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Evacuation Studies Session

**Human Factors Associated with the Certification of Airplane
Passenger Seats: Life Vest Retrieval**

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Background ...

Current Regulations / Policies Related to Floatation Devices (e.g., Life Preservers Installed Beneath Seats)

- Design and Performance : TSO C13
Responsibility ----> Manufacturer of Life Vest
- Installation and Containment on the Passenger Seat
Responsibility ----> Seat Manufacturer
- Evaluation of Access to Life Preserver
Assessment Responsibility --- > Approving Authority



Background ...

FAR 25.1411

➤ (f) Life preserver stowage provisions. The stowage provisions for life preservers described in § 25.1415 must accommodate one life preserver for each occupant for which certification for ditching is requested. Each life preserver must be within easy reach of each seated occupant.

➤ The pass/fail assessment of life preserver installation, based on the judgement of the approving official, is prone to be inconsistent and subjective.



Research Request ...

- Society of Automotive Engineers (SAE) Aircraft Seat Committee requested a research study be conducted.
- In an attempt to investigate the human factors affecting the “easy reach” requirement for underseat-mounted life preservers, a series of human subject tests were conducted by the Biodynamics Research Team at FAA’s Civil Aerospace Institute (CAMI).



Research Protocol:

- Method: Observe and measure the effects of certain human factors and life preserver installation variables associated with the ease of retrieval of underseat life preservers.
- Investigation Variables:
 - Container/Preserver Location under the seat
 - Physical Anthropometry of Human Subjects
 - Retrieval Time
 - Subjective Ranking of “Ease of Retrieval”

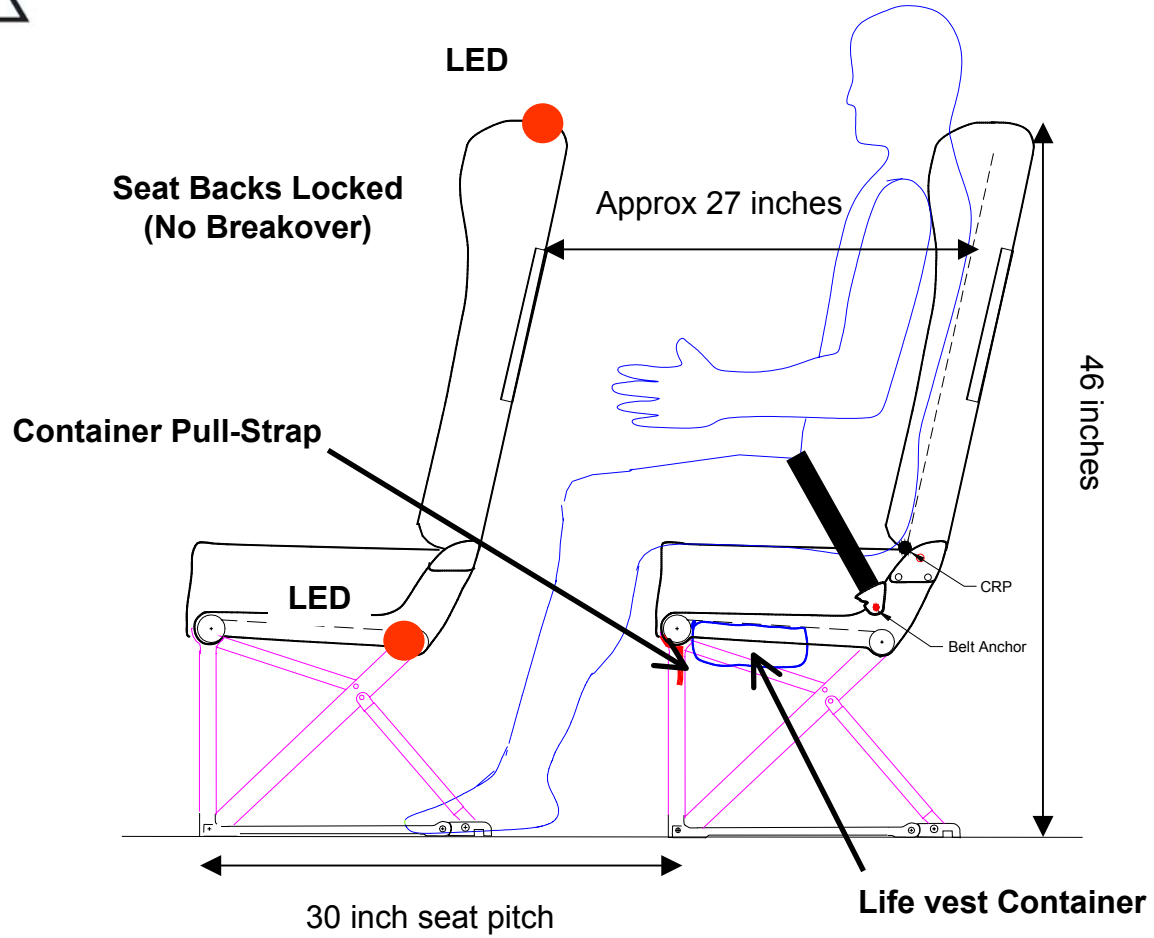


Test Setup ...



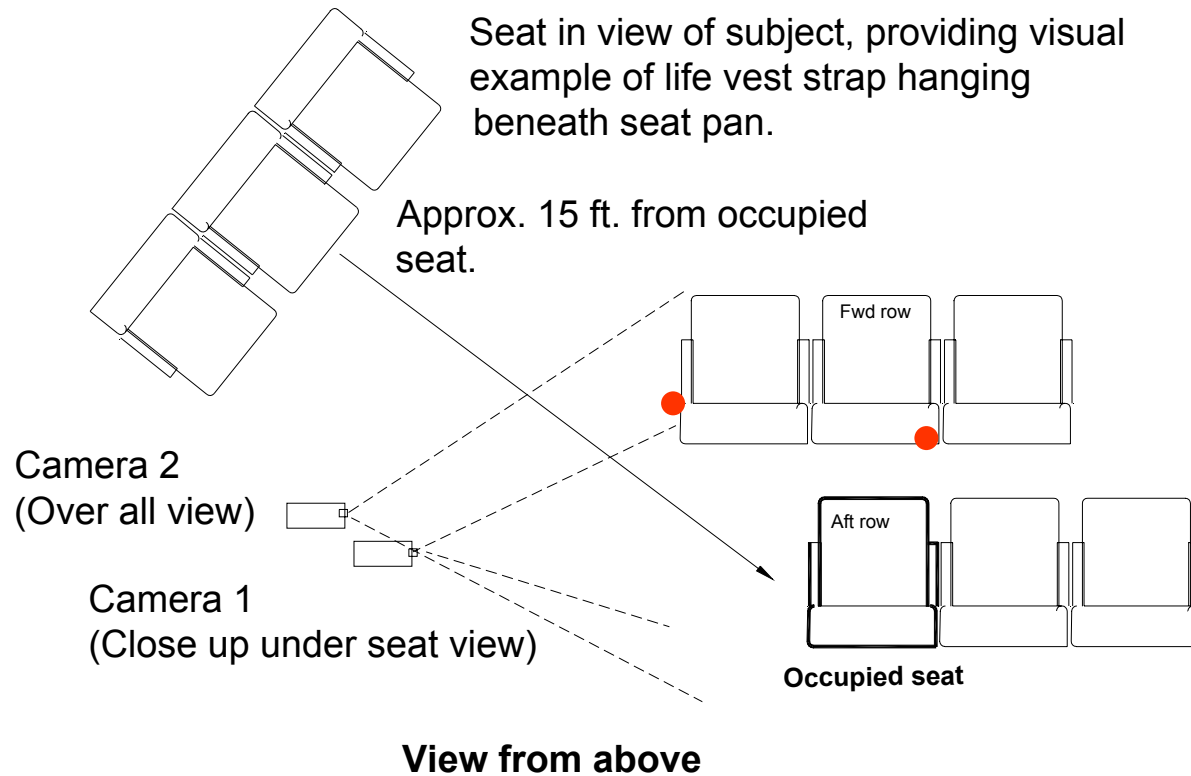


Test Setup ...





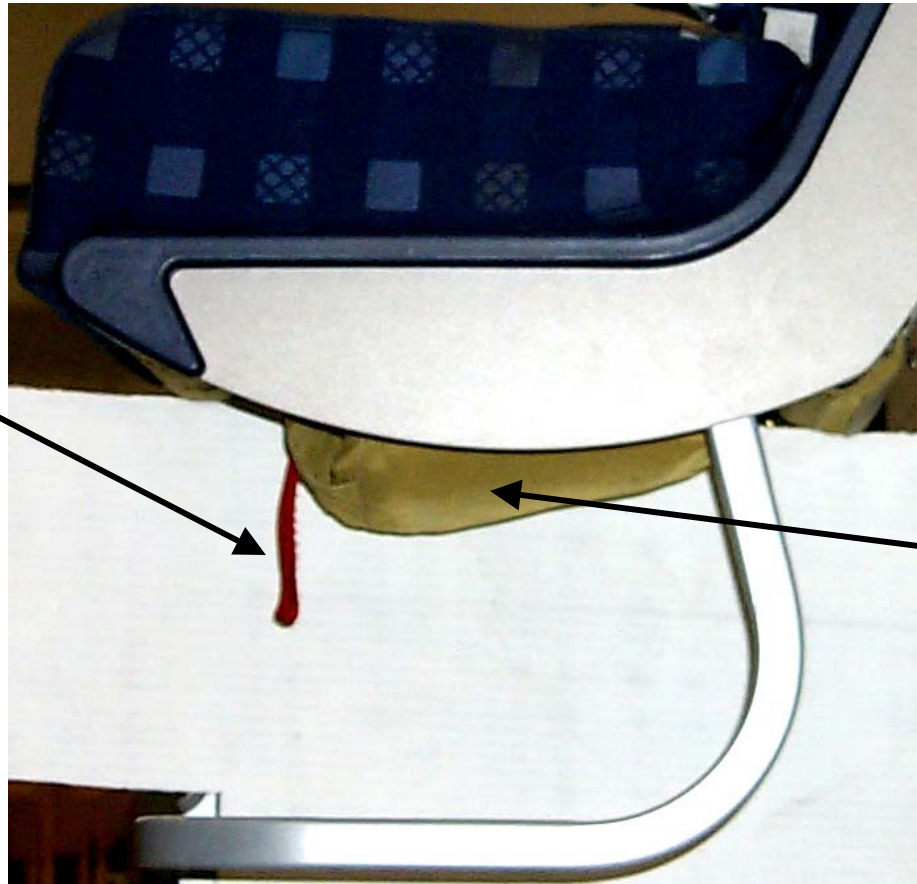
Test Setup ...





Life Vest Installation Variables

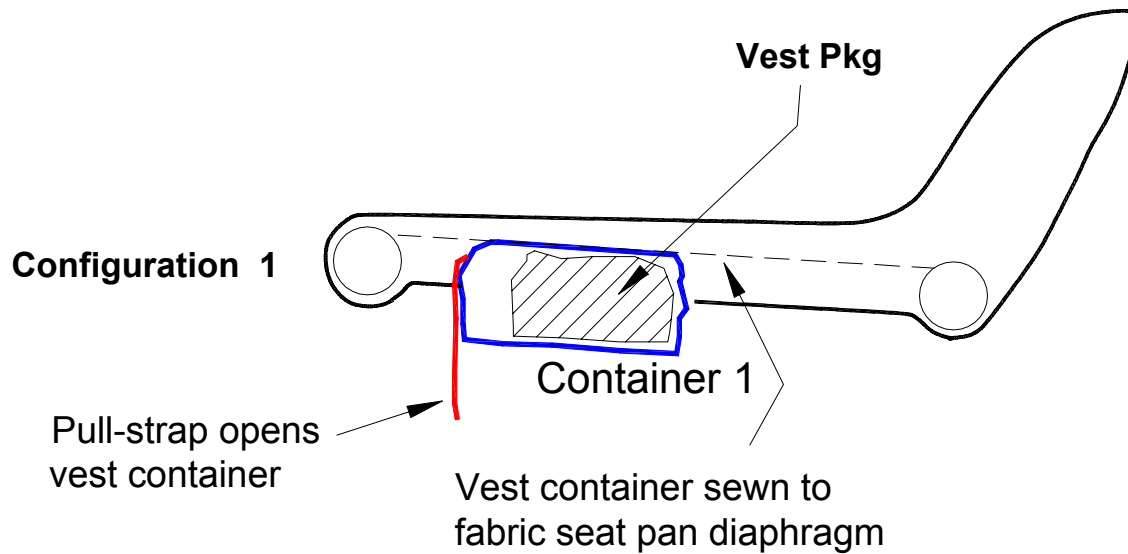
**Pull-strap to
open container**



Life Vest Container



Vest/Container Configuration 1

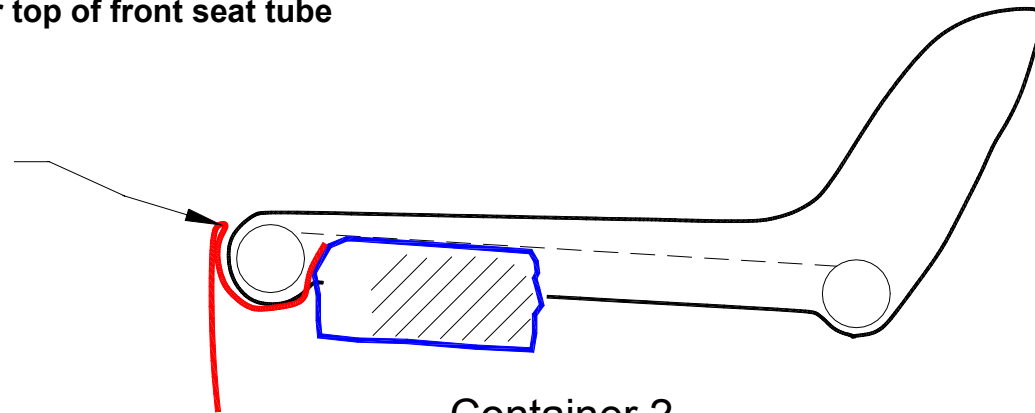




Vest/Container Configuration 2

Snap release near top of front seat tube

Configuration 2
Snap Position A



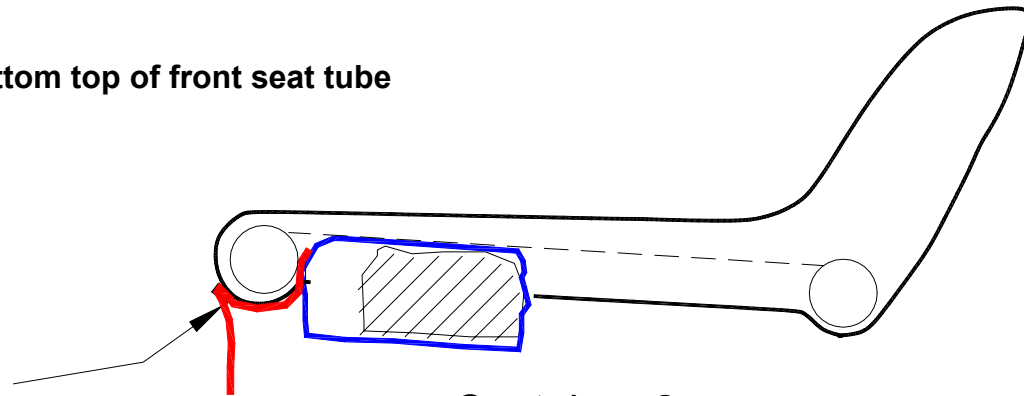
Container 2



Vest/Container Configuration 3

Snap release bottom top of front seat tube

Configuration 3
Snap Position B

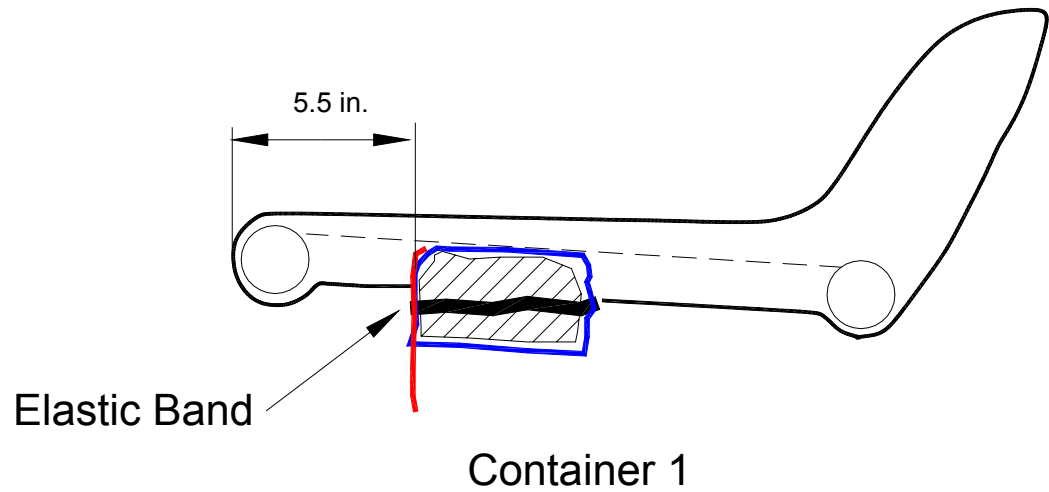


Container 2



Vest/Container Configuration 4

Configuration 4



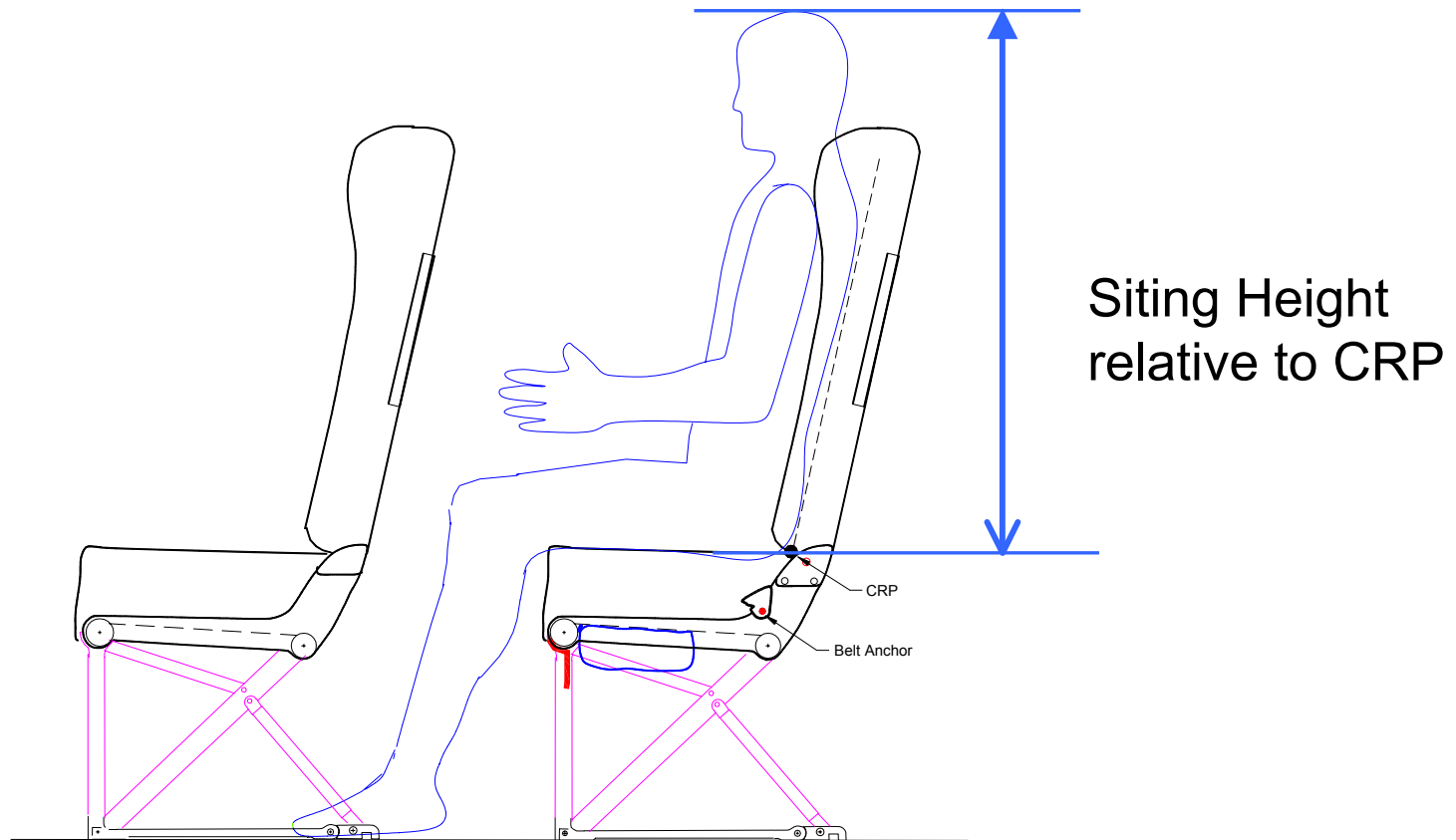


Human Subjects ...

- 134 adult subjects (18-65 years), selected from pool participating in concurrent research activity at CAMI
- In addition to randomly selected subjects, “large male” and “small female” subjects were specifically selected.
- Personal data (age, sex, weight, occupation), sitting height, and under-seat reach measurements were recorded.
- Each subject tested one time.



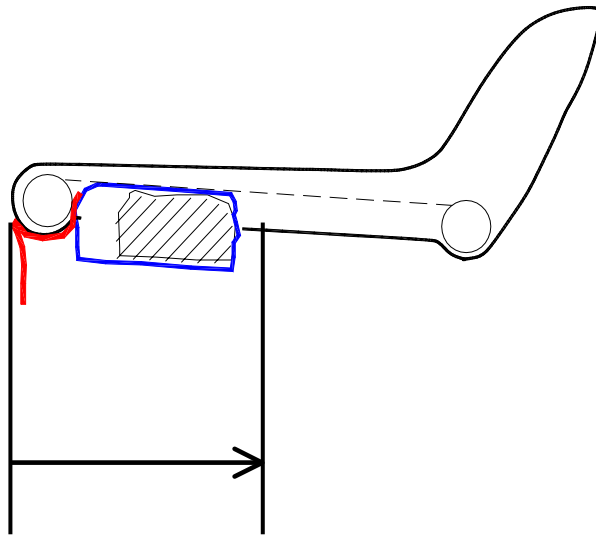
Sitting Height Measurement



Siting Height
relative to CRP



Under-Seat Reach Measurement



Under-seat reach distance





Subjects Anthropometry

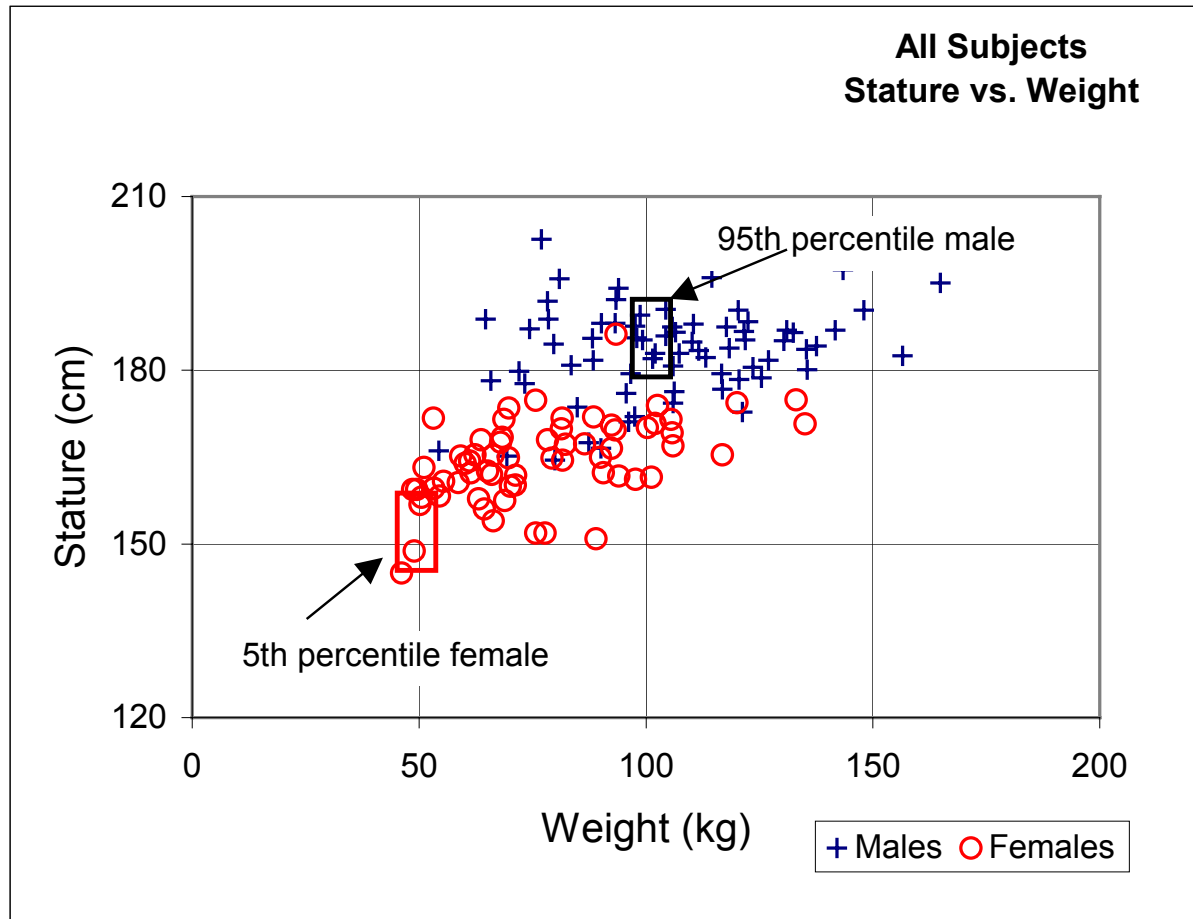
		Weight kg (lbs)		Stature cm (in)		Waist cm (in)		* Sitting Height cm (in)		**Under-Seat Reach cm (in)	
	N	Mean	σ	Mean	σ	Mean	σ	Mean	σ	Mean	σ
Males	70	104 (231)	23.1 (50.8)	183.4 (72.2)	7.9 (3.1)	107.7 (42.4)	17.3 (6.8)	87.4 (34.4)	3.8 (1.5)	18.3 (7.2)	7.9 (3.1)
Females	64	77 (170)	21.1 (46.5)	164.8 (64.9)	6.9 (2.7)	88.4 (34.8)	15.5 (6.1)	80.3 (31.6)	3.6 (1.4)	20.1 (7.9)	7.8 (3.1)

* Sitting height measured vertically from the top of subject's head to horizontal plane through the seat cushion reference point

Table 1

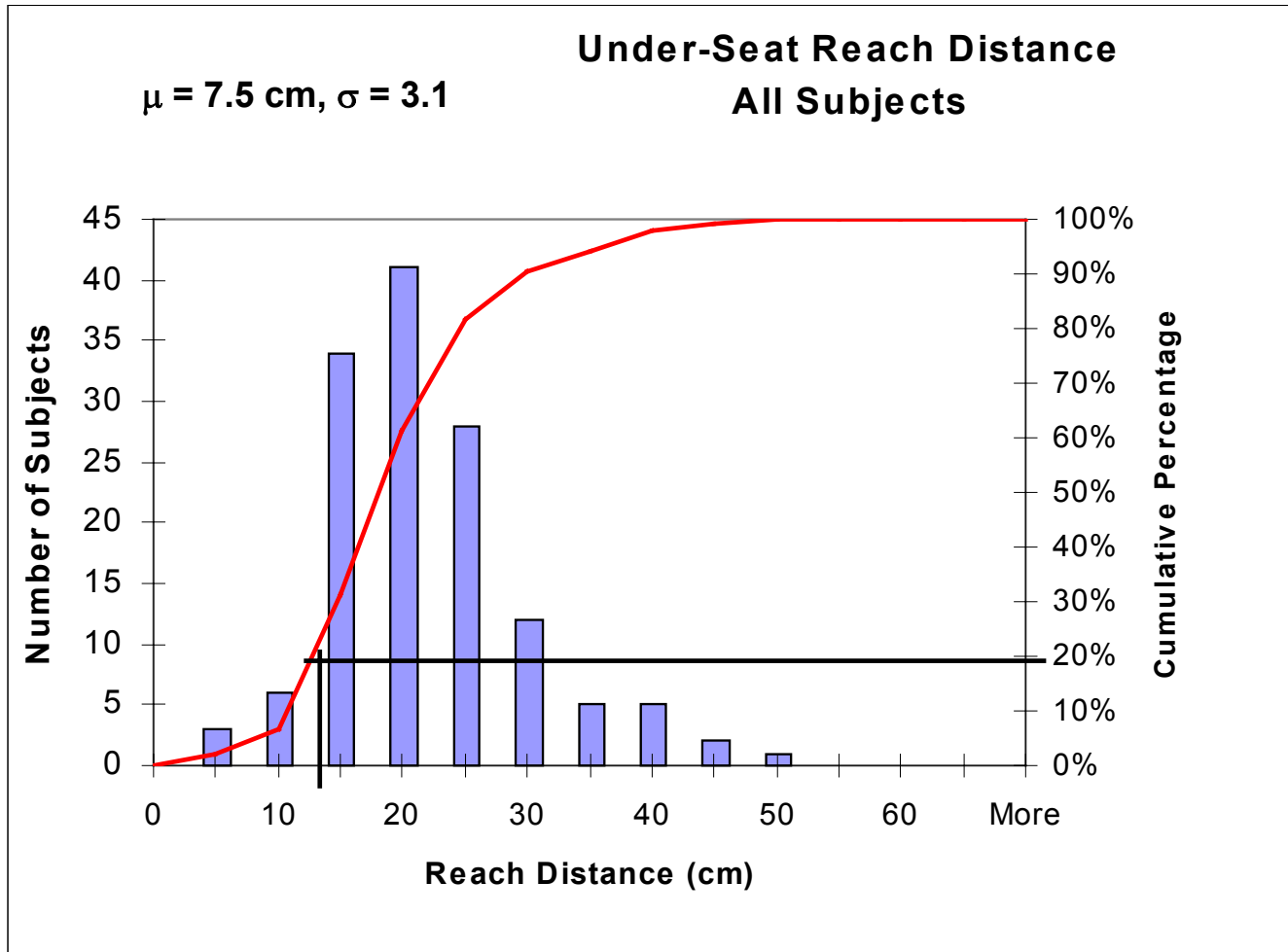


Subjects Anthropometry





Underseat Reach Measurements





Subject Instructions

➤ Leave seat belts fastened during test procedure.

➤ When LED illuminates :

- Lean forward, reach under seat open vest pouch
- Reach into pouch, remove vest
- Sit upright.

- Do not rush: “This is not an Olympic event.”



Example No. 1





Example No. 2





Example No. 3





Example No. 4

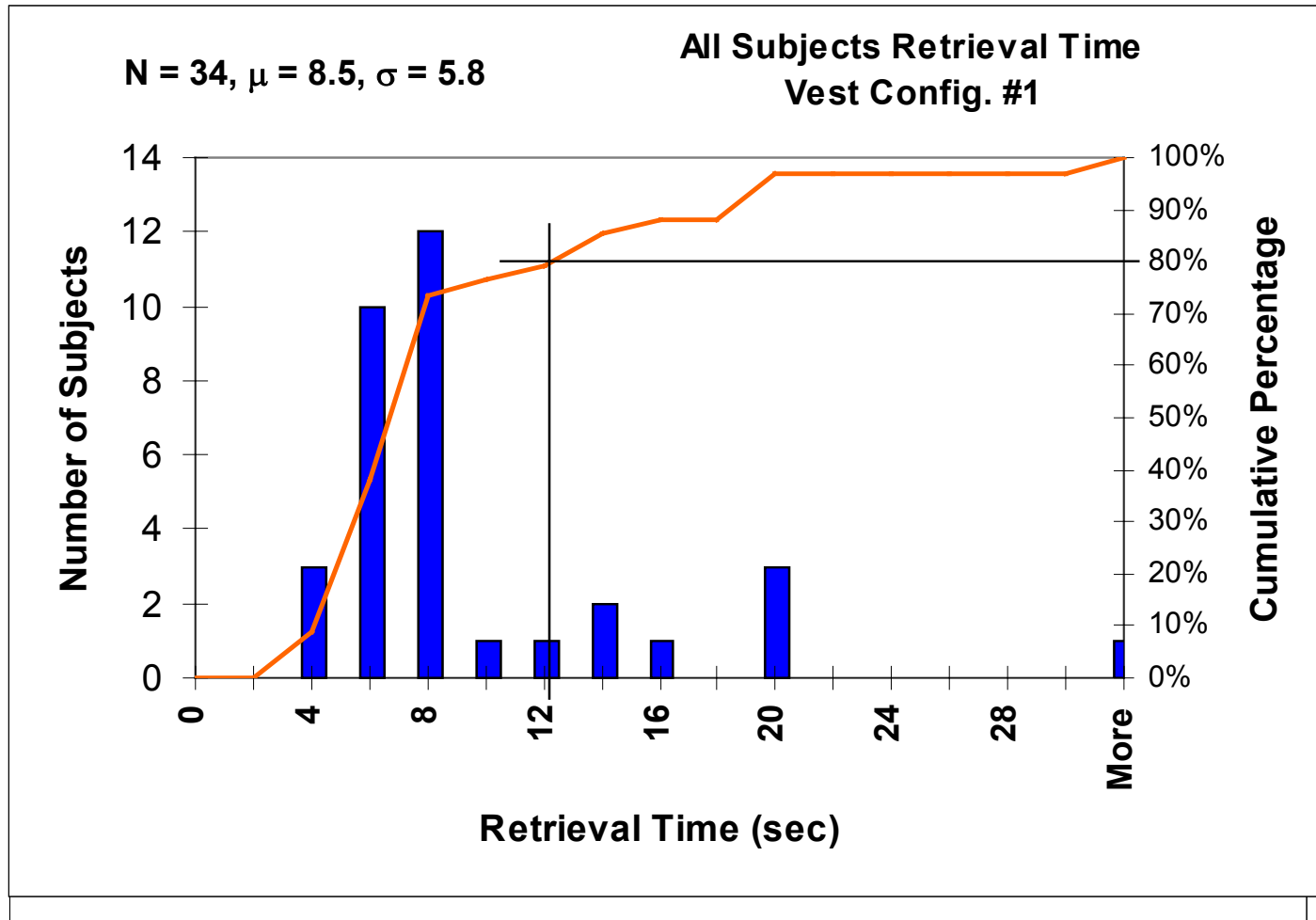




Results : Vest Retrieval Time

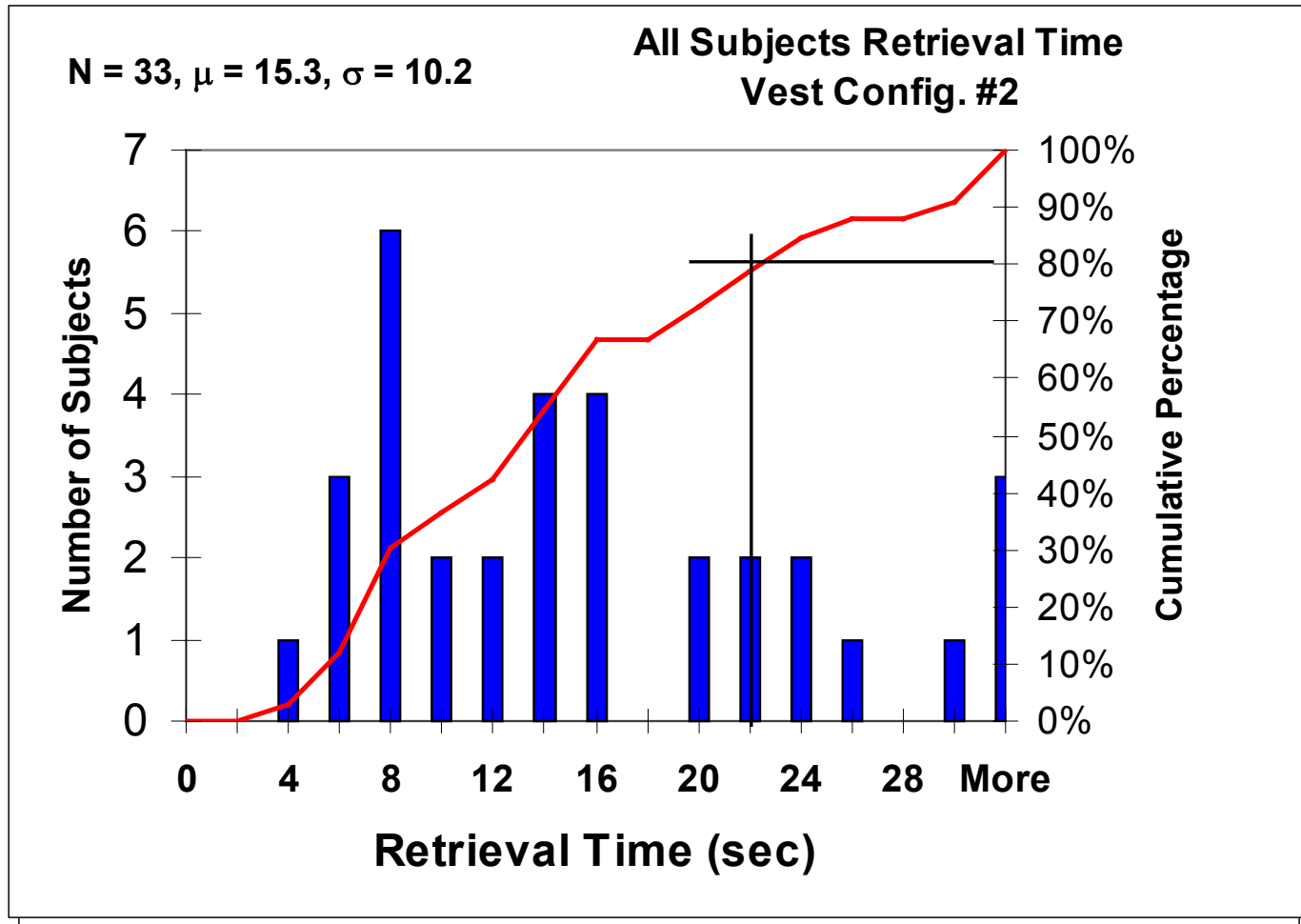


Retrieval Time - Configuration 1



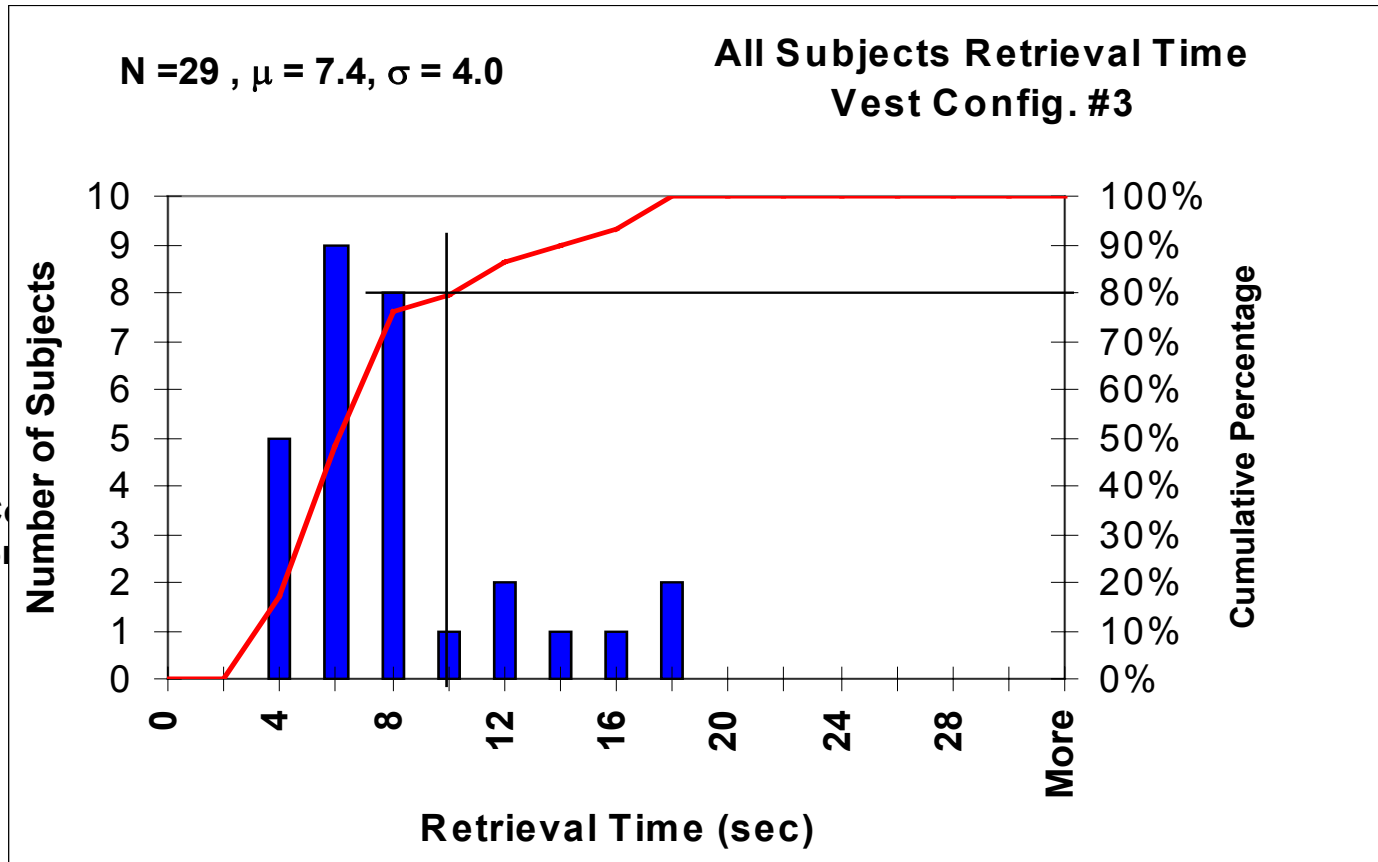


Retrieval Time - Configuration 2



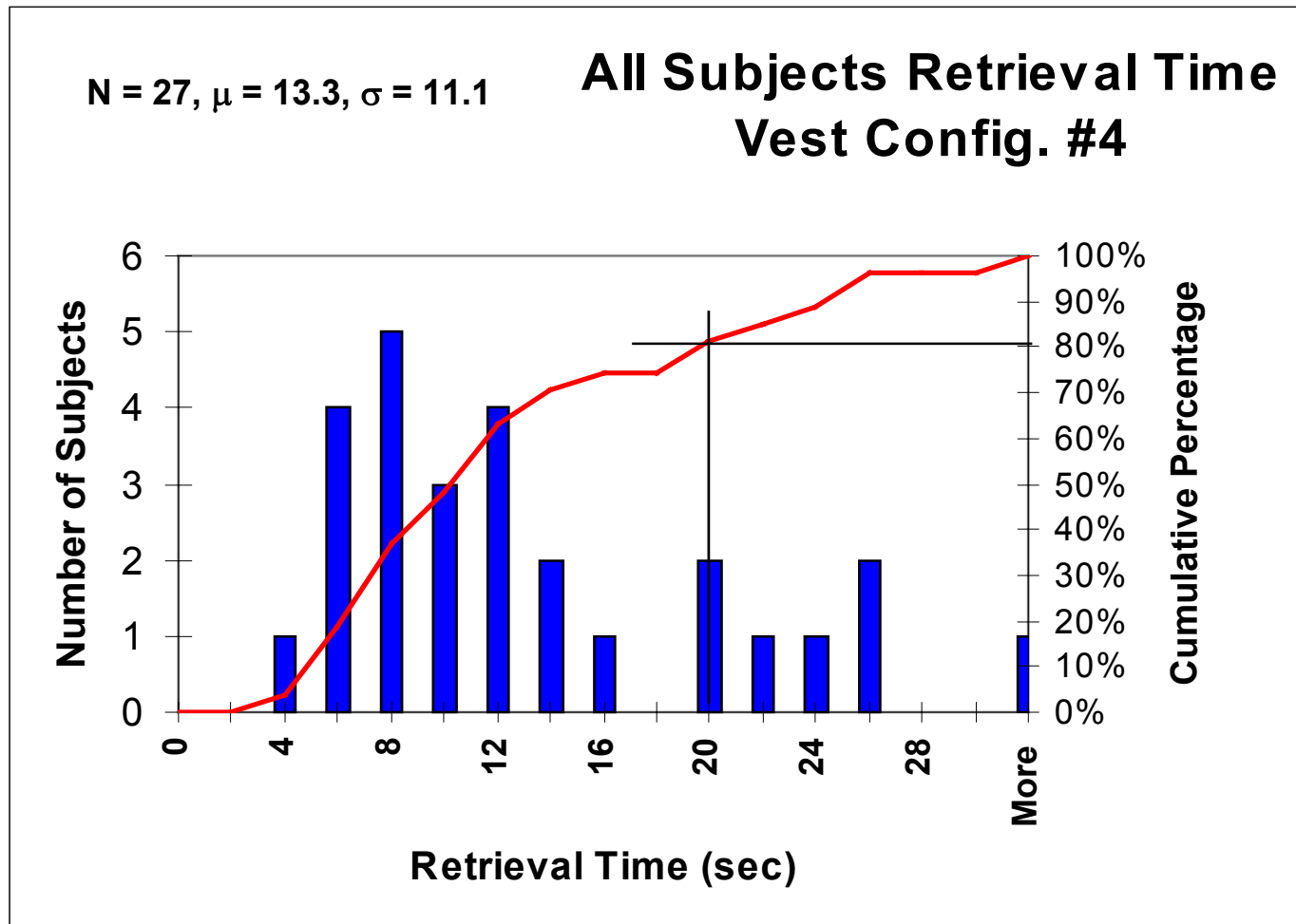


Retrieval Time - Configuration 3





Retrieval Time - Configuration 4





Results : Ease Assessment



Ease Assessment Method

- Enlisted the assistance of 11 outside evaluators
 - 4 Passenger seat manufacturers (engineers)
 - 1 Interiors/payloads engineer (Boeing)
 - 1 Cabin attendant
 - 3 FAA ACO staff engineers
 - 2 Office secretaries

- Each was provided a copy of the video tape for the complete test series, scoring instructions, and a scoring form.

- Evaluators were not provided with information regarding vest configuration or subject data



Ease Assessment Method

SCORE	ASSESSMENT	EXAMPLE OBSERVATIONS
1	Very Easy	Subject quickly and easily reached pull-tab, then removed vest in one continuous motion. No delays or difficulties observed.
2		
3	Easy, with minor difficulty	Subject successfully reached pull-tab AND removed vest <u>after first attempt</u> . Slight difficulty was observed, such as more than one tug on the pull-tab or more than one attempt to remove the vest package.
4		
5	Difficult, but successful	After repeated attempts and/or using different methods to open pouch and/or retrieve vest, the vest was extracted. The subject adjusted his/her "lean-over-posture" or reach path during the test.
6		
7	Very Difficult	Subject had great difficulty in reaching pull-tab, OR opening the pouch, OR it took too long to retrieve vest, OR the vest was not retrieved.



Ease Assessment Method

Vest Configuration	Average Score (All Subjects)	Average Retrieval Time (All Subjects)
1	3.3	7.8 Seconds
2	4.1	13.0
3	2.4	7.3
4	3.5	11.6



Ease Assessment Method

Statistical Analysis

1. Multiple Comparisons t-Test (Games-Howell)

(To determine if assessment scores from all evaluators indicate a significant difference between vest configurations)

Results: Significant Difference between Vest Configurations

2 and 3 ($p < 0.001$)

3 and 4 ($p < 0.001$)

2. Reliability Analysis - Scale Alpha (Cronbach's Alpha)

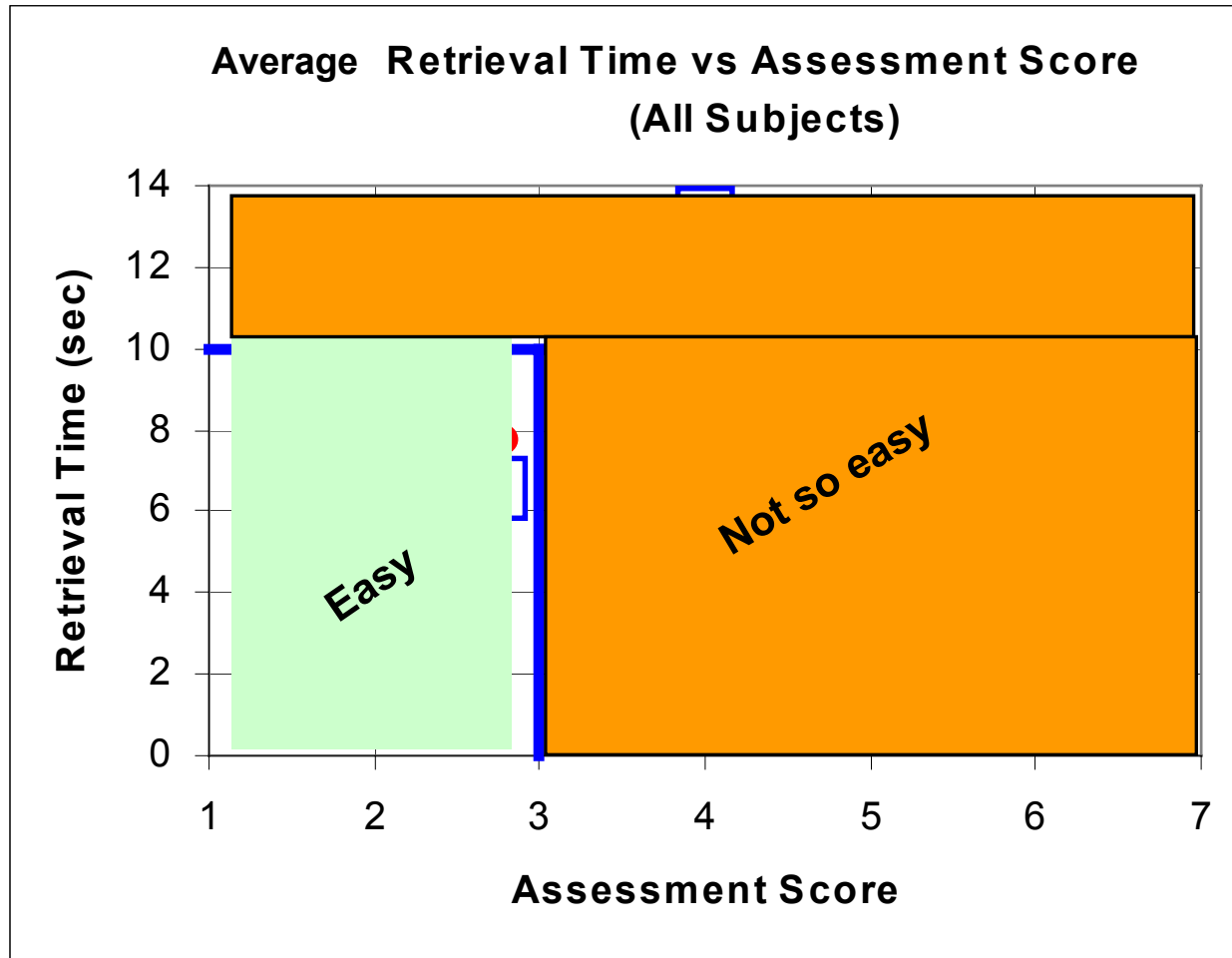
(To determine if any of the evaluator's scores differed significantly from the other evaluators' scores).

Results: 132 Tests, 11 Evaluators, $\alpha = 0.97$

e.g., the scores amongst the evaluators were consistent



Ease Assessment Method





Observations



Observations

The assessment of “Ease of Retrieval” for under-seat life vests is influenced by the following factors:

- **1. The time required to retrieve the vest from the container.
A retrieval time of >10 seconds is regarded as difficult**
- **2. Location of the pull-strap beneath the seat pan
> 5 inches from front of seat pan ---> difficult**
- **3. Pull angle to open container
(e.g., snap fastener in shear --> difficult)**
- **4. Size of occupant and seat pitch limitations on movement
(Large males exhibited more difficulty, longer retrieval time)**



Observations (cont'd)

- **The assessment of “Ease of Retrieval” was not affected by the evaluators job responsibilities or background.**

- **Guidance / standards may be developed to define installation factors, which should reduce the inconsistencies and subjectivity of life vest installation approval on airplane passenger seats.**