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Thermal Turbomachines – Excursion 2015
Day 1: Rolls-Royce, Oberursel - Summary

The Rolls-Royce Holding plc is a multinational company headquartered in the City of Westminster, London (UK). Its business segments include design, manufacturing, distribution and maintenance in the field of civil aero engines (53%), military aero engines (20%), marine propulsion systems (18%) and power generation equipment (9%). Rolls-Royce employs worldwide around 54,100 (2014) employees of which 15,500 (2014) are engineers. The underlying group revenue for 2014 is £14.588bn and a profit of £1.617bn. A direct subsidiary of the Rolls-Royce Holding plc is Rolls-Royce Deutschland with two facilities at Dahlewitz outside Berlin and Oberursel near to Frankfurt am Main combined with 3300 employees operating mainly in the field of civil and military aero engines. While in Dahlewitz the design and final assembly of the aero engines is located the sight at Oberursel focuses on production and maintenance. Today Rolls-Royce Deutschland is the only official licensed aero engine manufacturer in Germany operating in the field of design, production and maintenance of modern civil and military turbo jet engines.

In the course of this excursion we were able to visit the facility in Oberursel on Tuesday the 26th of May 2015. Two former RR employees gave us an insight view on the production site. Besides visiting the actual production and maintenance lines a key focus lay also on the historical development of the factory site Oberursel therefor our visit started at the in-house factory museum (Prof. Dr. Günter Kappler Haus) in which a wide range of products that where manufactured over the past in Oberursel were on exhibition. The excursion group was afterwards split into two groups one visiting the production lines while the other one stayed in the museum. Unfortunately taking pictures during the factory tour was strictly prohibited and only allowed within the museum.

Oberursel „In the Past“

The factory in Oberursel looks back on a long and diversified history. The facility in Oberursel is considered to be the oldest production site for engine components that is still in use today. In 1892 the „Motorenfabrik Oberursel“ was founded yet the production of engine components already started 2 years earlier. The first engine constructed in Oberursel was a small reliable 4 Ps petroleum engine called the „GNOM“ rumors say the acronym stands for („Geht nicht ohne Monteur!“) which means as much as “Doesn’t work without a Mechanic!”. Since 1908 aero engines were discontinuously designed and produced besides general engines in Oberursel. It started with revolving cylinder engines that were but into Fokker airplanes (Figure 1) and continued with radial and flat twin aero engines. WWI and the world financial crisis meant radical changes for the company though that the production of aero engines was temporarily abandoned and the company was taken over by the Deutz AG. After WWII Oberursel was used as repair site by American troops. The construction and production of thermal turbomachines in Oberursel started in 1956 with the gas turbine T16 when the production site returned to the KHD AG (Klöckner-Humboldt-Deutz AG). In 1959 Oberusel was licensed to build the Orpheus 803 D11 which marks the starting point for turbo jet engines in

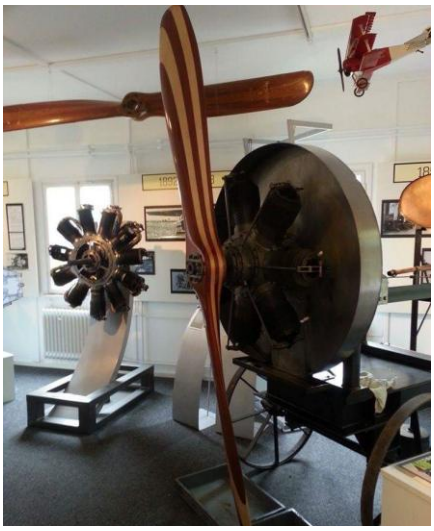

Figure 1: A restored revolving cylinder aero engine manufactured in Oberursel. The rotor is fixed to the casing therefore the cylinders are rotating allowing the idle stroke.

Oberursel. Over the course of time different turbo jet engine components where designed in Oberursel. During 1975-1990 Oberursel specialized on construction and production of APU's (Auxiliary Power Units) with which aircrafts are powered when the main engine is turned off. The Secondary Power Unit of the PA-200 Tornado is currently overhauled in Oberursel. Besides construction and production, maintenance became another important economic sector in Oberursel especially in the field of helicopter jet engines. Engines from several known aircrafts are overhauled in Oberursel such as the helicopters: Silorsky UH-3 „Sea King"and Bell UH-1. In 1990 BMW acquired the KHD Luftfahrttechnik GmbH and integrated it into the joint venture with Roll-Royce which goal was the production of a new family of modern two-shaft turbojet engines for civil application (BR 700). Since 2000 the site in Oberursel belongs directly to Rolls-Royce Deutschland.

Oberursel „Today"

40% of the 3300 employees working for RR Deutschland today work in Oberursel. 150-160 of them are currently employed in maintenance and repair. The remaining staff is involved in production since the design department was entirely taken over by the facility in Dahlewitz. Today the components produced in Oberursel are mainly used for turbo jet engines and leave the factory for the final assembly in Dahlewitz.

Figure 2: A BR710 turbo jet engine exposed at the Rolls-Royce museum in Oberrsel.

The factory tour started with an overview on the different components manufactured in Oberursel. A chart linked these components with different engines and aircrafts in which they are used including BR710 (Gulfstream 500), BR715 (Boing 717-200), BR 725 (Gulfstream 625), TP 400 (A400M), Larzac (Alpha jet), Trent XWB (A350), etc. Besides production of drums, HPT, HPC, etc. the key competence lays in the manufacturing of blisks (blade integrated disks). A traditionally manufactured rotor of a HPC or HPT used in a turbo jet engine consist of blades and a disks that are separately produced and put together afterwards. Blisks however are produced by cutting the profile of the blades out of the whole. This is done in a CNC-controlled five-axis milling machine. During our visit several of this machines where working on blisks. In total 15 of those machines are in use nonstop at the site in Oberursel. The advantage of blisks is the possibility of weight reduction due to lack of joining technology between blades and disks however blisks are more susceptible for vibrations since the conventional connection system show positive effect on damping. The reduction of aircraft noise is an important issue therefor noise emissions from blisks must be carefully handled. The long process time of a blisk which is about 80-130 hours is very cost-intensive. The price of a finished blisk can go up to 160,000 € with 90% of the sum accounting for process time and only 10% for the wrought product. To join the finished blisks rotational friction welding technique can be applied thereby on of the blisks which supposed to be joined is brought on highly rotational speed while the other one is pressed on it with up to 2000t of pressure. Friction heat and mechanical pressure weld the blisks together. One of only five of the largest machines worldwide using this technique is located in Oberursel weighing 450t. At the end of our factory tour we were able to witness a live test of an overhauled helicopter turbo jet engine for the „Sea King". A complex spectrum of different load configurations was tested. At maximum power of roughly 1200kW the engine was consuming 523 liter of kerosene per hour.