Thoughtful Silence

By David R. Miller, Associate Editor

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When Paul Simon and Art Garfunkel recently reunited for their first tour in 20 years, most concertgoers found it very easy to enjoy the intricate harmony of the duo's standard, "Sounds of Silence." Some modern realities are pushing the sounds of silence out of reach for residents of Oakland County, but thoughtful design can be utilized to reintroduce many to the simple pleasures of quiet conversation or a good night's sleep.

Few facilities present a greater noise control challenge than general aviation airports. Since general aviation, which includes all air traffic except military and airline flights, accounts for approximately 70 percent of the total flights in the United States, general aviation airports are usually situated in densely populated areas to allow easy access to their services. To be considered a good neighbor, general aviation airports must work diligently to control the noise generated by aircraft engines.

As part of a noise control effort, Oakland County International Airport (OCIA) in Waterford recently underwent a part 150 noise/land use compatibility study. This five-year study was instrumental in the development of a series of noise control recommendations for OCIA, including the creation of a Ground Run-up Enclosure (GRE). The Garrison Company of Farmington Hills and Blast Deflectors, Inc. of Reno, Nevada combined their talents to design and build this highly specialized aviation structure.

DEFINING PROBLEMS AND SOLUTIONS

Airports are never quiet, but several unique circumstances combine to make the noise generated at OCIA particularly troublesome. OCIA is designated as a reliever facility for Detroit Metro Airport, and OCIA therefore accommodates a large amount of business traffic that would normally have used Detroit Metro. Jets favored by business travelers are typically large enough to accommodate multiple passengers, but small enough to escape stringent federal noise regulations that govern jets in excess of 70,000 pounds. The engines that propel business travelers can be among the noisiest in the world and as the nation's 43rd busiest airport, OCIA frequently serves as ground zero for their sonic disruptions.

"We felt that it was necessary to address the noise," said J. David VanderVeen, director of the Department of Central Services for Oakland County. "Because of the combination of the traffic that we have, and the legislation that regulates that traffic, we have become a very noisy facility. We undertook a comprehensive study where we measured the volume of traffic, the intensity and longevity of noise, and its effect on our neighbors."

OCIA logs over 270,000 takeoffs and landings annually. These events generate a lot of noise, but they are less irritating than other airport operations because of the short duration. Ground run-ups are equally noisy, but their longer duration makes them a key area of concern.

"When engines are undergoing maintenance, they need to be run up, sometimes for periods of up to 20 minutes," said VanderVeen. "The duration plus the intensity makes run-ups a very irritating source of noise at this airport. The ground run-up enclosure will reduce that by up to 70 percent."

As part of its noise control program, the airport has purchased approximately 50 homes, and has implemented a "Fly Quiet" program to encourage pilots to use quiet arrival and departure procedures, but the GRE represents the most radical step taken by OCIA.

NOISE REDUCTION

Acoustical engineering is a complex science, however the movement of sound waves is surprisingly simple. Sound waves can be absorbed, reflected or transmitted when they strike an object. Walls can be designed to facilitate one or more of these three actions. Acoustical engineers design interior spaces with walls that offer a combination of these abilities, thereby controlling the sound that is gen-

Noise reduction was a key project consideration. Acoustic panels were installed along the inside of the wall (upper left photo), while vents are turned to direct sound towards the ground (lower left photo).
The sidewalls of the GRE feature a steep downward slope towards the front of the structure to eliminate any hard point that could create a vortex (right photo).

erated within the space.

Designers are using acoustic engineering principals to design the GRE at OCIA. Aircraft will be positioned inside the three-walled structure during run-up testing. Even though the structure has no roof, it will reduce the noise outside the facility by 15 decibels. Since sound is measured on a logarithmic scale, this represents a 70 percent decrease in overall noise transmission. After the GRE is in place, no sound louder than 70 decibels, which is roughly equal to the sound of a lawnmower, will reach any residential area during run-up testing.

"Sound travels in straight lines," said Karl Randall, airport manager for OCIA. "Right now, the sound just goes straight out into residential areas. This structure [the GRE] will absorb a lot of the sound. The rest of the sound will be deflected upwards. The open end of the structure faces towards the west, back towards the interior of the airport. Going that direction, sound needs to travel the better part of a mile before it exits airport property."

Although the engineering was quite complicated, the approach was fairly simple.

"We used absorbent barrier technology," said Mark Boe, chief engineer for Blast Deflectors, Inc. "If you have a sound source and a receiver, you can greatly reduce the noise level at the receiver by simply placing a barrier between the two. The sound needs to take a longer path up and over."

The GRE was a design/build project based against performance specs. In other words, the project team would be evaluated based on its ability to develop a cost-effective design that met a number of minimum standards set forth by the owner. Creating a barrier that would meet the noise reduction needs of OCIA required careful planning.

"It is very similar to the barriers that you see along highways, although 15 decibels is a big number for a barrier," said Boe. "We actually need to do two things with the wall. We need to make sure that no sound goes through, and that is done with the mass of the metal in the wall. We also need to make sure that sound that hits the wall is absorbed. We lined the inside with panels that were designed specifically for that application."

The acoustic panels are approximately six inches thick and are specifically designed to absorb the low frequency sounds that are most problematic with jet engines. Sound travels through the perforations in the metal face sheet of the panels and its energy is dissipated by the fiberglass fill until it is greatly reduced in intensity.

"Compared to any other stock panels on the shelf, these offer much more

The GRE frame features extensive cross bracing to provide sufficient wind resistance relative to the height of the structure.

absorption at the low frequencies," said Boe.

Acoustic engineering was a daunting challenge, but many other OCIA requirements equally tested the project team.

IT'S ALL ABOUT LOCATION

OCIA is situated on a 751-acre site in the heart of Oakland County. Despite a vast amount of available land, there were very few suitable sites for the GRE.

"We needed to have a location on the South side of the airport because the jet activity tends to be concentrated there," said VanderVeen. "The open end needed to face West because of the prevailing westerly wind."

The location was not ideal from a construction standpoint, and many subcontractors needed to alter tried and true methods to get the job done. G & B Electrical Co. provided a power supply for the sensitive monitoring equipment that will be accessed from a centralized control room built into the wall of the GRE.

"Routing the electrical lines from the terminal was a project in itself," said Danny Plantus, vice president of The Garrison Company. "Power was brought in underneath taxiways and ramps to power gauging and monitoring equipment for noise levels, exhaust and wind direction."

The site chosen for the GRE may not have been exactly where every contractor wanted, but the land at OCIA is almost uniformly conducive to construction.

"The airport happens to be blessed with very good soils," said Plantus. "There is a lot of sand, so it is a builder's dream to work out here. There also were not any other structures in the way, so the site happened to be a good place to build."

If the selected site had not been suitable, OCIA would have been left with few options. A stable airflow is needed to test jet aircraft. The opening of the structure needed to be positioned to provide this stable airflow from the prevailing winds. Even though wind conditions are not a constant, the project team was expected to design a facility that could be used 90 percent of the time.

"A jet engine needs to run pointed directly into the wind," said Boe. "By constructing the facility, we determine which way the jet is going to point."

The need for a stable airflow also mandated the addition of vents along the sides of the structure. Without careful planning, the vents could help the project team in meeting the aerodynamic needs of the facility while undermining their efforts to meet its acoustical needs.

The large vertical walls subject the structure to strong wind loads, while lightweight construction results in relatively low structural loads. A specialized foundation meets the support needs of the structure without adding more rigidity than needed.

"We will not see a lack of acoustic performance from the vents," said Boe. "They are fully lined and also turned down to direct sound into the ground. Sound will lose more intensity going through the vent than it will going over the top of the wall."

The unusually shaped walls of the structure are also instrumental in directing the proper airflow to jet engines. Walls at the sides of the GRE feature a steep downward slope towards the front of the structure.

"We are trying to get rid of any hard point in the front so we do not create a vortex that would be drawn into the engine inlet," said Boe. "We needed to create a smooth, steady airflow into the engine and the elimination of the sharp point in front helps."

The sidewalls of the GRE are parallel until they reach a certain point at the back of the structure. At that point, they angle inwards to narrow the space inside.

"It [the GRE] is a constant width until you get behind the wing area of the jet," said Boe. "We wanted to contain the area behind the high-velocity airflow so the air doesn't recirculate into the engine inlet. If the exhaust air got pulled into an engine, it could stall or surge, preventing successful testing."

Aircraft technicians who will use the GRE in the future should be thankful that the project team oriented the facility to supply a stable airflow. Contractors working on the project, however, would have appreciated calmer winds.

"It was very windy because of all of the open space," said Kurk Edwards, president of Edwards and Pollard Concrete Service. "We needed to keep an eye on everything that we brought to the jobsite because the owner didn't want anything to be able to blow onto the runways. They

The Oakland County Int'l Airport required a facility that was both practical and aesthetically pleasing. The solution was a Stabile Flow facility with steel siding.

Although designed to accomodate up to a B737, the facility is used primarily by business jets such as the Hawker/Beech (top) and Gulfstream (bottom).

The framing seen here will be covered with a pre-engineered metal skin. The Garrison Company worked with Butler Manufacturing to design the custom girts seen in this photograph.

were very strict about that."

Safety and security concerns placed an unusual burden on every contractor who worked on the job. Communications were difficult while airplanes roared overhead, and access to the jobsite was limited to a single gate that needed to be kept locked unless it was being used. Despite these constraints, Edwards and Pollard installed a flawless concrete floor for the GRE. The 16,000-square-foot floor consists of a one-foot thick layer of 4,000 psi concrete. Individual slabs are connected by steel dowels that allow a limited range of motion to accommodate freeze-thaw shifting while still maintaining a level surface.

Finding local contractors capable of meeting the rigorous demands posed by the GRE project could have been a tricky proposition for Reno, Nevada-based Blast Deflectors. Fortunately, the company was able to rely on The Garrison Company's local expertise to find qualified contractors.

"They [The Garrison Company] were great to work with," said Boe. "Our scope of work on this project was larger than on any other job that we've done, but Garrison really made things easy. They helped us find all of the local subs that we needed."

An additional challenge would impact the operations of every subcontractor

who was selected for the project. The completed GRE not only needed to meet all of the operational criteria set forth by OCIA, it also needed to look good.

CREATING A POSITIVE IMPRESSION

"This airport is a very important part of the community," said VanderVeen. "When people land at this airport, we make an impression about Oakland County. The question is, will it be a good one, or a bad one?"

Because of their specialized nature, GREs tend to stress function over form. OCIA asked the project team to facilitate a good impression by creating an attractive facility. Adding aesthetic touches to the purely utilitarian function of the GRE proved to be a daunting challenge that would require precise teamwork.

Blast Deflectors built the specialized framing that supports the GRE, while The Garrison Company worked with Butler Manufacturing to design custom girts upon which a pre-engineered metal skin could be placed. Fortunately, Butler Manufacturing has developed a national reputation for quality pre-engineered building components, and The Garrison Company has a 38-year working relationship with this industry leader. The cladding solution developed by the two companies proves that even custom applications can benefit from the efficiency of pre-engineered construction.

"This was a modification of a pre-engineered building," said Plantus. "The facility is, no doubt, prefabricated. A lot of the components, including the framing, round top frame covers and siding, were fabricated offsite and then brought onsite to be erected. The structure is actually a marriage between pre-engineered building and traditional construction techniques. We used some components normally found in a pre-engineered building, but the facility is not pre-engineered in terms of being prepackaged. It is a very specialized pre-engineered structure. It is one of those firsts that sometimes happen when engineers work to solve problems."

The finished GRE clearly demonstrates the success of this problem-solving approach.

"We insisted on aesthetic considerations, and they [the project team] met those objectives by designing a hangar-like building," said VanderVeen. "It looks like it belongs on an airport."

Creating the hangar-like appearance of the structure added an additional complication to the project. The large vertical walls would subject the structure to strong wind loads, while lightweight construction would result in relatively low structural loads. The Garrison Company installed a specialized foundation designed by Blast Deflectors to meet the unusual support needs of the structure without increasing costs by adding more rigidity than was needed. The 760-cubic-yard concrete foundation includes 31 tons of reinforcement, only slightly higher than the amount that would typically be included in a similarly sized foundation.

Overall, the project team has met a demanding list of acoustic, aerodynamic and aesthetic criteria to create the new GRE at OCIA. Visitors catching a glimpse of the facility from the air will probably be unimpressed by its attractive, but unremarkable, appearance. Residents near the airport will undoubtedly have a much deeper appreciation for the sounds of silence, as well as the thoughtful design process that brought them back.

The Following Subcontractors and Professional Consultants Contributed Their Skills to the Project:

Asphalt Paving – Nagel Paving Co., Farmington Hills

Concrete – North Channel Construction, Harsen's Island

Concrete Flatwork – Edwards and Pollard Concrete Service, Detroit

Electrical – G & B Electrical Co., West Bloomfield

Layout – Atwell-Hicks, Inc., Ann Arbor

Prefab Building – Parkline Great Lakes, Inc., Grand Blanc

Steel Erection – ACE Steel Erectors, Grand Rapids

Wall System – Butler Manufacturing, Kansas City, MO

Subcontractors and professional consultants listed in the Construction Highlight are identified by the general contractor, architect or owner.