure 38 it appears that a car pulled up close to the meter shortly after the test. This is also evident in the time history as the peak in noise shortly after the siren sounded. Fortunately this did not impact these measurements. The background noise in this area was in the low 50 dBC range.

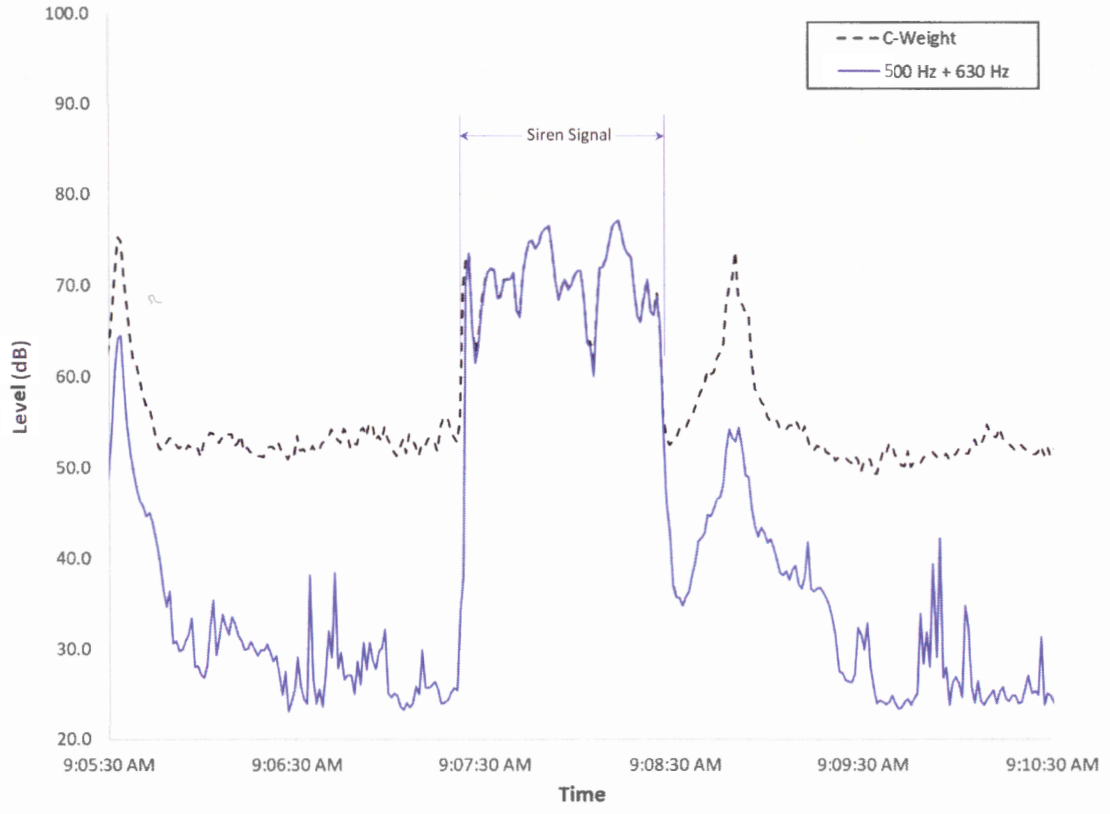


Figure 37. Time history from SLM ANO 02 for siren 5Z2

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 6/24/20 Time: 7:30-m

SLM Model: LD 831 SLM Serial Number: 3397

Preamp SN: 51240 Microphone SN: 307776

Tester's Name: Eric Tuncer

GPS Coordinates: 35.2967 West -93.2746 North

Checked Battery? Yes No

Checked Clock? Yes No

Memory Checked? Yes No

Calibration level before test: 94.0 dBC

30 second calibration tone recorded before test? Yes No

Calibration level after test: 94.0 dBC

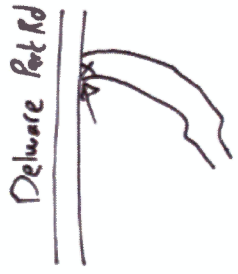
30 second calibration tone recorded after test? Yes No

Calibrator Model: Cal200 Calibrator SN: 15674

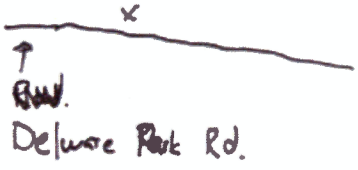
----------To be filled in be by the field crew at the site----------

Location Drawing:

Plan View
(Can also use provided map to mark location)



Major Elevation Changes



Measurement Location description: Inside a Public Park

Microphone height: 5 ft. Wind Dir: N 001 deg.

Photos Taken? Yes No Wind Spd: 0 mph

Meter Recording? Yes No Temp: 79 °F

Weather Station on and wind cover removed? Yes No

Ambient noise level before test: 56 dBC

Maximum level observed during the test: 77.2 dBC

Could you hear the sirens? Yes No

Ambient noise level after test: 57 dBC

Notes about test (including background noise and noise intrusions during the test): Only birds during test

Tester's Signature: EPZ.

A guy in a truck pulled over next to the meter for the last 2 mins or so

Figure 38. Data collection sheet for SLM ANO 02 for siren 5Z2

Far-Field Measurement of Siren 5Z2 from Sound Leve Meter ANO 03

This SLM was placed towards the end of Western Shores Drive. The time history from this test is shown in Figure 39, with the data sheet in Figure 40. The siren signal is clearly visible above the background noise, with the background noise level in the mid 50 dBC range. The data sheet for this test in provided in Figure 41.

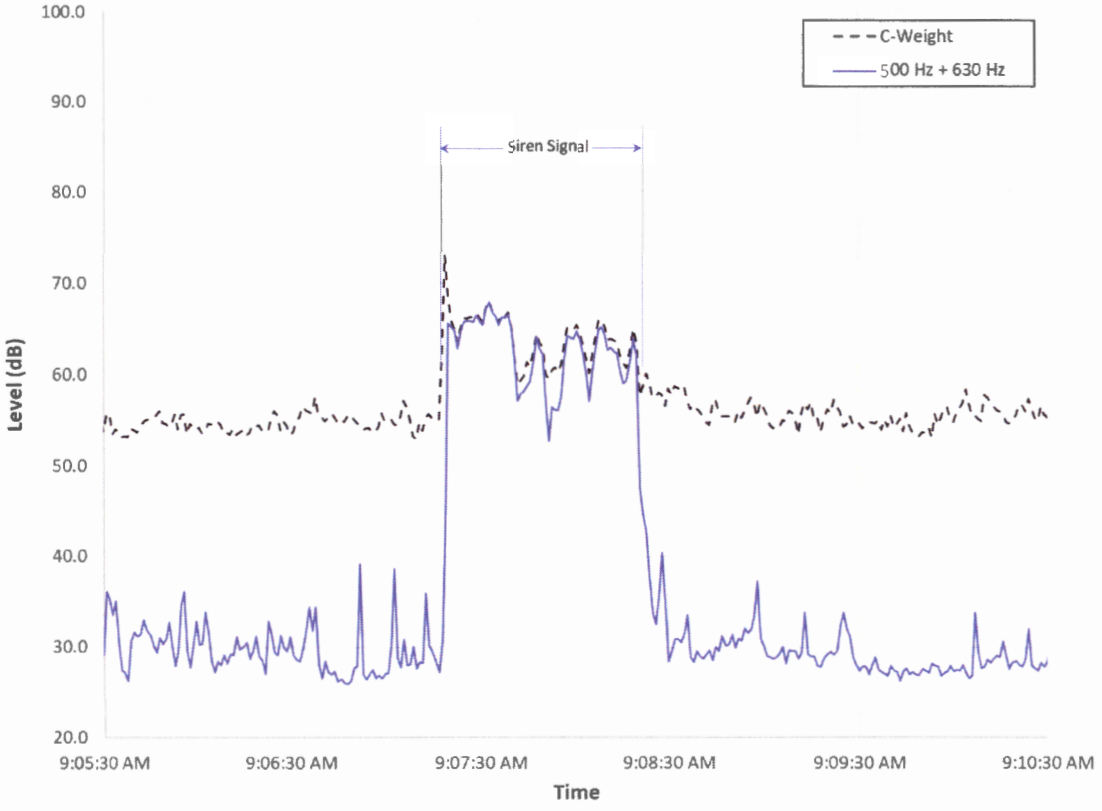


Figure 39. Time history from SLM ANO 03 for siren 5Z2

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 6/24/20 Time: 7:30 am

SLM Model: LD 831 SLM Serial Number: 4278

Preamp SN: 19136 Microphone SN: 307396

Tester's Name: Zhuoxing (Amy) Jiang

GPS Coordinates: -93.294007 West 35.28740 North

Checked Battery? Yes No

Checked Clock? Yes No

Memory Checked? Yes No

Calibration level before test: 93.9 dBC

30 second calibration tone recorded before test? Yes No

Calibration level after test: 94.0 dBC

30 second calibration tone recorded after test? Yes No

Calibrator Model: Cal200 Calibrator SN: 15674

----------To be filled in be by the field crew at the site----------

Location Drawing:

Plan View
(Can also use provided map to mark location)

Major Elevation Changes

No major elevation changes

Measurement Location description: ~1000' south of Western Shores Dr, located in a rural neighborhood

Microphone height: 5.0 ft. Wind Dir: 293 deg.

Photos Taken? Yes No Wind Spd: 0 mph

Meter Recording? Yes No Temp: ~~79~~ 83 °F

Weather Station on and wind cover removed? Yes No

Ambient noise level before test: 55 dBC

Maximum level observed during the test: 66.9 dBC

Could you hear the sirens? Yes No

Ambient noise level after test: 56 dBC

Notes about test (including background noise and noise intrusions during the test):
This site is located in a quiet residential area.

Tester's Signature: Zhuoxing Jiang

Figure 40. Data collection sheet for SLM ANO 03 for siren 5Z2

Field Measurements of Siren 3Z4

Siren 3Z4, a Whelen model WPS2907 siren, was measured on June 24th, 2020 at approximately 10:15 am. This siren is located on Fleetwood Rd, London, AR, about ¾ of a mile north-west of Akransas Nuclear One. This siren is mounted on top of an approximately 50 foot wooden pole. Far-field SLM ANO 01 was placed to the north of the siren, SLMs 02 was placed to the north-west of the siren, and 03 was placed south of the siren. This is shown in Figure 41 below. The ANSI S12.14 data sheet is provided in Figure 42, with a phot of the siren in Figure 43 and the acoustic time history of this test shown in Figure 44.

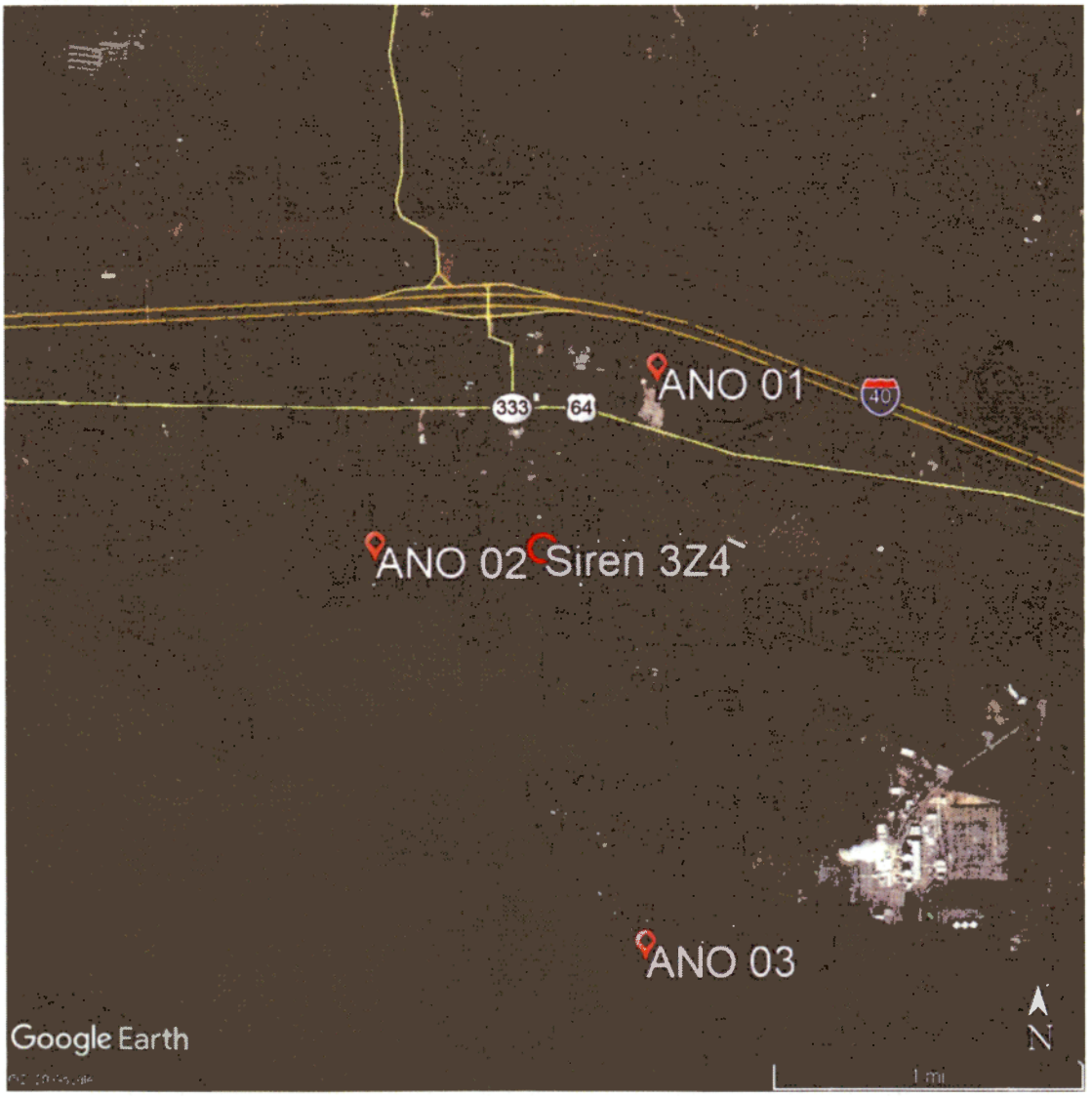


Figure 41. Position of siren 3Z4 relative to the far-field SLMs

Siren Sound Output Measurement per ANSI S12.14
Data Sheet

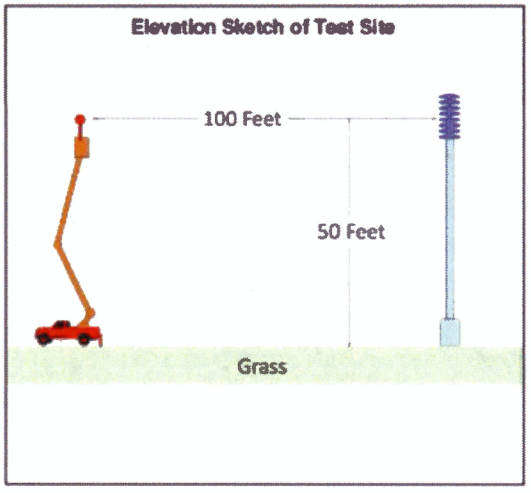
Siren Mfg: Whelen Model No: WPS2907 S/N: _____

Description: In situ measurement of ANO siren 3Z4

Meas. Loc. Measurement along the side of a small road.

Date: 6/24/20 Time: 10:15 am By: Bruce I. Title: _____

Temp 85 °F Wind speed: 2 mph Wind Dir: 0 Clouds 0 % Precip. (Y/N)? N



Mfg rec'd mtg. height: 50 feet Actual height: 47 feet Method: Laser Power correct (Y/N)? _____

Ground type & cover between siren and meas. loc. Grass

Deviations from test procedure: _____

SLM Mfg:	LD	Model No:	831	S/N	3174	Pri Cal Date:	3/11/20
Filter Mfg:		Model No:		S/N		Pri Cal Date:	
Calib Mfg:	LD	Model No:	Cal200	S/N	15674	Pri Cal Date:	6/19/20

Field Calibration: Before 94.0 dBC After 93.9 dBC

Max ambient: Before 48 dBC slow After 48 dBC slow

Microphone SN: 311593

Preamp SN: 51309

	Base Line Position	Secondary Position (if used)
Siren Sound:	Alert	Alert
MXSCL (max dBC, slow):	120.3	
Average SCL, dBC slow:	116.9	
Max 1/3 octave band, Hz:	500 Hz & 630 Hz	
MXSCL in max 1/3 octave band, dBC slow:	120.1	
Average SCL in max 1/3 octave band, dBC slow:	116.7	
Bystander MXSCL, dBC slow	114	XXX
Dist of bystander MXSCL from mount, feet	92	XXX

Other pertinent information: _____

Figure 42. ANSI S12.14 Data Sheet for Siren 3Z4

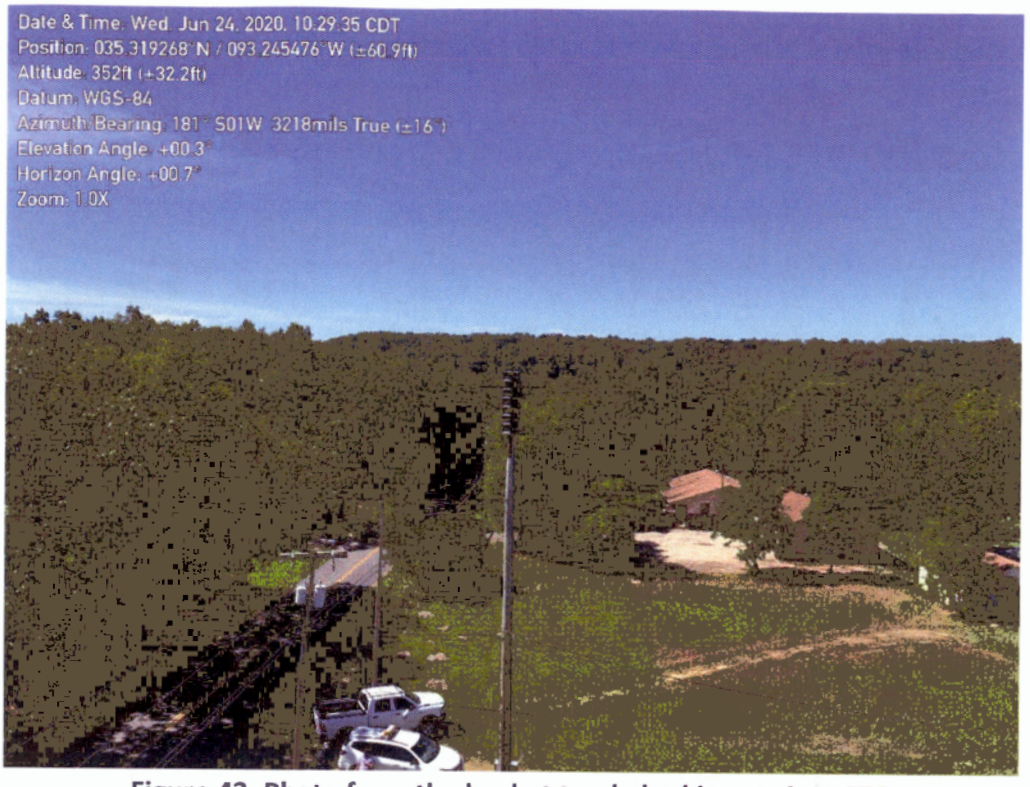


Figure 43. Photo from the bucket truck, looking at siren 3Z4

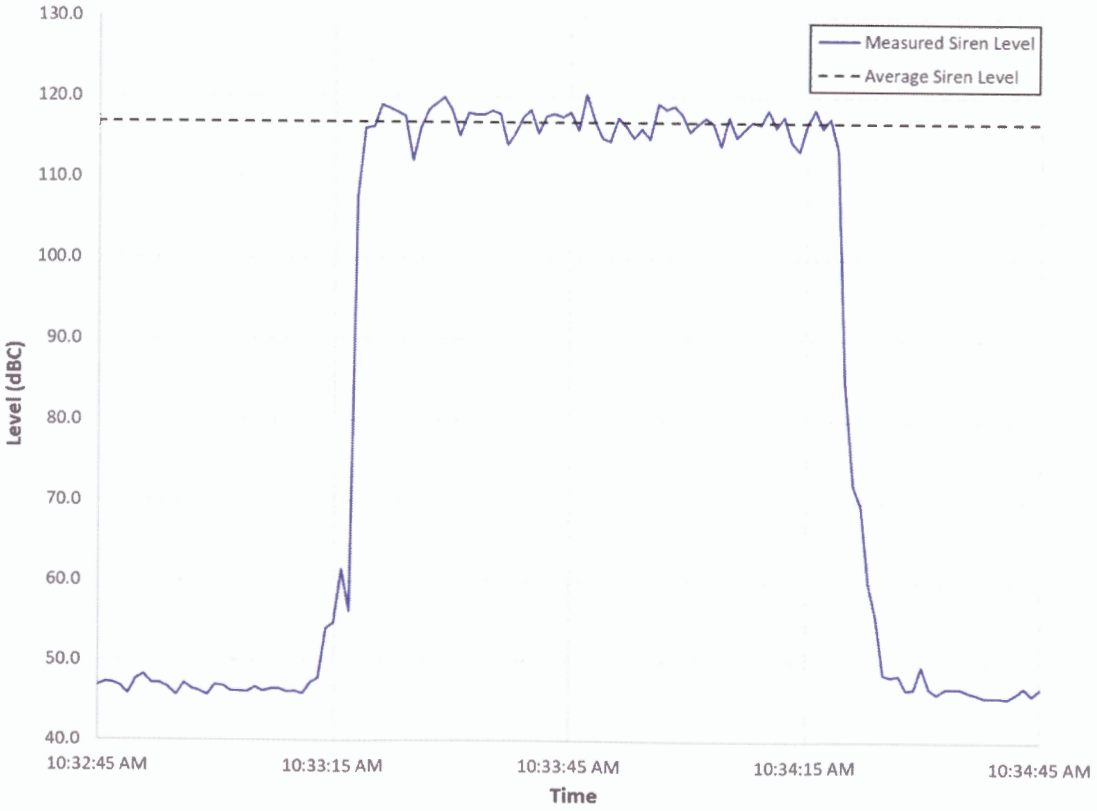


Figure 44. Time history of the received sound from siren 3Z4 as measured from the bucket truck

Far-Field Measurement of Siren 3Z4 from Sound Leve Meter ANO 01

This SLM was placed in the corner of a baseball diamond, close to the corner of Old Wire Rd. E. and Hays Ln. N. The siren signal does rise above the background noise when viewing the 500 Hz and 630 Hz signal (as shown in Figure 45). Background noise in this area was in the low 70 dBC range, probably driven by the presence of I-40 nearby. The data sheet for this test is provided in Figure 46.

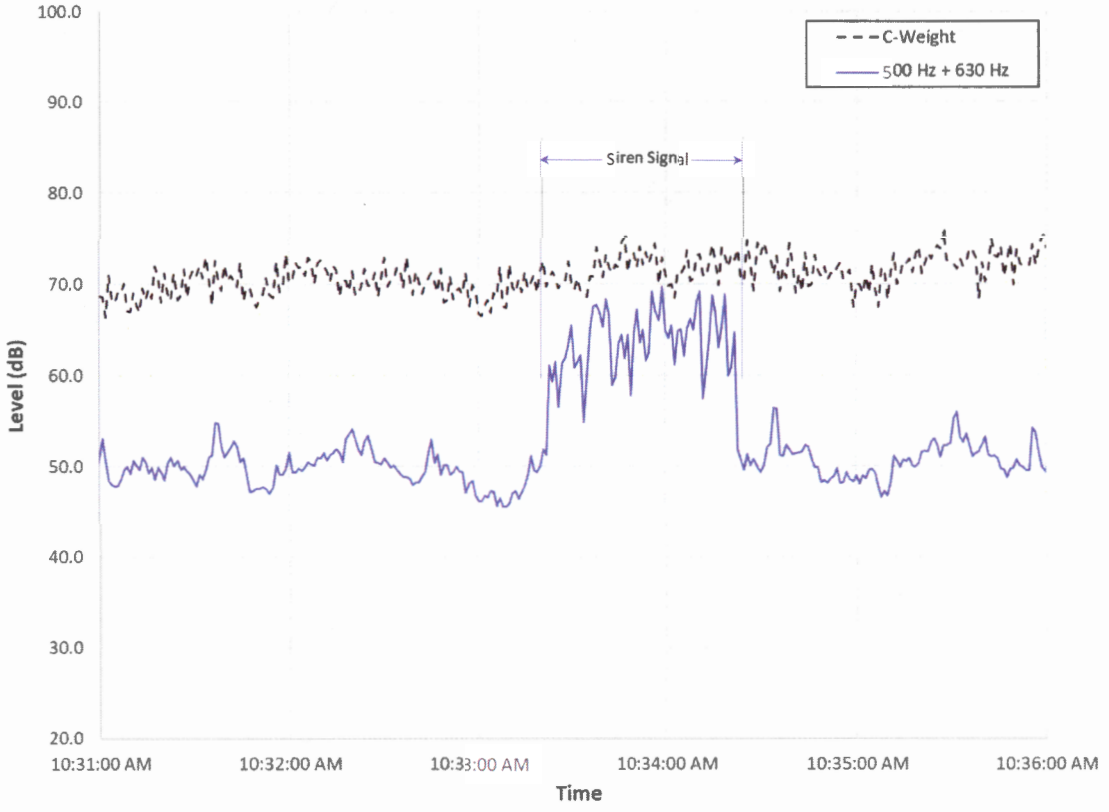


Figure 45. Time history from SLM ANO 01 for siren 3Z4

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 6/21/20 Time: 8130-m

SLM Model: LD 831 SLM Serial Number: 3558

Preamp SN: 58506 Microphone SN: 310089

Tester's Name: Danielle Mallon

GPS Coordinates: -93.245631 West 35.333159 North

Checked Battery? (Yes) No

Checked Clock? (Yes) No

Memory Checked? (Yes) No

Calibration level before test: 94.0 dBC

30 second calibration tone recorded before test? (Yes) No

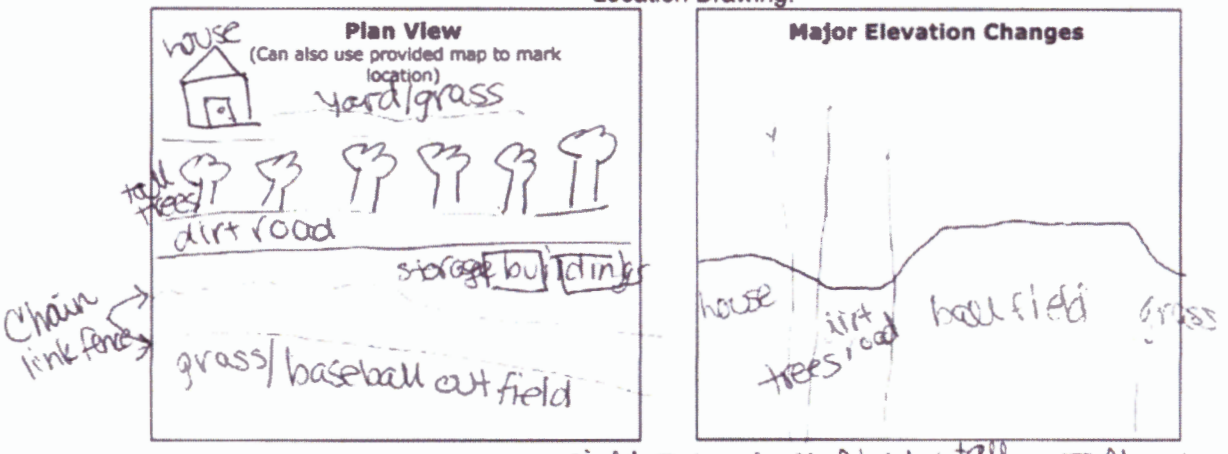
Calibration level after test: 94.0 dBC

30 second calibration tone recorded after test? (Yes) No

Calibrator Model: Cal 200 Calibrator SN: 15674

----------To be filled in be by the field crew at the site----------

Location Drawing:



Measurement Location description: outfield of baseball field, tall trees N150 ft away

Microphone height: 5 ft. Wind Dir: NE 37 deg.

Photos Taken? (Yes) No Wind Spd: 2 mph

Meter Recording? (Yes) No Temp: 82 °F

Weather Station on and wind cover removed? (Yes) No

Ambient noise level before test: 69 dBC

Maximum level observed during the test: 76.2 dBC ~~77.5~~ (not when sounding)

Could you hear the sirens? (Yes) No

Ambient noise level after test: 72 dBC

Notes about test (including background noise and noise intrusions during the test): Loud trucks/cars passing in distance from a nearby highway (?). Birds chirping. person mowing their lawn 200-300 ft away. crickets/bugs buzzing. car drove by.

Tester's Signature: Danielle Mallon

Figure 46. Data collection sheet for SLM ANO 01 for siren 3Z4

Far-Field Measurement of Siren 3Z4 from Sound Leve Meter ANO 02

This SLM was placed on Hill Blvd., close to its intersection with West Dr. The siren signal time history is provided in Figure 47 and the measurement data sheet is provided in Figure 48. The siren signal is evident above the background noise, with the background noise in the low 60 dBC range.

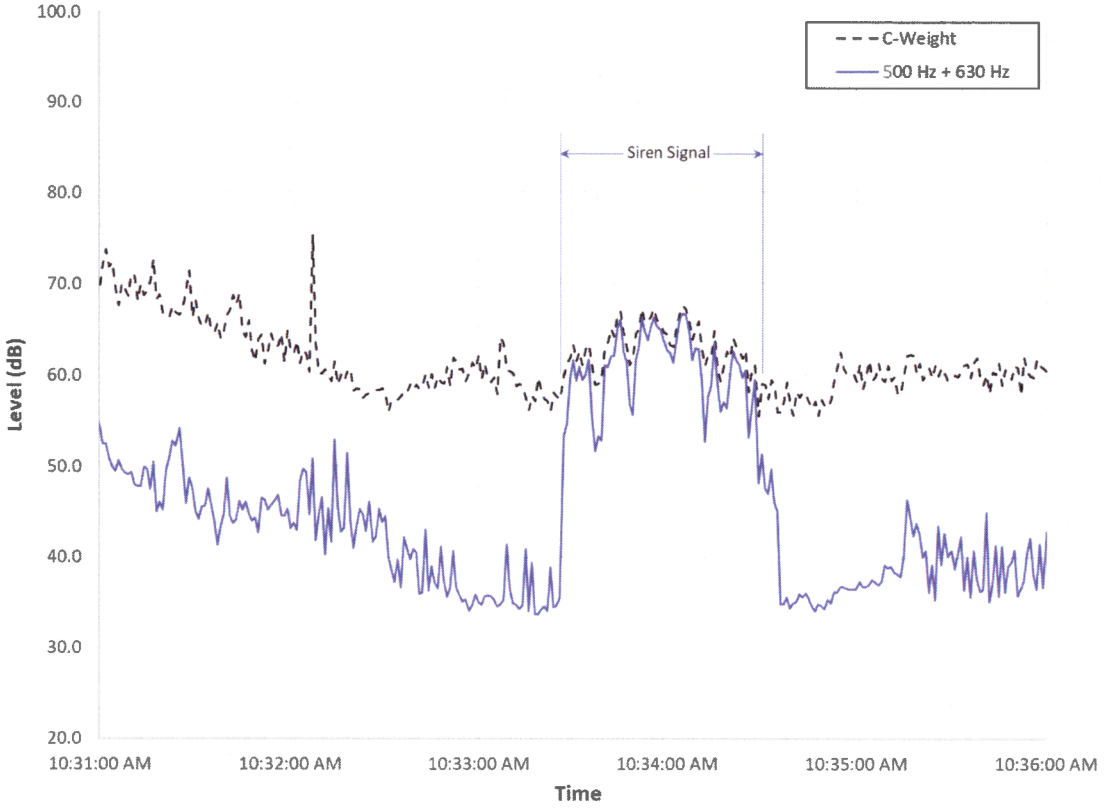


Figure 47. Time history from SLM ANO 02 for siren 3Z4

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 06/24/2020 Time: 10:20

SLM Model: LD 831 SLM Serial Number: 3397

Preamp SN: 51240 Microphone SN: 367776

Tester's Name: Ellie Turner

GPS Coordinates: 35.3249 West -93.2604 North

Checked Battery? Yes No

Checked Clock? Yes No

Memory Checked? Yes No

Calibration level before test: 94.0 dBC

30 second calibration tone recorded before test? Yes No

Calibration level after test: 94.0 dBC

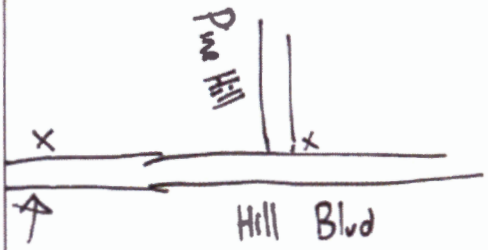
30 second calibration tone recorded after test? Yes No

Calibrator Model: Cal 200 Calibrator SN: 15674

----------To be filled in be by the field crew at the site----------

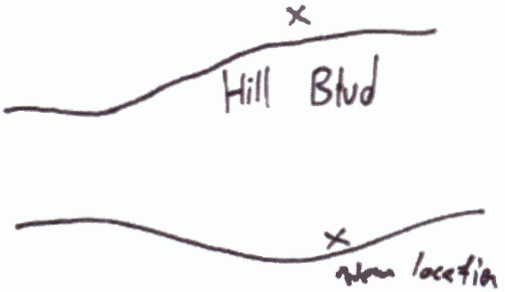
Location Drawing:

Plan View
(Can also use provided map to mark location)



New location during test had to move farm more near by.

Major Elevation Changes



Measurement Location description: Open field Residential Area

Microphone height: 5 ft.

Photos Taken? Yes No

Meter Recording? Yes No

Wind Dir: NNW 336deg.

Wind Spd: 6.1 mph

Temp: 82.0 °F

Weather Station on and wind cover removed? Yes No

Ambient noise level before test: 56.4 dBC

Maximum level observed during the test: 68 dBC

Could you hear the sirens? Yes No

Ambient noise level after test: 58.5 dBC

Moved to 35.3249, -93.2620 farm near

Notes about test (including background noise and noise intrusions during the test):

Dogs barking with the siren

Tester's Signature: E.

Figure 48. Data collection sheet for SLM ANO 02 for siren 3Z4

Far-Field Measurement of Siren 3Z4 from Sound Leve Meter ANO 03

This SLM was placed in the cul-de-sac at the end of Star Harbor Rd. The time history for this test is shown in Figure 49 with the data sheet provided in Figure 50. The 500 Hz and 630 Hz signal is moe then 10 dB above the background noise, where the levels were in the high 40 dBC range.

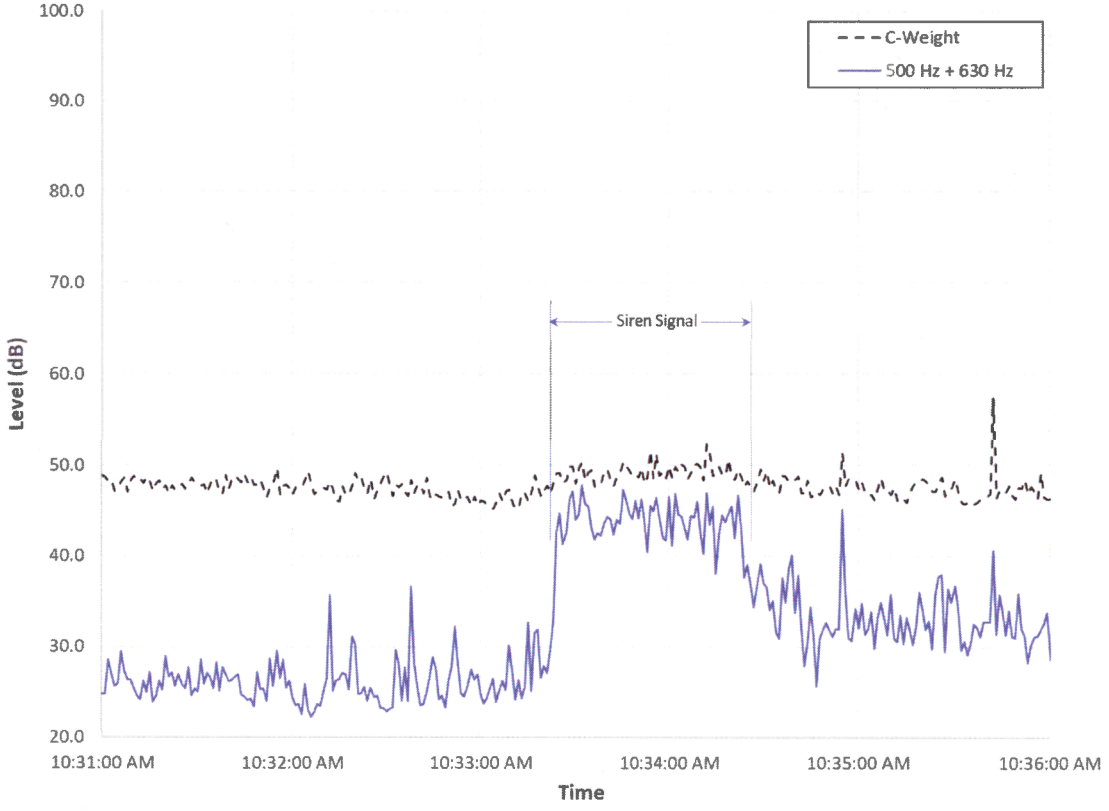


Figure 49. Time history from SLM ANO 03 for siren 3Z4

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 6/24/2020 Time: 10:20 am

SLM Model: LD 831 SLM Serial Number: 4278

Preamp SN: 19136 Microphone SN: 307396

Tester's Name: Zhuoying (Amy) Jiang

GPS Coordinates: -93.246369 West 35.306121 North

Checked Battery? (Yes) No

Checked Clock? (Yes) No

Memory Checked? (Yes) No

Calibration level before test: 94.0 dBC

30 second calibration tone recorded before test? (Yes) No

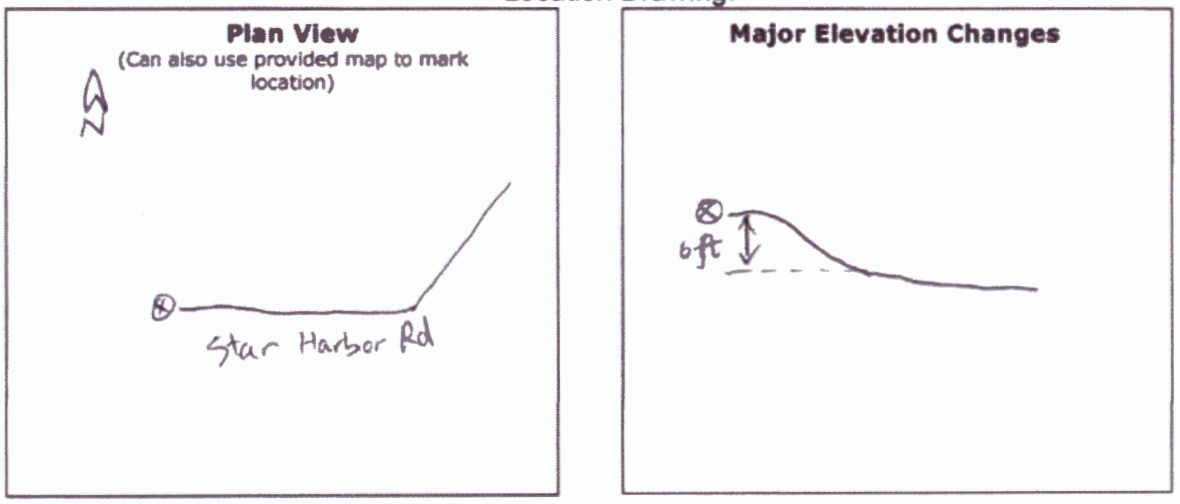
Calibration level after test: 94.0 dBC

30 second calibration tone recorded after test? (Yes) No

Calibrator Model: Cal 200 Calibrator SN: 15674

----------To be filled in be by the field crew at the site----------

Location Drawing:



Measurement Location description: The end of Star Harbor Rd (at the entrance of 290 Star Harbor Rd)

Microphone height: 5.0 ft.

Photos Taken? (Yes) No

Meter Recording? Yes No

Wind Dir: 41 deg.

Wind Spd: 1.4 mph

Temp: 83.1 °F

Weather Station on and wind cover removed? (Yes) No

Ambient noise level before test: 50 dBC

Maximum level observed during the test: 56.6 dBC

Could you hear the sirens? (Yes) No

Ambient noise level after test: 47 dBC

Notes about test (including background noise and noise intrusions during the test):

very quiet area, but has cicada sound from the surrounding trees.

Tester's Signature: Zhuoying Jiang

Figure 50. Data collection sheet for SLM ANO 03 for siren 3Z4

Field Measurements of Siren 3Z5

Siren 3Z5, a Whelen model WPS2907 siren, was measured on June 24th, 2020 at approximately 11:15 am. This siren is located on Hwy 64, just west of the junction with Old Hwy 64 W in London, AR. This siren is mounted on top of an approximately 50 foot wooden pole. Far-field SLM ANO 01 was placed to the south-west of the siren, SLMs 02 was placed to the south-east of the siren, and 03 was placed north of the siren. This is shown below in Figure 51. The ANSI S12.14 data sheet is provided in Figure 52, followed by a photo of the siren in Figure 53 and the measured time history in Figure 54.

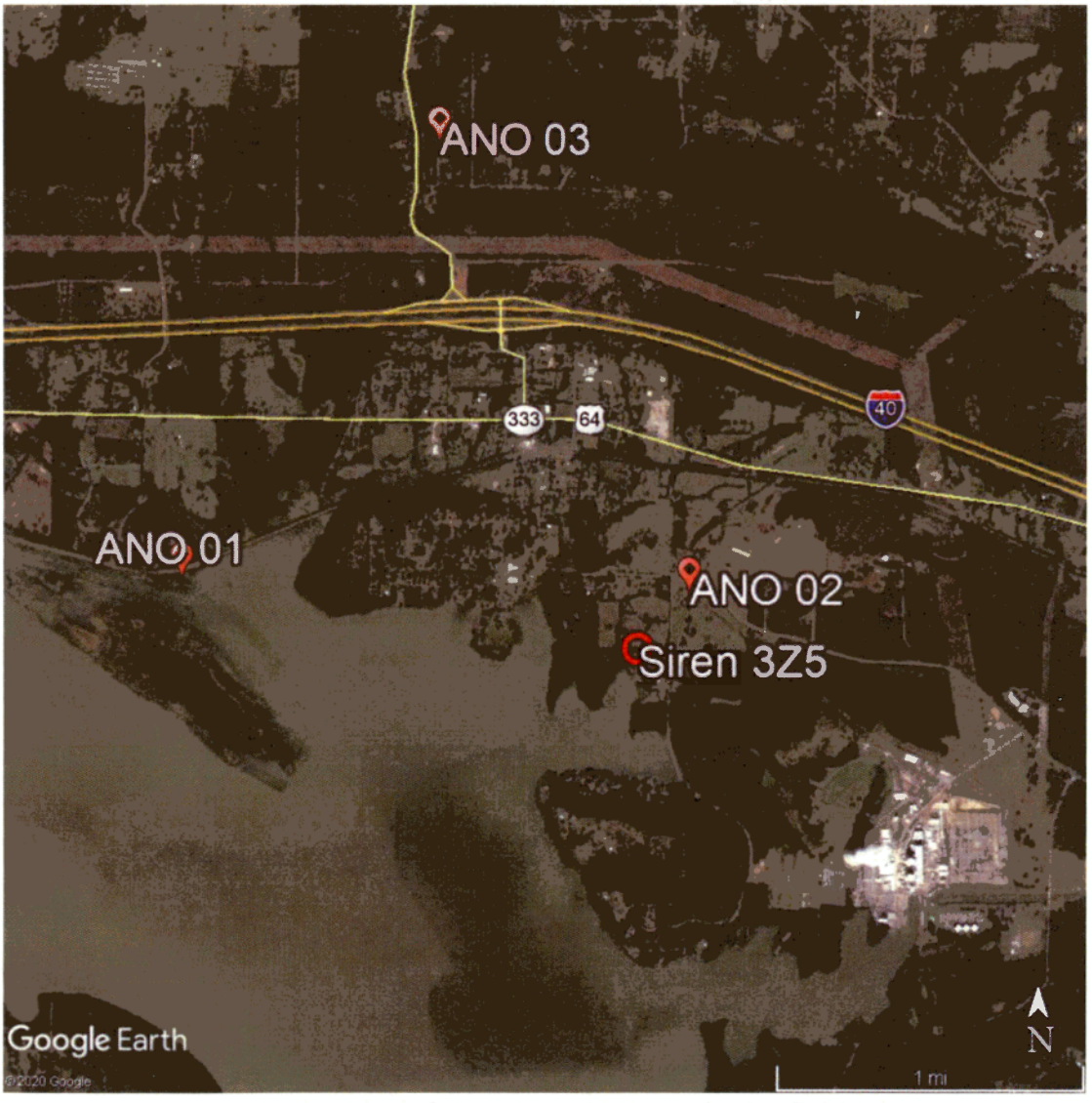


Figure 51. Position of siren 3Z5 relative to the far-field SLMs

Siren Sound Output Measurement per ANSI S12.14
Data Sheet

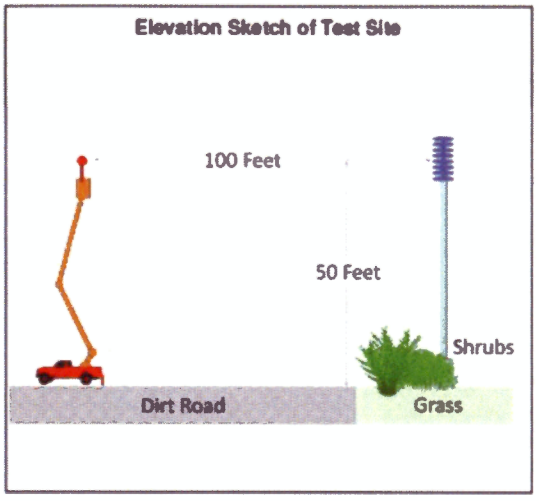
Siren Mfg: Whelen Model No: WPS2907 S/N: _____

Description: In situ measurement of ANO siren 3Z5

Meas. Loc. Measurement on the side of a busy road, along a dirt road with some shrubs.

Date: 6/24/20 Time: 11:15 am By: Bruce I. Title: _____

Temp 86 °F Wind speed: 0 mph Wind Dir: - Clouds 0 % Precip. (Y/N)? N



Mfg rec'd mtg. height: 50 feet Actual height: 50 feet Method: Laser Power correct (Y/N)? _____

Ground type & cover between siren and meas. loc. Grass, dirt road, and shrubs

Deviations from test procedure: _____

SLM Mfg:	LD	Model No:	831	S/N	3174	Pri Cal Date:	3/11/20
Filter Mfg:		Model No:		S/N		Pri Cal Date:	
Calib Mfg:	LD	Model No:	Cal200	S/N	15674	Pri Cal Date:	6/19/20
Field Calibration: Before	93.9 dBC			After	93.9 dBC		
Max ambient: Before	73	dBC slow		After	75	dBC slow	

Microphone SN: 311593
Preamp SN: 51309

	Base Line Position	Secondary Position (if used)
Siren Sound:	Alert	Alert
MXSCL (max dBC, slow):	119.2	
Average SCL, dBC slow:	116.1	
Max 1/3 octave band, Hz:	500 Hz & 630 Hz	
MXSCL in max 1/3 octave band, dBC slow:	119.2	
Average SCL in max 1/3 octave band, dBC slow:	116.0	
Bystander MXSCL, dBC slow	114	XXX
Dist of bystander MXSCL from mount, feet	92	XXX

Other pertinent information: _____

Figure 52. ANSI S12.14 Data Sheet for Siren 3Z5

Figure 53. Photo from the bucket truck, looking at siren 3Z5

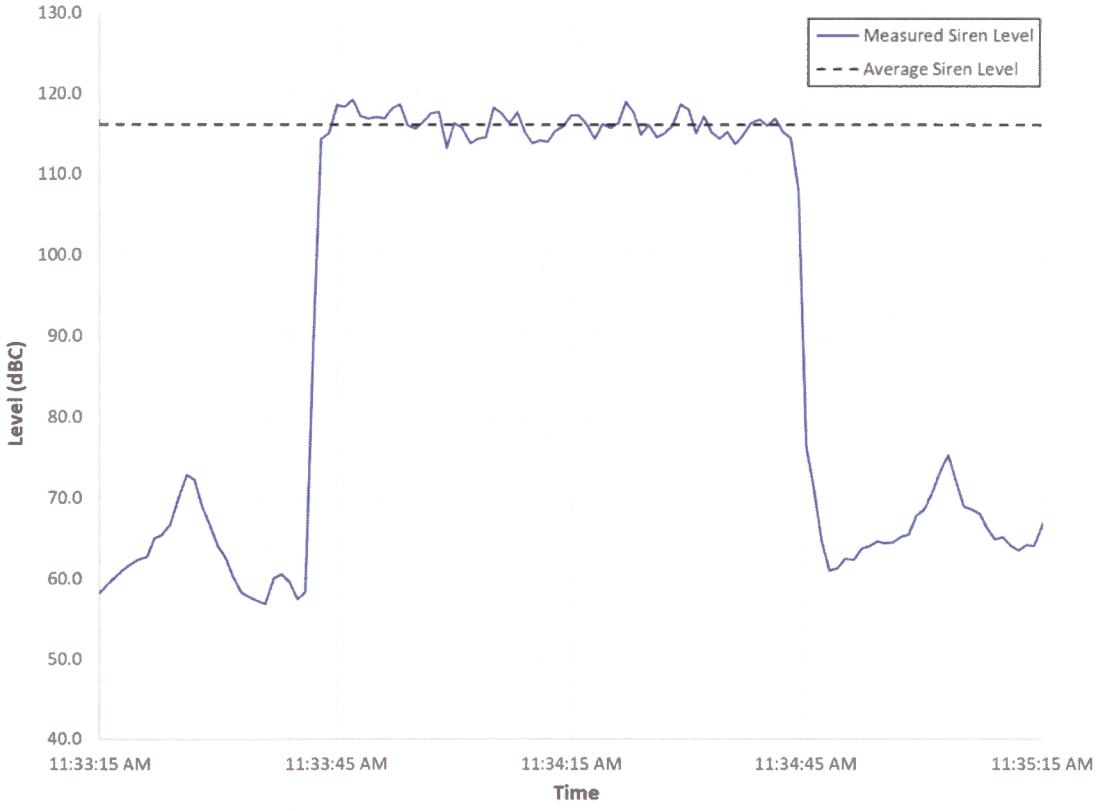


Figure 54. Time history of the received sound from siren 3Z5 as measured from the bucket truck

Far-Field Measurement of Siren 3Z5 from Sound Leve Meter ANO 01

Because of an equipment malfunction, no data was collected from SLM ANO 01 for this siren.

Far-Field Measurement of Siren 3Z5 from Sound Leve Meter ANO 02

This SLM was placed on Rte. 333, just to the east of some train tracks. The time history for this test is provided in Figure 55. The 500 Hz plus 630 Hz signal from the siren is over 10 dB above the background. Also visible in this plot are peaks generated by cars passing, fortunately not during the siren test. The background level (when cars were not present) is in the mid 50 dBC range. The data sheet for this test is shown in Figure 56.

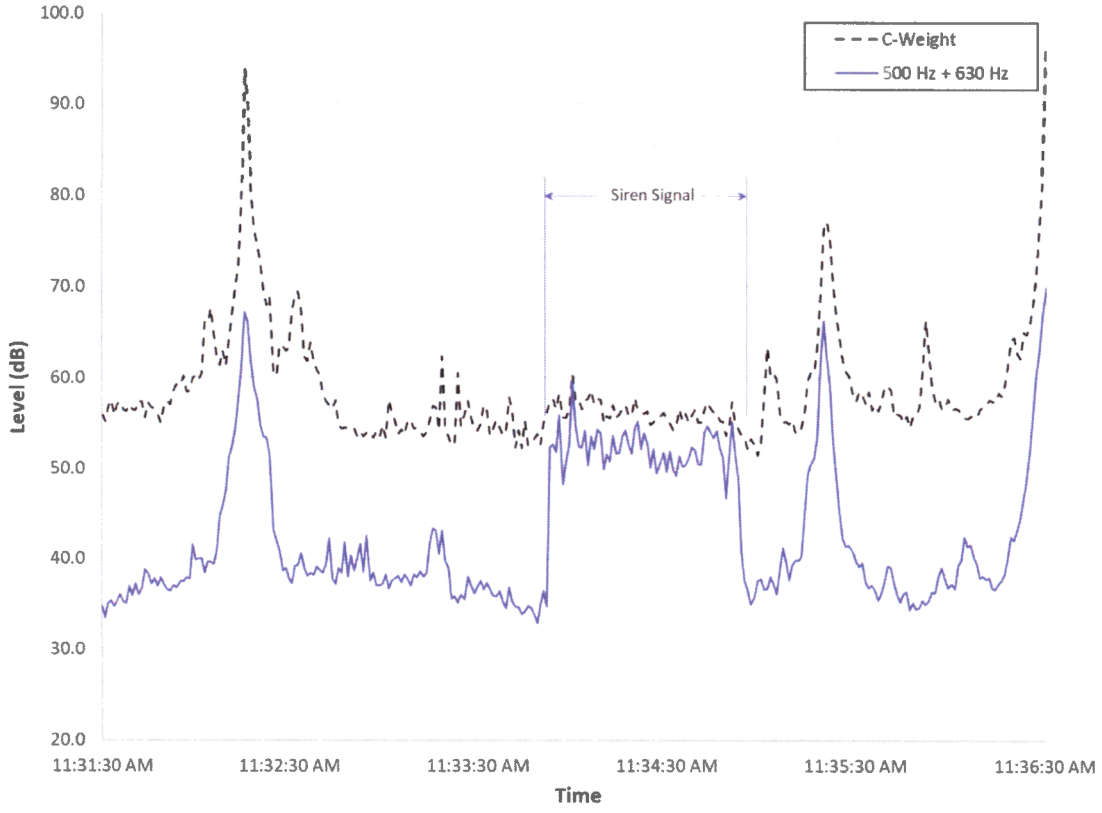


Figure 55. Time history from SLM ANO 02 for siren 3Z5

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 6/24/2020 Time: 11:23

SLM Model: LD 831 SLM Serial Number: 3397

Preamp SN: 51240 Microphone SN: 307776

Tester's Name: Efe Tuncer

GPS Coordinates: 35.3240 West 93.2441 North

Checked Battery? Yes No

Checked Clock? Yes No

Memory Checked? Yes No

Calibration level before test: 94.0 dBC

30 second calibration tone recorded before test? Yes No

Calibration level after test: 94.0 dBC

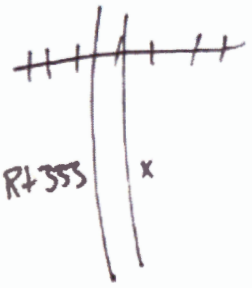
30 second calibration tone recorded after test? Yes No

Calibrator Model: Cal200 Calibrator SN: 15674

----------To be filled in be by the field crew at the site----------

Location Drawing:

Plan View
(Can also use provided map to mark location)



Major Elevation Changes

Flat

Measurement Location description: Open field near Rail Road tracks.

Microphone height: 5 ft. Wind Dir: _____ deg.

Photos Taken? Yes No Wind Spd: _____ mph

Meter Recording? Yes No Temp: _____ °F

Weather Station on and wind cover removed? Yes No

Ambient noise level before test: 55 dBC

Maximum level observed during the test: 59.3 dBC

Could you hear the sirens? Yes No

Ambient noise level after test: 54 dBC

Notes about test (including background noise and noise intrusions during the test):
Only birds.

Tester's Signature: _____

Figure 56. Data collection sheet for SLM ANO 02 for siren 3Z5

Far-Field Measurement of Siren 3Z5 from Sound Leve Meter ANO 03

This SLM was placed at the end of Rock Ln. The time history is provided in Figure 57 and the data sheet is in Figure 58. The 500 HZ and 630 Hz combine signal clearly shows the siren more than 10 dB above the background noise, which was in the mid 60 dBC range.

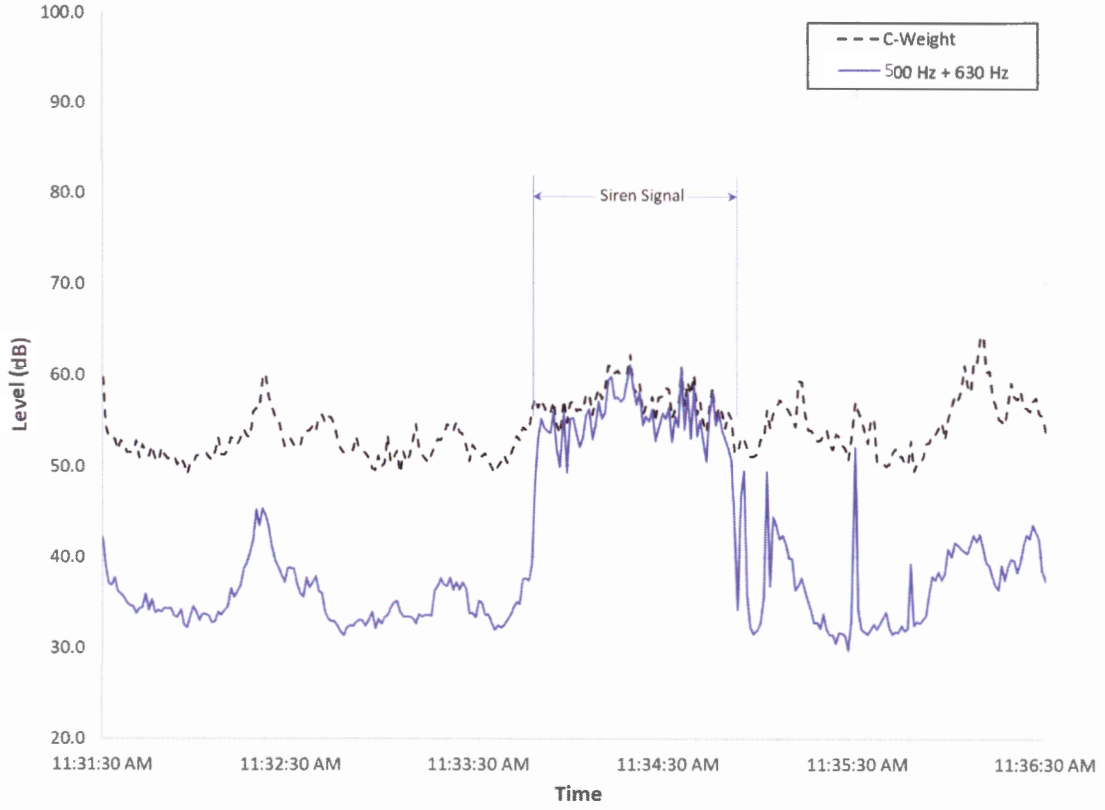


Figure 57. Time history from SLM ANO 03 for siren 3Z5

ANO Siren Test Datasheet

----------To be filled by support staff----------

Date: 6/24/2020 Time: 11:00

SLM Model: LD 831 SLM Serial Number: 4278

Preamp SN: 19136 Microphone SN: 307396

Tester's Name: Zhuoqing (Amy) Jiang

GPS Coordinates: -93.258734 West 35.34528 North

Checked Battery? (Yes) No

Checked Clock? (Yes) No

Memory Checked? (Yes) No

Calibration level before test: 94.0 dBC

30 second calibration tone recorded before test? (Yes) No

Calibration level after test: 114.0 dBC

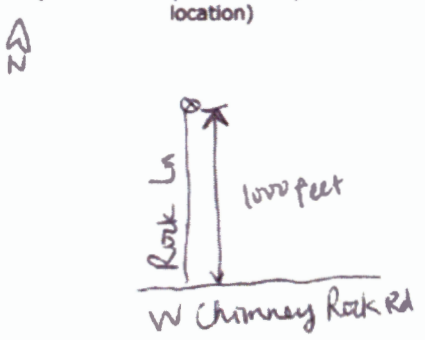
30 second calibration tone recorded after test? (Yes) No

Calibrator Model: Cal200 Calibrator SN: 15674

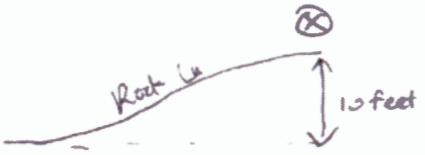
----------To be filled in be by the field crew at the site----------

Location Drawing:

Plan View
(Can also use provided map to mark location)



Major Elevation Changes



Measurement Location description: Located in a quiet residential area at the end of Rock Ln.

Microphone height: 5.0 ft. Wind Dir: 354 deg.

Photos Taken? (Yes) No Wind Spd: 3.2 mph

Meter Recording? (Yes) No Temp: 81.0 °F

Weather Station on and wind cover removed? (Yes) No

Ambient noise level before test: 52 dBC

Maximum level observed during the test: 63.3 dBC

Could you hear the sirens? (Yes) No

Ambient noise level after test: 55 dBC

Notes about test (including background noise and noise intrusions during the test):
Heard a dog howling in the house nearby when the siren was sounded.

Tester's Signature: Zhuoqing Jiang

Figure 58. Data collection sheet for SLM ANO 03 for siren 3Z5

Field Measurements of Siren 2Z13

Siren 2Z13, a Whelen model WPS2907 siren, was measured on June 24th, 2020 at approximately 1:00 pm. This siren is located near the corner of Reasoner Ln. and N. Arkansas Ave in Russelville, AR, next to a fire department. This siren is mounted on top of an approximately 50 foot wooden pole. Far-field SLM ANO 01 was placed to the north-west of the siren, SLMs 02 was placed to the north-east of the siren, and 03 was placed north of the siren. This is shown below in Figure 59. The ANSI S12.14 data sheet is provided in Figure 60, with a photo of the siren in Figure 61 and the measured time history in Figure 62.

The decision to measure this siren was made while in the field to add an additional test after siren 1Z9 appeared to be having a maintenance issue. Unfortunately, this meant that there were limited supplies, so the testers had to resort to hand-written datasheets rather than the pre-printed version usually employed.

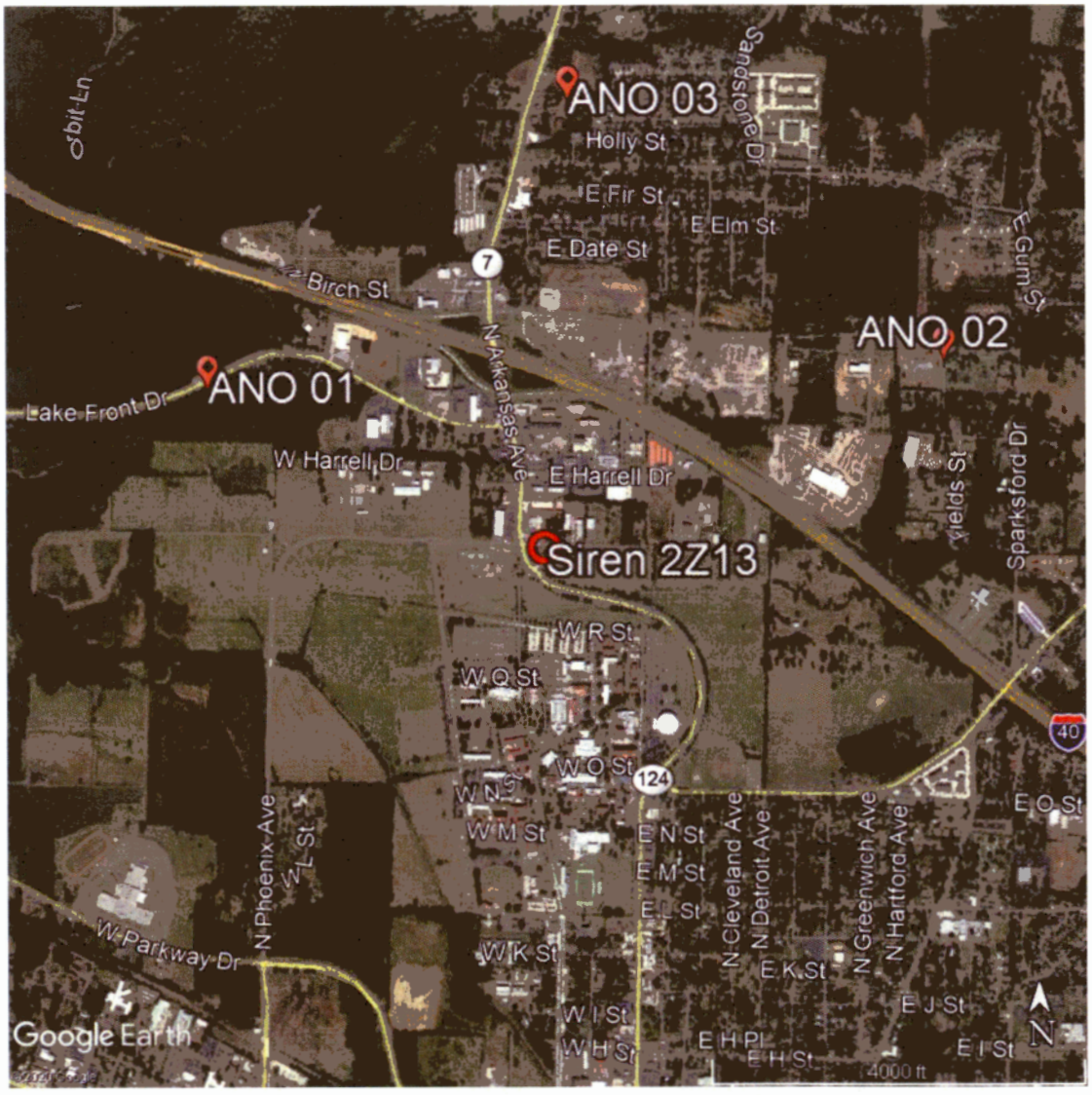


Figure 59. Position of siren 2Z13 relative to the far-field SLMs

Siren Sound Output Measurement per ANSI S12.14
Data Sheet

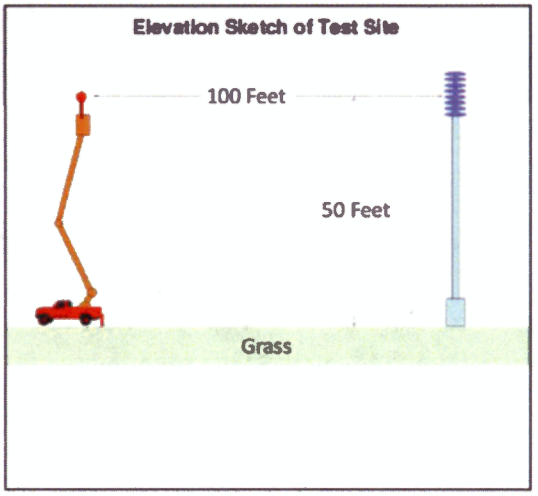
Siren Mfg: Whelen Model No: WPS2907 S/N: _____

Description: In situ measurement of ANO siren 2Z13

Meas. Loc. Measurement across grass in front of a fire department.

Date: 6/24/20 Time: 1:00 pm By: Bruce I. Title: _____

Temp 87 °F Wind speed: 2 mph Wind Dir: 30 Clouds 0 % Precip. (Y/N)? N



Mfg rec'd mtg. height: 50 feet Actual height: 48 feet Method: Laser Power correct (Y/N)? _____

Ground type & cover between siren and meas. loc. Grass

Deviations from test procedure: _____

SLM Mfg:	LD	Model No:	831	S/N	3174	Pri Cal Date:	3/11/20
Filter Mfg:		Model No:		S/N		Pri Cal Date:	
Calib Mfg:	LD	Model No:	Cal200	S/N	15674	Pri Cal Date:	6/19/20
Field Calibration: Before	93.9 dBC			After	93.9 dBC		
Max ambient: Before	66	dBC slow		After	69	dBC slow	

Microphone SN: 311593
Preamp SN: 51309

	Base Line Position	Secondary Position (if used)
Siren Sound:	Alert	Alert
MXSCL (max dBC, slow):	120.3	
Average SCL, dBC slow:	117.2	
Max 1/3 octave band, Hz:	500 Hz & 630 Hz	
MXSCL in max 1/3 octave band, dBC slow:	120.2	
Average SCL in max 1/3 octave band, dBC slow:	117.0	
Bystander MXSCL, dBC slow	114	XXX
Dist of bystander MXSCL from mount, feet	72	XXX

Other pertinent information: _____

Figure 60. ANSI S12.14 Data Sheet for Siren 2Z13

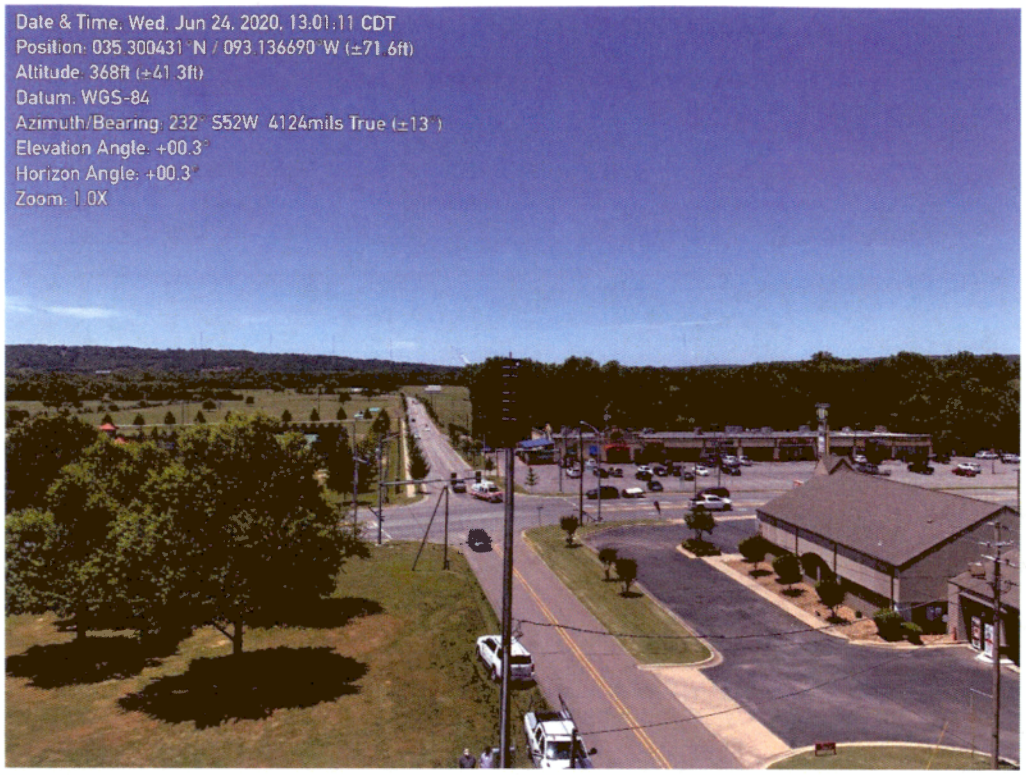


Figure 61. Photo from the bucket truck, looking at siren 2Z13

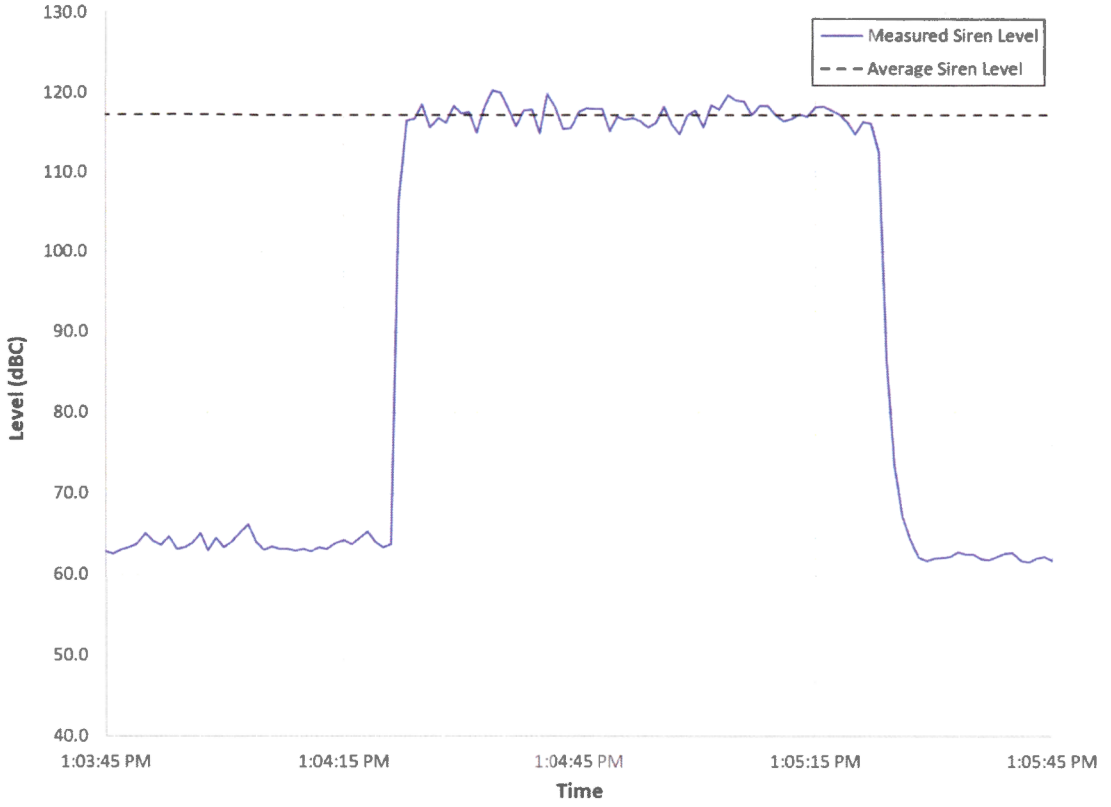


Figure 62. Time history of the received sound from siren 2Z13 as measured from the bucket truck

Far-Field Measurement of Siren 3Z5 from Sound Leve Meter ANO 01

This SLM was placed a pull out along Lake Front Dr. Unfortunately, this location was close to I-40 which resulted in elevated background noise levels. There is no obvious siren signal in the time history shown in Figure 63, with the background in the mid 70 dBC range. The hand-written data sheet is provided in Figure 64.

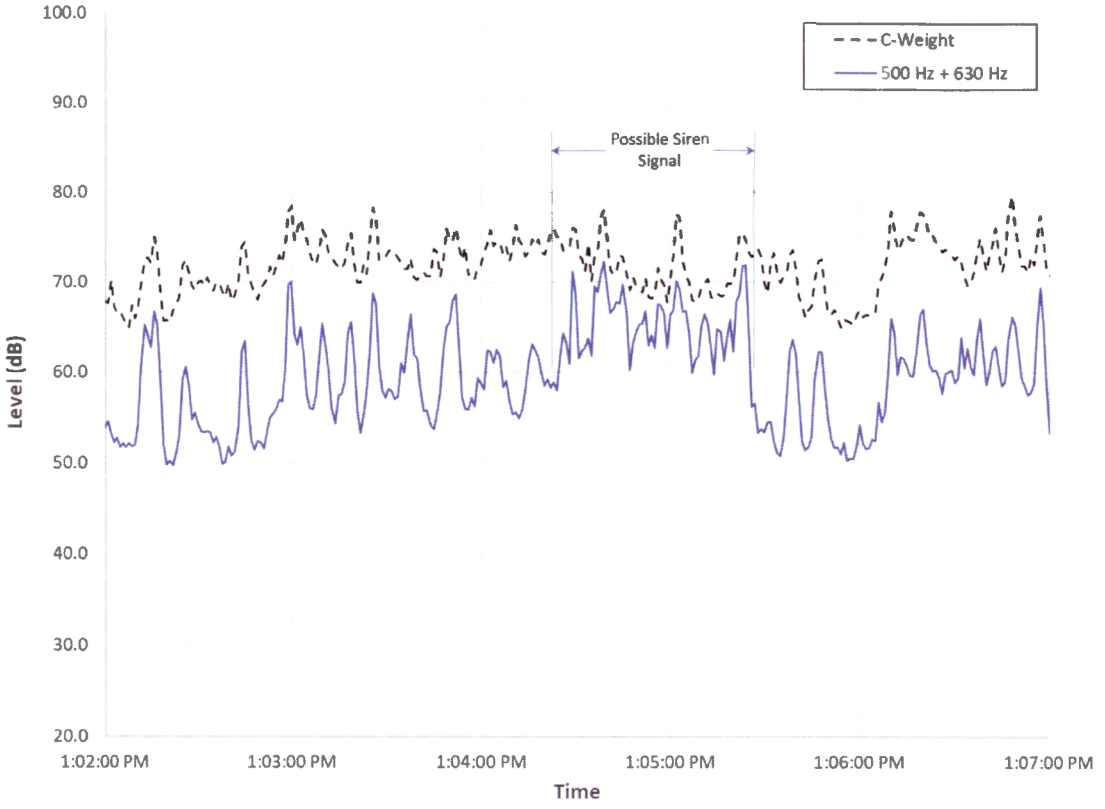


Figure 63. Time history from SLM ANO 01 for siren 2Z13

94 dB cal before - 30 sec rec

94.1 dB cal - 30 sec

-93.148826 W 39.305384 N

Parking lot pull off of somewhat busy 2 lane road, next to lake, highway bridge in distance. ~~NE~~ SSE.

6.5 ~~3~~ mph

86°F

69 dbc before

89.1 (not during sirens), 78.2 dBc during

~~(not during sirens)~~ 90 dbc after.

lots of wind + sounds from cars passing on road, lots of background sounds from Hwy, bridge, across the river. Energy truck pulled up early + was talking + idoling.

Danielle Mallen

Figure 64. Data collection sheet for SLM ANO 01 for siren 2Z13

Far-Field Measurement of Siren 3Z5 from Sound Leve Meter ANO 02

This SLM was placed at the corner of Cain Ave. and E. Aspen Ln. The time history is provided in Figure 65 with the data sheet in Figure 66. The 500 Hz and 630 Hz combined signal clearly shows the siren sounding over 10 dB above the background noise. There is clearly an intrusion in the C-weighted levels at the beginning of the siren sounding, but it did not appear to impact the 500 Hz and 630 Hz combine signal.

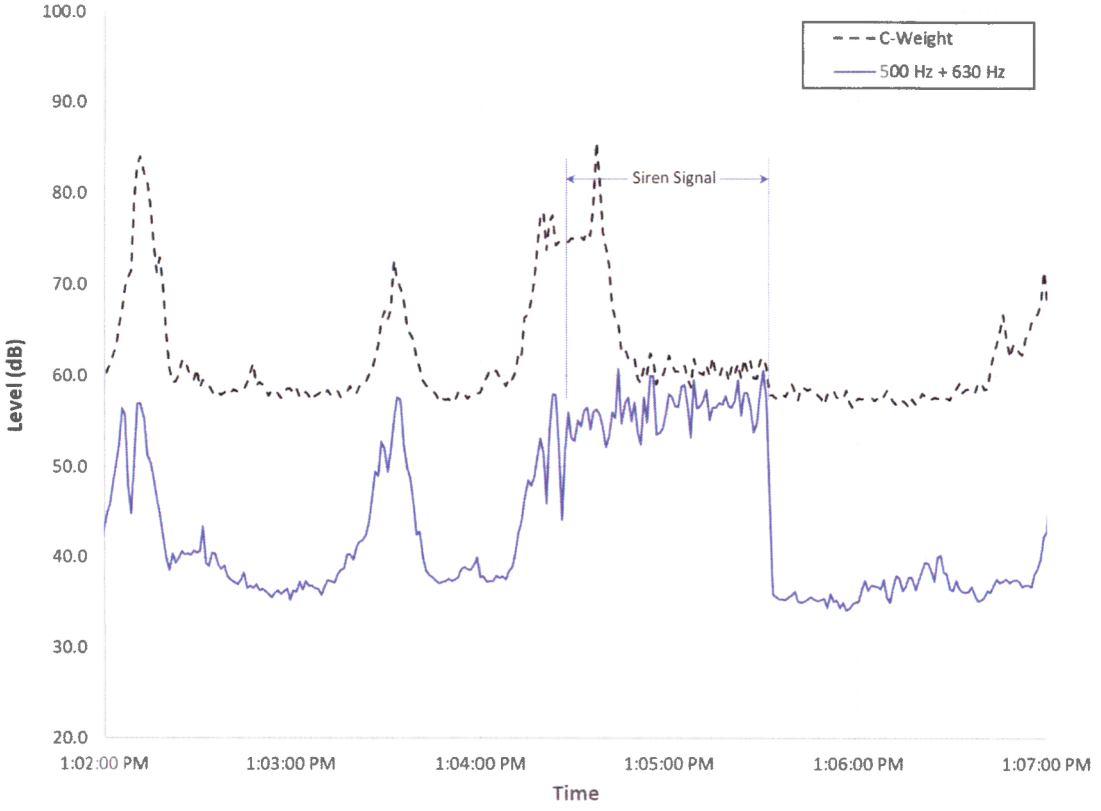


Figure 65. Time history from SLM ANO 02 for siren 2Z13

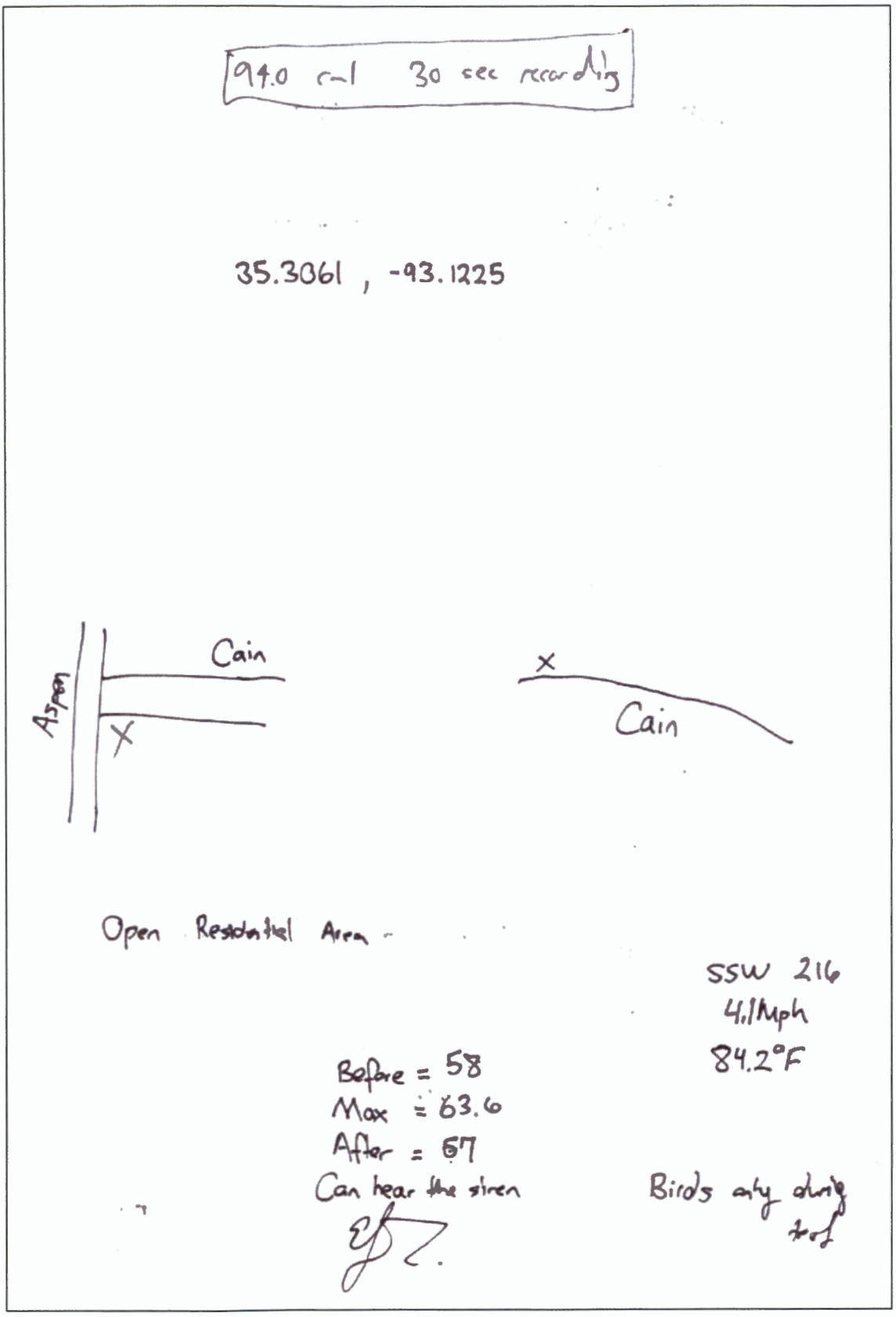


Figure 66. Data collection sheet for SLM ANO 02 for siren 2Z13

Far-Field Measurement of Siren 3Z5 from Sound Leve Meter ANO 03

This SLM was placed on the side of an unnamed road just north of Elliot Pl., off of Rte. 7. The time history is provided in Figure 67, with the hand-written data sheet provided in Figure 68. Unfortunately, the siren signal was not clearly visible in the time history and was not 10 dB above the background noise. Background noise in this area was in the mid 60 dBC range.

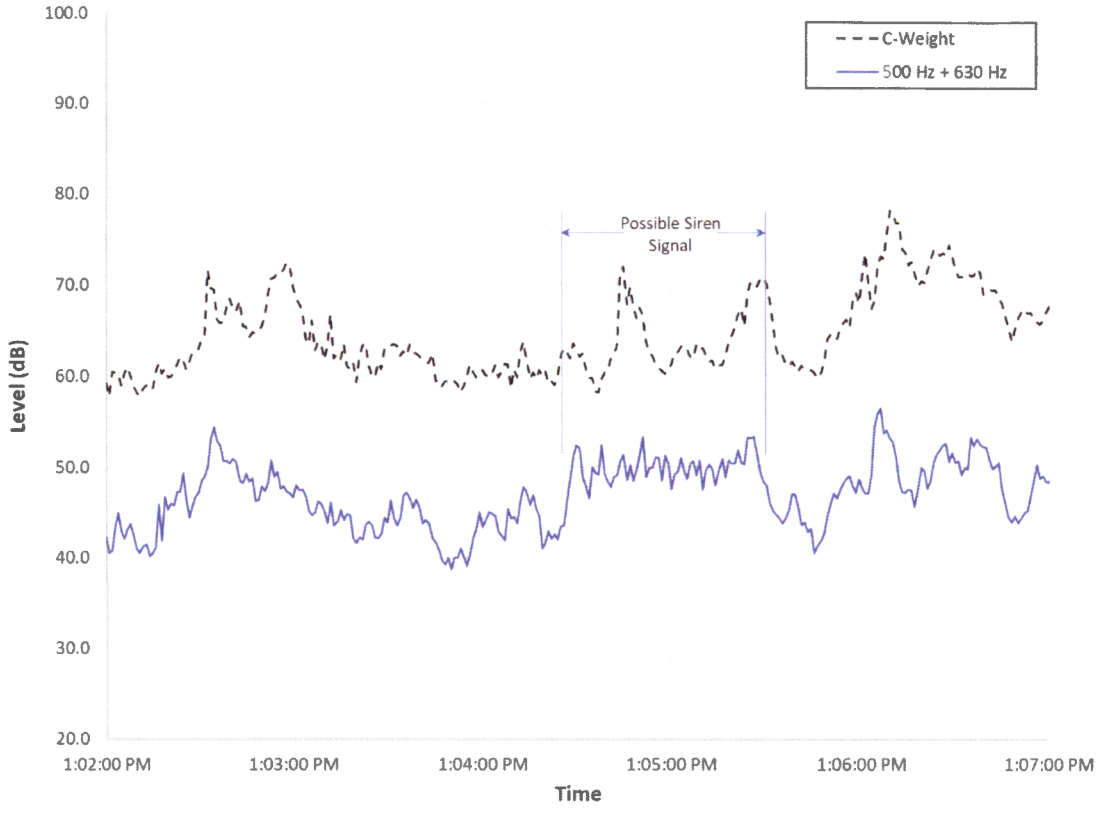


Figure 67. Time history from SLM ANO 03 for siren 2Z13

-93.135871 W 35.313796 N

94dB cal + 30 sec recording

Date: 06/24/2020

Meter: ANO 03

Tester: Zhuoxing (Amy) Jiang

Location: Near N Arkansas Ave & Elliot PL.

Ambient noise level before the test: 70dBC

The max. level observed: 70.6 dBC

Ambient noise level after the test: 63dBC

Temp: 86.3 °F

Wind Speed: 1.5mph

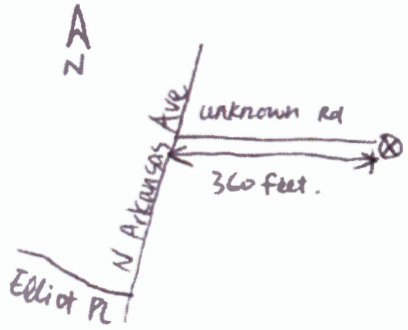
Wind Dir. 59°

Can you hear the siren? (Yes) No

Meter recording? (Yes) No

Notes. The additional site is close to a major road (N Arkansas Ave). The traffic is busy and the noise adds ~~the~~ sound levels to the background ambient noise level.

Site view:



Signature: Zhuoxing Jiang.

Figure 68. Data collection sheet for SLM ANO 03 for siren 2Z13

Appendix A – Acoustics, Perception, and the Weighting Scales

Perception of sound involves two main factors – amplitude and frequency. Amplitude is the measure of the sound's volume, while frequency is often described as the 'pitch' of the sound. For amplitude, sound is generally described using the logarithmic decibel scale, which uses the symbol dB. The 'd' is lowercase to represent 'deci' for a factor of 10, and the uppercase 'B' comes from the proper name in honor of Alexander Graham Bell. Zero decibels (0 dB) is defined as the threshold of human hearing. An increase of 10 dB is perceived as roughly twice as loud, and a level of 120 dB is at the threshold of pain.

In terms of frequency, humans can hear sounds in a frequency range from about 20 Hz (a very low rumble) to 20,000 Hz (a high-pitched whine). Our best hearing is centered around the frequencies most common in human voices, near 1,000 Hz. Because sound is so complex and has so many features, it is difficult to quantify a complex, time-varying signal with a single number. How does a noise at 20,000 Hz compare to a noise at 1,000 Hz?

To reduce the complexity, single number metrics are used. These metrics work by applying weightings to sounds of different frequencies. These weighting factors allow us to combine the noise from all frequencies into a single number by including a penalty (or addition) to certain frequencies, better representing human perception. The two most widely used weighting factors are the A-weighting, designated by dBA, and the C-weighting, designated by dBC. If no weighting is used, the amplitude is designated simply by dB. Figure 69 is a graph showing both the A and C weighting factors used to compute dBA and dBC values.

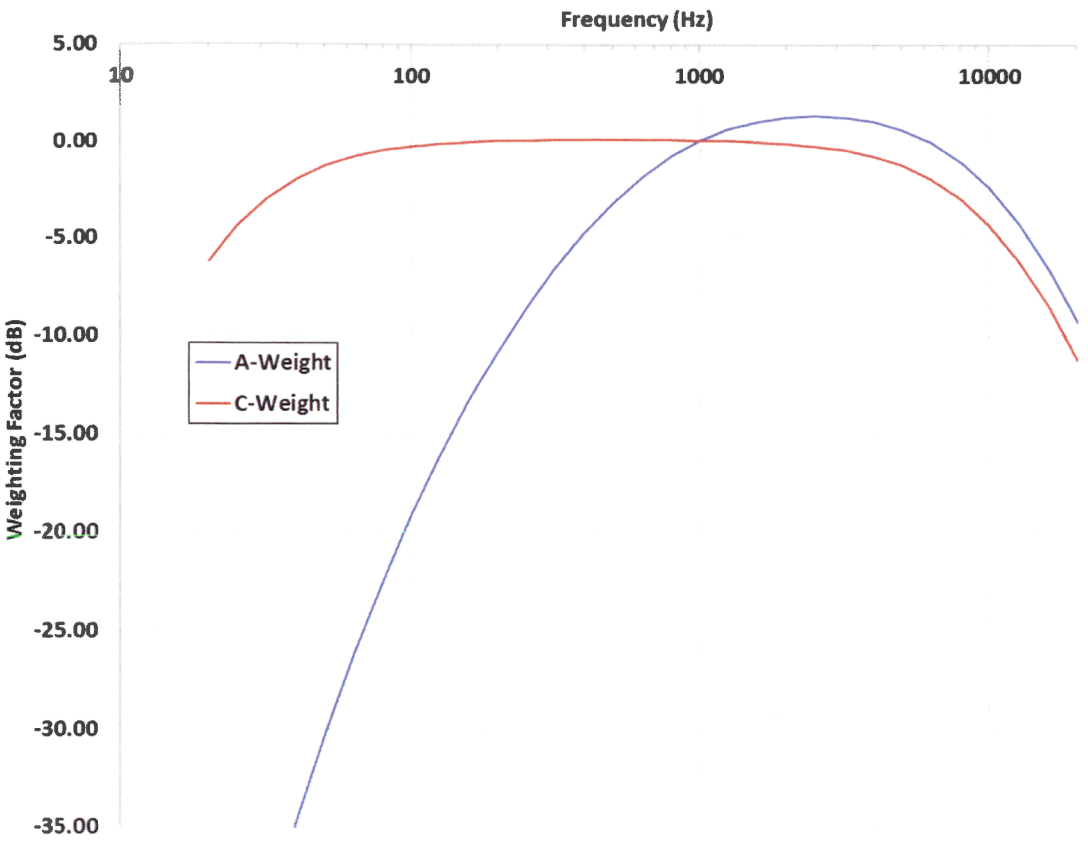


Figure 69. A and C frequency weighting.

The A-weighted factors, shown in blue in Figure 69, represents how the average human perceives sounds at normal, speaking amplitudes. We have the best hearing in the range from about 1,000 Hz to 5,000 Hz, and we have poor hearing at the very high and very low frequencies. A-weighted sound levels are the most commonly used when describing sound. Typical SLM tools and phone apps will often provide the A-weighted levels.

The C-weighting, shown in red in Figure 69, represents how humans perceive high amplitude sound. If the noise we hear is loud, our ear responds differently than for quieter sounds. At higher amplitudes, people can hear frequencies between 100 Hz and 5,000 Hz at about the same amplitude. This means that our ear responds better when the sound is louder – proof that music *does* sound better if it is played loud. For siren analysis, FEMA recommends using the C-weighting scale for descriptions of siren sound levels.

Appendix B – Testing Procedures for Measuring the Acoustical Output of a System Siren Test

Overview:

The purpose of this measurement protocol is to collect acoustical data using hand-held sound level meters to characterize the sound produced from a full-scale siren system test

Test Schedule and Procedure:

Please plan on arriving at your location at least 45 minutes before the test to ensure that you have time to find the spot and park your car and set up the equipment. Each measurement location has been selected so that the sound level should not be excessive. No hearing protection will be needed. In addition, each tester will be required to completely fill in the lower half of their datasheets, starting with the drawings.

At your location, you should find a good level spot away from any major vertical surfaces such as walls, large boulders, or even cars. The requirement is to be at least 50 feet from any such objects, and farther is better. Once the exact location has been selected, set up the two tripods a few feet apart. Then carefully mount both the Sound Level Meter (SLM) and the weather station to the tripods. For the weather station, please follow the instructions attached for assembling and mounting the weather vane and weather station.

The microphone of the SLM should be 5 feet above the ground (mark the actual meter height on your datasheet). Use the tape measure to make sure that the height of the microphone is correct. The weather station should be mounted as high as the tripod will normally reach. Make sure that the weather station is level by adjusting the tripod such that the spirit level is centered. Once the weather station is properly set up make sure to open the impeller cover so that the system can collect wind speed data. Finally, please snap at least three pictures showing the measurement set-up in relation to the things around it from different vantage points.

After the test equipment is set up, please take a few moments to draw the top-down plan view of your measurement location, including all buildings, vehicles, and walls within 300 feet. Make sure to note where the meter is in relation to these and all major roads. In addition, please provide a brief identifying description so that someone else could find this same spot again (assuming they were in the right general location). For example, '75 feet in front of 32 W. Walnut St.'

The measurement should be started at least 10 minutes before all the sirens sound off. First, turn the weather station on and then turn on your SLM. After the meter has started up (which may take a few moments for some of the meters), start the meter recording data.

Before the siren sounding, please record on the datasheet what the main source of background noise is (such as traffic, a lawnmower or dogs barking), what the ambient noise level is, and the current wind speed, direction, and temperature.

During the test, all cell phones should be turned off, and please refrain from talking while the meter is recording data. During the measurement observe the SLM and keep a note of the highest noise level recorded during the test. If this was caused by something other than the sirens (a barking dog for instance) please note that on the datasheet.

After the siren sounding is complete check and record the ambient noise level again. Please wait for a full 10 minutes after the sirens finish siren sounding before stopping the meters and turning them off. Then please return the meter and weather station with the datasheet to Dr. Ikelheimer.