

Tanker Remote Vision System (TRVS)

A high performance vision system for air-to-air refuelling operations.



Screenshot KDC-10 refuelling using TRVS

Introduction

The Tanker Remote Vision System (TRVS) supports the in-flight refuelling operator with adequate view on the refuelling scene below the tanker aircraft and information concerning the tanker process during air-to-air refuelling operations. The system is initially designed for KDC-10 tanker aircraft of the Royal Netherlands Air Force (RNLAF) but can be used in any type of tanker aircraft. TRVS is based on a modular approach and consists of a surveillance vision system to obtain optimal situational awareness around the aircraft and a stereo vision system for crystal clear stereoscopic operator viewing along the refuelling boom.

System overview

The Royal Netherlands Air Force (RNLAF) employs two McDonnell Douglas DC-10 aircraft that are converted to serve as tanker and transporter in a mixed role. These aircraft are therefore designated as 'KDC-10' ('K' is the type designation for tanker). The RNLAF KDC-10s resemble their American counterparts, however, they differ in fuel loading capacity and set-up of their inflight-refuelling system.

In the RNLAF configuration, the boom-operator station is located directly behind the cockpit. The boom is tele-controlled by using joysticks. The required visual feedback information is displayed on the operator

console. The boom is controlled through a separate Boom Control Unit (BCU) which is integrated in the operator console. The BCU is not a part of TRVS. The TRVS interfaces with the BCU receive information concerning the boom's position and status. This information is presented in a graphic overlay on top of the refuelling image, together with the annunciators.

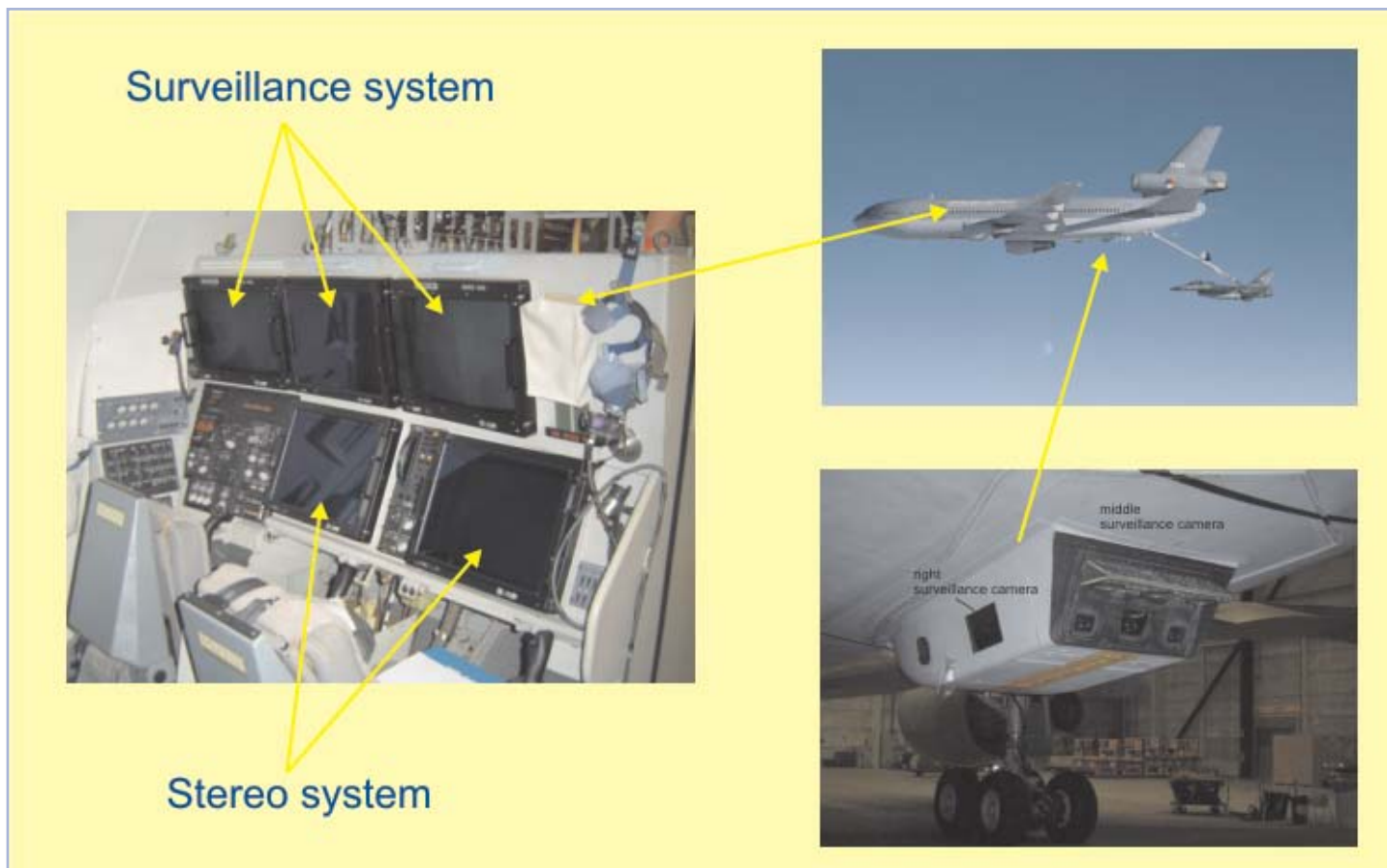
Visual information is generated by means of two video systems, a surveillance vision system and a stereoscopic vision system. Together, these systems form the 'Tanker Remote Vision System' (TRVS).

The surveillance vision system makes use of three cameras covering more than 180 degrees horizontal field-of-view, between both the KDC-10's wingtips in aft direction. The images are displayed in a panoramic view on three monitors in the operator console. The stereoscopic vision system uses dual-channel images from two cameras aimed at the refuelling boom tip.

Stereoscopic images are obtained by using a shutter system. The operator wears passive polarised glasses that separate the images yielding a vivid stereoscopic image. The stereoscopic vision system also comprises synthetic symbology in depth. The vision system is suitable for day and night vision (Near Infra-Red). TRVS has been proven as a high-performance vision system that has demonstrated its potentials during several air-to-air refuelling test flights

System architecture

The architecture of the TRVS is based on a modular approach. Five different modules are identified:



System configuration

- **Camera Module**

Mechanical construction including Camera Units. The Camera Module is placed in a camera bay under the tail of the aircraft in order to protect the cameras from severe environmental influence and dust during take-off and landing. The camera bay does not need pressurised air.

- **Interface Module**

The Interface Module contains the Graphic Processor Units and an I/O Processor Unit. The Graphic Processor Unit performs the image processing. The I/O Processor Unit takes care for interfacing the Boom Control Unit and operator control panels, and for generating caution and warning signals.

- **Video Module**

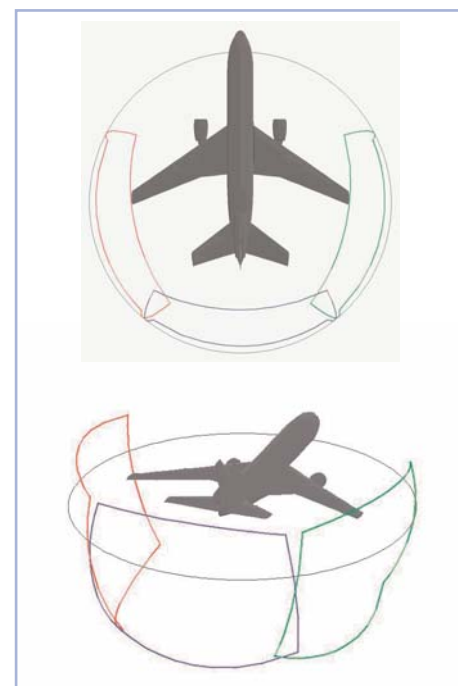
The Video Module consists of units for video switching, video recording and video play back.

- **Monitor Module**

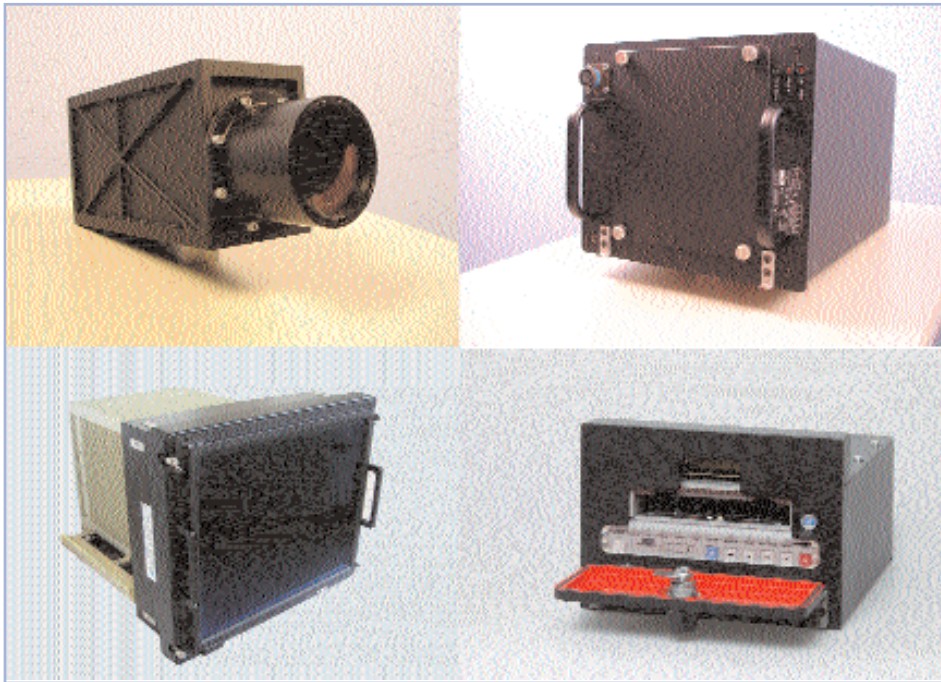
The Monitor Module includes the video monitors for the surveillance vision system and the stereo vision system. The stereo monitors are equipped with a shutter system.

- **Operator Control Module**

Operator control for the TRVS vision system is performed by using the controls of the operator station.



Field of view surveillance system



TRVS camera unit, graphic processor unit, monitor unit and recorder unit

System performance:

- TRVS provides full operator viewing into direct sunlight, even in glare and blooming conditions. A superb picture for day, dusk and night operations exists.
- The surveillance system shows a high quality, more than 180 degrees panoramic field of view. High resolution and contrast sensitivity offer an extreme object detection range.
- The TRVS operator station offers a full color dynamic graphics overlay showing safety envelope brackets, boom position indicators, warning and caution indicators and fuel flow indication.
- The visual acuity of the video system approaches that of the unaided human eye.
- The stereoscopic system results in a depth acuity performance a factor 3 better than with the unaided human eye.
- The recording subsystem provides time-stamped video for training and legal purposes

System aspects:

- The use of high-performance monochrome cameras allows very high dynamic range

and excellent contrast sensitivity.

- High system reliability and built-in diagnostics (user-initiated and continuous diagnostics) guarantee easy maintenance and repair
- The use of polarised stereo imagery in combination with lightweight, easy-to-wear, polarised glasses for the operators guarantees a superb stereoscopic performance without the physical load that occurs in case a helmet mounted display is used
- The modular system concept based on Line Replaceable Units uses fiber-optic imagery transmission in combination with complete digital image processing. This concept together with the extensive built-in test and diagnostic facilities offers a robust low level maintenance solution for in-flight refuelling operations
- TRVS is an effective and modest-cost solution to operate an air refuelling boom
- TRVS can also be used for other applications such as improving the situational awareness aside the A/C (e.g., through video images of the Wing Aerial Refuelling Pods)

- The system is designed under contract of the Royal Netherlands Airforce by TNO, KLM Engineering & Maintenance, ARVOO and Adimec.

Specifications

Field-of-view surveillance system

Horizontal at least 180 degrees, vertical 62.0 degrees

Field of view stereoscopic system

Horizontal 35.5 degrees, vertical 27.0 degrees

Certification based on

DO-178B, DO-160D, DO-254

Electrical power consumption

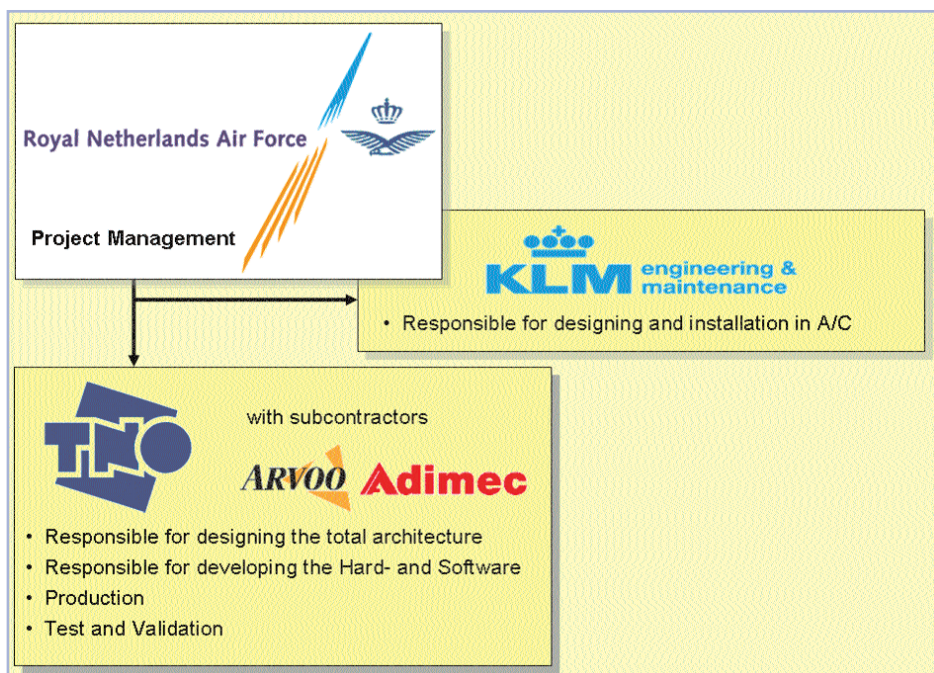
Approx. 2 kW

Total installed weight

Approx. 280 kg



Receivers view



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J.C.P. (Hans) Bol, BSc.
Dr. L. (Leo) van Breda

M. (Michiel) Ringers, MSc.
trvs@tno.nl

Oude Waalsdorperweg 63
P.O. Box 96864
2509 JG The Hague
The Netherlands

P +31 70 374 00 38
F +31 70 374 06 53
info-DenV@tno.nl
www.tno.nl