USN/USMC EJECTION SEAT EQUIPPED AIRCRAFT ANTHROPOMETRIC ACCOMMODATIONS

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Abstract

USN/USMC ejection seat equipped aircraft anthropometric accommodation guidance is outdated and undocumented. Recent reassignments of aviators within the USN/USMC have highlighted an area where operational dollars could be saved by assigning candidate aviators to a correct and safe pipeline. These issues were revealed during the course of NAVAIRSYSCOM (PMA-202) Aircrew Accommodation Expansion Program where AIR 4.6, Patuxent River was tasked to perform a baseline accommodation assessment of in-service USN/USMC aircraft. The methods used in the program approach were different than procedures historically used to determine USN/USMC aviator suitability and to verify cockpit design. A multivariate statistical approach was employed and served as the basis for determining the safe accommodation envelope. The revised guidance suggested here accounts for:

- the location of the seat with respect to the competing variables that drive the seat location
- the operational use of the anthropometric accommodation guidance and pipeline relational charting
- the cost avoidance associated with inappropriately assigning aviators

These revised guides help to define the acceptable range of aircrew anthropometric dimensions that must be satisfied to achieve safety of flight and mission effectiveness.

INTRODUCTION

BACKGROUND

Anthropometric restriction codes (ARC's) contained in (references 1 and 2) are outdated, undocumented, and require the use of a fit check process that is subjective. Recent reassignments of aviators within the USN/USMC have highlighted an area where small improvements to a simple non-clinical test could save operational dollars, and potentially reduce mishaps where ill suited anthropometrics have been cited as causal and contributory factors. These issues were revealed during the course of the NAVAIRSYSCOM (PMA-202) Aircrew Accommodation Expansion Program where AIR 4.6, Patuxent River was tasked to perform a baseline accommodation assessment of in-service USN/USMC aircraft (reference 3). The methods used in the program approach were different than procedures historically used to determine USN/USMC aviator suitability and verify cockpit design. A multivariate statistical approach was employed and served as the basis for determining the safe accommodation envelopes for each platform/crew station. The revised ARC's and resultant percent accommodated within this report account for the:

- location of the seat with respect to the interacting variables that affect the appropriate seat location.
- operational use of the codes and pipeline relational charting.
- potential cost avoidance associated with the early assignment of aviators to their suitable aircraft via the proposed ARC system presented.

These revised ARC's and percent accommodated are established from the aircrew accommodation analyses conducted under reference 3. These revised ARC's define the acceptable range of aircrew anthropometric dimensions that must be satisfied to achieve safety of flight and mission effectiveness.

PURPOSE

The purpose of this effort was to provide revised ARC's for tactical USN/USMC aircraft and their respective training aircraft pipeline and to provide an estimated percentage of a given population (reference 4) that is accommodated in each aircraft.

SCOPE OF TESTS

Evaluations of aircrew anthropometric accommodation in T-34C, T-2C, T-45A, F/A-18C/D, F-14D, and S-3B aircraft were conducted at NAS Patuxent River, Maryland. The AV-8B evaluation was conducted at MCAS Cherry Point, North Carolina. Additional Man-Machine Integration Laboratory (MMIL) work augmented the on-aircraft data collection where subject data was unable to be attained appropriately. Each of the evaluations typically required 30 hours of ground tests conducted over a 3-day period. Subsequent ground tests for data verification were conducted on the T-45A, F/A-18C/D and the F-14D during the Engineering Proofing Article, Phase II evaluations for the NACES P^3I program. Aircrew accommodation data were collected in both crew stations for tandem aircraft. All crewstations in the EA-6B were assessed in accordance with available archived data (reference 5). In all measured test trials subjects were attired in the full complement of summer flight gear as specified for each aircraft in reference 6. Evaluation of aircrew anthropometric accommodation included the following five functional parameters:

a. External field of view (EFOV): ability to obtain Design Eye Point.
b. Functional arm reach: ability to operate critical flight and time-critical emergency controls with a locked harness.
c. Functional leg reach: ability to operate pedals.
d. Cockpit volume clearances, including ejection clearances (where applicable): ability to safely clear escape path and operate foot controls.
e. Overhead clearance to canopy or canopy breakers: ability to safely clear escape path and maintain EFOV.

The ARC's presented within this report do not address these additional accommodation issues:

- flying aggressive flight profiles
- individual aircrew strength
- enlisted crew stations.

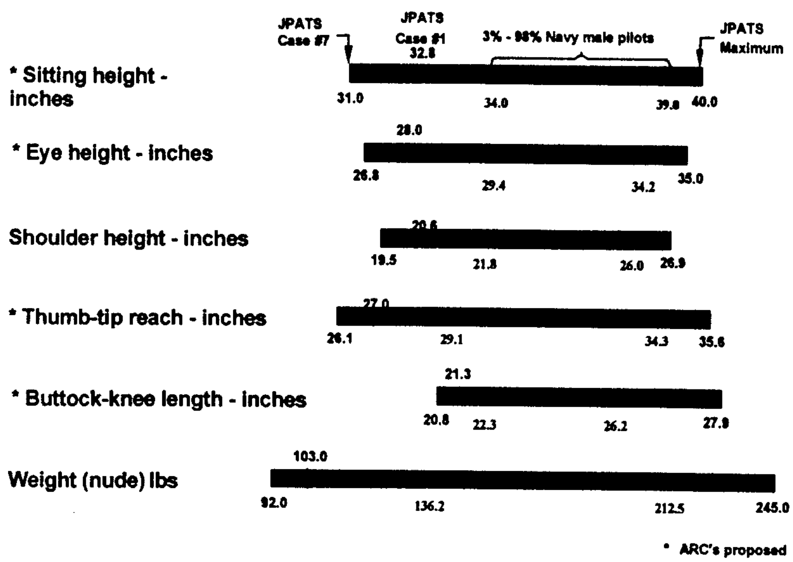
Although the methods employed in this accommodation study differ from those utilized during aircraft and escape system design and development, the results reported do not imply any deficiency with respect to specification compliance by either the airframe manufacturer, seat contractors, or the procuring agency.

METHOD

GENERAL

A pool of 10 (on-aircraft) to 30 (MMIL) test subjects, representing the range of candidate aviator anthropometric characteristics (reference 4) and figure 1, were measured in accordance with the methods established by reference 7. Crew station geometry and subject accommodation data were collected using the procedures outlined in reference 8.

Figure 1



DATA COLLECTION

The crew station geometry measurements were collected by the FaroArm™, a 6-ft long, 6 degree of freedom, articulating arm with an accuracy of 0.012 inch. The FaroArm™ is a coordinate measurement machine that takes data such as points, lines, and planes in a three-dimensional coordinate system, and places these features in an AutoCAD® drawing via AnthroCAM™, the software that interfaces AutoCAD® and the FaroArm™. The crew station geometry measurements were made to align the FaroArm™ with the aircraft coordinate reference system, when available, and to record the location of flight control and cockpit control test points, clearance obstructions, and the adjustment ranges of the seat and rudder pedals.

Specific measurement criteria were as follows:

a. Clearance measurements were taken (head stationary and upright) between the top of the helmet and the overhead/canopy surface or the canopy breakers in aircraft so equipped.

b. Lower leg clearance distances were measured between the shin line and the line along the lower edge of the main instrument panel.

c. The ability of each subject to reach and operate the control stick and other essential or emergency controls in each crew station was evaluated. Functional reach was evaluated in the Zone 2 condition (shoulder harness locked with maximal stretching of arm and shoulder). Sitting acromial (shoulder) height plus seat adjustment height established the discrete shoulder position of each subject as the origin of functional reach.

d. Vertical FOV was evaluated by determining whether the subject could establish a horizontal vision line through the design eye point (DEP).

POST PROCESSING

The data generated by the routine was then organized into a MS Excel® worksheet. The data was reduced into accommodation prediction equations through multiple regression analyses. The independent variables were subjects' anthropometric measurements and the seat adjustment heights, and the dependent variables were miss/over reach or clearance distances.

The final accommodation prediction equations were entered into a software package, Automated Anthropometric Evaluation Program (AAEP), which delivers the predicted seat adjustment range available for the individual anthropometric dimension inputs.

The newer anthropometric specification guidance (reference 4), figure 1 was used to prepare a proposed revised coding interval system, table 1. Each aircraft and crew station had its own unique set of univariate thresholds established from the regression analyses.

The proposed revised coding interval system, table 1, was used in combination with the resultant univariate analyses to

Table 1

PROPOSED USN/USMC ANTHROPOMETRIC DIMENSION CODES

CODE	Nude Body Weight (lbs.)	Sitting Eye Height (in.)	Functional Reach (in.)	Buttock Knee Length (in.)	Sitting Height (in.)
0	**<100[1]**	**<26**	**<26**	**<20.4**	**<31**
1	**100[2]-116.5[3]**	**26-26.4**	**26-26.4**	**20.5-20.9**	**31-31.9**
2	**116.6-136[4]**	**26.5-26.9**	**26.5-26.9**	**21-21.9**	**32-33.9**
3	**136.1-140[5]**	**27-27.4**	**27-27.4**	**22-22.9[16, 17]**	**34-34.4[21, 22]**
4	**140.1-155**	**27.5-27.9**	**27.5-27.9**	**23-25.4[18]**	**34.5-35.9**
5	**155.1-170**	**28-28.4**	**28-28.4**	**25.5-25.9[19]**	**36-37.4[23]**
6	**170.1-185**	**28.5-28.9**	**28.5-28.9**	**26-26.4[20]**	**37.5-38.4**
7	**185.1-195**	**29-29.4[10]**	**29-29.4[13, 14]**	**26.5-26.9**	**38.5-38.9[24]**
8	**196.1-204[6]**	**29.5-29.9[11]**	**29.5-29.9**	**27-27.4**	**39-39.4[25]**
9	**204.1-213[7]**	**30-30.4**	**30-30.4**	**27.5-27.9**	**39.5-39.9**
10	**213.1-235[8]**	**30.5-30.9**	**30.5-30.9**	**28-28.4**	**40-40.4**
11	**213.1-245[9]**	**31-31.4**	**31-31.4[15]**	**28.5-28.9**	**40.5-40.9**
12	**>245**	**>31.5[12]**	**>31.5**	**>29**	**>41**

Nude Body Weights

1. Below MANMED lower limit (reference 9)
2. NACES P^3I seat lower limit (reference 10)
3. JPATS seat lower limit (reference 11)
4. 3^{rd} = 136 (reference 12)
5. 5^{th} = 140 (reference 12)
6. 95^{th} = 204 (reference 12)
7. 98^{th} = 213 (reference 12)
8. MANMED upper limit (reference 9)
9. NACES P^3I and JPATS seats upper limits (references10 & 11)

Sitting Eye Heights

10. 3^{rd} = 29.41 (reference 12)
11. 5^{th} = 29.70 (reference 12)
12. 50^{th} = 31.52 (reference 12)

Functional Reach

13. 3^{rd} = 29.07 (reference 12)
14. 5^{th} = 29.33 (reference 12)
15. 50^{th} = 31.40 (reference 12)

Buttock Knee Length

16. 3^{rd} = 22.28 (reference 12)
17. 5^{th} = 22.50 (reference 12)
18. 50^{th} = 24.06 (reference 12)
19. 95^{th} = 25.80 (reference 12)
20. 98^{th} = 26.24 (reference 12)

Sitting Heights

21. 3^{rd} = 33.96 (reference 12)
22. 5^{th} = 34.24 (reference 12)
23. 50^{th} = 36.27 (reference 12)
24. 95^{th} = 38.36 (reference 12)
25. 98^{th} = 38.95 (reference 12)

generate the updated and revised anthropometric restriction coding for USN/USMC aircraft. The ARC's are presented in a series of four sets of two charts including sitting eye height, functional reach, buttock knee length, and sitting height for US Naval and Marine Corps pilots and flight officers.

A percentage of the population defined in reference 4 was determined by dividing the number of successful accommodation values by the total number of individuals in the population. The charts presented in the appendix display the percentage of aviators affected within each coding interval per dimension.

RESULTS AND EVALUATION

ANALYSIS

The analysis was based on an expanded range of anthropometric dimensions reflecting an anticipated DOD population defined in reference 4. The critical cockpit anthropometric characteristics of this anticipated DOD population are covered within table 1, which defines USN/USMC Tactical Aircraft ARC's in terms of thirteen intervals around four significant cockpit-critical anthropometric dimensions, as noted by the "*" in figure 1.

Analyses of the accommodation data collected in each aircraft yielded sets of accommodation prediction equations for each anthropometric dimension. These prediction equations were then employed to determine the accommodation envelope for each anthropometric dimension in each aircraft. The equations exhibit coefficients of determination (R^2) of 0.7 or greater. The standard error associated with each regression equation was generally less than 0.5 inches except for those involving the prediction of arm reach capability where the goal was generally to achieve 1 inch or less standard error. The revised ARC's, derived as described above for USN/USMC tactical aircraft, are presented in appendix 1.

The results of these tests indicate recommended minimum pilot sitting eye heights in USN/USMC tactical aircraft ranges from 28.5 to 29.5 inches. These minimum sitting eye heights are based on external visibility requirements listed in reference 13, which in turn drove the location of the design eye point (DEP). Individuals at or near the minimum sitting eye height will require a seat location near full up or approximately 2 inches higher than the neutral seat reference position to obtain a horizontal line of vision through the DEP.

The results of these tests indicate a recommended minimum pilot thumbtip reach of 28.5-29.5 inches for primary flight controls and immediate action emergency controls. As a single axis seat moves upward along the ejection rail, the occupant is pulled away from the primary flight controls and other instrument panel and side console controls but is placed closer to higher controls. There is a strong relationship between obtaining the requisite downward, over the nose field of view capability and maintaining full reach capability to all controls.

The results of these tests indicate that a buttock knee length of greater than 21.0 inches is recommended for rudder pedal access and proper center of gravity upon ejection. In general, these measurements indicate that a buttock knee length of less than 28.0 inches will safely clear cockpit structures on ejection.

Based on our analyses table 2 presents the percentage of personnel accommodated for each respective platform/crewstation:

Table 2

Aircraft	Percentage Accommodated Pilot	NFO
T-34C	89.59%	91.46%
T-2C	52.52%	57.89%
T-45A	65.83%	N/A
T-45A*	86.51%	N/A
F/A-18C/(D)	66.29%	(88.42%)
F/A-18C/(D)*	86.88%	(92.62%)
F-14D	50.61%	88.00%
F-14D*	66.20%	92.62%
S-3B	67.74%	69.19%
EA-6B pilot	58.22%	N/A
ECMOS 1/2/3	N/A	57.89%
AV-8B	59.71%	NA

* NACES P^{3}I installed

Limitations to accommodating an increased percentage of smaller dimension/weight personnel in the above USN and USMC tactical aircraft were noted. These limitations included nude body weight ranges certified for safe escape, and the ability to maintain external field of view simultaneously while maintaining a capability to reach and operate primary flight controls or other immediate action emergency controls with a locked harness. Additionally, limitations to accommodating an increased percentage of larger dimension/weight personnel in the above USN and USMC tactical aircraft were noted. These included nude body weight ranges certified for safe escape, and the ability to safely clear cockpit structures in the event of an in flight emergency escape via ejection. The ARC's and resultant percent accommodated presented within this report do not address additional accommodation limitations due to the effects of flying aggressive flight profiles or based on individual aircrew strength.

REFERENCES

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6. NAVAIR Technical Manual 13-1-6.7, Aircrew Personal Protective Equipment, of 14 Apr 1989, Change 10 of 1 Apr 1997.
7. A Short Course in Anthropometry, Anthropology Research Project, December 1993
8. United States Navy Advanced Crew Station Evaluation Techniques, Crawford, J., et al., 1999 Safe Association Proceedings.
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10. NACES P^{3}I, Phase I – A Progress Report, SAFE Association Proceedings 1997
11. Joint Primary Aircraft Training System specification, F335657-93-C0001, *Draft,* Attachment 2 to Section J. 30 June 1993
12. NAEC-ACEL-533, Anthropometry of Naval Aviators–1964, Report AD 62632, of 8 Oct 1965.
13. MIL STD 850B, Aircrew Station Vision Requirements for Military Aircraft, 23 November 1984.

Appendix

Figure 2

Sitting Eye Height

Pilot Sitting Eye Height (SEH) in Inche

[redacted] 3 4 5 6 7

Aircraft	<26	26-26.4	26.5-26.9	27-27.4	27.5-27.9	28-28.4	28.5-28.9	29-29.4
T-34	[redacted]							
T-2C	[redacted]							
T-45A T-45A	[redacted]							
F/A-18C/D F/A-18C/D	[redacted]							
F-14D F-14D	[redacted]							
S-3B	[redacted]							
EA-6B	[redacted]							
T/AV-8B	[redacted]							

Naval Flight Officer SEH in Inches

[redacted] 3

Aircraft	<26	26-26.4	26.5-26.9	27-27.4
T-34	[redacted]			
T-2C	[redacted]			
F/A-18C/D F/A-18C/D	[redacted]			
F-14D F-14D	[redacted]			
S-3B	[redacted]			
EA-6B	[redacted]			

Figure 3

Sitting Eye Height

Percentage of Population Affected per Coding Interval per Platform

SITTING EYE HEIGHT

JSSG Case #	Code	Minimum Dimension (in.)	Maximum Dimension (in.)	Reference 12 percentiles		T-34	T-2	T-45	T-45 P3I	F/A-18	F/A-18 P3I	F-14D	F-14D P3I	S-3B	EA-6B	EA-6B ECMO 1	EA-6B ECMO 2	EA-6B ECMO 3	AV-8B	# of females	% of female population	cumulative % of female population	# of males	% of male population	cumulative % of male population
	12	>31.5	>31.5	50th	50th															52	6.13%	100.00%	684	52.86%	100.00%
	11	31	31.4	31st	45th															65	7.67%	93.87%	176	13.60%	47.14%
	10	30.5	30.9	16th	30th															79	9.32%	86.20%	156	12.06%	33.54%
	9	30	30.4	8th	15th															121	14.27%	76.89%	112	8.66%	21.48%
	8	29.5	29.9	4th	7th															120	14.15%	62.62%	91	7.03%	12.83%
	7	29	29.4	2nd	3rd															118	13.92%	48.47%	34	2.63%	5.80%
	6	28.5	28.9	<1st	1.5th															120	14.15%	34.55%	27	2.09%	3.17%
#1 @ 28	5	28	28.4	<<1st	<<1st															85	10.02%	20.40%	12	0.93%	1.08%
	4	27.5	27.9	<<<1st	<<<1st															51	6.01%	10.38%	2	0.15%	0.15%
	3	27	27.4	<<<<1st	<<<<1st															22	2.59%	4.36%	0	0.00%	0.00%
#7 @ 26.8	2	26.5	26.9	<<<<<1st	<<<<<1st															12	1.42%	1.77%	0	0.00%	0.00%
	1	26	26.4	<<<<<<1st	<<<<<<1st															2	0.24%	0.35%	0	0.00%	0.00%
	0	<26	<26	<<<<<<<1st	<<<<<<<1st															1	0.12%	0.12%	0	0.00%	0.00%
																				848	100.00%		1294	100.00%	

Figure 4

Thumb Tip Reach

Pilot Thumb Tip Reach (TTR) in inches

Aircraft	<26	26-26.4	26.5-26.9	27-27.4	27.5-27.9 (4)	28-28.4 (5)	28.5-28.9 (6)	29-29.4 (7)	29.5-29.9 (8)	SEH +TTR
T-34	[redacted]									>9
T-2C	[redacted]									>17
T-45A	[redacted]									>13
T-45A										>11
F/A-18C/D	[redacted]									>13
F/A-18C/D										>11
F-14D	[redacted]									>18
F-14D										>16
S-3B	[redacted]									>12
EA-6B	[redacted]									>12
T/AV-8B	[redacted]									>15

Naval Flight Officer TTR in Inches

Aircraft	<26	26-26.4	26.5-26.9	27-27.4
T-34	[redacted]			
T-2C	[redacted]			
F/A-18C/D	[redacted]			
F/A-18C/D				
F-14D	[redacted]			
F-14D				
S-3B	[redacted]			
EA-6B	[redacted]			

Figure 5

Thumb Tip Reach

Percentage of Population Affected per Coding Interval per Platform

THUMB TIP REACH

JSSG Case #	Code	Minimum Dimension (in.)	Maximum Dimension (in.)	Reference 12 percentiles		T-34	T-2	T-45	T-45 P3I	F/A-18	F/A-18 P3I	F-14D	F-14D P3I	S-3B	EA-6B	EA-6B ECMO 1	EA-6B ECMO 2	EA-6B ECMO 3	AV-8B	# of females	% of female population	cumulative % of female population	# of males	% of male population	cumulative % of male population
	12	>31.5	>31.5	52nd	52nd															13	1.53%	100.00%	643	49.69%	100.00%
	11	31	31.4	40th	50th															23	2.71%	98.47%	164	12.67%	50.31%
	10	30.5	30.9	25th	39th															33	3.89%	95.75%	143	11.05%	37.64%
	9	30	30.4	15th	24th															58	6.84%	91.86%	123	9.51%	26.58%
	8	29.5	29.9	7th	14th															77	9.08%	85.02%	112	8.66%	17.08%
	7	29	29.4	3rd	6th															87	10.26%	75.94%	60	4.64%	8.42%
	6	28.5	28.9	<1st	2nd															124	14.62%	65.68%	25	1.93%	3.79%
	5	28	28.4	<<1st	<<1st															126	14.86%	51.06%	15	1.16%	1.85%
	4	27.5	27.9	<<<1st	<<<1st															134	15.80%	36.20%	7	0.54%	0.70%
#1 @ 27	3	27	27.4	<<<<1st	<<<<1st															83	9.79%	20.40%	1	0.08%	0.15%
	2	26.5	26.9	<<<<<1st	<<<<<1st															60	7.08%	10.61%	1	0.08%	0.08%
#7 @ 26.1	1	26	26.4	<<<<<<1st	<<<<<<1st															19	2.24%	3.54%	0	0.00%	0.00%
	0	<26	<26	<<<<<<<1st	<<<<<<<1st															11	1.30%	1.30%	0	0.00%	0.00%
																				848	100.00%		1294	100.00%	

Figure 6

Buttock Knee Length

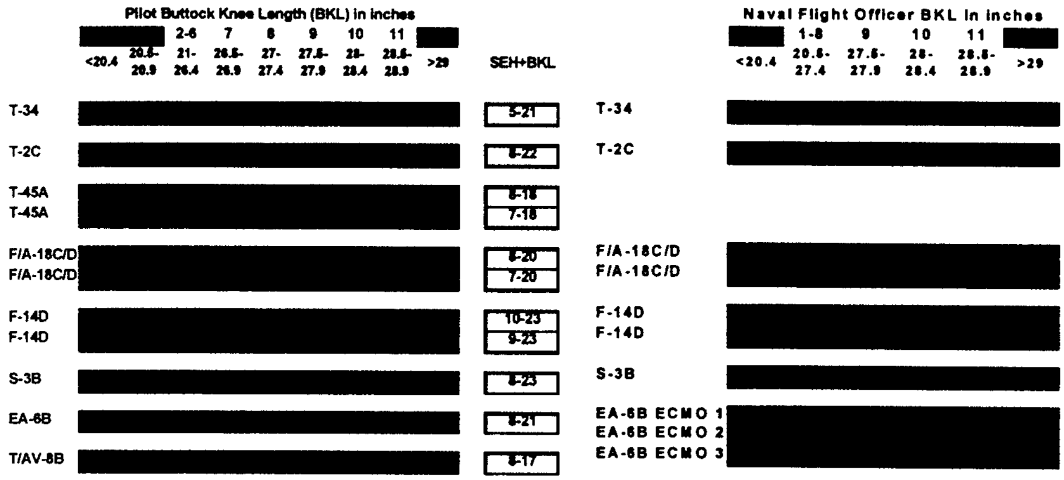


Figure 7

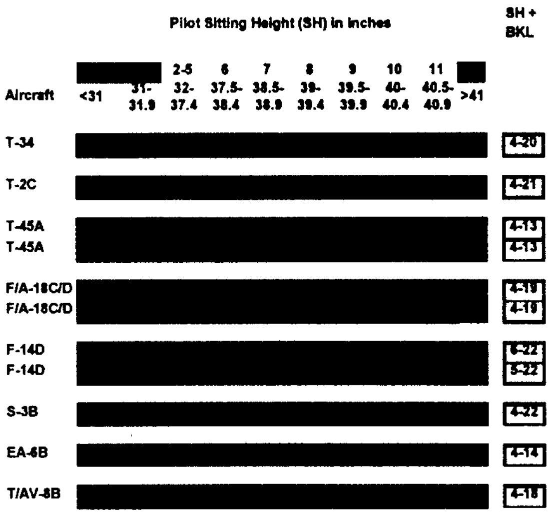
Buttock Knee Length
Percentage of Population Affected per Coding Interval per Platform

BUTTOCK KNEE LENGTH

JSSG Case #	Code	Minimum Dimension (in.)	Maximum Dimension (in.)	Reference 12 percentiles		T-34	T-2	T-45	T-45 P3I	F/A-18	F/A-18 P3I	F-14D	F-14D P3I	S-3B	EA-6B	EA-6B ECMO 1	EA-6B ECMO 2	EA-6B ECMO 3	AV-8B	# of females	% of female population	cumulative % of female population	# of males	% of male population	cumulative % of male population
	12	>29	>29	>>>>>>99th	>>>>>>99th	■	■	■	■	■	■	■	■	■	■	■	■	■	■	0	0.00%	100.00%	0	0.00%	100.00%
	11	28.5	28.9	>>>>>99th	>>>>>99th	■	■	■	■	■	■				■		■		■	0	0.00%	100.00%	0	0.00%	100.00%
#6 @ 27.9	10	28	28.4	>>>>99th	>>>>99th	■		■	■	■	■				■		■		■	0	0.00%	100.00%	0	0.00%	100.00%
	9	27.5	27.9	>>>99th	>>>99th			■	■	■	■								■	0	0.00%	100.00%	1	0.08%	100.00%
	8	27	27.4	>>99th	>>99th			■	■										■	0	0.00%	100.00%	5	0.39%	99.92%
	7	26.5	26.9	99th	>99th			■	■											0	0.00%	100.00%	16	1.24%	99.54%
	6	26	26.4	96th	98th															1	0.12%	100.00%	40	3.09%	98.30%
	5	25.5	25.9	91st	96th															2	0.24%	99.88%	94	7.26%	95.21%
	4	23	25.4	15th	90th															344	40.57%	99.65%	977	75.50%	87.94%
	3	22	22.9	2nd	14th															311	36.67%	59.08%	137	10.59%	12.44%
#1 @ 21.3	2	21	21.9	<1st	1st															160	18.87%	22.41%	23	1.78%	1.85%
#7 @ 20.8	1	20.5	20.9	<<1st	<<1st	■	■	■	■	■	■	■	■	■	■	■	■	■	■	23	2.71%	3.54%	0	0.00%	0.08%
	0	<20.4	<20.4	<<<1st	<<<1st	■	■	■	■	■	■	■	■	■	■	■	■	■	■	7	0.83%	0.83%	1	0.08%	0.08%
																				848	100.00%		1294	100.00%	

Figure 8

Sitting Height



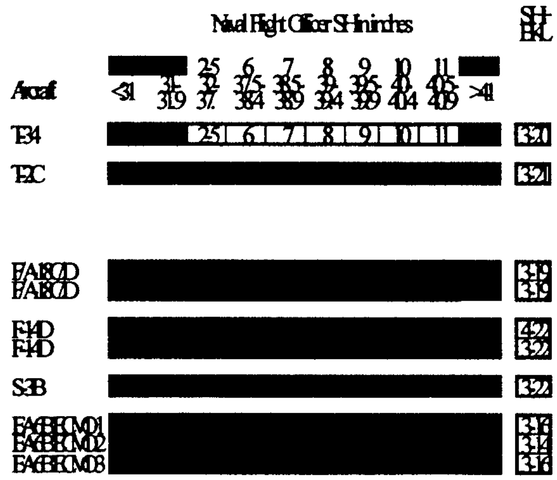


Figure 9

Sitting Height

Percentage of Population Affected per Coding Interval per Platform

SITTING HEIGHT

JSSG Case #	Code	Minimum Dimension (in.)	Maximum Dimension (in.)	Reference 12 percentiles		T-34	T-2	T-45	T-45 P3I	F/A-18	F/A-18 P3I	F-14D	F-14D P3I	S-3B	EA-6B	EA-6B ECMO 1	EA-6B ECMO 2	EA-6B ECMO 3	AV-8B	# of females	% of female population	cumulative % of female population	# of males	% of male population
	12	>41	>41	>>>>99th	>>>>99th															0	0.00%	100.00%	0	0.00%
	11	40.5	40.9	>>>99th	>>>99th															0	0.00%	100.00%	2	0.15%
#5 @ 40	10	40	40.4	>>99th	>>99th															0	0.00%	100.00%	3	0.23%
	9	39.5	39.9	>99th	>99th															0	0.00%	100.00%	8	0.62%
	8	39	39.4	98th	99th															0	0.00%	100.00%	12	0.93%
	7	38.5	38.9	95th	98th															0	0.00%	100.00%	44	3.40%
	6	37.5	38.4	82nd	95th															4	0.47%	100.00%	192	14.84%
	5	36	37.4	40th	82nd															60	7.08%	99.53%	512	39.57%
	4	34.5	35.9	3rd	40th															247	29.13%	92.45%	398	30.76%
	3	34	34.4	1st	3rd															124	14.62%	63.33%	63	4.87%
#1 @ 32.8	2	32	33.9	< 1st	< 1st															359	42.33%	48.70%	60	4.64%
#7 @ 31	1	31	31.9	<< 1st	<< 1st															50	5.90%	6.37%	0	0.00%
	0	<31	<31	<<< 1st	<<< 1st															4	0.47%	0.47%	0	0.00%
																				848	100.00%		1294	100.00%

Figure 10
Nude Body Weight
Percentage of Population Affected per Coding Interval per Platform

WEIGHT

Recent Technical Specifications	Code	Minimum Weight (lb.)	Maxmum Weight (lb.)	Reference 12 percentiles		T-34	T-2	T-45	T-45 P3I	F/A-18	F/A-18 P3I	F-14D	F-14D P3I	S-3B	EA-6B	EA-6B ECMO	EA-6B ECMO	EA-6B ECMO	AV-8B	# of females	% of female population	cumulative % of female population	# of males	% of male population	cumulativ % of male population
	12	>245	>245	>>> 98th	>>> 98th															0	0.00%	100.00%	0	0.00%	100.00%
JPATS and NACES PI maximum @ 245 lb.	11	235.1	245	>> 98th	>> 98th															0	0.00%	100.00%	16	1.24%	100.00%
	10	213.1	235	98th	>98th															0	0.00%	100.00%	17	1.31%	98.76%
	9	204.1	213	95th	98th															0	0.00%	100.00%	113	8.73%	97.45%
	8	196.1	204	90th	95th															0	0.00%	100.00%	153	11.82%	88.72%
	7	185.1	195	77th	90th															2	0.24%	100.00%	250	19.32%	76.89%
	6	170.1	185	48th	77th															9	1.06%	99.76%	289	22.33%	57.57%
	5	155.1	170	20th	48th															35	4.13%	98.70%	225	17.39%	35.24%
	4	140.1	155	5th	20th															129	15.21%	94.58%	150	11.59%	17.85%
	3	136.1	140	3rd	5th															84	9.91%	79.36%	35	2.70%	6.26%
	2	116.6	136	< 1st	3rd															444	52.36%	69.46%	46	3.55%	3.55%
NACES PI mimimum @ 100	1	100	116.5	< 1st	< 1st															136	16.04%	17.10%	0	0.00%	0.00%
JPATS minimum @ 92 lb.	0	<100	<100	<< 1st	<< 1st															9	1.06%	1.06%	0	0.00%	0.00%
																				848	100.00%		1294	100.00%	

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14. ABSTRACT

USN/USMC ejection seat equipped aircraft anthropometric accommodation guidance is outdated and undocumented. Recent reassignments of aviators within the USN/USMC have highlighted an area where operational dollars could be saved by assigning candidate aviators to a correct and safe pipeline. These issues were revealed during the course of NAVAIRSYSCOM (PMA-202) Aircrew Accommodation Expansion Program where AIR 4.6, Patuxent River was tasked to perform a baseline accommodation assessment of in-service USN/USMC aircraft. The methods used in the program approach were different than procedures historically used to determine USN/USMC aviator suitability and to verify cockpit design. A multivariate statistical approach was employed and served as the basis for determining the safe accommodation envelope. The revised guidance suggested here accounts for:

- The location of the seat with respect to the competing variables that drive the seat location
- The operational use of the anthropometric accommodation guidance and pipeline relational charting
- The cost avoidance associated with inappropriately assigning aviators

These revised guides help to define the acceptable range of aircrew anthropometric dimensions that must be satisfied to achieve safety of flight and mission of effectiveness.

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