

Evidence for flotation requirements used to qualify aircrew life preservers (LPs)

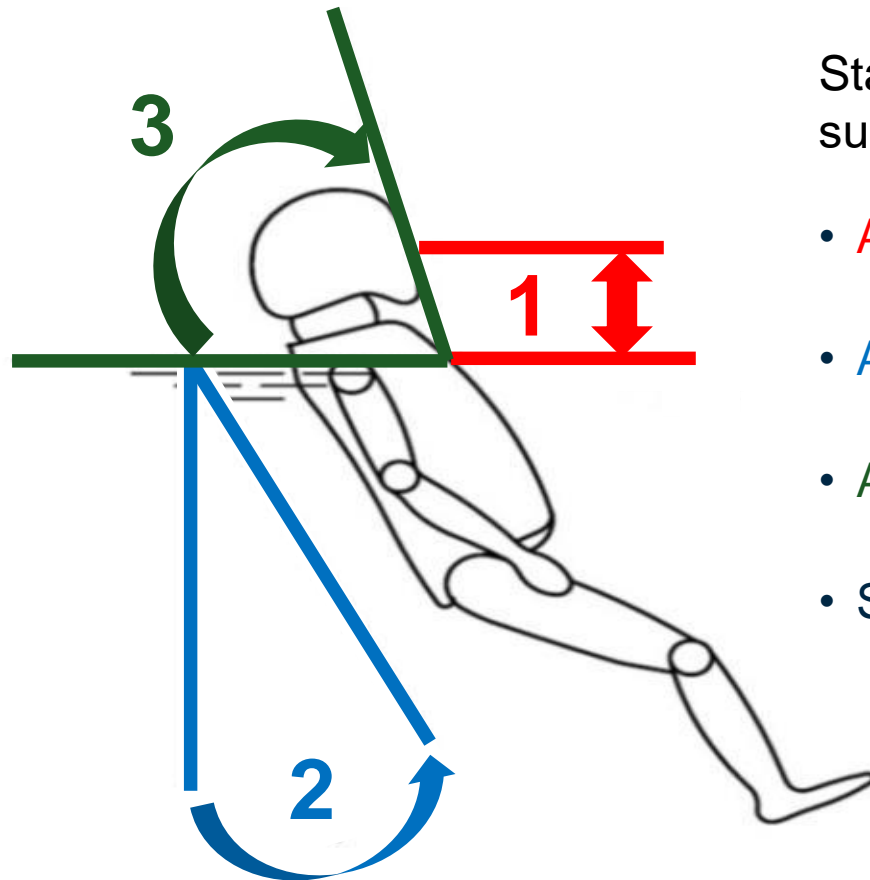
Dr Andy Weller
asweller@QinetiQ.com

SAFE Symposium Stockholm
April 9th 2019



Qualification of LP flotation performance

- Follow international standards (non-specific applications)
 - *ISO 12402:2 (2006) – Performance level 275 N*



Static (calm water) measures with subjects in 'swim wear'

- **Airway freeboard (1), > 120 mm**
- **Angle of body plane (2), > 30° < 90°**
- **Angle of face plane (3), > 40° < 90°**
- **Self-righting, < 5 s**

Drivers & objective of review

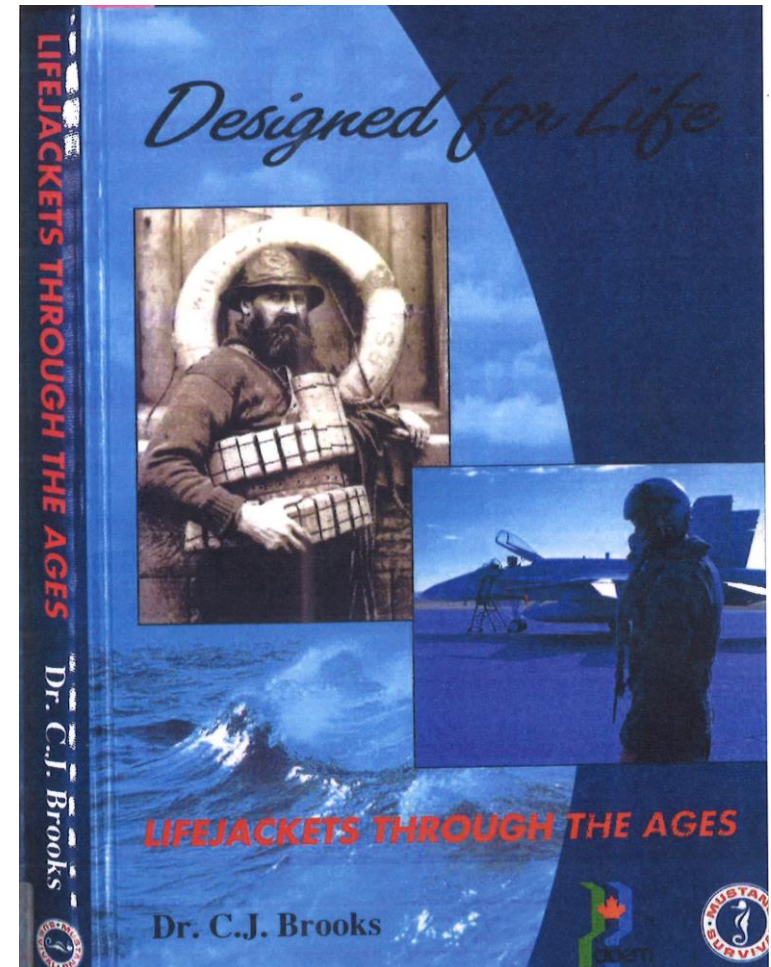
- Recent issues relating to the modification of LPs to meet the flotation criteria
- RTS concerns of LPs that have been qualified under different criteria
- Stakeholders have posed the following questions:
 - *What is the evidence underlying the flotation performance measures?*
 - *Are they relevant for aircrew immersed in realistic sea states wearing representative AEA?*
 - *What is the implication of qualifying aircrew LPs against less stringent performance measures?*
- The review set-out to address these questions and inform future qualification of aircrew LPs and risk to duty holders

Approach & scope

- Limited review of the open literature & MoD reports (latter sourced by Dstl)
- Personal communication with SMEs with experience on relevant standards committees
- Review of validity rather than methodological issues relating to the flotation measures

Content of presentation

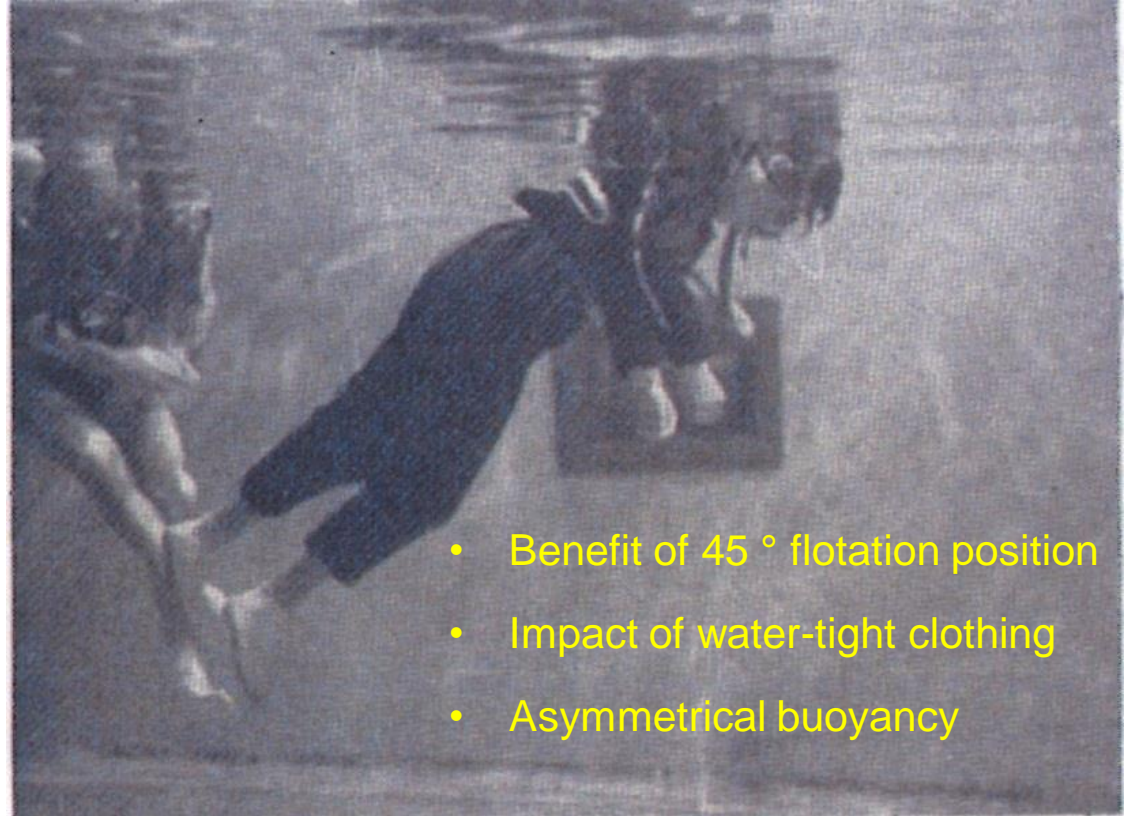
- Evolution of flotation performance requirements
- Evidence/validity of flotation requirements
- Summary of findings
- Implications for qualifying aircrew LPs
- Way forward



Brooks (1995)

Evolution of flotation criteria

- SOLAS established after Titanic disaster
- Second World War
 - First in-water assessments
 - Talbot review
- IMO (under SOLAS Convention)
 - 1948: LP shall hold up the head
 - 1960: SR requirement specified (no time limit)
 - 1983 (1974):
 - **Freeboard** > 120 mm
 - **Body angle** > 20 < 50 °
 - Self righting < 5 s



- Benefit of 45 ° flotation position
- Impact of water-tight clothing
- Asymmetrical buoyancy

From Macintosh & Pask (1957)

British, European & International & EASA Standards

Standard	Year	Status	Airway freeboard (mm)	Body plane angle (°)	Face plane angle (°)	Self righting (s)	Other
BS 3595	1963	Superseded	-	-	-	Rapid	n=?
BS EN 399 (275 N)	1994	Superseded	> 100	> 30 < 90	-	< 5	n=5
BS EN ISO 12402:2 (275 N)	2006	CURRENT	> 120	> 30 < 90	> 40 < 90	< 5	n=8
ISO / DIS 12402:2 (275 N)	2012	DRAFT	> 120	Average > 30 [no individual < 20]	Average > 40 [no individual < 30]	< 5	n=12
ETSO- * 2C504 Hostile Seas	2006	CURRENT	> 120	> 60 (FROM HORIZONTAL)	-	< 5	n=?

* Dress state not defined but specifies testing of relevant LP / Immersion Suit combination

Evidence/validity: Static flotation measures

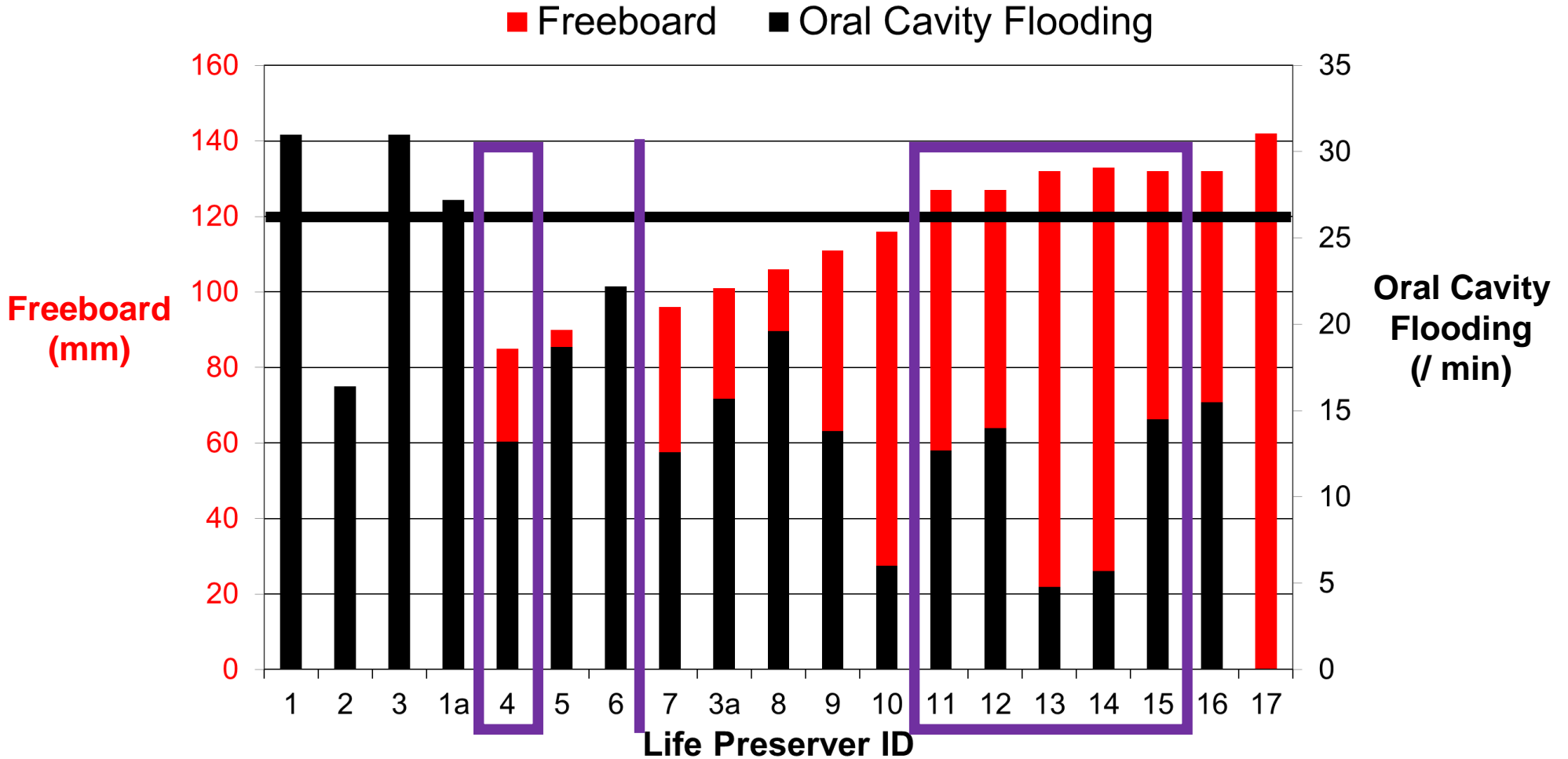
- Difficult to objectively assess the flotation performance of LPs in realistic sea states
- Currently rely on static measures to predict dynamic performance but without a scientific basis
- Static flotation criteria based on SME 'judgement' and indirect evidence from studies of immersion manikins in wave tanks
 - Standards have been written for the approval of the LP in still water and '**RESET**' to accommodate rough water conditions (*Brooks, 2006; page 105*)
 - User is advised to take account of clothing which will influence flotation – but how can this be applied?
 - Airway protection (splashing & passive inhalation of water) quantified in manikins and related to static flotation measures

RAMM



Brooks (1995)

Evidence/validity: Static vs. dynamic performance



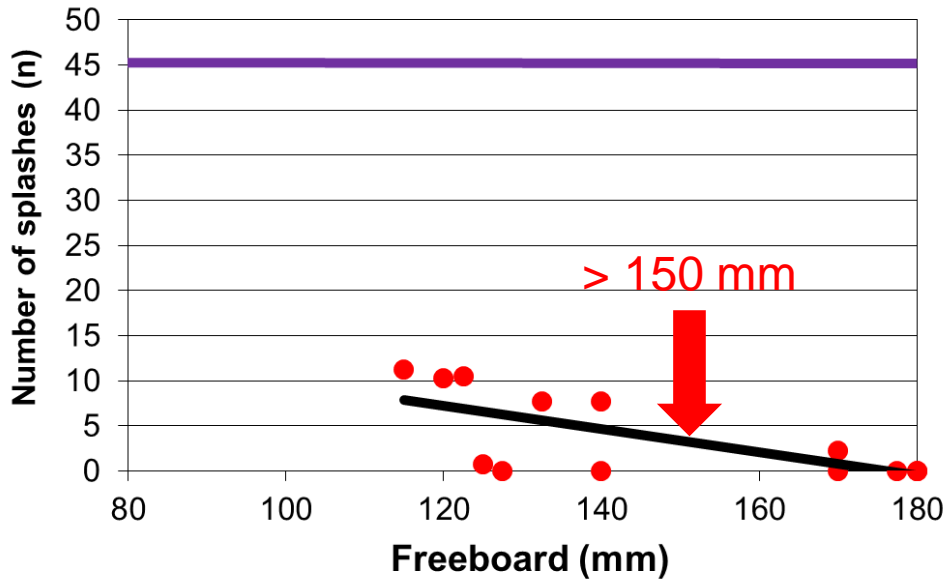
From Herman & Störmer (1985)

Evidence/validity: Influence of clothing & sea state

Critical airway immersion

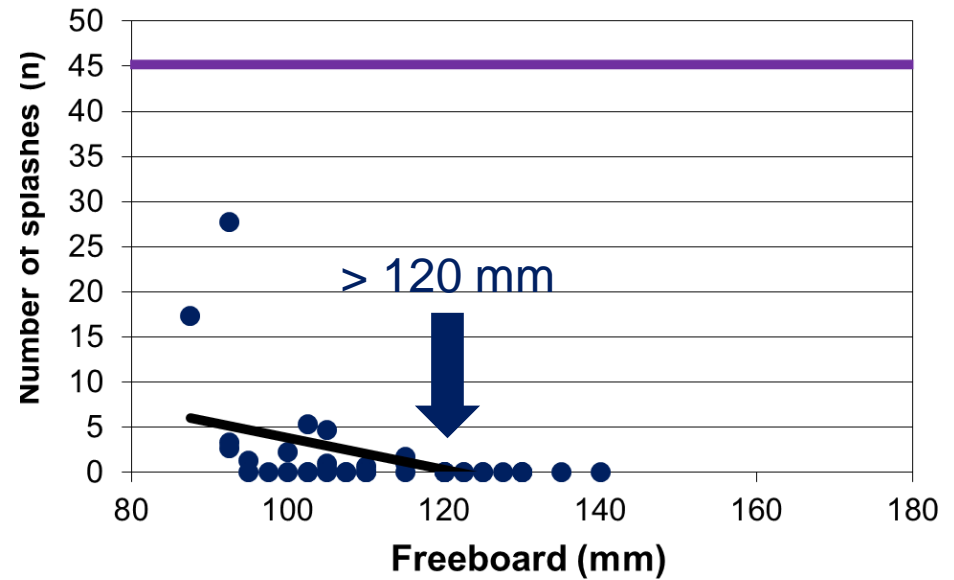
MODERATE

STANDARD CLOTHING + LP



- Self righting performance = 100 %
- Freeboard = 146 mm
- Total airway protection = 46%

IMMERSION SUIT + LP



- Self righting performance = 46 %
- Freeboard = 112 mm
- Total airway protection = 67%

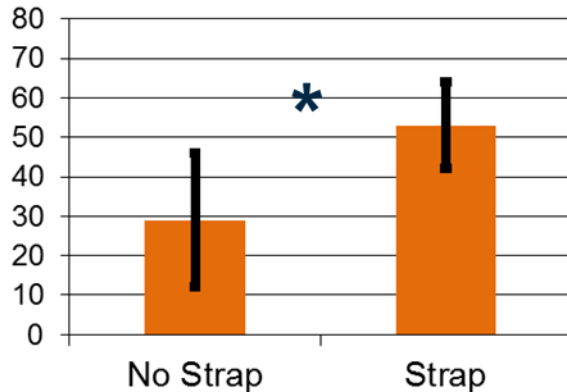
From Light & Slater (1991)

ROUGH = performance worse

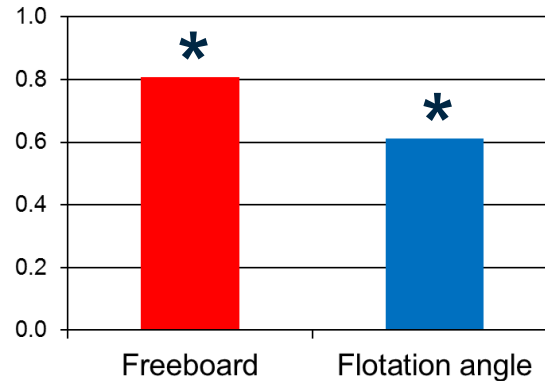
Evidence/validity: Variability in measures and more correlations

- Recent study of flotation performance with human & manikin elements
- Human: Assessment of 3 types of 150 N LPs
 - Static flotation measures
- Manikin: Assessment of 3 types of 150 N & 275 N LPs
 - Static measures & time to aspirate a lethal dose of water

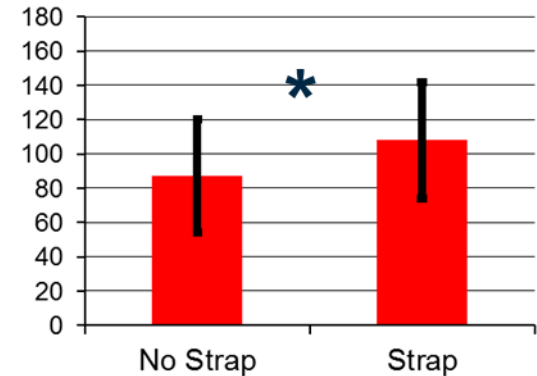
Time to aspirate lethal dose of water (min)



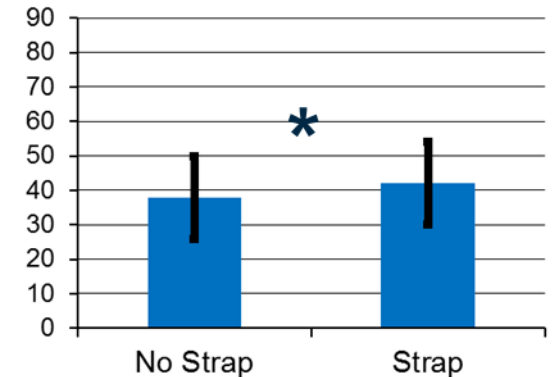
Correlations with time to aspirate lethal dose



Freeboard (mm)



Flotation Angle (°)



From Lunt et al. (2014)

Summary of findings

- No direct evidence to support the use of static flotation measures to predict the performance of LPs in realistic sea states
- The static flotation measures are likely based on SME judgement and indirect evidence from studies with instrumented manikins in wave tanks, but dependent on:
 - Sea state
 - Clothing worn
 - Large variability in measures (so difficult to apply absolute performance criteria)
- **ISO 12402:2 (2006)** flotation criteria apply to 'swim wear', but:
 - Freeboard takes account of sea state (although evidence not known)
 - The user must take account of clothing and equipment carried (no direction as to how)
 - Immersion clothing reduces freeboard BUT airway protection may not be compromised
 - Is 120 mm relevant?

Implications for qualifying aircrew LPs

- The static flotation measures defined in **ISO 12402 (2006)** and **ETSO-2C504 (2006)** provide the only means of qualifying aircrew LPs and are applicable to representative subjects wearing the full range of aircrew clothing schedules
- It is possible that immersion protection schedules improve airway protection at a given freeboard when wearing an aircrew LP, but there is no evidence to support lowering the 120 mm freeboard requirement

Way forward

- Pool studies using immersion manikins in wave tanks are recommended to evaluate the airway protection of aircrew LPs with different clothing schedules and relate this to the static flotation measures that can be routinely assessed by test houses
- The International Standards Organisation should be consulted as to the status of the flotation criteria proposed in **DRAFT ISO 12402 (2012)**
 - Qualification based on meeting average thresholds (but with individual limit values) for flotation angles – why not freeboard?
- Consideration should be given to the qualitative evaluation of aircrew LPs in wave-tanks

Acknowledgement

This work was funded by the UK MoD through the Defence Science & Technology Laboratory (Dstl)

QINETIQ