

# Review of advice to RAF aircrew for operating in extreme thermal environments

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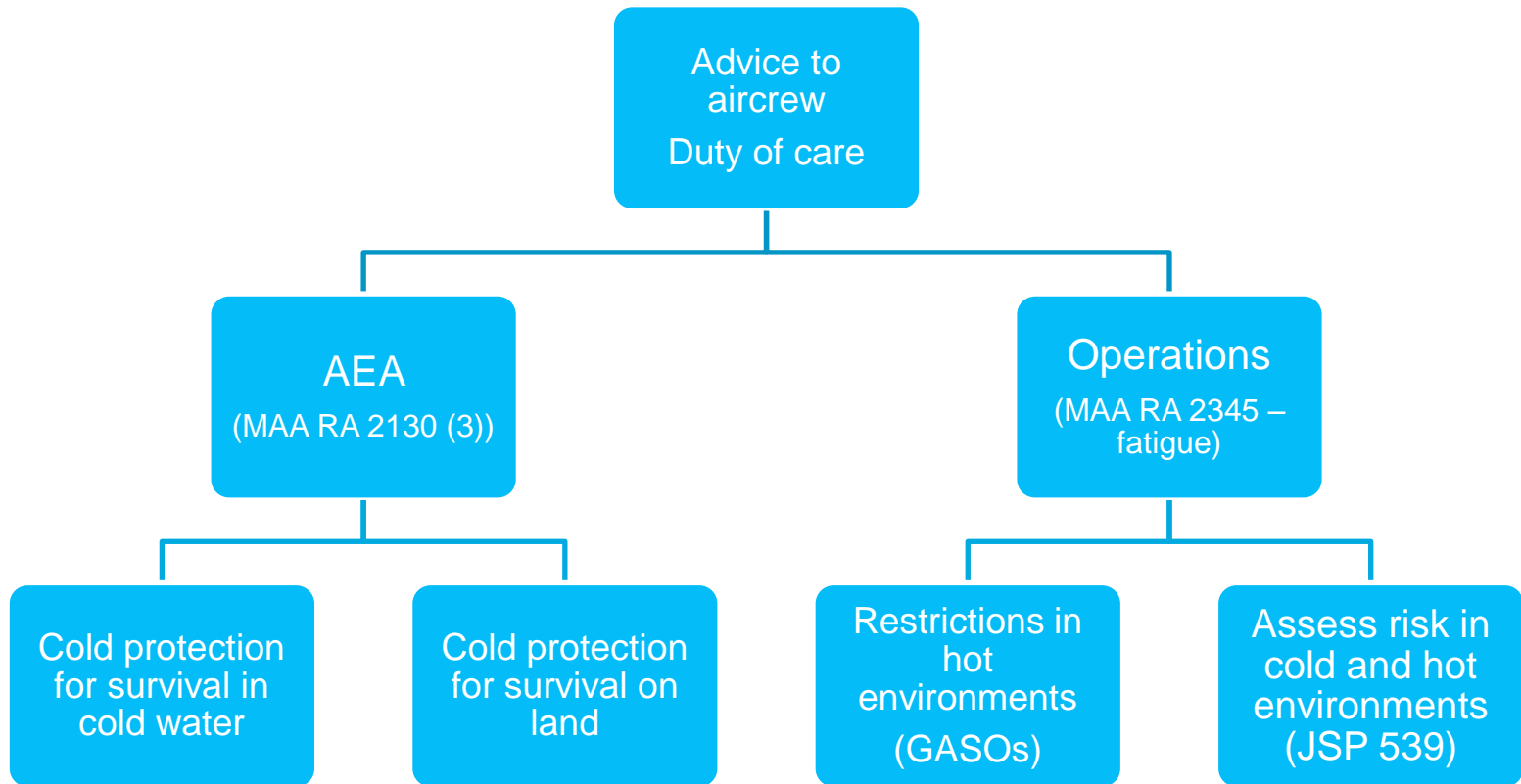
# Presentation Overview

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1. Background on current advice to aircrew in extreme thermal environments
2. Review of UK aircrew “dress-to-survive” guidelines for cold-water immersion
3. Proposed revision of guidelines for cold-water immersion

The studies were conducted on behalf of RAF Centre of Aviation Medicine (RAF CAM)

# RAF advice to aircrew for operating in thermal extremes

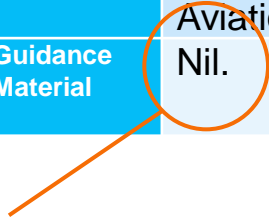


GASOs = Group Air Staff Orders, JSP = Joint Service Publication, MAA RA = Military Aviation Authority Regulatory Article

# RAF advice to aircrew for operating in thermal extremes

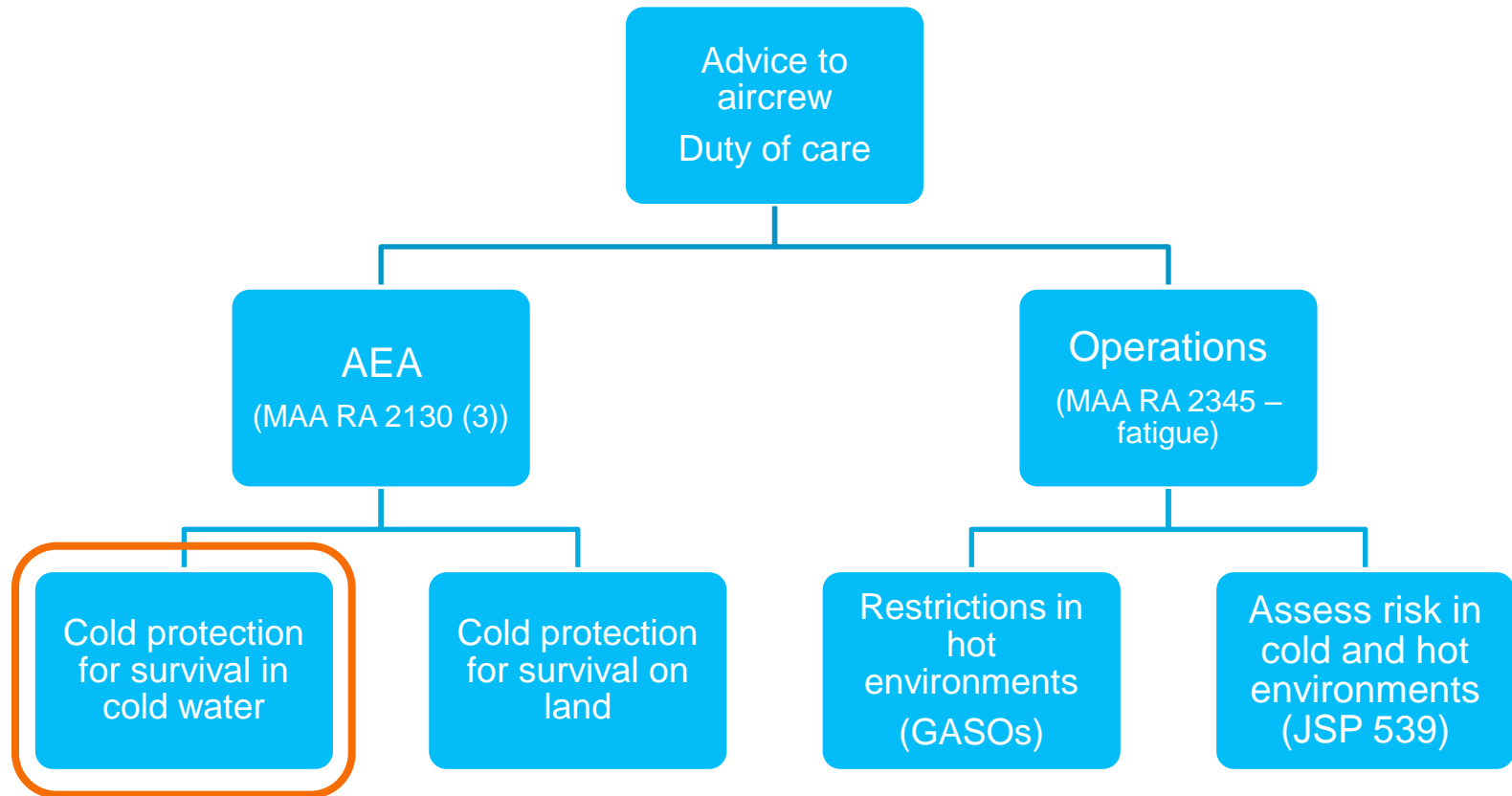
MAA RA 2130(3):

Regulation	<b>Wearing and Carriage of Aircrew Equipment Assemblies (AEA) and Safety Equipment (SE)</b> 2130(3) Aviation Duty Holders and AM(MF) shall issue detailed orders covering the wearing and carriage of approved AEA and SE by aircrew, supernumerary crew and passengers in all aircraft under their AoR.
Acceptable Means of Compliance	For aircraft with a Release To Service (RTS), only AEA and SE approved in the Aircraft Document Set (ADS) should be worn or carried. For non-RTS aircraft, Aviation Duty Holders and AM (MF) Orders and/or Defence Contractor Flying Organizations' Clearances should detail the AEA and SE to be worn and carried. Modification of Equipment. AEA and SE should not be modified in any way without approval of the relevant equipment authority. Where no equipment authority exists, approval should rest with the Aviation Duty Holder or AM (MF).
Guidance Material	Nil.



No longer any guidance on 'dress-to-survive' advice for cold water immersion

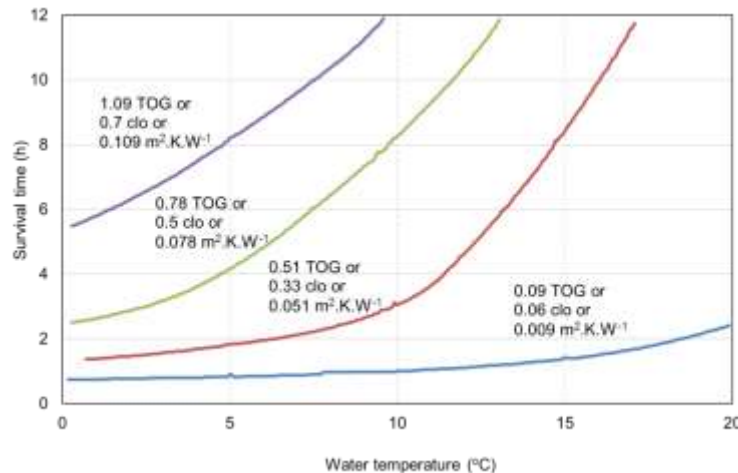
# RAF advice to aircrew for operating in thermal extremes



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# RAF advice to aircrew for operating in thermal extremes

Previous guidelines based on ASIC standard:



	Assembly description	Total thermal resistance (immersed)	
		TOG	(m².K.W⁻¹)
No immersion Coverall	A Jockey underpants, Aircrew shirt cotton olive drab Mk 2, Aircrew coverall Mk15/14A	0.10	0.009
	B A + Vest and drawers long cotton ribbed in place of jockey underpants	0.13	0.012
AEAs including Mk 10 Immersion coverall	C Vest and drawers long cotton ribbed, Aircrew shirt cotton olive drab Mk 2	0.50	0.050
	D C + Jersey heavy olive drab	0.60	0.060
	E C + Coverall aircrew inner Knitted Mk 1	1.15	0.115
	F C + 2 x Coverall aircrew inner Knitted Mk 1	1.40	0.140
	G C + Inner coverall Mk 3	1.20	0.119
AEAs including Inner Immersion coverall	H Vest and drawers long cotton ribbed. Aircrew shirt cotton olive drab Mk 1	0.40	0.040
	I H + Jersey heavy olive drab	0.50	0.050
	J H + Coverall aircrew inner knitted Mk 1	1.05	0.105
	K J + Jersey heavy olive drab	1.15	0.115
	L C + 2 x Coverall aircrew inner Knitted Mk 1	1.30	0.130

- ‘Survival’ curves based on Wissler mathematical model and brief instructions
- A graph on how to account for water ingress into the immersion suit
- Similar model predictions for survival on land in tables and a Windchill chart

# Review of guidance on AEA for cold-water immersion

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## Approach:

- Comparison of UK guidance against guidance provided to non-UK aircrew in other countries
- Comparison of UK Wissler model used to create the 'survival' curves with other models
- Benchmark existing/future AEA against existing thermal insulation data

# Review of guidance on AEA for cold-water immersion

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Benchmark against non-UK advice to aircrew:

- Requested information from TTCP participating countries and performed an open literature search on the internet e.g. dtic.mil
- ASIC standard and STANAG – same ‘survival’ curves as UK
- US Navy provide similar advice in tabular format (matrix table of clothing configurations and colour coding), don immersion suit  $\leq 10$  °C water temperature
- US Air Force has a similar document to JSP 539 for assessment of risk of cold injury but nothing for immersion



# Review of guidance on AEA for cold-water immersion

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## Verification of Wissler model:

- Comparison against other models used: Cold Exposure Survival Model (CESM), NAVAIR Wissler model
- Limited data available – different approaches, not all information published
- CESM – UK Wissler model generally more conservative (cautious) results
- NAVAIR Wissler – UK Wissler model generally more conservative (cautious) results (different assumptions used in the measurement of thermal insulation and the model)

# Review of guidance on AEA for cold-water immersion

Benchmark thermal insulation data:

- Only data available for non-Typhoon AEA were from 1980's
- Typhoon AEA measured but modified method of calculating immersed thermal insulation from test results – lack of consistency between data
- Future Aircrew Clothing System (FACS) is to come into service and there is no immersed thermal insulation data



# Proposed revision of cold-water immersion guidance

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The proposed revision consisted of:

- De-emphasis of 'survival' times and 'survival' curves
- Colour coded zones for determining thermal insulation requirement
- Matrix style tables of AEA clothing configurations (platform specific)
- More explicit step-by-step instructions – more practical given the information available to Duty Holders
- Removal of 'leakage' advice

# Proposed revision of cold-water immersion guidance

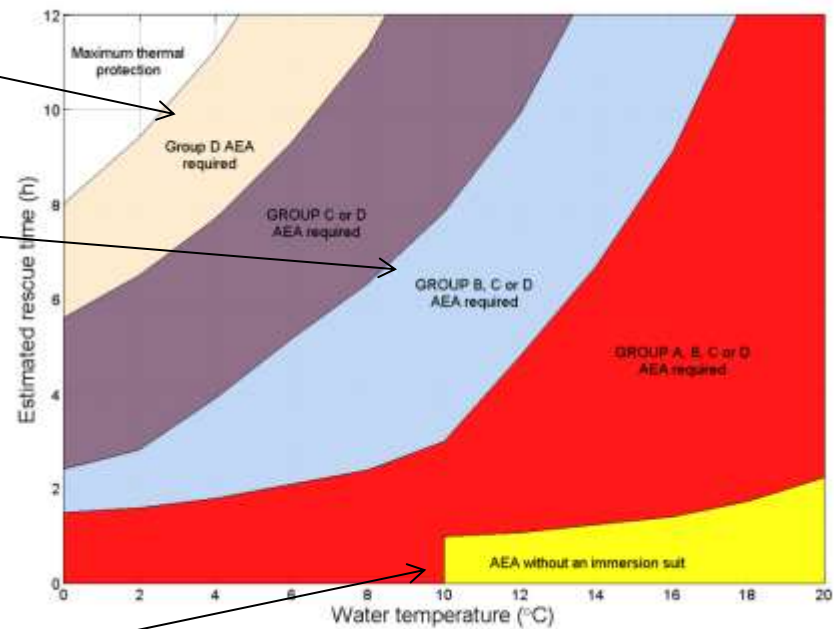
Revised 'survival' curves:

Specific curve to account for maximum thermal insulation

Colour coded zones

Estimated rescue time NOT 'Survival time'

Accounts for GASO requirement to wear immersion suit



Example for AEA of all platforms except Typhoon

# Proposed revision of cold-water immersion guidance

New table to represent AEA clothing and equipment:

Combination of clothing layers represented in a matrix table

	AEA items for Typhoon							Immersed thermal resistance	
	General coverall	Winter-land coverall	Immersion coverall	Roll neck/shirt	TPG: shortie	TPG: longie	TPG: combie	Group	(clo)
Without immersion suit	x1	-	-	x1	-	-	-		
	-	x1	-	x1	Any combination				
With immersion suit	-	-	x1	-	x1	-	-	E	0.41
	-	-	x1	-	-	x1	-	F	0.54
	-	-	x1	-	-	-	x1	F	0.56
	-	-	x1	-	-	x1	x1	G	0.69

Colour coded to aid decision making

Example for Typhoon AEA

# Proposed revision of cold-water immersion guidance

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The limitations of the revision are:

- Lack of data for non-Typhoon AEA
- Historical inconsistencies in the method of calculating thermal insulation
- New AEA (FACS) to come into service without any thermal insulation data
- Lack of research quantifying impact of conditions outside of the assumptions (e.g. rough seas)
- No guidelines for dressing for abandonment on land in cold conditions

# Summary

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- A revision of 'dress-to-survive' guidance has been proposed focussing on improved ease of use and ensuring all aircrew platforms are addressed and the most up-to-date data is included
- The guidance can be further improved through:
  - Measurement of current and future AEA thermal insulation
  - Standardised approach to measurement and calculation of thermal insulation
  - Research to quantify the impact of rough seas and optimising AEA in terms of thermal burden
  - Inclusion of guidance for dressing for abandonment on land in cold conditions

# Acknowledgements

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