Executive summary

Overview of MAR-FSTD
Military Aviation Requirements
Flight Simulation Training Devices
Qualification requirements for military flight simulators

Introduction
The Military Aviation Authority the Netherlands (MAA-NLD) was confronted with several challenges when it started to develop standards and regulations for simulators. Where the military has operations similar to civilian operators, civilian rules are quite appropriate. But military operation can differ considerably from civilian operations and can lead to different and additional regulations.

Secondly, existing simulators were not always built against a known standard, so the MAA also has to qualify simulators which possess a very limited data set.

In this paper we give an overview of the qualification system as designed for the MAA and inform you about the first experiences with this Dutch qualification system.

Considerations
It is impracticable to set Flight Simulator Training Device (FSTD) standards in absolute terms. The
FSTD is not a goal in itself but training in an FSTD is an integral part of the complete training syllabus. Consequently it is better to build a direct relation between simulator capabilities and the required training impact. This implies that the Military Aviation Authority of the Netherlands (MAA-NLD) will not demand the operator to have a simulator with a certain standard. However having a certain standard of simulator will enable the operator to economize on training hours in the real aircraft.

An FSTD can have the following impacts on a specific task:

- The FSTD can fully replace actual flying for this task. (including ‘ab initio’ pilots).
- The FSTD is good enough to replace a certain percentage of actual flying for this task.
- The FSTD is not suited to train for this task.

The MAA-NLD has designed a system to rate all the major FSTD features (seventeen in total). The number of levels per feature range between two and seven.

The method employed is based on the following principles:

- Do not rate the complete simulator but qualify subsystems (features);
- Rate the training tasks vs. subsystem qualification level. These tasks include specific military operations as well.

This gives the operator the possibility to exploit all the capabilities. Furthermore it is easy for the operator to check which FSTD upgrades will be economical.

**Results and conclusion**

The initial regulation for aircraft (both fixed wing and rotary wing) simulators MAR-FSTD (“Military Aviation Requirements Flight Simulation Training Devices”) is finalized. Based on this version of the MAR-FSTD the qualification of Dutch Flight Simulation Training Devices is in progress. The aim is to give the operator maximum flexibility in the employment of existing and future simulators.

An interesting point for existing simulators is ‘how to handle when no proof-of-match data with the real aircraft are available’ and how to get to an alternative Qualification Test Guide (QTG). Results of some qualifications will be presented.

We could benefit a lot from the existing JAA regulations, and we could even combine the helicopter and fixed wing regulations and use the best of both worlds. We were able to use a similar methodology for military sensors, threats and targets as is used in ICAO 9625. (“Manual of Criteria for the Qualification of FSTDs”).

It is rewarding to see that the operator is welcoming this regulation as a way to improve its training, improve the quality of its simulators and to guide him in making investment decisions.
Overview of MAR-FSTD
Military Aviation Requirements
Flight Simulation Training Devices
Qualification requirements for military flight simulators

C.J. Jansen and H.J. Koolstra

1 Military Aviation Authority the Netherlands (Militaire Luchtvaart Autoriteit)

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<table>
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<th>Reviewer</th>
<th>Managing department</th>
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</table>

August 2011
Summary

The initial regulation for aircraft (both fixed wing and rotary wing) simulators (Military Aviation Requirements – Flight Simulation Training Devices MAR-FSTD) is published. Based on this version of the MAR-FSTD the qualification of Dutch military simulators has been started. The aim is to give the operator maximum flexibility in the employment of existing and future simulators.

The method employed is based on the following principles:

- Do not rate the complete simulator but qualify subsystems.
- Rate the training tasks vs. subsystem qualification level. These tasks include specific military operations as well.

An interesting point for existing simulators is ‘how to handle when no proof-of-match data with the real aircraft are available’ and how to get to an alternative Qualification Test Guide (QTG).

Results of some qualifications will be presented.

The complete range of FSTDs is covered:
From Full Flight Simulators, Flight Training Devices through to basic devices
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<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAR</td>
<td>Air to Air Refueling</td>
</tr>
<tr>
<td>AIFF</td>
<td>Advanced Identification Friend Foe</td>
</tr>
<tr>
<td>BFM</td>
<td>Basic Fighter Manoeuvres</td>
</tr>
<tr>
<td>ECM</td>
<td>Electronic Counter Measures</td>
</tr>
<tr>
<td>TBD</td>
<td>To Be Determined</td>
</tr>
<tr>
<td>FFS</td>
<td>Full Flight Simulator</td>
</tr>
<tr>
<td>FOV</td>
<td>Field of View</td>
</tr>
<tr>
<td>FSTD</td>
<td>Flight Simulation Training Device</td>
</tr>
<tr>
<td>ICAO</td>
<td>International Civil Aviation Organization</td>
</tr>
<tr>
<td>IIR</td>
<td>Imaging Infra Red</td>
</tr>
<tr>
<td>IMC</td>
<td>Instrument Meteorological Conditions</td>
</tr>
<tr>
<td>IOS</td>
<td>Instructor Operating Station</td>
</tr>
<tr>
<td>JAA</td>
<td>Joint Aviation Authorities</td>
</tr>
<tr>
<td>MAA (-NLD)</td>
<td>Military Aviation Authority The Netherlands</td>
</tr>
<tr>
<td>MAR</td>
<td>Military Aviation Requirement</td>
</tr>
<tr>
<td>MAWS</td>
<td>Missile Approach Warning System</td>
</tr>
<tr>
<td>MLA</td>
<td>Militaire Luchtaart Autoriteit; see MAA</td>
</tr>
<tr>
<td>NVG</td>
<td>Night Vision Goggle</td>
</tr>
<tr>
<td>POM</td>
<td>Proof-of-Match</td>
</tr>
<tr>
<td>QTG</td>
<td>Qualification Test Guide</td>
</tr>
<tr>
<td>VMC</td>
<td>Visual Meteorological Conditions</td>
</tr>
</tbody>
</table>
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1 Introduction

Military aviation, being a governmental organization did not have an independent Military Aviation Authority to enhance safe operation. However, since 2005 the Netherlands has an independent Military Aviation Authority (MAA-NLD). Its tasks are to develop standards, certify aircraft, validate operations, determine required training, approve operations manuals and to inspect.

MAA-NLD Regulation system

The MAA-NLD was confronted with several challenges when we had to develop standards and regulations for simulators. Where we have operations similar to civilian operators, civilian rules are quite appropriate. But military operation can differ considerably from civilian operations and can lead to different and additional regulations. Secondly, existing simulators were not always built against a known standard, so we also have to qualify simulators which possess a very limited data set.

In this paper we explain the qualification system we have designed and inform you about our first experiences with the Dutch system.
2 Considerations

It is impracticable to set Flight Simulator Training Devices (FSTD) standards in absolute terms. The FSTD is not a goal in itself but training in an FSTD is an integral part of the complete training syllabus. Consequently it is better to build a direct relation between simulator capabilities and the required training impact. This implies that the Military Aviation Authority of the Netherlands (MAA-NLD) will not demand the operator to have a simulator with a certain standard. But having a certain standard of simulator is required to enable the operator to economize on actual training hours. An FSTD can have the following impacts on a specific task:

1. The FSTD can fully replace actual flying for this task. (Even for ‘ab initio’ pilots).
2. The FSTD is good enough to replace a certain percentage of actual flying for this task.
3. The FSTD is not suited to train for this task.

To implement this system, it is necessary to qualify simulators and tasks to enable quick checking which task can be performed with a certain FSTD. The MAA has designed a system to rate all the major FSTD features (seventeen in total). The number of levels per feature ranges between two and seven.

This rating of simulation features is comparable with the latest ICAO document 9625 [3rd edition] “Manual of Criteria for the Qualification of FSTDs –Aeroplanes”.

The MAA-NLD however is not combining these rating in one overall rating, but keeps a finer grid where all features can be recognized. This gives a finer resolution to range each FSTD and gives the operator the possibility to exploit all the capabilities. Furthermore it is easy for the operator to check which FSTD upgrades will be economical.
2.1 Features (or subsystems)

The different features identified are:

1. Hardware:
   a. Instructor / Operator Station (IOS)
   b. Visual,
      1. Image
      2. Field of View
   c. Motion
      1. Envelope
      2. Phase
   d. Sound
   e. Cockpit

2. Standard software models
   a. Aircraft performance and control
   b. Aircraft subsystems
   c. Military subsystems (including weapons, jammers etc.)
   d. Avionics performance
   e. Military sensors performance
   f. Weather
   g. ATC (includes: navigation database and ATC communication).

3. Mission related software models (specific military requirements)
   a. Threats, targets, weapon trajectories and effects, ECCM and ECM, hoisting, sling load, aerial deliveries.
   b. Cooperative system modelling. (Tankers, formation members, moving landing platforms etc.).

4. System integration and correlation

Each feature is rated and given a level. For the determination of levels analogy has been sought with the JAR rating system (JAR-FSTD H &A). And for each feature a cross reference is made with applicable JAR standards. For example, the Joint Aviation Requirements JAR-FSTD A distinguishes 4 levels of full flight simulators and for each level the requirement for the motion is different. This will also give at least four levels of motion in the Military Aviation Requirement MAR-FSTD. However, if for the four levels of simulator in the JAR only two different engine models are described, the MAR-FSTD will only have two types of engine models.
The qualification levels for the military features are (in line with ICAO 9625):

<table>
<thead>
<tr>
<th>Level</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>NA</td>
</tr>
<tr>
<td>Generic</td>
<td>TBD suitable for initial training</td>
</tr>
<tr>
<td>Representative</td>
<td>“25%” suitable for advanced training</td>
</tr>
<tr>
<td>Specific</td>
<td>“10%” specific models, exactly corresponding to the training theatre</td>
</tr>
</tbody>
</table>

The tolerance levels are depending on the specific feature and are established after consultation of subject matter experts (e.g. instructor pilots).

Aspects to assess are:
- switchology
- pilot-system-interface
- performance (range, accuracy)

The qualification of a simulator is carried out by the MAA. The rating of the FSTD will be based on an inspection of the hardware, software, documentation and on tests performed. The test will be performed by a qualified inspection team. The operator will be given a qualification certificate which states the level of his FSTD. (e.g. 17 times a level for each feature)

2.2 Training credits

The required training per type of operation is described in the MAR-OPS and the approved Operating Manual of the operator.

If the FSTD has the maximum required level for a particular task the operator is allowed to use the FSTD for the following percentage of training:
- 100% of the initial training
- 100% of the re-currency training
- 100% of the currency training
- 100% of the proficiency checks including upgrade testing.

If the FSTD has the minimum required level for a particular task the following percentage of training for that task may be performed in the FSTD:
- 50% of the initial training
- 50% of the re-currency training
- 50% of the currency training
- It may be used for proficiency checks if the previous check was in the aircraft and the test is not an upgrade.
If an FSTD does not fully meet the requirements for a 50% or 100% replacement of training for a certain task, but the deficiency is compensated by other means of training acceptable to the authority, the authority may grant the right to use the FSTD combined with the additional means for the level of task replacement sought.

2.3 MAR-FSTD technical requirements per feature

Three examples are given below:

<table>
<thead>
<tr>
<th>Qualification Level</th>
<th>General Technical Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FOV 45°H x 30°V per pilot (=JAR level A)</td>
</tr>
<tr>
<td>2</td>
<td>FOV 120°H x 40°V per crew, continuous</td>
</tr>
<tr>
<td>3</td>
<td>FOV 120°H x 60°V per crew, continuous</td>
</tr>
<tr>
<td>4</td>
<td>FOV 180°H x 40°V per crew, continuous (=JAR A level D)</td>
</tr>
<tr>
<td>5</td>
<td>FOV 180°H x 60°V per crew, continuous (=JAR H level D)</td>
</tr>
<tr>
<td>6</td>
<td>Forward hemisphere 180°H x 90°V up + 45°V down</td>
</tr>
<tr>
<td>7</td>
<td>FOV identical with FOV from the pilot station of the simulated aircraft.</td>
</tr>
</tbody>
</table>

Theodolite to measure angles of the visual field-of-view
### Military sensors

<table>
<thead>
<tr>
<th>Qualification Level</th>
<th>General Technical Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Generic sensor performance but with correct switchology</td>
</tr>
<tr>
<td>2</td>
<td>Representative sensor performance</td>
</tr>
<tr>
<td>3</td>
<td>Specific sensor performance (including effects of weather).</td>
</tr>
<tr>
<td>A</td>
<td>Sensor integrated with other databases (‘within’ same FSTD)</td>
</tr>
<tr>
<td>B</td>
<td>Abnormal and failure modes are included.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Specific models, exactly corresponding to the training theatre with exact player behaviour.</td>
</tr>
<tr>
<td>Specific interaction</td>
<td>The interaction with the model is correct.</td>
</tr>
<tr>
<td>Visual appearance</td>
<td>The visual appearance should enable the recognition of player at realistic range and show enough detail.</td>
</tr>
<tr>
<td>Detectability</td>
<td>The detection range of the representative player deviates less than 20% from the known detection range.</td>
</tr>
<tr>
<td>Dynamic behaviour</td>
<td>Dynamic behaviour which is specific for the cooperative player</td>
</tr>
<tr>
<td>Threat and targets sensors</td>
<td>Player sensor emissions are detected at realistic ranges.</td>
</tr>
<tr>
<td>Weather effect</td>
<td>Detection range shall be affected by weather.</td>
</tr>
</tbody>
</table>

**The more detailed assessment and requirements for a level 3 cooperative player**

#### 2.4 Flight tasks to be trained

Interviews with and consultation of experienced instructor pilots and simulator operators have resulted in two sets of training tasks; one for all fixed-wing aircraft and the other for rotary-wing aircraft. The training is divided into relatively high level task descriptions. This keeps the amount of different tasks to a manageable level, but still with enough segmentation to differentiate in real life and thus in the necessary simulator features.
## Overview of military fixed-wing flight tasks

### Tasks, identical to civil aircraft

- Task (general)
- Ground operations
- Normal flight ops
- Malfunctions

### Specific military tasks

- Abnormal Flight operations
  - Spins
  - Departures
  - Asymmetric Flight (asymmetry caused by engine(s) wing stores or mechanical failures)
- Trainer
  - Forced Landing
  - Aerobatics
- Fighter-general
  - Defensive actions
  - AAR A/A refuelling
  - NVG operation
  - IIR operation
- Fighter Air to Air
  - Close in visual air combat (BFM, VID etc)
  - Medium range visual air combat
  - Beyond visual range Air to Air
- Fighter Air to Surface
  - Visual Weapon employment
  - Low level
  - Visual weapon employment
  - Medium level
  - Sensor based weapon employment
  - Close Air Support
  - Reconnaissance medium level
  - Reconnaissance low level
- Tactical Transport
  - Non straight-in approach/landing
  - Mountain operations
  - Para drop
  - Aerial cargo delivery
  - Parachute extraction of cargo
  - Rough field landing
  - Short and narrow field operations
  - Stuck cargo on delivery ramp
### Specific military tasks

<table>
<thead>
<tr>
<th>EC &amp; evasive manoeuvres</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tanker</strong></td>
</tr>
<tr>
<td>air refuelling [delivering]</td>
</tr>
<tr>
<td>air refuelling [receiving]</td>
</tr>
<tr>
<td><strong>Multi-ship operation</strong></td>
</tr>
<tr>
<td>Close formation flying</td>
</tr>
<tr>
<td>Tactical Formation Flying</td>
</tr>
<tr>
<td>Integrated Operations</td>
</tr>
<tr>
<td>Mission rehearsal type I</td>
</tr>
<tr>
<td>Fully integrated environment</td>
</tr>
<tr>
<td>Mission rehearsal type II</td>
</tr>
<tr>
<td>Flow and communication integration check</td>
</tr>
</tbody>
</table>

Cross-wind landing; no difference between civil and military FSTD requirements
### Overview of rotary-wing flight tasks

#### Tasks

- **Ground operations**
  - Start up
  - Taxi

- **Normal flight ops**
  - Take off
  - Take off confined area
  - Climb VMC
  - Instrument departure
  - Level flight (medium level navigation IMC)
  - Level flight (medium level navigation VMC)
  - Level flight (low level navigation) > 150'
  - Mountain operations
  - Hot & high operations
  - NVG operations
  - NVS (IIR) operations
  - Instrument approach
  - Descent
  - Quick stop
  - Hover
  - Landing IFR (on controlled airfield)
  - Landing circuits
  - Landing confined area
  - Pinnacle landing
  - Approach & Landing under adverse weather conditions (snow/rain/icing)
  - Slope landings
  - Cross wind landings/ windshear
  - Brown out/ white out landings

- **Malfunctions**
  - Autorotation
  - Engine related emergency procedures
  - System and avionic related emergencies
  - Landing related emergencies
  - Flight control emergencies
  - Rotor & drive train related emergencies
  - Emergency descent
  - Unusual attitudes
  - Sling load emergencies

#### Military operations

- **Hoisting**
- Under slung load operations
- Roping, paradrop, abseilen hover jump
- Sonar operations
- Deck landings
- A/G gunnery (= all weapon delivery)
- Threat recognition and reaction
- Threat manoeuvring
- Nap of the earth flying

- **Multi-ship operation**
- Integrated Operations
- Mission rehearsal
3 Classification of tasks

3.1 Introduction
Humans have sensor capability in the visual, tactile, haptic, motion and sound dimension. The use of these capabilities is limited by the cockpit, which reduces the available field of view, limited motion cueing, but also the headset will reduce the observed sound levels. The required sensor simulation depends on the specific task to be trained. Some tasks only require a limited number of sensor inputs. (e.g. instrument flying generates less motion and visual cues than Basic Flight Manoeuvres (BFM)). If the simulation of a specific task is within the human sensory resolution the simulation of this task may be considered perfect. Perfect simulation not only requires the hardware to perform accurately but also that the underlying models work with the accuracy required for this task. When simulation is possible within the human sensory limits, the FSTD is capable to replace actual flying. This sets the upper boundary in simulation requirements for this particular task. A checklist for categorizing the maximum level is inserted below.

The lower boundary of a simulation is base on requirement levels for the features where the simulator training will still have adequate training value and does not give any negative transfer of training. This lower boundary will be surpassed when time delays exceed certain limits or trends have a different sign compared to reality or simulation differs considerably from reality. However, it is presently not always possible to set absolute criteria for the lower boundary. The checklist for the minimum level gives guidance based on the presently available information. In the end, during the subjective test, the required tasks should be executable without any negative transfer of training in the FSTD and has a positive effect on training of the task.

Even if the simulator hardware and software passes the required maximum level per feature this does not nullify the need to pass the subjective test in which the complete task is evaluated.

3.2 Task qualification checklist for maximum level:
Two examples from the checklist are presented, first military sensors and secondly threats and targets.

It is paramount that the number of different models should be consistent with the level of training sought.
**Military sensors**

An FSTD may have several military sensors (Radar, IIR, AIFF, MAWS etc.) and each sensor shall be rated separately:

a. If only generic sensor performance with correct switchology is required the minimum is level 1.

b. If representative sensor performance is required the minimum is level 2.

c. If specific sensor performance is required the minimum is level 3.

d. If sensor integration with other databases is required the minimum is indicated by level + A.

e. If normal and abnormal system operation and failure modes are required the minimum is indicated by level + B.

**Threats and targets**

All threats & targets models should be listed. The level is determined per model.

a. In the ideal case all threats and targets are specific (level 3),

b. However for some tasks the training with a representative threat/target is identical, in the latter case level 2 is sufficient, in the other case level 3 is required.

c. For 100% flight replacement generic threats and targets are normally insufficient.

### 3.3 Task qualification checklist for minimum level:

General guideline: The subjective rating for the *minimum* levels is primarily done during the initial qualification of the simulators. Therefore all tasks to be flown will be rated by experienced pilots. The primary questions to be answered are:

a. Do manual skills have to be trained with an exact feel and touch?

b. Are procedures the same as in the actual aircraft?

c. Is the workload for this task similar to that during the real task execution? When the workload is higher than in the real environment this might be a problem if it leads to a different behaviour. If the workload is considerably lower than in the real aircraft the simulator is probably not fit for the task.

d. Is the crosscheck similar as in the real environment?

e. Is crew coordination similar as in the real environment?

Note: All threat and target models should be listed. The level is determined per model. In general, downgrading from specific to representative or from representative to generic is applicable for most tasks.
In the task-feature matrices (one for maximum and one for minimum level requirements) the required qualification level of each feature is indicated for each training task. A part of the rotary-wing maximum requirements is shown below.

<table>
<thead>
<tr>
<th>Task</th>
<th>100% Level</th>
<th>50% Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal flight ops</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Take off</td>
<td>2 2 2 2</td>
<td>2 3 4 4A</td>
</tr>
<tr>
<td>Take off confined area</td>
<td>2 2 7 2</td>
<td>2 3 4 4A</td>
</tr>
<tr>
<td>Low level navigation &lt;100 ft</td>
<td>2 3 2 2</td>
<td>2 3 4 4 2</td>
</tr>
<tr>
<td>Mountain operations</td>
<td>2 2 3 3 2</td>
<td>2 3 4 4 2</td>
</tr>
<tr>
<td>Hot &amp; high operations</td>
<td>2 1 2 2 2</td>
<td>2 3 4 4 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Task</th>
<th>100% Level</th>
<th>50% Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Military operations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoisting</td>
<td>2 2 5 2</td>
<td>2 3 4 4A</td>
</tr>
<tr>
<td>Under sling load operations</td>
<td>2 3 5 2 2</td>
<td>2 3 4 4A</td>
</tr>
<tr>
<td>Roping, abseil, hover jump</td>
<td>2 3 5 2 2</td>
<td>2 3 4 4A</td>
</tr>
<tr>
<td>Nonar operations</td>
<td>1 2 3 2</td>
<td>2 3 4 4A</td>
</tr>
<tr>
<td>Deck landings</td>
<td>2 3 5-6 2</td>
<td>3 4 4 4A</td>
</tr>
<tr>
<td>A/T gunnery (all weapon delivery)</td>
<td>2 3 5 2 2</td>
<td>3 4 4 4A</td>
</tr>
</tbody>
</table>

When the levels of all features of a certain FTSD are established it is easy to see for which tasks 100%, or 50% flight replacing training is allowed or not ('not' marked by orange shade).

<table>
<thead>
<tr>
<th>FSTD feature</th>
<th>Virtual</th>
<th>F.O.V.</th>
<th>Military</th>
<th>Subsystems</th>
<th>Mil. Sensors</th>
<th>Weather</th>
<th>ATC</th>
<th>Threats</th>
<th>Load models</th>
<th>Sling load</th>
<th>Cooperative</th>
<th>Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hell xxx FSTD</strong></td>
<td></td>
<td>2 5</td>
<td>0 3A</td>
<td>0 3AB</td>
<td>4 1</td>
<td>2 2</td>
<td>3A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Task 100%</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landing confined area</td>
<td>3 3 0</td>
<td>0 0 0 3B</td>
<td>2 0 0 0 0 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Under sling load operations</td>
<td>3 3</td>
<td>0 3A 0 3A 0 3A 0 3A 0 3A 0 3A 0 3A</td>
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<td>Roping, abseil, hover jump</td>
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<tr>
<td>Threat recognition/reaction</td>
<td>2 5</td>
<td>2 0 3A</td>
<td>2 0 2 0 0 0 3A 0 3A 0 3A 0 3A 0 3A 0 3A</td>
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| **Task 50%**         |         |        |          |            |              |         |     |         |              |            |             |             |
| Landing confined area | 2 3 0 | 0 0 0 1 | 1 0 0 0 0 2 |
| Under sling load operations | 1 2 | 0 2 0 1 0 0 2 2 2 |
| Roping, abseil, hover jump | 1 2 | 0 2 0 1 0 0 2 2 2 |
| Threat recognition/reaction | 1 2 | 2 0 | 2 1 0 1 0 0 3A |

*Not suited* marked by orange shade.
Practical experience

The practical experience, up to now, can be divided in two parts, first the experience with simulators presently under contract with a reference to civil requirements. This involves the NH-90 simulator, the KDC10 simulator and the C-130 simulator, and secondly the experience with existing simulators without any clear reference to required performance.

3.4 The new simulators

There were two favourable aspects of the new simulators, first we were involved early in the program and secondly with these simulators there is a lot of commonality with civilian simulators as the required performance is mainly based on civil standards.

The KDC-10 has the least differences between the military and civil standards. The main difference is the tanker operation which necessitates the modelling of the effect of an aircraft moving into refuelling position and furthermore the addition of specific tanker scenarios. Fortunately data about the aerodynamic effect of tanker operation were available which makes it possible to incorporate this effect in the flight model and also to verify the correct operation quantitatively. The testing of the scenarios is more a subjective test, the number of players and their behaviour must match the expected behaviour. The basic simulator is built contractually to level D standard\(^1\). We as MAA will translate this to the MAA levels and add levels for the additional features.

\(^1\) When the contract was signed the draft MAR-FSTD was not yet ready and consequently could not be used.
The C-130 is a more military aircraft; typical military operations include cargo drop, parachute extraction, rough field landings and flying in a threat rich environment where optimum use has to be made of threat warning equipment, electronic counter measures and manoeuvring. The majority of these military tasks require that the threat and counter measure database is of a high quality and that scenarios are flexible. The most practical way to check the threat is to compare it with the threat database which is maintained by the NLR for the RNLAF. But comparing one database against another is not a sufficient test. On top of that some scenarios will have to be developed where the threat performance can be measured against the pre calculated performance. For instance a manoeuvre which positions the aircraft just outside the lethal zone of the weapon should prevent a hit and inside the lethal zone we should have an opposite effect. It is of course not wise to include detailed requirements for threat and targets in the MAR-FSTD. Classification makes that improper and details about enemy system may change as well. The most important fact the MAA has to establish is to determine if threats are generic, representative or specific.

The NH-90 differs most from civilian systems. This was not only due to the added military sensors with their specific performance but also caused by the operator requirement to be able to simulate deck landings. The latter requirement necessitated a complete different design of the flight loop. Instead of a single disk model a multi element blade model was now required. Furthermore the wind field around the helicopter has to be defined in a much finer grid. This approach will, in theory, enable the NH-90 simulator to be used for deck landing training. The MAA has an additional challenge. We must find a way to validate that the simulated deck landing resembles the actual deck landings. The most convenient way is a Proof of Match (POM) test where actual flight test data is incorporated in the simulator. This in itself is not a problem, however, the actual wind field may differ from the calculated wind field, and the complete wind field is never measured. Therefore we are presently not sure if we can use the same limits as the RAeS reference book (see references) is presently using for landing performance.

3.5 Existing simulators
The situation with existing simulators is completely different. Some simulators are bought as part of a military sale, which gave us simulators which were identical to the one the USA had bought (such as the Apache simulator). The problem with these simulators is not that they are not up to standard but that we lack the evidence to which standard they perform. A further limitation is that in general these simulators are not capable of automatic QTG (Qualification Test Guide) testing. This makes it even harder to prove that they maintain a certain standard.
This situation does not look very promising at first sight; however there are some advantages too. The RNLAF has an experimental test pilot on every type flown. These pilots can be used to gather quantitative data with standard flight test techniques and let them fly similar profiles in the simulator. This approach was also used for the RNLAF PC-7 simulator. But in that particular case the flight test data was used to tune the flight model from scratch. The experience was that a limited number of dedicated test flights was sufficient to get a good set of data to test the simulator. But there were of course also limitations. These test mostly verified the aircraft behaviour in the air; ground effect and surface effects cannot be collected that easily with simple hand held instrumentation. On the other hand, most of the simulation is not intended to train for those tasks, which makes it a useable method to employ.

The simulator for the Lynx helicopter on the other hand has a relatively high level of fidelity (“D level comparable”). A noticeable limitation exists for military deck landings. The air wake model of the airflow around the ship is generic and the aerodynamic model lacks some details in blade modelling. This level is sufficient for “50 % training”, i.e. for training the operational procedures. Final training of the flight handling and qualification of the pilot for this task has to be performed during actual flight, supervised by an instructor.
4 Results and conclusion

The initial regulation for aircraft (both fixed wing and rotary wing) simulators (MAR-FSTD) is finalized. Based on this version of the MAR-FSTD the qualification of Dutch military simulators is in progress. The aim is to give the operator maximum flexibility in the employment of existing and future simulators.

An interesting point for existing simulators is ‘how to handle when no proof-of-match data with the real aircraft are available’ and how to get to an alternative Qualification Test Guide (QTG). Results of some qualifications have been presented.

It is a challenging task to develop new regulations. The MAA-NLD could benefit a lot from the existing JAA regulations, and could even combine the helicopter and fixed wing regulations and use the best of both worlds. It was also possible to use a similar methodology for military sensors, threats and targets as is used in ICAO 9625. (“Manual of Criteria for the Qualification of FSTDs)

The present day MAR-FSTD is still a document under initial proof in practice. It is rewarding to see that the operator is welcoming this regulation as a way to improve its training, improve the quality of its simulators and to guide him in making investment decisions.
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Author's Biographies

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Ir. Hans Jansen holds an MSc degree in Aerospace Engineering from Delft University of Technology. After graduation he joined NLR in 1973 at the Flight Division. For over 35 years he is active in the field of flight simulation. He has been involved in specifying requirements for and testing subsystems of research simulators (motion, control loaders) and participated in AGARD Working Groups. He worked on simulator research topics like: simulation of wind and turbulence, effect of structural modes on flying qualities, handling qualities of high performance fighters. He has been a member of the NHI Training Media task force for the NH90 helicopter.

Herman J. KOOLSTRA
Lt Col Herman Koolstra served in the Royal Netherlands Air Force as operational fighter pilot and as experimental test pilot. He has over 3000 hrs in fast jets. He was Head of the International Test Team for the OT&E of the Mid-Life Update F-16, Head of Fighter Requirements and Head of Flight Testing. He worked on several simulation projects for the F-16 and PC-7. He is presently military retired and works partly as flight inspector for the Military Aviation Authority the Netherlands and is studying at Delft University of Technology for the remainder of the time.

Since end 2007 both are posted at Military Aviation Authority the Netherlands (MAA-NLD) to set up a system for the qualification of military simulators. As a result the ‘MAR-FSTD’ “Military Aviation Requirements - Flight Simulation Training Devices” has been formulated. From November 2009, as Technical and Flight Inspector members of the MAA-NLD qualification team, they have qualified six simulators of the Netherlands Ministry of Defence.