14.0 Noise and Vibration

Due to the nature of static rocket engine testing, noise and, to a smaller extent, vibrations have always been issues at SSC. The land area required for the Fee Area and the Buffer Zone was calculated based upon acoustic environment calculations made for the NOVA first stage rocket engine. NASA determined that it was necessary to purchase all land within a 125 dB[1] acoustical boundary and to prohibit human habitation within a 110 dB acoustical boundary. Since its establishment, SSC has hosted tests of rocket motor engines and has developed a program to ensure that the tests are not conducted when atmospheric conditions could increase the impact on the environment.

Observed sound levels are affected by many factors, including the location of major receptors, topography, and meteorological conditions. Sound intensity attenuates with distance from the source, so the impact of the sound generated is greatly affected by the distance from the source to the receptor. Since the land surrounding SSC is basically flat, the effects of terrain on propagating sound waves is usually ignored in sound analyses performed at SSC. Meteorological conditions, however, can have a great effect on sound wave intensity. Acoustic focusing can be caused when the speed of sound increases with altitude due to certain wind speeds and temperature profiles. When this occurs, sound waves are refracted and combine with the sound wave traveling along the ground, causing higher noise levels at a given distance than would normally be expected.

14.1 Background Noise Levels

Generally, noise levels at SSC are low. The following continuous sources of noise at the facility have been identified:

- Diesel generators
- Pumps
- Boilers
- Automotive traffic

[1]Noise levels are measured using two different scales, dB and dBA. The dB scale is used when determining the overall sound pressure level (OASPL). The dBA, scale or A-weighted sound level, is used to account for the insensitivity of the human ear to frequencies on the high and low ends of the acoustical range.

The effects of the generators, pumps, and boilers are minimal because these sources are contained within structures on-site. Traffic noise is highest during the morning and evening as employees are transporting themselves to and from work. One-hour noise measurements were recorded at SSC at four locations within the Fee Area in 1974 when no rocket tests were being conducted. The results of these measurements are summarized in Table 14-1, and the locations of the monitors are shown in Figure 14-1. For comparison, the Federal Highway Administration's design noise levels are provided in Table 14-2. In addition to NASA's measurements, background noise levels measured along Interstate 10 at the Highway 607 interchange are 60 dBA to 75 dBA, depending on traffic levels.

14.2 Rocket Engine Testing Noise

As anticipated when the facility was established, the noise created by static rocket testing has affected the local environment. Historically, the only measure of SSC's effect on local ambient noise levels has been complaints by citizens in the communities surrounding the facility. During the Saturn V rocket-testing program, NASA logged 160 complaints, of which 57 resulted in formal administrative claims to NASA. Eighteen of the complaints resulted in financial settlements totaling $39,405. No test data is available at the Buffer Zone except for 1988 data collected along Interstate 10 and Route 607 (3).

During that period, NASA also collected more than 2,500 rawinsonde observations of the upper air meteorological parameters such as temperature, relative humidity, wind speed, and wind direction. Using the aforementioned data and theoretic models on the propagation of sound in an inhomogeneous atmosphere, NASA can predict the location of zones of intensification and the average sound pressure in the zones of intensification. Current Space Shuttle Main Engine (SSME) test procedures require pre-test prediction of the Overall Sound Pressure Level (OASPL) at the Buffer Zone boundary and at acoustic focusing points beyond the Buffer Zone. If the predicted OASPL is greater than 120 dB linear (lin), no firing is approved until meteorological conditions change favorably. If the predicted OASPL is between 110 dB (lin) and 120 dB (lin), firing is at the discretion of the project manager. Since this program has

Table 14-1
Ambient Noise Survey

Site	Location and Characteristics	Noise Levels dbA L_{eq}*	Noise Levels dba L_{10}**
A	Adjacent to Sewage Lagoon and heavily wooded. Daytime noise is that emitted from vehicles on Highway 43 and birds. Night time noise sources are insects and wildlife. There is no perceivable noise from sewage operations.	41.1	43
B	Located in a grassy field between Dean Road and Road A. Daytime noise sources include cars on Road A, light truck traffic on Gravel Pit and southern Dean Roads, and insects. Forests surround the field on all sides.	37.8	45
C	Located on Navy Road north of the old Bombing Range and just off Mainline Road. The Bombing Range (north of bombing Range Road and east of Mainline Road) is a large grassy expanse with very few trees. The remainder of the area is heavily forested with much undergrowth. Noise sources include birds and insects.	38.7	41
D	Directly in front of the parking lot for Building 1100. The area consists of mown grass with several large office buildings. Noise sources include vehicles and air handling units for the surrounding buildings.	41.6	45

*L_{eq} The equivalent continuous noise level having the same energy as the actual time-varying noise during the observation period.

**L_{10} The noise level that is exceeded 10 percent of the time (90th percentile) during the observation period.

Source: NASA, 1980, Environmental Resource Document, Inventory Summaries, Stennis Space Center

Figure 14-1 Ambient Noise Measurement Sites

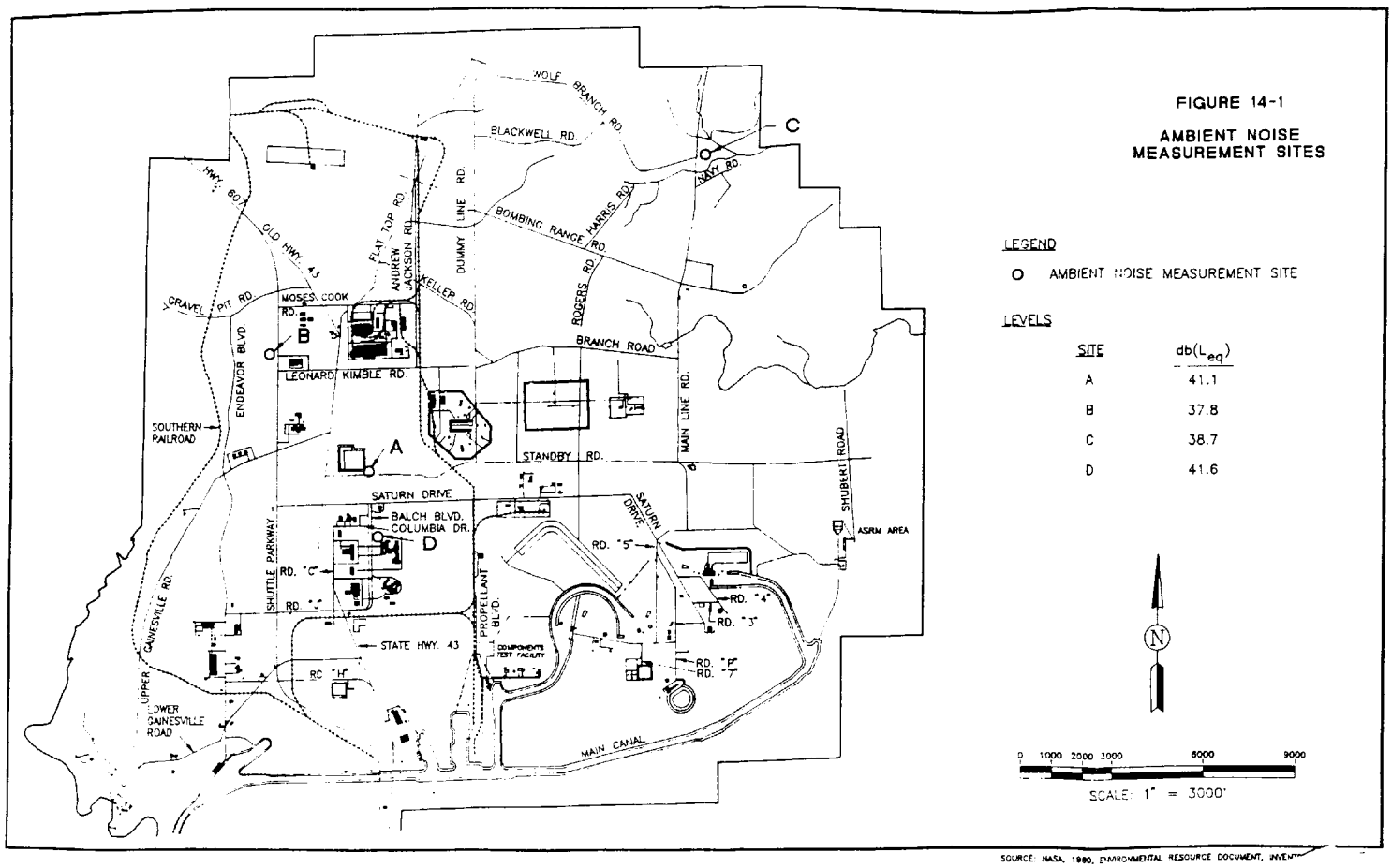

FIGURE 14-1

AMBIENT NOISE MEASUREMENT SITES

LEGEND

O AMBIENT NOISE MEASUREMENT SITE

LEVELS

SITE	db(L_{eq})
A	41.1
B	37.8
C	38.7
D	41.6

SOURCE: NASA, 1980, ENVIRONMENTAL RESOURCE DOCUMENT, INVENT

Table 14-2
Federal Highway Administration Noise Standards

	Design Noise Level/Land-Use Relationship	
Land-Use Category	Design Noise Level, L_{10}	Description of Land-Use Category
A	60 dBA (exterior)	Tracts of land in which serenity and quiet are of extraordinary significance and serve an important public need, and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose. Such areas could include amphitheaters, particular parks or portions of parks, or open spaces that are dedicated or recognized by appropriate local officials for activities requiring special qualities of serenity and quiet.
B	70 dBA (exterior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, picnic areas, recreation areas, playgrounds, active sports areas, and parks.
C	75 dBA (exterior)	Developed lands, properties or activities not included in categories A and B.
D	---	For requirements on undeveloped lands see *FHPM 7-7-3 (3)*.
E	55 dBA (interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

been adopted, there have been no complaints about noise that could be attributed to rocket test firing operations. Noise expected for future rocket testing will be less than those generated during the Saturn V program but more than the levels generated by the SSME.

14.3 Vibration

Due to the soil conditions at SSC (swamps, quicksand, 19.8-meter [65-foot] deep unconsolidated layers), the facility and surrounding areas are susceptible to acoustic-seismic effects. However, years of testing the Saturn V rocket motor showed that the effect from rocket test firings is limited to swaying and falling objects. The greatest concern from seismic effects caused by operations at SSC is the falling of objects in occupied buildings due to the slight swaying induced by seismic vibrations (3).

14.4 Major Environmental Considerations for Proposed Actions

Over the years of rocket testing at SSC, NASA has developed procedures to manage the effects of project-generated noise. A critical element of the noise management procedures is an estimation of noise level prior to commencement of noise generating activities. NASA has developed models for noise level prediction based upon atmospheric conditions. Any proposed action that may generate significant amounts of noise should estimate the effect and develop a program to manage the noise. The Facilities Master Plan should be consulted to ensure that manufacturing facilities and other continuous noise sources are located away from the more densely populated areas of the site to protect the low ambient noise levels.

While seismic effects have been minimal at SSC, the potential for damage to property exists. Vibrations caused by proposed actions should also be evaluated to determine what, if any, effect the action will have on SSC and the surrounding communities.

14.5 References

1. Cheng, A., Dr. and Hines, M., 1990, Summary Report of ASRM Acoustic Study, Applied Mathematics and Physics, Department of Engineering and Science, Sverdrup Technology, Inc.

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3. Ebasco, 1989, Final Environmental Impact Statement, Space Shuttle Advanced Solid Rocket Motor Program.

4. NASA, 1980, Environmental Resource Document, Inventory Summaries, Stennis Space Center.

5. Transportation Research Board, National Research Council, 1976, Highway Noise, A Design Guide for Prediction and Control, National Cooperative Highway Research Program Report 174.