nato's rotorcraft aviation forces rely heavily on ship based operations for both military and commercial applications. the requirements to provide surveillance supplies and force projection options in areas where land based operations are not available also dictate aircraft ship operations. these multi-national forces operate from a variety of different aircraft and ships in both weather and visibility extremes. basic helicopter flight limitations are usually determined in a land based environment by the aircraft manufacturer and or by the procuring activity. the land based limitations are not valid in the shipboard environment due to the individual factors including ship airwake turbulence, ship motion, confined landing areas, and visual cue limitations and due to the combined effects of these factors. future nato operators and force commanders may require the maximum helicopter ship operational capability that can be accomplished in any environmental condition. the purpose of this agardograph is to document the helicopter ship qualification test procedures including the preparation, execution, and data analysis of helicopter ship flight testing that should be employed combined with best safety practices to obtain that maximum operational capability. attention is focused on helicopter take-off and landing, which constitutes the main part of the test programme. flow visualisation tests were performed about the helicopter deck of a 1/35 scale model of the hydrographic ship in the low speed wind tunnel at the aeronautical and maritime research laboratory. the model was tested over a range of relative wind angles using tuft smoke and surface flow visualisation techniques to determine regions of adverse airflow that may have a detrimental effect on helicopter ship operations. in order to meet certification requirements, in particular turbulent flow in the vicinity of the flight deck, vertical replenishment area, and the ship's anemometer installation were identified, photographed, and recorded on video. effects of two fixed ship roll angles on the flow were also investigated. this document contains extensive results for all model configurations tested and describes in detail the flow features observed in the past decade. there has been a dramatic increase in the use of helicopters in conjunction with non-aviation ships. in the presence of high winds and stormy seas, it can be a hazardous process. the safe operating envelopes are determined at sea by the navy using simulation and is a slow, laborious, and expensive process. moreover, there is a substantial backlog of about eleven helicopters and twenty ships that at the present rate cannot be cleared in this century. this has led to the suggestion that the problem might be solved by simulation. and it is with this suggestion that the present paper is concerned. the airflow to the ship can be predicted accurately. a good basic ship motion prediction exists but requires some further development and validation. the ship airwake is almost unknown, and previous attempts to analyze it were faulty. further work is required on turbulence modeling of helicopters and it is possible to determine the size of computer necessary for simulation. it is necessary to determine the extent to which the mathematical model of the helicopter and the physical model of the complex fluid flowfield can be simplified while still retaining the fidelity of the helicopter motion. the helicopter operations from ships other than aircraft carriers hostac supplement contains information to allow greater flexibility and safer operational capability for short term helicopter cross operations with aviation facility ships of nato countries. the dynamic interface between a ship and a helicopter is a complex hazardous environment demanding high levels of pilot workload in modeling simulation of such environment. for pilot training purposes, high levels of fidelity are required on the airwake module. the objectives of this research effort are to analyze in detail the effects of the turbulence present in the atmospheric boundary layer (abl) on ships and the resulting airwake. the other objective is to use airwake data saved from the numerical simulations as external disturbances to a helicopter model in order to quantify an increase in pilot workload. two different types of inflow are investigated: unsteady abl and steady abl. unsteady cases are executed in openfoam and represent an appropriate velocity profile but do not include any freestream turbulence. uniform inflow cases are also executed on both codes as baseline.
cases the sfs2 ship geometry is used and it is modeled by the immersed boundary method within openfoam while body fitted overset grids are used in overflow pilot workload is quantified by a frequency domain analysis of the energy associated with the usage of the input sticks initially neutral cases with two levels of shear are investigated and compared to uniform inflow solutions analysis of velocity distributions along probe lines at the deck revealed that the presence of an abl modifies the recirculation region and delays the reattachment point different levels of shear yield different characteristics for airwakes modified by unsteady abl inflow spectral analysis at locations near the ship’s flight deck indicated that higher energy content at frequencies above 3 hz with better agreement to kolmogorov’s 5/3 cascade have been captured increased content has also been observed in the 0 1 0 3 hz range this energy cascade matches in situ experiments spectral content on the uniform inflow cases fails to match content above 3 hz which are also not usually captured in standard cfd simulations the airwakes related to abl inflows were not related to each other by a common factor indicating that these solutions are not scalable differently than what is usually observed for uniform inflows next two hover locations outside of the airwake are considered subject only to the turbulence present in the inflow in an altitude of 20 ft and another at 80 ft the abl turbulence had a substantial effect on the vehicle resulting in significantly more disturbances considerably more power fluctuations and fluctuations on the vehicle’s attitudes while this was observed on both cases it was much more prominent in the high altitude case the fluctuations were reflected on the stick usage and thus pilot workload the uniform inflow case barely exerted any effect and had comparable results to a scenario where only pitt peters inflow model is used no external disturbances analysis of the energy related to the stick usage showed that substantially more energy was found for the abl case across all of the frequency range investigated for high altitude case and a lower increase for the lower altitude case found in the range of approximately 0 1 0 6 hz these results suggested that the large length scale eddies that are present in the atmosphere seems to affect the vehicle and the pilot workload lastly two hover locations at the flight deck have been investigated the vehicle was subject to the highly turbulent air shedding off the superstructure and chimney comparisons between steady abl unsteady abl and uniform inflow are made one hover location is within the highly separated region and another is slightly higher the second location represents a mix of the pure unsteady abl flow and airwake turbulence these locations were selected in order to check whether or not the effects from the atmospheric turbulence observed previously would apply here for the unsteady abl case the results indicated that when the airwake turbulence dominates an increase in the energy associated with frequencies in the range of 0 1 0 3 hz has been observed for frequencies above 0 5 hz not many differences are observed at the energy associated with the stick use however one of the main findings of this work is that when the aircraft was hovering only 10 ft higher in a flowfield that was a mix of airwake and atmospheric turbulence the energy associated with the unsteady abl was higher than that associated with the uniform inflow for all of the 0 2 2 hz spectrum now with respect to the overflow’s steady abl case no appreciable differences have been captured in neither of the hover locations the steady abl approach did not affect the vehicle nearly as much as the unsteady abl did in fact the uniform inflow consistently exhibited higher energy although very small than that seen under the steady abl the steady abl did not add any relevant information the results indicate that when the aircraft is flying at a location that is subject to more of the atmospheric eddies the vehicle tends to react to the unsteadiness present which represents additional pilot workload this is especially relevant for a ship with a flat deck similar to the lha class if the vehicle is solely in the wake of the superstructure no relevant differences were observed the lower fidelity approach of modeling the abl as a steady abl did not add any relevant pilot workload for the sfs2 with zero wind over deck case investigate this manual describes the tactics techniques and procedures for use by army aviation units during operations from navy and coast guard ships it is written to reflect peacetime operations that may transition into warfighting execution and assumes that the deployment of army helicopters is the result of careful presail planning this manual is intended for commanders staffs aircrews and instructors it will be used to coordinate plan execute and teach shipboard operations along with navy publications it provides information for developing a standardized progressive program to train crews to proficiency on shipboard operations appendixes a through f provide supplemental information on aircraft handling signals aircraft arming and safing signals weapons loading strikedown downloading and recovery guide operations from single and dual spot ships standing operating procedures for overwater operations and flight deck clothing and duties appendix g provides information on helicopter ship interface the most
Current memorandum of understanding between the army air force and navy for deck landing operations is found in appendix H. This publication also reflects navy terminology, regulations, procedures, and traditions that are necessary for safe operation aboard ships. This publication provides operating and aviation ordnance procedures required to plan and conduct shipboard helicopter operations and places emphasis on single ship, single helicopter independent operations. The publication is written to reflect routine operations for the deployment of joint force helicopters on board US Navy USN and US Coast Guard USCG ships. This is generally the result of careful presail planning but does not preclude crisis response, surge requirements, or warfighting execution. This publication describes shipboard helicopter operational procedures for both embarked and transient aircraft and aviation detachments. Some of the terminology, regulations, and routine I encountered aboard ship reflect naval traditions and contribute to efficient and safe operations. The Visual Technology Research Simulator VTRS at the Naval Training Systems Center was used to study the effects of six simulator features on performance for helicopter landings on small ships. The purpose of the experiment was to obtain information relevant to the design of simulators for skill maintenance and transition training and to obtain information for decisions about future transfer of training. Studies the six simulator factors were scene detail, high detail ship deck and hangar markings versus no deck and hangar markings, field of view VTRS wide versus reduced SH 60B Operational Flight Trainer field of view, System Visual Lab 217 msec versus 117 msec G seat acceleration cuing off versus on and collective sound cuing off versus on. These factors were tested across two levels of seastate and pilot experience. Pilots who participated in the experiment were experienced Navy H-3 rotary wing pilots. Results indicated large effects of scene detail, small to moderate effects for visual lag, small effects for field of view, and no meaningful effects for the G seat factors and collective sound. Performance was better with the high detail ship, the shorter visual lag, and the VTRS wide field of view. Transfer of training research is recommended as the next step to further explore these findings and to obtain information directly relevant to the design of simulators for use by student pilots. Keywords: flight simulator, visual simulation, scene content, helicopter landing, landing at sea, and simulator design. March 1995.
nato s rotorcraft aviation forces rely heavily on ship based operations for both military and commercial applications the requirements to provide surveillance supplies and force projection options in areas where land based operations are not available also dictate aircraft ship operations these multi national forces operate from a variety of different aircraft and ships in both weather and visibility extremes basic helicopter flight limitations are usually determined in a land based environment by the aircraft manufacturer and or by the procuring activity the land based limitations are not valid in the shipboard environment due to the individual factors including ship air wake turbulence ship motion confined landing areas and visual cue limitations and due to the combined effects of these factors future nato operators and force commanders may require the maximum helicopter ship operational capability that can be accomplished in any environmental condition the purpose of this agardograph is to document the helicopter ship qualification test procedures including the preparation execution and data analysis of helicopter ship flight testing that should be employed combined with best safety practices to obtain that maximum operational capability attention is focused on helicopter take off and landing which constitutes the main part of the test programme

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in the past decade there has been a dramatic increase in the use of helicopters in conjunction with non aviation ships by the u s navy landing the helicopter on the ship in the presence of high winds and stormy seas can be a hazardous process the safe operating envelopes are determined at sea by the naval air test center and is a slow laborious and expensive process moreover there is a substantial backlog of about eleven helicopters and twenty ships that at the present rate cannot be cleared in this century this has led to the suggestion that the problem might be solved by simulation and it is with this suggestion that the present paper is concerned 1 the airflow to the ship can be predicted sufficiently accurately 2 a good basic ship motion prediction exists but requires some further development and validation with real ships 3 the ship airwake is almost unknown and previous attempts to analyze it were faulty 4 further work is required on turbulence modeling of helicopters and 5 before it is possible to determine the size of computer necessary for simulation it is necessary to determine the extent to which the mathematical model of the helicopter and the physical model of the complex fluid flowfield can be simplified while still retaining the fidelity of the helicopter motion

the helicopter operations from ships other than aircraft carriers hostac supplement contains information to allow greater flexibility and safer operational capability for short term helicopter cross operations with aviation facility ships of nato
Helicopter-Ship Qualification Testing 2019

The dynamic interface between a ship and a helicopter is a complex hazardous environment demanding high levels of pilot workload in modeling simulation of such environment for pilot training purposes high levels of fidelity are required on the airwake module. The objectives of this research effort are two-fold: the first one is to analyze in details the effects of turbulence present in the atmospheric boundary layer (ABL) on ships and the resulting airwake; the other objective is to use airwake data saved from the numerical simulations as external disturbances to a helicopter model in order to quantify an increase in pilot workload. Two different types of inflow are investigated: unsteady ABL and steady ABL. Unsteady cases are executed in OpenFOAM while body fitted overset grids are used in OVERFLOW, Pilot workload is quantified by a frequency domain analysis of the energy associated with the usage of the input sticks. Initially neutral cases with two levels of shear are investigated and compared to uniform inflow solutions. Analysis of velocity distributions along probe lines at the deck revealed that the presence of an ABL modifies the recirculation region and delays the reattachment point. Different levels of shear yield different characteristics for airwakes modified by unsteady ABL. Spectral analysis at locations near the flight deck indicated that higher energy content at frequencies above 3 Hz with better agreement to Kolmogorov's 5/3 cascade have been captured. Increased content has also been observed in the 0-10 Hz range. Uniform inflow cases fail to match content above 3 Hz which are also not usually captured in standard CFD simulations. The airwakes related to ABL inflows were not related to each other by a common factor indicating that these solutions are not scalable differently than what is usually observed for uniform inflows. Next, two hover locations outside of the airwake are considered subject only to the turbulence present in the inflow at an altitude of 20 ft and another at 80 ft. The ABL turbulence had a substantial effect on the vehicle resulting in significantly more disturbances, considerably more power fluctuations and fluctuations on the vehicle's attitudes. This was observed on both cases but was much more prominent in the high altitude case. The fluctuations were reflected on the stick usage and thus pilot workload. The uniform inflow case barely exerted any effect and had comparable results to a scenario where only Pitt Peters inflow model is used. No external disturbances analysis of the energy related to the stick usage showed that substantially more energy was found for the ABL case across all of the frequency range investigated for high altitude case and a lower increase for the lower altitude case. The results suggested that the large length scale eddies that are present in the atmosphere seems to affect the vehicle and the pilot workload. Lastly, two hover locations at the flight deck have been investigated. The vehicle was subject to the highly turbulent air shedding off the superstructure and chimney. Comparisons between steady ABL, unsteady ABL and uniform inflow are made. One hover location is within the highly separated region and another is slightly higher. The second location represents a mix of the pure unsteady ABL flow and airwake turbulence. These locations were selected in order to check whether or not the effects from the atmospheric turbulence observed previously would apply here for the unsteady ABL case. The results indicated that when the airwake turbulence dominates an increase in the energy associated with frequencies in the range of 0-10 Hz has been observed for frequencies above 0.5 Hz. Many differences are observed at the energy associated with the stick use, however one of the main findings of this work is that when the aircraft was hovering only 10 ft higher in a flowfield that was a mix of airwake and atmospheric turbulence, the energy associated with the unsteady ABL was higher than that associated with the uniform inflow for all of the 0-2 Hz spectrum. Now with respect to the OVERFLOW's steady ABL case, no appreciable differences have been captured in neither of the hover locations. The steady ABL approach did not affect the vehicle nearly as much as the unsteady ABL did. In fact, the uniform inflow consistently exhibited higher energy although very small than that seen under the steady ABL. The steady ABL did not add any relevant
information the results indicate that when the aircraft is flying at a location that is subject to more of the atmospheric eddies the vehicle tends to react to the unsteadiness present which represents additional pilot workload this is especially relevant for a ship with a flat deck similar to the lha class if the vehicle is solely in the wake of the superstructure no relevant differences were observed the lower fidelity approach of modeling the abl as a steady abl did not add any relevant pilot workload for the sfs2 with zero wind over deck case investigate

Helicopter Operations at Sea 1999-01-01

this manual describes the tactics techniques and procedures for use by army aviation units during operations from navy and coast guard ships it is written to reflect peacetime operations that may transition into warfighting execution and assumes that the deployment of army helicopters is the result of careful presail planning this manual is intended for commanders staffs aircrews and instructors it will be used to coordinate plan execute and teach shipboard operations along with navy publications it provides information for developing a standardized progressive program to train crews to proficiency on shipboard operations appendixes a through f provide supplemental information on aircraft handling signals aircraft arming and safing signals weapons loading strikedown downloading and recovery guide operations from single and dual spot ships standing operating procedures for overwater operations and flight deck clothing and duties appendix g provides information on helicopter ship interface the most current memorandum of understanding between the army air force and navy for deck landing operations is found in appendix h this publication also reflects navy terminology regulations procedures and traditions that are necessary for safe operation aboard ships

The Application of Modelling and Simulation to Ship Design for Helicopter Operations 2018

this publication provides operating and aviation ordnance procedures required to plan and conduct shipboard helicopter operations and places emphasis on single ship single helicopter independent operations the publication is written to reflect routine operations for the deployment of joint force helicopters on board us navy usn and us coast guard uscg ships this is generally the result of careful presail planning but does not preclude crisis response surge requirements or warfighting execution this publication describes shipboard helicopter operational procedures for both embarked and transient aircraft and aviation detachments some of the terminology regulations and routine i encountered aboard ship reflect naval traditions and contribute to efficient and safe operations

Instrumentation for Airwake Measurements on the Flight Deck of a FFG-7 1991

the visual technology research simulator vtrs at the naval training systems center was used to study the effects of six simulator features on performance for helicopter landings on small ships the purpose of the experiment was to obtain information relevant to the design of simulators for skill maintenance and transition training and to obtain information for decisions about future transfer of training studies the six simulator factors were scene detail high detail ship deck and hangar markings versus no deck and hangar markings field of view vtrs wide versus reduced sh 60b operational flight trainer field of view system visual lab 217 msec versus 117 msec g seat acceleration cuing off versus on and collective sound cuing off versus on these factors were tested across two levels of seastate and pilot experience pilots who participated in the experiment were experienced navy h 3 rotary wing pilots results indicated large effects of scene detail small to moderate effects for visual lag small effects for field of view and no meaningful effects for the g seat factors and collective sound performance was better with the high detail ship the shorter
visual lag and the vtrs wide field of view transfer of training research is recommended as the next step to further explore these
findings and to obtain information directly relevant to the design of simulators for use by student pilots keywords flight
simulator visual simulation scene content helicopter landing landing at sea and simulator design


march 1995

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