4.2.2. Controls and Displays

4.2.2.1. Purpose

The purpose of this test is to assess the suitability and utility of the FLIR controls and displays for the assigned mission as an interface between the operator and the FLIR system.

4.2.2.2. General[15]

As good as many FLIRs are in generating a visual representation of the IR scene, they have failed if the operator is not presented with a usable display or if the operator is not given adequate controls to operate the system. The controls and displays must be usable in every conceivable flight regime, ambient lighting condition, weather condition, and by aviators with the range of anthropometric measurements for which the system was designed to operate. For the modern fighter or attack airplane this is usually all weather, day or night, around +9 to -4 gs, for the 3 to 98 percentile groups, and in a realistic tactical environment filled with urgent decisions demanding the aviator's attention. For this reason, the controls and display should require an absolute minimum of operator input or interpretation and the information imparted and required from the operator should be kept at a minimum and precisely what the aviator needs to execute the current phase of flight.

Controls should be easily manipulated wearing the proper flight clothing. The range of control (both the physical range of movement of the knob, dial, lever, etc. and the range of effect that the control has on the FLIR) and sensitivity should be compatible with the expected flight regime. Controls that require manipulation while airborne should be reachable from the DEP, particularly if they must be activated in a combat environment. As an example, the FLIR targeting mode controls must be reachable while performing high g maneuvers and while maintaining a body position ready for a safe ejection. An accurate FLIR update of the target position is essential for targeting inputs to the weapons release computers. The operative sense must be correct. This means that the direction of activation should conform to the standards of common sense (turn the knob to the right to turn on the system) and to the standards set in references 12 and 13 (which for the most part merely put on paper the standards of common sense).

The FLIR line of sight slew controls often present a problem in selection of the correct operative sense. These difficulties sometimes do not become apparent until the controls are manipulated in a mission relatable fashion. The operation of the controls should be clear, requiring a minimum of operator concentration and attention. This leaves the operator free to make tactical decisions. The controls should be placed in logical functional groups, reducing the area of scan required to check the FLIR set up. The FLIR controls should be integrated well into the cockpit. This means that the FLIR controls should operate harmoniously with the other controls within the cockpit and without hindering the simultaneous operation of other airplane systems. Mission relatable hand offs between the radar and FLIR and between the different stabilization modes of the FLIR should be performed.

The integration must be evaluated during a mission relatable workload and while simultaneously operating all the other airplane systems. This is important since good FLIR work is usually just a part of the mission. Lastly, the controls should provide good tactile feedback. For example, detents should provide the proper amount of "click" and all the knobs shouldn't feel exactly alike when reaching for a control with eyes on the FLIR display. Applying a little common sense and manipulating the controls in a mission relatable environment usually uncovers most of the control human factors violations.

Many modern aircraft have a large number of the avionics controls included in the Hands-On-Throttle-And-Stick (HOTAS) format, allowing manipulation without releasing the throttle and stick. These implementations have their own human factors challenges. Typical problems

[15] For an introduction into controls and displays human factors, see references 20, 54 and 73.

include the mounting of too many controls in the available area, appropriate control sensitivity across broad flight conditions and tactile feedback considerations.

The FLIR displays should be clearly visible from the DEP in bright daylight as well as complete darkness. In bright daylight, the display must be usable under all conditions of glare including sunlight directly over the operator's shoulder onto the display (a particularly serious problem for most displays). In the dark, the display should not be so bright that it distracts the operator or affects his or her night vision. A good range of the brightness control that integrates harmoniously with the rest of the cockpit is required. The display resolution must be matched to the FLIR resolution. The display should be able to provide a "picture" quality presentation that is similar in appearance to a visual scene, accounting for the fact that the display is actually a visual representation of IR.

The display must refresh itself quickly enough so that the symbology, alphanumerics and video present an even and continuous display without noticeable flicker. Alphanumerics must be clear and legible. The messages should be short and easily understood without excessive coding or operator interpretation. The information displayed to the operator, including video, symbols and alphanumerics must be sufficient for the current phase of flight while at the same time not overloading the operator with information. This usually requires tailoring the display to the specific attack mode/mission/phase of flight, that is currently being used. The display should be assessed for the information load in a mission relatable scenario to determine its utility as an aid in the combat environment. Since the display of FLIR information approximates the visual world, the display should provide sufficient information so that the FLIR does not disorient the operator as to the attitude of the aircraft. This usually requires an easily visible and interpretable display of the FLIR line of sight orientation.

It is unlikely that a display compatible in size, weight, power and cooling requirements with a tactical airplane will be built in the near future that has too large of a usable display face. Thus, the display should be evaluated for size in a relatable mission environment, accounting for this element of realism. The display should be positioned in a location suitable for the mission. As an example, a display for a FLIR that includes targeting modes should be high on the front panel, or even on the HUD, to allow the pilot to glance down or look through the HUD and gather the FLIR derived information while at the same time minimizing the time he or she spends with his or her eyes in the cockpit and consequently away from his or her visual scan for the target. As with controls, display human factors problems typically surface by applying a little common sense while using the FLIR in a mission relatable scenario.

4.2.2.3. Instrumentation

A tape measure and data cards are required for this test. A voice recorder is optional.

4.2.2.4. Data Required

Record qualitative comments. Record the evaluator's anthropometric data and a list of personal flight gear worn. A description of the FLIR line of sight orientation displays must be recorded. The usable display area should be measured. Location of the display from the DEP should be measured if a qualitative problem is noted. Reach length of controls that are beyond the operator's reach while seated at the DEP during any mission relatable scenario must be noted.

4.2.2.5. Procedure

Find the DEP as outlined in the radar theory section. All ground and airborne tests should be performed while at this position and wearing a complete set of flight gear. Perform a system turn up on the ground outside of the hangar in a range of ambient lighting conditions (bright daylight to darkness which may be simulated using a canopy curtain). Manipulate all the controls noting the factors discussed above. Measure the display usable area. Evaluate the display for the factors discussed above. Note and measure the position and reach to all controls and displays that pose a visibility or reach problem from the DEP. During airborne testing, manipulate the controls and make qualitative comments during mission relatable attacks and intercepts. Take particular note during the extremes of ambient lighting for displays and during high g maneuvers for controls. Confirm

the ground checks for reach and visibility during these circumstances. Check the extremes of control limits and sensitivity. Repeat for each test flight.

4.2.2.6. Data Analysis and Presentation

Present a table of the operator's anthropometric data and the personal flight equipment worn during the tests. Present the seat position as the number of inches from the bottom of the seat travel. Relate the sensitivity of the controls to the tactical environment in which they are to be used. For example, an attack airplane's slew control may be too sensitive to use for an accurate update of the target position under moderate g or turbulence making it unusable while maneuvering for an attack. Relate the accessibility, placement and grouping of the controls under mission relatable conditions. An attack mode selector must be readily accessible while scanning outside the airplane and maneuvering violently. Relate the control clarity, operative sense and tactile feedback to a multiple threat, combat scenario requiring the operator to make quick tactical decisions. If ambient lighting affects the display in any way, relate this to the limits of the possible combat environments. Compare the display resolution to the "picture" quality of the IR scene.

Relate the information load presented the operator to the combat scenario discussed above and evaluate whether the needed information is present and whether too much information is cluttering the display. This information can include FLIR video, alphanumerics or symbols. This concept is closely related to the size of the display face usable area. A large scope can present more information without cluttering the display and requires less concentration to read and evaluate. The refresh rate should be related to the concentration required to evaluate a lagging display. The utility of the FLIR line of sight orientation displays should be related to the likelihood of the display disorienting the pilot and causing him to make improper adjustments to the aircraft's attitude. The display position should be evaluated considering the type of information involved, the eye position required for using the display and the display position's effect upon scan.

4.2.2.7. Data Cards

Sample data cards are presented as cards 57 and 58.

CARD NUMBER ___

CONTROLS

CLARITY OF OPERATION:

ACCESSIBILITY (MEASURE REQUIRED REACH IF A PROBLEM):

OPERATIVE SENSE:

ADJUSTMENT SENSITIVITY:

RANGE OF ADJUSTMENT:

TACTILE FEEDBACK:

FUNCTIONAL LOCATION/GROUPING (SKETCH IF A PROBLEM):

INTEGRATION:

Card 57: Controls Data Card

CARD NUMBER ___

DISPLAYS

[PERFORM IN BRIGHT DAYLIGHT TO DARKNESS.]

LOCATION QUALITATIVE COMMENTS (MEASURE LOCATION IF A PROBLEM):

CONTRAST/BRIGHTNESS/GAIN CONTROLS (RANGE OF EFFECTIVENESS):

GLARE (BOTH FROM OUTSIDE AND INSIDE COCKPIT LIGHT SOURCES):

RASTER LINES/INCH_____

USABLE DISPLAY AREA _____X_____

RESOLUTION QUALITATIVE COMMENTS:

REFRESH RATE QUALITATIVE COMMENTS:

LOCATION OF SYMBOLOGY/ALPHANUMERICS:

INTERPRETATION OF SYMBOLOGY/ALPHANUMERICS:

UTILITY OF FLIR LINE OF SIGHT ORIENTATION DISPLAYS:

INTEGRATION:

Card 58: Displays Data Card