Nationaal Lucht- en Ruimtevaartlaboratorium

National Aerospace Laboratory NLR

Executive summary

Recent developments for efficient helicopter-ship qualification testing

Problem area
The Rotorcraft/Ship Dynamic Interface can be a hostile environment with the operational availability of an embarked rotorcraft being dictated by its operating limits (launch and recovery envelope).

Description of work
NLR has 40 years of experience in the field of helicopter-ship qualification testing. A cost effective and safe approach has been developed in the course of time, based on a thorough understanding of the helicopter (shore-based) operational characteristics and the ship's environment.
In the process of the helicopter-ship qualification testing, several separate programmes are defined. Each programme has its own particular requirements, resulting in a list of essential parameters, defining the data acquisition systems.

This report focuses on the instrumentation systems, data-acquisition and data processing methodology, as applied on helicopter-ship qualification testing.

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This report is based on a presentation held at the 17th SFTE (EC) symposium, Amsterdam (the Netherlands), 12-14 June 2006.

The instrumentation system as well as the data- acquisition and -processing software has a modular set-up. This subdivision into modules follows the subdivision into the various testing activities of the NLR methodology of helicopter-ship testing.

Results and conclusions

The capability to perform on-line data processing, analysis and presentation provides the test team with a good insight into the progress of the test programme. As a result the various test campaigns within a helicopter-ship qualification programme can be performed safe and efficient. Preliminary SHOLs (Ship Helicopter Operational Limitations) can be handed over to the customer shortly after leaving the ship, which are very similar to the end result, because only limited post analysis has to be performed by the test team.

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Summary

In the process of the helicopter-ship qualification testing, several separate programmes are defined. Each programme has its own particular requirements, resulting in a list of essential parameters, defining the data acquisition systems.
After a brief discussion of the test programmes and their impact on the design of the instrumentation systems, a modular solution is presented. This enables the NLR test-team to adapt the initial test programme using the acquired data, resulting in a reduction of total flight testing hours and increased safety.
Based on actual field-testing the reader is led through the process of helicopter-ship qualification testing. The emphasis will be put on the on board flight test facilities, especially the real-time quick look and data processing.

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Contents

Abbreviations

BOB	Beeld Over Beeld (picture over picture)
DAU	Data Acquisition Unit
DVD	Digital Versatile Disk
FDO	Flight Deck Officer
FLYCO	Flight Coordinator
GPS	Global Positioning Sysytem
GUI	Graphical User Interface
HDD	HarDDisk
LPD	Landing Platform Dock
NLR	Nationaal Lucht- en Ruimtevaartlaboratorium (National Aerospace Laboratory NLR - the Netherlands)
OAT	Outside Air Temperature
PC	Personal Computer
RMDU	Remote Multiplexing/Digitizer Unit
RNLAF	Royal Netherlands Air Force
RNLN	Royal Netherlands Navy
SHOLs	Ship Helicopter Operational Limitations
TCG	Time Code Generator
T/M	TeleMetry
UVW	Orthogonal velocity components of a local wind velocity vector
VAC	Volt Alternate Current
VDC	Volt Direct Current
WAU	Wind data Acquisition Unit

1 Introduction

The Rotorcraft/Ship Dynamic Interface can be a hostile environment with the operational availability of an embarked rotorcraft being dictated by its operating limits (launch and recovery envelope). NLR has 40 years of experience in the field of helicopter-ship qualification testing. A cost effective and safe approach has been developed in the course of time, based on a thorough understanding of the helicopter (shore-based) operational characteristics and the ship's environment. A scheme of the activities performed by NLR is given in figure 1.

The airflow characteristics above the ship's flight deck and along the flight approach paths are measured on a scaled model in the wind tunnel and verified experimentally on the actual subject ship.
The helicopter operational characteristics (hover in wind, omni-directional) are measured during shore based trials.
A candidate flight envelope is assessed by determining the influence of the ship environment on the helicopter capabilities.
Finally the candidate envelope is verified by means of flight trials on-board the ship by means of (subjective) pilot ratings and (objective) measurements of helicopter and ship key parameters.

The test results lead to safe maximum Ship Helicopter Operational Limitations (SHOLs) in terms of helicopter take-off mass, atmospheric restrictions (relative wind & sea state), ship motions and applied operating procedures during day-time and night time operations.
More information on the NLR methodology of helicopter-ship testing is presented in reference 1.

This paper will focus on the instrumentation systems, data-acquisition and data processing methodology, as applied on helicopter-ship qualification testing. The instrumentation system as well as the data- acquisition and -processing software has a modular set-up. This subdivision into modules follows the subdivision into the various testing activities of the NLR methodology of helicopter-ship testing. The same division is applied in this paper.

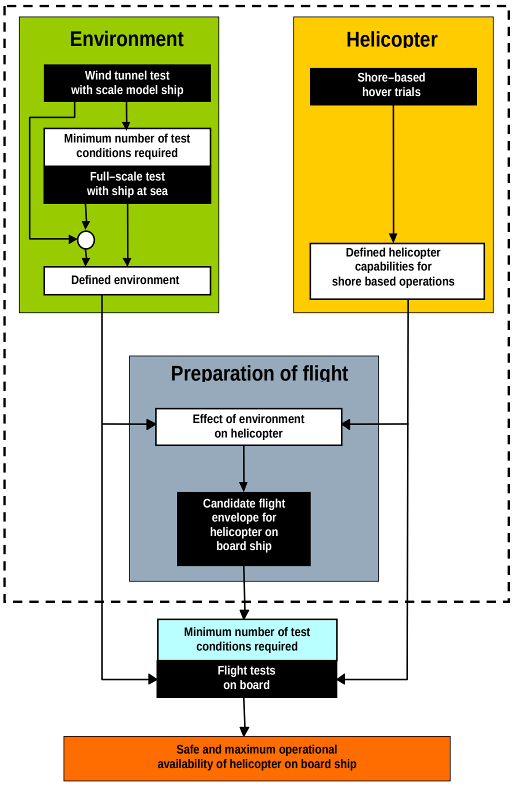

Figure 1 Set-up of helicopter-ship qualification programme as applied by NLR.

2 Wind tunnel tests on a scale model of the ship

Wind tunnel tests on a scale model of the ship are carried out to determine the airflow characteristics (airflow deviations with respect to the undisturbed oncoming relative wind, turbulence) above the flight deck and in the possible approach paths of the helicopter to the ship as function of the relative wind. The relative wind is the wind vector resulting from the true wind and ship's course and speed.
Next, the position error of the ship's anemometer is determined which is, apart from the instrumentation error of the anemometer, needed to establish the relation between the undisturbed relative wind conditions and those prevailing above the flight deck and along the helicopter approach paths.

Furthermore the ship's exhaust plume paths and prediction of plume temperature (by plume dispersion measurement) as a function of ship's power settings and relative wind conditions are determined.

The information obtained from the wind tunnel tests is used in all subsequent test activities. A test set-up for airflow measurements in the wind tunnel is given in figure 2.

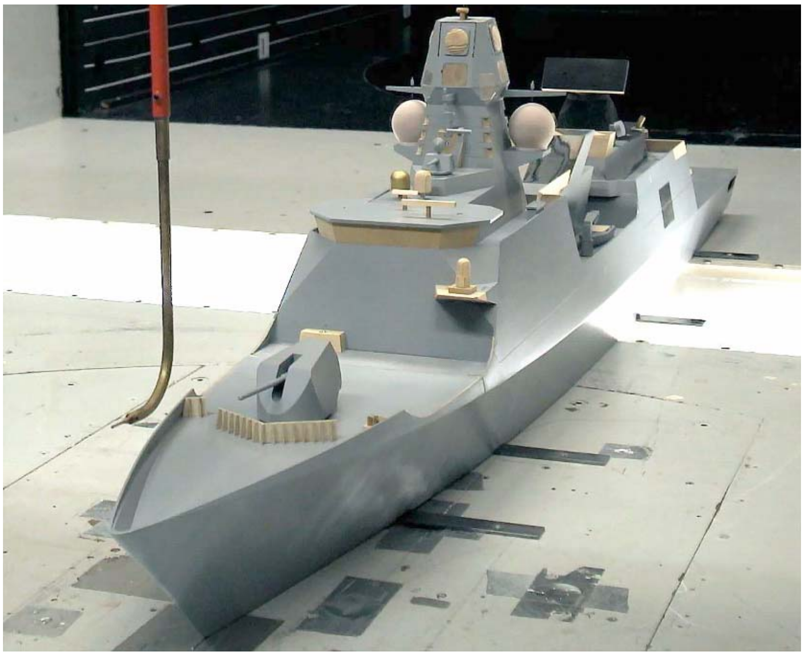

Figure 2 Test set-up of airflow measurements on a scale model of a ship in the wind-tunnel. Shown are measurements with a 5-hole pyramid probe at the NLR reference position on top of the jack staff.

3 Wind climate and ship motion full scale tests

3.1 General

To properly correlate the wind tunnel data with full scale data NLR carries out a dedicated test programme to measure the airflow above the ship, especially over the flight deck. During these tests data on the ship motions as a function of sea state, ship’s course and speed are collected as well. The list of parameters, as recorded during these tests is given in table 1.

Table 1 Parameters recorded during wind climate & ship motions measurements

Parameter	Location	Range	Unit
Velocity components UVW	Bow & Flight deck	0/50	m/s
Local temperature	Bow & Flight deck	-30/70	°C
Indicated wind speed	Port & Starboard	0/60	m/s
Indicated wind direction	Port & Starboard	0/360	deg
Selected wind sensor	Port or Starboard	0/1	
Atmospheric pressure		900/1100	hPa
Ship speed		0/50	m/s
Ship heading		0/360	deg
Ship pitch angle		+/-20	deg
Ship roll angle		+/-30	deg

Sample frequency 5 Hz

On-line processing is also carried out to monitor the various parameters and to adapt the test programme if required.
In the following sections a brief description of the data acquisition and processing systems is given.

3.2 Ship instrumentation system

On board of the ship an instrumentation system is installed, consisting of:

- a reference anemometer system (Fig. 3)
- two masts containing three anemometer systems (Fig. 4)
- a Data Acquisition Unit (DAU) (Fig. 5)
- “Mobile” test centre (Figs.15 and 16)

3.2.1 Wind data acquisition system

The wind measurements are performed with low-inertia Gill-Young anemometer units. These units consist of three orthogonal propellers (UVW) and are used to measure the local wind velocities in three perpendicular directions. The units are sealed and incorporate internal blowers maintaining positive pressure within the unit to limit environmental contamination of the bearings.
In the base of each anemometer unit a Wind data Acquisition Unit (WAU) and a temperature sensor to measure the local air temperature are installed. The small, ruggedized and salt spray resistant WAU is developed by NLR. In this unit the analogue signals of wind and temperature are multiplexed and converted into a digital form. Depending on the application, the digitizing process may include conversion to engineering units. Hereafter, the data is serially exported

through a serial communication interface, following the RS422 protocol, to the host processor system for logging of the data and further processing.
Although the wind sensor assemblies require 115 VAC power, for safety reasons the supply voltage to the data acquisition unit has been kept below 42 VAC. Therefore the required 115 VAC is derived from the input voltage using a step up transformer in the data acquisition unit.

3.2.2 Reference anemometer

As a reference position, for the calculation of the undisturbed relative wind, the top of the jack staff at the bow is chosen. The anemometer system as installed on the jack staff of the ship (Fig. 3) is of the Gill-Young type. This anemometer is equipped with carbon fiber propellers specially made by NLR, with proven durability in bow waves.
This reference position is chosen for the following reasons:

- Correction factors to be applied are known, as a calibrated system and available wind-tunnel data on the position are used.
- Information is acquired to determine the atmospheric boundary layer correction coefficient.
- The air flow deviations, due to the presence of the ship, are minimal over a wide range of azimuth angles.

From the measured components, the local horizontal and vertical wind direction and the local wind speed are calculated.

Figure 3 NLR reference anemometer (Gill-Young type), installed on the jack staff of a ship.

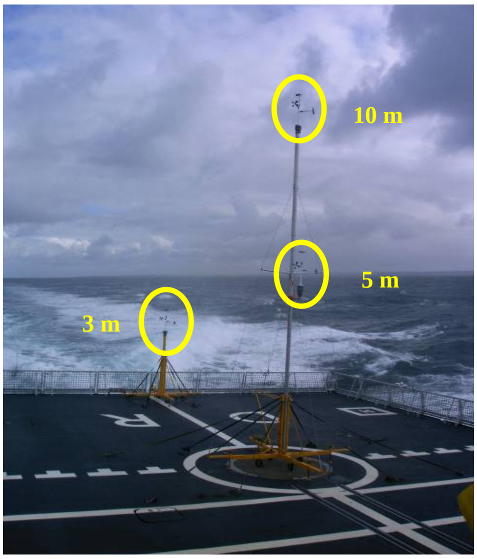

Figure 4 NLR wind measuring masts.

3.2.3 Wind measurements above the flight deck

The wind measurements above the flight deck are performed by means of two movable masts fitted with low-inertia Gill-Young anemometers at three heights (3m, 5 and 10m) above the flight deck (Fig. 4).

The general procedure for collecting data is as follows. For a particular true wind the moveable mast is placed on a predefined position on the flight deck. This position is similar to a position as measured in the wind tunnel. Dependent on sea state a ship speed is defined and ship's heading is into the wind. Data are collected during a 5-minute period. After this period only the ship's heading is changed and again data are collected. After several changes in heading (approximately 210°) a new ship speed and heading is selected and data collection continues as described. The mast is then placed on a new position and the process is repeated.

3.2.4 Data Acquisition Unit (DAU)

A Data-Acquisition Unit (Fig. 5) is installed on board the ship, generally in the vicinity of the bridge. This PC based unit is in fact a computerized data interface unit. The output of the DAU is exported to the ground station following the RS-422 protocol.

The following ship systems are connected to the DAU:

- Wind measuring system for acquisition of:
  - Port indicated wind direction and speed.
  - Starboard indicated wind direction and speed.
  - Wind measuring system selector switch position (indicating port or starboard system selection).
- Gyro’s and log
  - Ship’s heading and speed.
  - Ship's pitch and roll angles.
- Meteo system
  - Atmospheric quantities such as Out side Air Temperature (OAT) and pressure. When these parameters are not available on board the ship, additional sensors are installed.
- GPS system information such as:
  - GPS longitude
  - GPS latitude
  - GPS Ship’s track
  - GPS Ship’s ground speed

NOTE: Generally a ship is equipped with two anemometer systems providing redundancy and avoiding erroneous readings. The ship parameters are sampled with a frequency of 5 Hz.

Figure 5 Data Acquisition Unit (DAU), installed in the vicinity of the bridge.

4 Helicopter shore based hover trials

4.1 Measured parameters

An overview of the essential helicopter parameters which are recorded during the hover trials for the proper determination of the SHOLs is given in table 2. The data are recorded on a back-up system in the helicopter and simultaneously transmitted to the mobile test centre. Apart from helicopter data also data on the atmospheric conditions (Table 3) are recorded in the test centre.

Table 2 List of helicopters' parameters recorded during the shore based hover trials

Parameter	Unit	SampleFreq. [s^{-1}]
Cyclic stick position fore/aft	%	REFER TO NOTES
Cyclic stick position lateral	%	
Pedal position	%	
Collective stick position	%	
Torque engine 1	%	
Torque engine 2	%	
Bank angle	deg	
Pitch angle	deg	
Magnetic heading	deg	
Doppler velocity in X-direction	kt	
Doppler velocity in Y-direction	kt	

Parameter	Unit	SampleFreq. [s^{-1}]
Radar altitude	ft	REFER TO NOTES
Actual helicopter mass/fuel quantity	kg	
Latitude	deg	
Longitude	deg	
Barometric altitude	ft	
Outside Air Temperature	°C	
Engine inlet temperature (NLR sensor)	°C	

Notes to table 2:
Sampling frequencies for analogue systems: 4 to 16 Hz
Sampling frequencies for digital available data on a Bus depends on the availability in the helicopter.

Table 3 List of atmospheric parameters recorded during shore based hover trials

Parameter	Range	Unit
NLR reference systems and sensors		
Barometric pressure	900 – 1100	hPa
Time from Midnight	0 – 86400	sec
Wind velocity U-direction	0 / 50	m/s
Wind velocity V-direction	0 / 50	m/s
Wind velocity W-direction	0 / 50	m/s
Temperature	-30 /+70	°C

Notes to table 3:
sample frequency: 1 Hz.

4.2 Helicopter instrumentation system

The instrumentation system installed in the helicopter does not only consist of a data acquisition and recording system but also of brackets, cabling, additional sensors and displays when required. A block diagram of a typical data acquisition system installed in the helicopter is shown in figure 6.

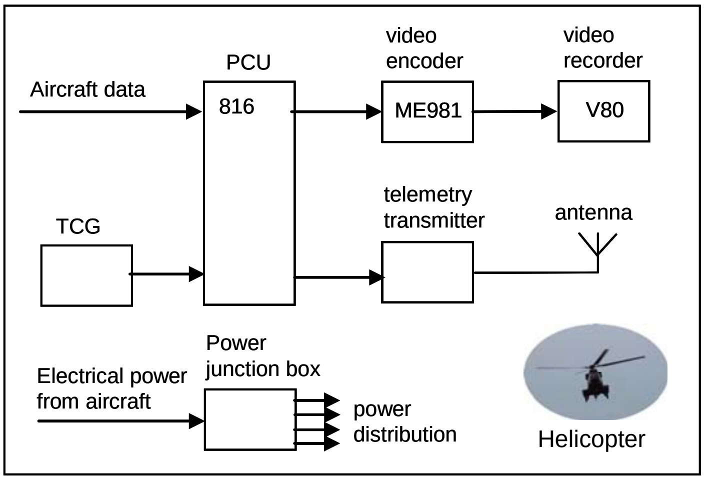

Figure 6 Block diagram of NLR data acquisition system installed in the helicopter.

The aircraft data are connected to the appropriate inputs of the acquisition system, where they are sampled and formatted into an IRIG PCM output stream. Time information used for time stamping the received data is also embedded in the output format and is supplied by means of a Time Code Generator (TCG). The output data is sent to the test centre by means of a telemetry channel and is also recorded on tape for backup purposes in case of telemetry failures. Electrical power from the helicopter (28 VDC) is obtained from a nearby available receptacle and is distributed to the instrumentation components by means of a power junction box.

The data acquisition system is normally mounted in standard instrumentation racks equipped with shock mounted installation shelves for vibration isolation of the individual components. The complete rig is mounted on a wooden board and is strapped to the cabin floor using the available fixing points (Fig. 7).
A recorder control panel and an event/recording number panel are installed in the pedestal of the helicopter cockpit for crew operation (Fig. 8).

Figure 7 Helicopter data acquisition system installed in the cabin of the helicopter.

Figure 8 Control panels of NLR instrumentation installed in the pedestal of the helicopter cockpit.

For those helicopters that can become limited in yaw control (insufficient pedal deflection or tail rotor pitch angle) NLR installs a pedal indicator in the cockpit (Fig 9). In this manner the pilot has an indication on his yaw (pedal deflection) reserves.

Figure 9 NLR pedal indicator installed in the instrument panel in the helicopter cockpit.

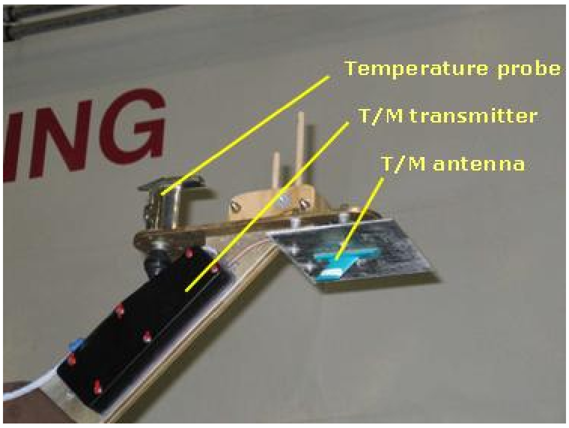

Figure 10 Instrumentation bracket installed by NLR on the upper cable cutter.

Figure 10 shows an example of a bracket installed on a cable cutter in front of the cockpit. On this bracket, the following items are mounted:

- an outside air temperature probe to measure engine inlet temperature;
- a Telemetry transmitter and antenna;
- a RNLAF blade strike indicator, consisting of several vertical balsa wooden sticks of different height.

Figure 11 shows the cable feed-through installed on the right hand eyebrow window. The standard cover is replaced by a watertight cable feed-through machined at NLR.

Figure 11 Cable feed through opening available in the right hand eyebrow window.

4.3 Helicopter all-up mass

During the shore based hover trials the maximum required helicopter all-up mass can be obtained by using:

- Lead (Fig. 12; right upper corner)
- Bags of sand
- Fuel
- Dummy torpedo’s (Fig. 12; left hand side)
- Water (Fig. 12; right lower corner)

Figure 12 Methods of ballasting a helicopter.

By frequently refueling, the helicopter mass is kept within the required mass bracket for the specific test condition.

During the shore based hover trials, lead and sand ballast are good alternatives. However they are dangerous during flight trials at sea as one cannot dump the ballast in a split second. Therefore dummy torpedo’s and water are the best options during trials at sea (Fig. 13). In the older days “fuel dump” was also a common option. Nowadays, with the imposed environmental restrictions, this is the less favorable option and is only used in extreme emergencies.

Figure 13 Example of water dump at sea.

5 Helicopter – ship flight trials

5.1 Measured parameters

The essential helicopter parameters for the proper determination of the SHOLs are the same as measured during the shore based hover trials.
The essential ship parameters are the same as measured during the wind climate and ship motion full scale tests, with the exception of flight deck wind and temperature parameters.

5.2 Instrumentation

An overview of the complete instrumentation is given in figure 14. The system is modular in architecture allowing the same system to be used for the different measurement programs defined previously.

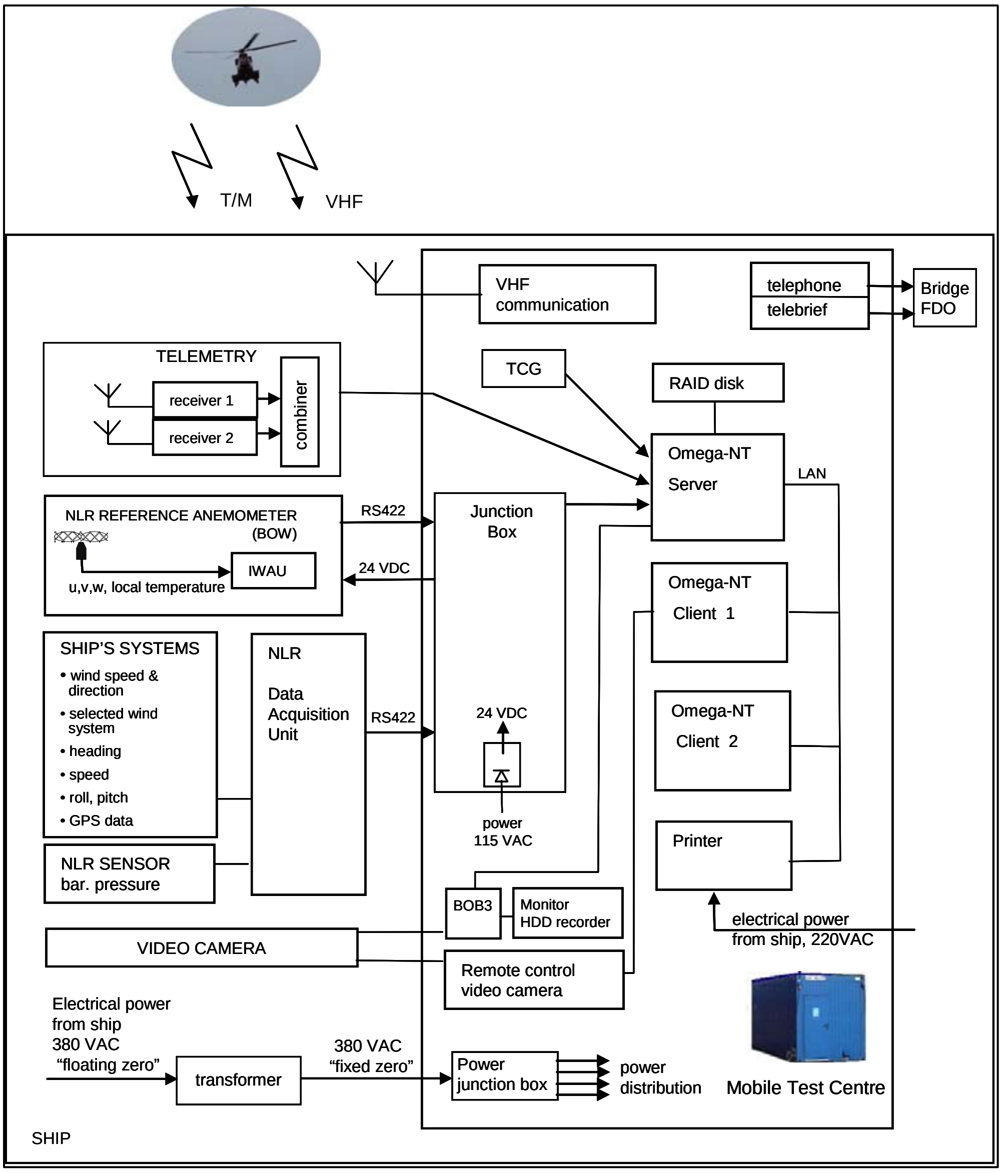

Figure 14 Block diagram of the instrumentation system used on board the ship.

5.3 Mobile test centre.

Most of the equipment is installed in the mobile test centre which is used when sufficient space is available on board a ship (Fig. 15 and Fig 16.).

Figure 15 Mobile test centre (porta-cabin) located in the hangar of "Hr. Ms. Rotterdam".

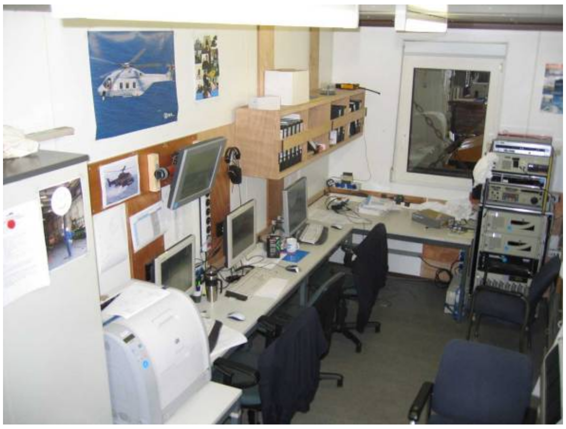

Figure 16 Set-up of working stations in the mobile test centre.

Generally most ships are not so spacious as a support ship or a LPD (e.g. "Hr. Ms. Rotterdam") and one has to make use of the available space in the vicinity of the hangar to create a test centre. In mutual concert with the maintenance crew chief, use of his office can be made for the duration of the flight trials. An example of such a solution is shown in figure 17.

Figure 17 NLR test centre in crew chief office.

5.3.1 Electrical power supply

On board a ship, 320 V three-phase electrical power with so-called “floating zero" is generally available (common practice). An additional transformer is required to transform the "floating zero" to "fixed zero" electrical power. This set-up allowed a split-up to several constant 220 VAC two-phase electrical power lines, distributed to the installed equipment.

5.3.2 Telemetry receiving system

For reception of the helicopter data a mobile telemetry receiving system is used, consisting of two antenna/receiver combinations (Fig. 18). The antennas are spatially separated for improved telemetry coverage. The outputs of the receivers are combined in space diversity mode in a signal combiner for optimal signal output for the processing system. In order to reduce antenna cable length the unit is installed on board the ship in the close vicinity of the antennas.
The locations of the T/M antennas and the VHF antenna are shown in figure 19. Both T/M antennas are fitted with a plastic cover to protect them from salt water. All antennas are mounted near the hangar and in such a manner that maximum line of sight with the helicopter is achieved.

Figure 18 Telemetry receivers and signal combiner used by the test centre.

Figure 19 NLR telemetry - and VHF antenna as installed on a ship.

5.3.3 Telemetry ground station

The NLR telemetry ground station has recently been improved and now uses a WYLE Omega real-time telemetry processing system in a server-client network environment. The server is operated by the instrumentation engineer and processes and distributes all available data from helicopter, ship and anemometers. The system design allows for quick configuration changes for the different test programmes (i.e. activating or deactivating telemetry).
A shared RAID disk is used for securely archiving the received data.
The specialists are provided with client computers, enabling them to monitor and analyse the distributed data as necessary.

The network is completed with several laptop stations to facilitate in transport of data for further analysis off-line and a network printer.
Using the open structure of the Omega system, custom Active-X displays were developed to improve visualization of the available data. An example of the display used for the helicopter-ship flight trials is shown in figure 20.

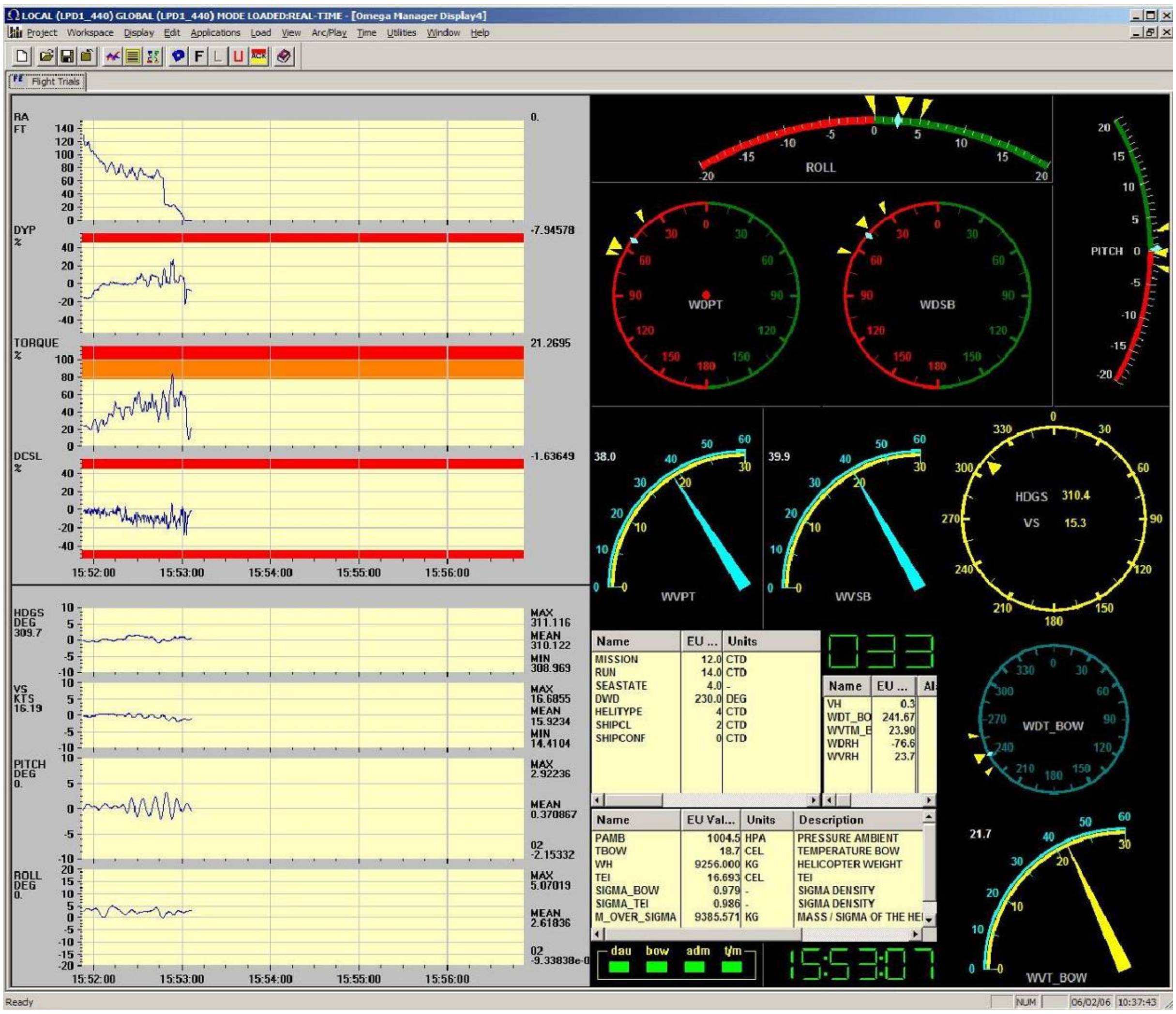

Figure 20 Real-time Quick-look display for flight trials.

In the top left corner the most critical helicopter data (radio altitude, pedal deflection, engine torque and lateral cyclic stick deflection) are displayed in strip charts, together with color-coded limit indications. This enables the NLR crew to monitor the limiting parameters for flight safety.
In the lower left corner the ship's heading, speed and motion in roll and pitch is displayed to monitor the stability of the conditions. These data are also presented in strip charts, however the

offset of the x-axis is determined using the data in the first measurement which allows better monitoring.
The upper right part of the screen is used for angular gauge presentation of ship data, including wind direction and speed from the port and starboard ship anemometers. The wind direction gauges also display the minimum, maximum and mean value calculated during the measurement run.
In the lower middle part some administrative and more or less static parameters are displayed in table format. At the bottom some indicators are placed to monitor the instrumentation subsystems. Adjoining them is the color-coded time-display, indicating the backup tape recording status in the helicopter (amber: recording not started, green: recording started).
Finally in the lower right corner the true wind conditions are displayed. These are real-time calculated using the output of the reference anemometer on the bow and are corrected for instrument error and position error caused by ship geometry influence.

In order to facilitate in operating the telemetry ground station, a separate application is developed allowing the operator to enter administrative data and to start and stop archiving (Fig. 21).

Figure 21 Graphical User Interface of the administration and control application.

After initial setup, defining for instance the directory to store the archive data, the administration and control tab sheet is used for entering data for the measurement run to be conducted. After starting the archive an automatic reset is supplied to the displays, starting the minimum, maximum and mean calculations from scratch. No changes in administration data are possible during the archive session (grayed out). The reset switch allows for resetting the displays in between measurement runs.
During the measurement run the archived data is concurrently converted from the native archive format to a MATLAB data file, facilitating a more suitable format for post-processing.

Due to this concurrency the archived data is available for further processing moments after the measurement run has stopped.

5.3.4 Video camera

To monitor the helicopter movements in the vicinity of the flight deck, a remote controlled video camera is installed. Figure 22 shows the installation on a ship with a FLYCO cabinet. Generally the camera has to be mounted on an external position outside of the hangar. In this event a perspex dome (Fig. 23) is used to house and to protect the camera.
The camera is manually operated by the flight test team. For identification of the images a “BOB3” unit (a Dutch acronym for picture-in-picture) is used for inserting mission and run numbers obtained from the Omega server into the video picture.
The video data is recorded on a HDD/DVD video recorder.

Figure 22 Video camera installed in the FLYCO cabinet.

Figure 23 External installation of the video camera

6 Post-processing

Recently, it has been decided to improve the post-processing activities that are performed after each run. The existing software written in Turbo Pascal was converted to a number of MATLAB scripts, which enabled the addition of a Graphical User Interface (GUI) and a number of additional functionalities.
After a run is finished, the data becomes available on the local network from Omega as a binary Matlab file. This file is post-processed as follows:

- Any required operations are performed to obtain a clean data set (such as removal of stale and overflow data).
- Subsequently spikes are removed from the data. Initially this is performed automatically. If required, this can be followed by a manual spike removal process, using a GUI, which

allows fast and accurate spike removal (including undo function, usage of the mouse to remove multiple points).

- Post-processing: the measured (indicated) wind data is converted to undisturbed relative wind and finally to true wind using sensor calibrations and wind tunnel results.
- For analysis purposes the mean, minimum, maximum and RMS of selected parameters is calculated and sent to file and hardcopy output.
- Selected mean and RMS data is added to an Excel sheet of the current test mission for manual addition of pilot rating and comments.

Subsequently, the results can be graphically displayed. A MATLAB GUI provides the following functions (Fig. 24):

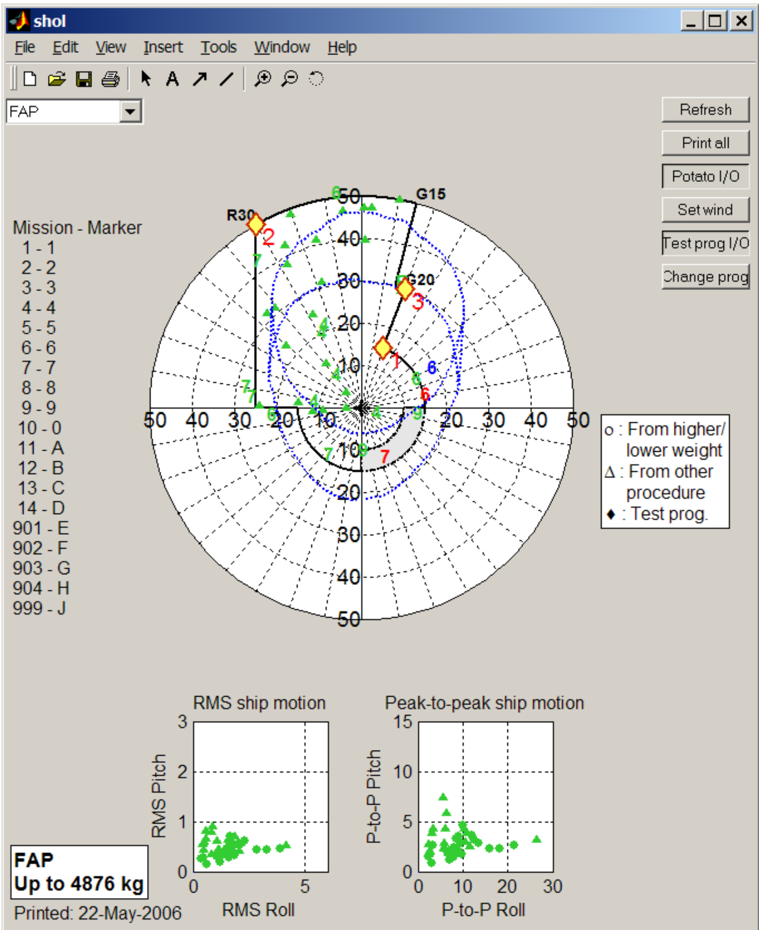

Figure 24 MATLAB Graphical User Interface in use with helicopter flight trials on board a ship.

Selection of the landing procedure and weight class (if applicable);

- Display of Candidate Flight Envelope;

- Display of previous runs of the same landing procedure, color coded (accepted/marginal/rejected);
- Cross plotting of previous runs: for example a run of one procedure and weight class at night which is accepted, will also be accepted in the same procedure and weight class during daytime. Cross plotted points are indicated with different symbols.
- Representation of encountered ship motion;
- Representation of wind envelope: the current or recently measured true wind can be used to calculate possible indicated (relative wind) conditions. In figure 24 this is represented by 2 blue round objects. The blue lines are not perfect circles, because the possible true wind conditions are converted to indicated wind.
- Representation and editing of test program. The yellow/red diamonds in figure 24 represent points of the currently selected test program. Test programs can be edited, loaded and saved. A set of briefing sheets can be printed containing a map of the current location, the applicable SHOL's with previous runs and test program, such as in figure 24.

Furthermore, for a series of test points, a range of required true wind speeds can be calculated and plotted. This is represented in figure 25. This tool helps the planning of the test campaign, since it indicates if high or low true wind speeds are required. It also shows, for example, that the first and second condition in figure 25 can never be tested at the same time as the last two conditions.

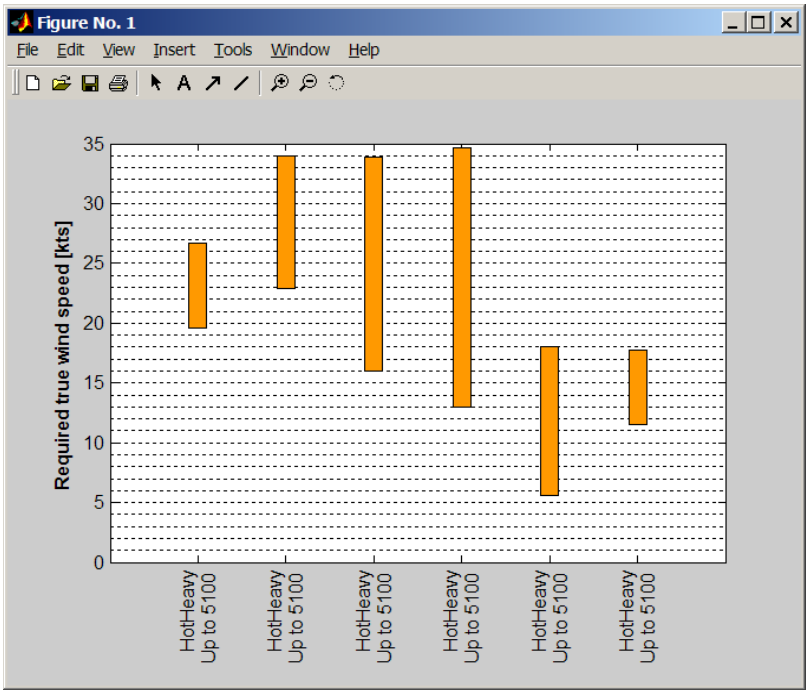

Figure 25 Graphic display to present true wind speed required for helicopter-ship flight trials.

Additionally, some other tools were developed:

- Easy plotting of time traces of selected parameters, including additional statistical functionalities.
- A ‘Course/Speed Advisor’ tool, which calculates from the current true wind and required test condition (indicated wind) what the ship’s course and speed should be. Since this tool uses the ship’s sensor calibrations and wind tunnel results, this provided a faster and more accurate result than the manually calculated course and speed by the Officer of the Watch on the bridge.
- Data mining tool to obtain results over a large amount of runs (for example: maximum engine torque for all runs with high mass and green winds).

These tools were extensively tested, polished and compared to the older post-processing procedure during three test campaigns executed in 2005. The improvements in calculation speed and graphical interface have reduced the entire post-processing procedure to a matter of minutes per run, allowing a fast analysis of the flight test results.

7 Concluding remarks

In this paper, a description has been given of the recently developed instrumentation systems, data-acquisition and data processing methodology, as applied on helicopter-ship qualification testing developed by NLR. The instrumentation system as well as the data- acquisition and -processing software has a modular set-up. This subdivision into modules follows the subdivision into the various testing activities of the NLR methodology of helicopter-ship testing.

The capability to perform on-line data processing, analysis and presentation provides the test team with a good insight into the progress of the test programme. As a result the various test campaigns within a helicopter-ship qualification programme can be performed safe and efficient. Preliminary SHOLs can be handed over to the customer shortly after leaving the ship, which are very similar to the end result, because only limited post analysis has to be performed by the test team.

8 References

[1] R. Fang, P.J.A. Booij, "Helicopter-Ship qualification testing, The Dutch clearance process", Presented at the American Helicopter Society 2nd Annual Forum, Phoenix, Arizona, May 9-11 2006