A HUSH OVER HAMBURG

SUCCESS TURNS ON THE MASSIVE DOORS IN AIRBUS'S NEW GROUND RUN-UP ENCLOSURE. CARROLL MCCORMICK REPORTS.

The new ground run-up enclosure (GRE) at Airbus's Finkenwerder Airfield factory (IATA XFW) in Hamburg, Germany was constructed and equipped uniquely for the A320 family of aircraft. A four-sided design solved challenging aerodynamic and acoustic issues.

Having to dismantle its old A320 GRE after 30 years of service, Airbus hired Reno, Nevada-based Blast Deflectors, Inc (BDI) to design and build a new structure adjacent to the A380 engine run-up facility on the western side of the airfield. Civil work began in September 2015 and BDI began erecting the GRE in February 2016, finishing the structure that December.

As the general contractor for the GRE, BDI was responsible for all labour and work related to the project, including civil, structural and electrical. Key subcontractors were: Strabag and Siemke & Co Brücken- & Ingenieurbau for the civil work; Weyler Electrotechnik for the electrical tasks, and Sellhorn Ingenieurgesellschaft for the civil design.

Unlike with GREs built to accommodate a mixture of aircraft types, designers could take advantage of the fact that the new Finkenwerder GRE was exclusively for A320 twin-engine jet variants. For example, it has automated wheel chocks built into the pavement, since the main gear is always in the same relative position for all A320-family aircraft, and the engine inlet vortex eliminators and a 400hz ground power unit are placed specifically for the airliner's footprint.

Also, because the GRE would be used for pushback operations only (as opposed to entering the GRE nose first, then turning 180 degrees) the facility footprint could be minimised, while still maintaining the necessary

Huge, vented doors allow air in, but minimise noise outside the GRE. (BDI)


Wheel chocks and vortex eliminators are built into the new ground run-up enclosure. (BDI)

clearances. Looking at the GRE from above, it's apparent that this led to a very unusual shape.

BDI President, Don Bergin, explained: "The geometry of this facility is unlike any other GRE ever built. A design with walls that taper to the rear of the facility produces optimal aerodynamic performance for twin-engine aircraft."

The GRE is 282ft (86m) long with the doors open, and 240ft (73m) long with them shut. It is 180ft (55m) wide. The height of the walls range from 153ft (6m) to 79ft (24m), and the two doors, with a combined weight of 813.6 short tons (738 tonnes), are 66ft (20m) high. The entire structure weighs over 1,378 short tons (1,250 tonnes). Underpinning the GRE and the door rail systems are 135 piles, sunk to a depth of 76ft (23m).

A GRE must meet certain acoustic objectives, that is, to limit the engine noise escaping it to some contractually-specified level. This is partly solved by the choice of materials used in the walls, such as acoustic panels, and building them to various heights, depending on the directions they face; the higher walls face the more noise-sensitive areas, such as residential communities.

For the Finkenwerder Airfield GRE, for example, Mr Bergin says: "The noise reduction required to the southeast of the facility was much greater than to the northwest side of the airport. As a result, the walls on the southeast side of the facility are 8m taller than the walls on the northwest side."

The acoustic objectives are also partly solved, in the case of a three-walled design, by pointing the open, noisy end toward an area where noise is less of an issue, such as a large body of water or the interior of the airport.

However, the orientation and design of a GRE must take into account the prevailing winds and the aerodynamic conditions they create. Normally, the open end would face the prevailing winds. In the case of the new Airbus GRE, however, the required location and heading, while optimal from an operational standpoint, meant that the prevailing winds would blow into the back of the facility.

"The specified location and orientation of the new facility made the project extremely challenging both acoustically and aerodynamically. Alternate facility locations or headings were not an option, so BDI had to develop a design that allowed high usability in virtually all wind conditions," Mr Bergin noted.

Of the two possible solutions, a roofed or a four-sided facility, Airbus determined that the four-sided facility, a first for BDI, was a better option

The GRE's shape is optimised for the A320 family of aircraft. (BDI)

BDI added acoustically treated vents to all four sides of the Finkenwerder GRE. (BDI)

SOME FEATURES OF THE AIRBUS GRE

- Sound-proof control room with restroom, cockpit communication system, HVAC and window into the facility.
- CCTV system with four pan zoom cameras and a video monitor in the control room.
- Building management system to control the GRE's mechanical and electrical equipment.
- Wind speed and direction monitoring system.
- PLC control panel for all mechanised features and wind status monitoring.
- Two storage rooms with interior and exterior access.
- Two AFFF (aqueous film-forming foam) stations installed on the interior of the facility.
- Fuel-proof concrete pad with oil-water separators and spill storage tanks.
- Emergency door opening sequence with fi re alarm notifi cation.
- Heated mirrors mounted on the GRE door interiors that allow pilots to visually monitor engine conditions during run-ups from the fl ight deck.
- Facility status light incorporated into the interior of the GRE door.

than a fully-enclosed GRE with a roof. The latter would have been more complicated and costly.

The acoustic and aerodynamic solutions for the Finkenwerder Airfield GRE include a jet blast deflector incorporated in the rear wall, and around 21,528 sq ft (2,000m^2) of acoustic panels in each door. Additionally, each door has nine large vents, which permit adequate air flow and the air volume required by the engines and auxiliary power units. "The doors have more than 60% open area in order to allow adequate airflow during engine run-ups. The addition of a fully vented front door system significantly improved aerodynamic and acoustic performance," said Mr Bergin.

However, he noted: "Adding doors to the front of the facility solved the acoustic issues but created aerodynamic challenges that were compounded by the prevailing winds, which were from the rear. BDI's solution was the add acoustically-treated vents to all four sides [of the GRE] that provide improved air flow in all wind conditions."

Those doors have eye-opening specifications. Each is 85ft (26m)-long, 66ft (20m)-high and 15ft (4.5m)-thick. Each weighs approximately 460 short tons (420 tonnes). To ensure they can withstand the wind loads, more than 353 short tons (320 tonnes) of concrete ballast are incorporated into the door bases. The doors are mounted on rails and each one is moved by four 7.5hp Demag gear motors. The rails can be heated to prevent ice accumulation during winter conditions.

"Adding doors to the front of a GRE required complex safety and redundancy systems. For example, in the event of a power outage, the doors are designed to be opened or closed with a standard aircraft tug. Also, emergency vehicle access doors were incorporated into the side walls. Finally, the very strict European safety codes required numerous redundant safety measures to ensure operators safety," Mr Bergin explained.

Aside from the design challenges, some of which were investigated using 1:32, 1:60 and 1:250 scale models and wind tunnel testing, Mr Bergin added: "We found that the wet and windy conditions of Hamburg in the winter was, perhaps, the most challenging construction climate we'd ever faced. Operating multiple cranes on a windy airfield while installing 79ft (24m)-tall structural members and then attaching acoustic panels to them was challenging."

They say the proof of the pudding is in the eating. In the case of a GRE, it is the post-construction taking of noise readings that provides the proof of a successful design.

Mr Bergin said: "The testing of the facility involved two main aspects. First, a series of microphones were set up at designated location around the facility and noise levels were recorded ruing a run-up. Airbus compared the recorded noise levels to the levels specified in the contract and determined that the facility met the requirements.

"The second aspect of the acceptance testing involves long-term monitoring of the aerodynamic performance. Based on feedback BDI has received from Airbus, the aerodynamic performance of the facility has far exceeded the project expectations."