Helicopter-Ship Qualification Testing

By Alrik Hoencamp

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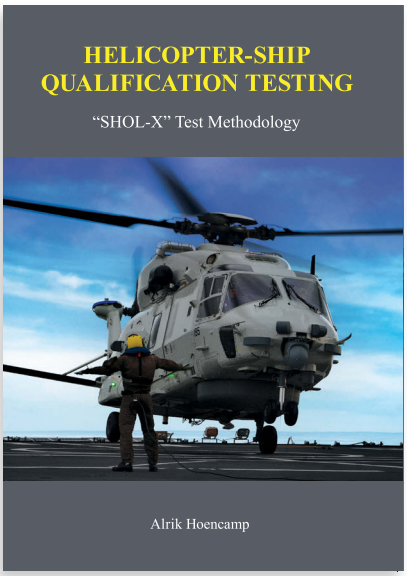
The Royal Netherlands Navy (RNLN) was one of the first operators of shipborne helicopters on small ships. Together with the Netherlands Aerospace Centre (NLR), the RNLN has pioneered the development of helicopter-ship qualification procedures over the past 50 years. It has occasionally happened that — due to either prevailing weather conditions, ship availability or helicopter availability — the limits of the helicopter-ship combination could not be fully explored, thereby restricting the operational capability. The goal of this book is to present a test methodology that can be used for optimizing cost and time efficiency of helicopter-ship qualification testing without reducing safety. For this purpose, the so-called "SHOL-X" [Ship Helicopter Operational Limitations] test methodology has been established, including the associated predictive software tool as developed during the author's doctoral research project.

Methodology Described

The main advantage of the test methodology, which is thoroughly described in the book and aided by the presented predictive tool, is that the operator can perform an early evaluation of safety limits for helicopters operating on ships in a wide range of in-service conditions. In this way, the qualification process is less dependent on the successful outcome of solely qualitative assessed test points during dedicated sea trials. As such, the test methodology can be used to allow a well-considered assessment of the gap between the manufacturer-determined safe flight envelope and the user-defined operational flight envelope for a particular helicopter-ship combination. The test methodology, including the associated predictive tool, has (among other examples) been successfully applied since 2011, during the helicopter-ship qualification process of the NH90 NATO Frigate Helicopter (NFH) across the entire Dutch fleet.

The described test methodology provides two methods for constructing operational limitations. The first and most common approach relies on dedicated sea trials, during which the potential boundaries for the various takeoff and landing procedures are (partially) validated. The second option is the construction of the operational limitations for hot and heavy conditions by desktop analysis alone, i.e., (hot) outside air temperatures above approximately 25°C (77°F) using the helicopter's maximum weight (heavy). The construction of the operational limitations for hot and heavy conditions are based on the data gathered during shore-based hover trials and the flight test results for other referred weights (i.e. helicopter weight as a function of air density) on board the same ship type. The construction of operational limitations by desktop analysis alone is a novel approach, and can be seen as the most important achievement of this work.



Structure of the Book

This book is structured into seven chapters. Chapter 1 presents a short literature review and the doctoral research objectives and limitations. Chapter 2 gives an introductory tour of the relevant aspects and operational procedures required for a basic understanding of helicopter-ship qualifications testing. Chapter 3 explains the possible model and measurement uncertainties, and how these uncertainties propagate in the predictions made by the predictive tool. Furthermore, the safety margins and confidence levels of the various helicopter parameters are discussed.

Based on the half-century of experience within the RNLN, the test methodology discussed consists of three distinctive phases. In Phase I, as discussed in Chapter 4, the ship environment in which the helicopter will operate is determined by conducting wind tunnel measurements of the airflow in the takeoff and landing paths of the ship. For a specific helicopter, a ground assessment and shore-based hover trials are described to verify precisely the helicopter limitations, including aspects such as pilot workload in crosswind conditions, engine performance and control margins.

These initial chapters are necessary to rightfully support use of the predictive tool to assess the likely operational capability for takeoff and landing of a particular helicopter-ship combination. Thereafter, in Phase II, as discussed in Chapter 5, the potential operational limitations are derived by combining the behavior of the isolated helicopter and the environmental conditions for a particular ship type. The outcome is used as the starting point for sea trials. Finally, in Phase III, as discussed in Chapter 6, a (partial) flight test campaign on board the ship is described to be conducted in a range of weather conditions by day and by night. This is to determine for the particular helicopter-ship combination the effects on the pilot workload from, for example, visual references, ship motion and turbulence. In addition, the flight test results from various sea trials are used to validate the predictions made by the predictive tool. The book concludes with Chapter 7, in which the results are summarized, conclusions are drawn, and recommendations are given.

Conclusion

This book covers an area of flight-testing that has not been described to such a level of depth before. It is aimed at both junior and experienced rotorcraft engineers, researchers, academics, flight test engineers and pilots. But it is just as relevant for managers who are involved in flight trials of helicopter-ship combinations as part of a complex flight test program for which they are required to plan, conduct and report on ship helicopter operational limitations. This wonderful book forms a solid foundation for standardization in helicopter-ship qualification. Not surprisingly, its contents are now captured in the innovative training course for helicopter-ship qualification offered by NLR and AeroMath.

Pick up this book and start reading at random and you will experience a good read that may increase your theoretical knowledge and practical understanding of helicopter-ship qualification. But there is so much good material in this book that it really deserves to be read from beginning to end.

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Joost Hakkaart manages the Helicopters & Aeroacoustics Department of the Netherlands Aerospace Centre (NLR). He holds a MSc. in aerospace engineering from Delft University of Technology and has extensive experience in helicopter ground and flight testing, including SHOL. Hakkaart is a member of the AHS Test & Evaluation committee (since 2012), and is the national representative in the European Rotorcraft Forum (ERF) committee and in the GARTEUR Helicopter Group of Responsables.