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DERIVATION OF EXISTING CF PILOT ANTHROPOMETRIC SELECTION STANDARDS

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DERIVATION OF EXISTING CF PILOT ANTHROPOMETRIC SELECTION STANDARDS

EXECUTIVE SUMMARY

A redress of grievance querying the legitimacy of anthropometric selection standard limits was recently filed. An individual whose anthropometric dimensions were outside those set for pilots by the CF was refused a request to retrain as a pilot after spending some years as a navigator.

The documents relating to cockpit accommodation indicate that the current selection standard is not based on physical restrictions imposed by aircraft in the CF inventory but rather on a population of pilots and navigators that were on strength in the early 60s. Had it been based on current aircraft cockpit restrictions, the limits would be more restrictive than they now are. The reason the standard "works" is that it puts lower and upper bounds that are "reasonable" from various perspectives. Although pilot candidates are required to be within those limits of stature, thigh length, sitting height and leg length, those dimensions do not appear to be checked periodically once they have been admitted. As a consequence of growth between the screening age of say 18 to the age of 25 (when individuals cease to grow) pilots that are on strength may well exceed the standard limits. A review of the 1985 survey of pilots and navigators has shown that one in ten pilots was outside the selection limits in one or more dimensions.

The fact that the selection standard was not based on cockpit limitations at the outset does not necessarily mean that it is not valid in some aircraft types. The current standard does include a range of body sizes that is a reasonable target for aircraft designers to accommodate. Some of the earlier aircraft, such as the T33, were apparently not designed for such a population in view of the very restrictive ejection clearances found in them. However, there is a push for future aircraft to be more accommodating of smaller and larger individuals as evidenced by recent US (through JPATS) and European requirements.

It was recommended that the individual in question be re-measured to resolve some conflicting information between DCIEM and AETE measurements. It was also recommended that a verifiable process be developed by which accommodation limits could be established based on either test subjects or 3D man-modeling data, in order to provide the CF with a defendable aircrew selection standard.

TECHNICAL MEMORANDUM

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DERIVATION OF EXISTING CF PILOT
ANTHROPOMETRIC SELECTION STANDARDS

BACKGROUND

A redress of grievance querying the legitimacy of anthropometric selection standard limits was recently filed. An individual whose anthropometric dimensions were outside those set for pilots by the CF was refused a request to retrain as a pilot after spending some years as a navigator.

The following is a review of how the current standard was derived, and some of the issues surrounding cockpit accommodation.

DERIVATION OF THE CURRENT SELECTION LIMITS

Except for stature, current guidelines for aircrew selection "were derived from, but not identical to, the 1st to 99th percentile values from the 1962 survey of CF aircrew" (MacDonald & Beevis, 1979, Smiley, 1962). The only reason they are not identical is because of the rounding of the survey's values to the nearest half-inch. Once the rounding is done, the figures exactly match today's standard. For some reason, stature requirements are different. They seem to have been relaxed over the years, perhaps because it was deemed less relevant than seated posture measurements. The current value (1940 mm) represents the 99.67th percentile rather than the 99th percentile (1916 mm) of the Smiley (1962) survey; a difference of 24 mm. Table 1 shows a comparison of the current pilot selection criteria with the DCIEM measurements of the subject in question.

Table 1 Comparison of pilot selection criteria with subject anthropometry.

Measurement	Standard (maximum) (mm)	Smiley (1962) 99th percentile (mm)	Subject (mm)
Stature	1940 (76.4 in)	1916	1950
Leg length	1232 (48.5 in)	1232	1270
Sitting height	1003 (39.5 in)	1003	962
Thigh length	673 (26.5 in)	673	675

Exception to selection limits

The standard applies to all CF aircraft. However, candidates having buttock-knee length measurements greater than 630 mm are deemed unfit for the T-33, which has special restrictions due to limited ejection seat clearance (Cressman, 1971, Cressman, 1973).

Comment on the current selection standard

The current selection standard is not based on physical restrictions imposed by aircraft in the CF inventory (if that were the case, the limits would be more restrictive than they now are) but rather on a population of pilots and navigators that were on strength in the early 60s. The reason the standard "works" is that it puts lower and upper bounds that are "reasonable" from various perspectives. For instance, if subjects measured in the 1997 survey of the Land Forces (Chamberland, Carrier, Forest, & Hachez, 1998) were to be screened in accordance with the current pilot anthropometric selection standards (except for leg length), over 92% (430/465) of them would pass. There is no specific reason for preferring these limits to any other "reasonable" limit. The CF is not alone in this approach: other Air Forces use different values, some of which are more lenient (e.g. USAF pilot selection limits (stature < 1956 mm, sitting height < 1016, for JPATS/Harvard II accommodation criteria) some of which are more stringent than our own. None are based on cockpit accommodation data. This is about to change as the USAF, USN and the RAF are in the process of determining accommodation ranges for their aircraft, something the CF advocated doing around 15 years ago.

Link between selection limits and safety

The statement made by AOT (Air Operations and Training) that the measurement limits have been established in order to reduce individual risk of injury and ensure pilots can meet the universal demands of flying various types of operational aircraft is at best only partially true. It has not been proven (nor can it be proven as pilots outside the limits have not been allowed to fly CF aircraft) that pilots outside of those limits run a higher risk of injury. In fact, based on the 1985 survey of aircrew (Stewart, 1985), some evidence does exist to counter this statement. For instance, of the 376 pilots measured in the 1985 survey, only 341 met the current selection standard (91%). Oddly enough, this represents a higher rejection rate than for the Land Forces males. This points out another anomaly in CF practice in that pilots are only measured on initial selection, not prior to employment in cockpits of particular concern. Except for leg length, there were and are individuals flying CF aircraft that are taller in every measurement category than the individual currently of interest. Furthermore if safety were the only criterion, the maximum Thigh Length (TL) limit would have been set much lower to reflect limitations found by Cressman, 1973 in the CF aircraft inventory. Due to the possibility of knee contact on ejection, a safe Thigh Length would have been 630 mm, rather than 673 mm, in order to accommodate the T33 (TL < 630 mm), the CF104 (TL<655), and the CF100 (TL<655). The latest data on ejection clearance dates back to 1973, but anthropometry related problems are also known to exist with other aircraft, such as the Slingsby, the Jet Ranger and others. These problems have not been scientifically documented.

What is known of the F18 ejection clearance comes from the US Navy, who appear to have guidelines rather than established limits. The USN conducts fit checks on personnel having a

thigh length of greater than 673 mm, sitting height of 1003 mm, and buttock-heel length of 1219 mm (ASCC, 1996). Details of how these figures were obtained, and what the exact rejection rate has proven to be in practice, are being sought at the moment. However, the USN-suggested upper limits are suspiciously similar across their various aircraft types, which may be a sign that these are merely convenient numbers to use. Further information would be required before concluding that these figures validate our selection standards.

It should be noted that future aircraft are likely to be more accommodating of smaller and larger individuals, since the US Congress is forcing the Department of Defence to better cater to its male and female constituents. A recent example is the Joint Primary Aircraft Training System (JPATS). There is a similar push in Europe (NATO). The Harvard II (JPATS aircraft), for instance, has a safe buttock-knee length dimension of 709 mm according to USAF tests (telecon Meunier/Zehner 9 December, 1998).

ALSE

The argument that ALSE has become smaller and therefore has expanded the range of accommodation may be true, but since it implies that the standards were based on accommodation (which is not true) it is a moot point. The real issue is whether the selection limits represent the true limits of accommodation based on clothing, ALSE, tasks, and escape systems.

ANTHROPOMETRIC MEASUREMENTS

Stature

Stature is known to decrease during the day due to compression of the intervertebral discs and increased curvature of the spine. Decreases of the order of 3-5 cm have been reported (NASA, 1978). The selection standard does not state at what time of day stature must be measured. It is quite possible, then, that the individual in question could "make-up" the 1 cm difference at some time during the course of a day.

Thigh Length

A large discrepancy was noted between the DCIEM and the AETE measurements. In one case the Thigh Length was found to be outside the limits, in the other within. Several factors can come into play. The first that comes to mind is the measuring posture. That in itself could explain the 20-30 mm difference found between the two measurements of buttock-knee length, let alone the 2 mm difference with the standard. An analysis of measurement error performed in the 1997 Land Forces survey showed that expert measurers made an average error of 2 mm when re-measuring the same subjects (Forest, Chamberland, Billette, & Meunier, 1999).

Leg Length

Leg Length of the individual appears to be well outside the limits. However, there is some doubt as to whether the DCIEM measuring rig was in good working condition. During a study on the effects of three parachute packs on knee position (Meunier & Theriault, 1998) it

was noticed that the CMB measuring rig was off. The reason for this was a misplaced (as in "position") scale, which in effect subtracted approximately 1.2 cm from leg length. The reading in this case would have been favourable to the individual in question, but there is no assurance that this scale was positioned unfavourably at the time of his measurement. It would not be surprising to find different measurements than those listed in Table 1 if the individual were to be re-measured with a properly calibrated rig.

Seated Height

Seated height was not at issue.

CONCLUSIONS

There are two major issues at stake:

1. whether the anthropometric selection standards are what people assume they are, and,
2. whether the individual met those requirements.

The selection standards are not based on cockpit accommodation studies, nor are they based on flight safety considerations. The fact that one out of ten pilots surveyed in 1985 does not meet the current selection standard yet manages to fly without apparent difficulty shows the limited usefulness of the standard in that regard. However, the ultimate test of safety and compatibility, which is an aircraft ejection, is fortunately very rare. The truth of the matter is that the standard is based on the assumption that if the population of pilots serving in 1962 was OK, then future generations of pilots should be OK if they are similar in size. The current standards should certainly not be portrayed as being founded on the principles of universality or flight safety, since they are not based on aircraft cockpit compatibility.

On the second point, it is not clear whether the individual really failed to meet the requirements. He may not have been measured properly at DCIEM. A re-measurement may be in order in view of the error found on the measuring jig and of the different measurements obtained by AETE.

The question concerning why anthropometric dimensions outside of the selection standard would preclude the individual from flying in CF aircraft can not be answered at the moment. If known cockpit restrictions were to be used as a basis for setting the standard (Cressman, 1973), then the current selection standard can be viewed as inadequate since it does not conform with the information available. If cockpit restrictions are not used, then one could wonder what the standards mean.

RECOMMENDATIONS

It is recommended that the individual in question return to DCIEM to be re-measured in view of the doubts about the accuracy of the mini-rig at the time of his initial measurement.

It is further recommended that the Aircrew Cockpit Compatibility Evaluation study that began in the mid 1980's be revisited. A verifiable process by which accommodation limits could be established based on either test subjects or 3D man-modeling would be of value to the CF in establishing defendable selection standards. Moreover, the process could be used to determine the adequacy of cockpit dimensions of new aircraft, before they are purchased, and to keep the standards up to date, as aircraft come into and out of service. The cost of completing the ACCE project was estimated to be of the order of $600K in 1994 (3753A-1 (DRDA 5), 25 Jan 1994).

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