UK review of ANEP/MNEP 86 for review and comment at NATO SMERWG

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ANEP/ MNEP 86 - TECHNICAL AND MEDICAL STANDARDS AND REQUIREMENTS FOR SUBMARINE SURVIVAL AND ESCAPE
Edition A Version 1 dated July 2014

Collective comments presented from:

- Submarine atmosphere toxicology
- INM Underwater Medicine
- UK equipment authority

ANEP/ MNEP 86 - TECHNICAL AND MEDICAL STANDARDS AND REQUIREMENTS FOR SUBMARINE SURVIVAL AND ESCAPE

Generic comments:

It would be beneficial to all nations if the document references values in both Bar / Torr, %vol / ppm etc

Phrasing in the document should move away from Man / Male / Female and use crew / person(s) and generic phrases such as they them etc

CHAPTER 1 - MINIMUM CONDITIONS FOR SURVIVAL IN A DISTRESSED SUBMARINE (DISSUB) PRIOR TO ESCAPE OR RESCUE

Specific comments on content:

Para ref	Existing content	Proposed
Para 1.3 General Details	The longer the survivors spend in the DISSUB the more likely the environmental conditions will deteriorate and result in adverse affects	Adverse effects
Para 1.3 General Details	Many of the DISSUB environmental factors are interrelated and time dependant.	Dependent
Para 1.A.1 DISSUB INTERNAL PRESSURE	This magnitude of exposure will result in a deterioration of lung function due to pulmonary oxygen toxicity that gets progressively worse with prolonged exposures above an oxygen partial pressure of 0.5 bar	Insert text
Para 2 DISSUB INTERNAL PRESSURE	The safety of escape is dependant on the type of escape system being used (national variation), the depth of the DISSUB and the internal pressure within the DISSUB.	Dependent

CHAPTER 1 - MINIMUM CONDITIONS FOR SURVIVAL IN A DISTRESSED SUBMARINE (DISSUB) PRIOR TO ESCAPE OR RESCUE

Specific comments on content:

Para ref	Existing content	Proposed
Para 3a O_2 consumption	DISSUB has been shown to range from 20 to 40 litres/man /hour at STP	The UK have extended this to 20-50Ltrs/person/hour?
Para 3b O_2 usage	27 litres /man/hour at STP	INM report 2015:032 suggests the Mean average for O_2 when Working, resting and sleeping is 32ltrs / person / hr at STP. In DISSUB, (after the initial event, you are likely to be conserving energy more, and be on the lower end of the O_2 requirement scale which was found to be 22 ltrs / man / hr. If you take the upper and lower value from this report and the divide by 2 the value would suggest 27ltrs / person / hr is credible as a requirement. (32+22 / 2 = 27)

CHAPTER 1 - MINIMUM CONDITIONS FOR SURVIVAL IN A DISTRESSED SUBMARINE (DISSUB) PRIOR TO ESCAPE OR RESCUE

Specific comments on content:

Para ref	Existing content	Proposed
Table 1A-1 acute affects of hypoxia	0.15bar Concentration on and reliability of tasks slightly impaired	BR1326 states Concentration on and reliability of tasks SERIOUSLY impaired at this level
Table 1A-1 acute affects of hypoxia	0.13bar Co-ordination affected; respiratory effects stimulated by hypoxia	BR1326 states Coordination and mental abilities affected: respiratory effects stimulated by hypoxia
Para 3e - Oxygen	Cerebral oxygen toxicity may occur if the partial pressure of O_2 exceeds 1.6 bar;	Current diving recommendation for the onset of CNS O_2 toxicity is 1.7 bar

CHAPTER 1 - MINIMUM CONDITIONS FOR SURVIVAL IN A DISTRESSED SUBMARINE (DISSUB) PRIOR TO ESCAPE OR RESCUE

Specific comments on content:

Para ref	Existing content	Proposed
Para 3f - Oxygen	Above a fractional concentration of 23 % oxygen becomes a significant fire hazard	The UK uses 22% as the limit for atmosphere control
Para 4a - Oxygen	oxygen partial pressure between 0.15 bar and 0.5 bar (physiological matters);	Remains physiologically appropriate and will leave personnel functional to complete DISSUB tasks.
Para 4b - Oxygen	Partial pressure of oxygen does not fall below 0.13 bar	PP Below 0.13 bar - escape and rescue activities could be compromised.

CHAPTER 1 - MINIMUM CONDITIONS FOR SURVIVAL IN A DISTRESSED SUBMARINE (DISSUB) PRIOR TO ESCAPE OR RESCUE

Specific comments on content:

Para ref	Existing content	Proposed
Para 5a – Carbon Dioxide production	23 litres/man/hour at STP	INM report 2015:032 suggests the Mean average for CO_2 when Working, resting and sleeping is 28ltrs / person/ hr at STP. In DISSUB, (after the initial event, you are likely to be conserving energy more, and be on the lower end of the CO_2 requirement scale which was found to be 19 ltrs / man / hr. If you take the upper and lower value from this report and the divide by 2 the value would suggest 23.5ltrs / person / hr is credible as a requirement. (28+19 / 2 = 23.5)
Table 1A-2- Acute effects of CO_2 (short term exposure)	Review table content	After a recent UK review with the UK HSE this table may require further update (UK TBC)

CHAPTER 1 - MINIMUM CONDITIONS FOR SURVIVAL IN A DISTRESSED SUBMARINE (DISSUB) PRIOR TO ESCAPE OR RESCUE

Specific comments on content:

Para ref	Existing content	Proposed
Para 6b – CO_2 advice	In the absence of instructions from the surface, escape should be planned such that the partial pressure of carbon dioxide does not exceed 0.05 bar at the end of the escape . Due to both acute and chronic effects on cognitive function, limit remains appropriate.	Due to both acute and chronic effects on cognitive function, limit remains appropriate.

CHAPTER 1 - MINIMUM CONDITIONS FOR SURVIVAL IN A DISTRESSED SUBMARINE (DISSUB) PRIOR TO ESCAPE OR RESCUE

Specific comments on content:

Para ref	Existing content	Proposed
Table 1A-4 – Carbon monoxide	Symptoms vrs concentration	UK data table holds different information (see slide)
Para 11(3)b Advice on rescue	A continuous exposure of up to 200 ppm may still allow survivors to undertake the required DISSUB tasks to affect a rescue within 7 days	Will reduce functional ability, especially if combined with hypoxia or hypercarbia. However, as there is no method for removal from the DISSUB then tolerating these effects will maximise stay time to rescue.

CHAPTER 1 - MINIMUM CONDITIONS FOR SURVIVAL IN A DISTRESSED SUBMARINE (DISSUB) PRIOR TO ESCAPE OR RESCUE

Specific comments on content:

Para ref	Existing content	Proposed
Table 1.A-5 & A6	Acute effects of Chlorine & Acute exposure guidelines for Chlorine	The HSE have provided a report on concentration against signs and Symptoms; Microsoft Word - CHLORINE Toxicological overview v2.doc (publishing.service.gov.uk) See table 1 Review content against this refence. Query how the acceptable exposure timelines have been generated
Table 1. A6	5ppm @1 bar Dangerous after approximately 1 hour	Considered lethal after 30mins
Para 1 A.2.5	Monitoring of gasses	Should we not also be monitoring for HF, HBr, Cl, O_2 and CO_2 as well as pressure? Also if we are advising monitoring should we be advising on response to detection, and / or providing specific guidance on escape vs await rescue?

Table 1A-2 – Carbon dioxide ANEP / MNEP Vrs UK HSE guidance

Table 1.A-2 Acute effects of CO_2 from short term exposure

Partial Pressure of CO_2 (bar)	Health Effects
0.01 - 0.02	Slight increase in depth of respiration; headache & fatigue after several hours
0.03	Severe headache; diffuse sweating; laboured or difficult respiration
0.04	Flushing of face; palpitations
0.05	Mental impairment
0.06	Hard work impossible; visual disturbance
0.08	Tremors; convulsions
0.12	Unconsciousness

Table 1.A-3 Effects of CO_2 from chronic exposure

Partial Pressure of CO_2 (bar)	Health Effects
0.03	Threshold for dyspnoea at rest
0.03 - 0.04	Headaches but likely to subside
0.03 - 0.06	Increasing incidence of dyspnea
0.05	Lower limit for reduced intellectual and cognitive capacity
0.06	Dyspnoea at rest
> 0.08	Expect tremors/convulsions/loss of consciousness

TABLE 1 TOXIC EFFECTS OF CARBON DIOXIDE

Effective Concentration (% at 760 Torr)	Partial Pressure (Torr)	Effect	Remarks
1 to 2	7.6 - 15.2	Gradual increase in depth and rate of respiration.	This may occur below 1% but individuals acclimatise after a few days.
2 to 3	15.2 - 22.8	Headaches.	There is good evidence to suggest that headaches do not occur below a CO_2 level of 2.8%.
3	22.8	Severe headaches, profuse sweating, laboured or difficult respiration, tremors.	Acceptable limit for alertness.
4	30.4	Visual disturbance.	
5	38.0	Mental depression.	Ventilation essential.
6	45.6	Hard work impossible, impaired movement.	
7	53.2	Convulsions.	
8	60.8	Unconsciousness.	
15	114.0	Death.	

UK HSE have suggested that on the basis of new research, the UK table on effects should be reviewed and updated. This review could also impact ANEP / MNEP advice, and the UK will share its update once agreed

Table 1A-4 – Carbon monoxide ANEP / MNEP Vrs UK BR1326

Table 1.A-4 Acute effects of carbon monoxide

Conc. in inhaled air (ppm) at 1 bar	CO % saturation of the haemoglobin	Symptoms
25	0 – 5	Safe for all individuals
50	0 – 10	None
100	10 – 20	Tightness across forehead, slight headache. Approx. upper limit of continuous exposure with minor symptoms only
200	20 – 30	Headache and throbbing in temples. Mild symptoms for ~~8 hour~~8-hour exposure; moderate symptoms for continuous exposure
300	30 – 40	Severe headache, weakness, disorientation, confusion and collapse
500	40 – 50	Same as above but earlier - after 3 - 4 hours exposure.
1000	60 – 70	Immediately dangerous - severe symptoms after minutes exposure: coma, intermittent convulsions; depressed heart action; possible death
2000	80 – 90	Death in less than 1 hour
4000	90 – 100	Death in few minutes

PPM.

TABLE 1 TOXIC EFFECTS OF CARBON MONOXIDE

Carbon monoxide concentration in air (ppm)	COHb level in blood	Symptoms
0 - 30 (MPC_r = 12ppm Routine Operations) (MPC_r = 6ppm in the event of a declared pregnancy)	0 - 5	None
30 - 70 (MPC_{24} = 60ppm Routine Operations) (MPC_{24} = 6ppm in the event of a declared pregnancy))	5 - 10	Decreased exercise tolerance in individuals with respiratory or cardiovascular disease
70 - 120 (MPC_{60} =100ppm Routine Operations) (MPC_{60} = 6ppm in the event of a declared pregnancy))	10 - 20	Headaches and breathlessness on vigorous exertion
120 - 220	20 - 30	Throbbing headache, irritability, emotional instability, impaired judgement, defective memory, rapid fatigue
220 - 350	30 - 40	Severe headache, weakness, nausea, vomiting, dizziness, dimness of vision, confusion
350 - 520	40 - 50	Increasing confusion, severe ataxia, increased respiratory rate, possible hallucinations
520 - 800	50 - 60	Syncope, coma, convulsions, tachycardia with weak pulse
800 - 1220	60 - 70	Increasing depth of coma with incontinence
1220 - 1950	70 - 80	Profound coma, weak pulse and death
> 1950	>80	Rapid death

5 Carbon monoxide is routinely monitored by the CAMS with Drager tubes as a back up in the case of CAMS malfunction. .

Table 1A-5 – Chlorine ANEP / MNEP Vrs UK HSE

Table 1.A-5 Acute effects of chlorine

Chlorine concentration at 1 bar (ppm)	Health Effects
0.2 - 0.4	The odour threshold.
0.5	No change in pulmonary function after 8 hr. exposure.
1.0	Tolerable for 8 hrs but some significant changes in pulmonary function.
2.0	A 2-hr. exposure produced no statistically significant changes in pulmonary function.
3 – 6	Severe irritant to eyes, nose, throat and upper respiratory tract.
15	Lowest conc. causing respiratory distress.
14 – 20	Exposure for 1 hour reported as dangerous.
100	Tolerable for a maximum of 1 minute.
430	Lowest lethal conc. for a 30 min. exposure.
1000	Usually lethal after a few good breaths.

Table 1: Summary of acute toxic effects in relation to approximate (air) concentration of chlorine [5]. Concentration (mg m^{-3}) are approximate conversions from the corresponding ppm value.

Concentration		Signs and symptoms
ppm	mg m^{-3}	
1 – 3	3 – 10	Mild mucous membrane irritation
5 – 15	15 – 45	Moderate irritation of upper respiratory tract
30	90	Immediate chest pain, vomiting and coughing
40 – 60	115 – 175	Toxic pneumonitis and pulmonary oedema
430	1250	Lethal after 30 minutes exposure
1000	2900	Lethal in minutes

ANEP / MNEP appears to be ‘optimistic in the table of effects’ provided should this be aligned and / or simplified to represent the HSE table above? And what impact do these readings have on the decision to await rescue or escape / evacuate?

SUBMARINE ESCAPE AND SURFACE SURVIVAL PERSONNEL EQUIPMENT (SESSPE)

Specific comments on content:

Para ref	Existing content	Proposed
Chapter 2 Para 2.2 purpose	The primary function of the SESSPE is to enable the user to make a safe ascent from the DISSUB to the surface	The primary functions of the SESSPE, is to enable the user to make a safe ascent from the DISSUB to the surface and enable survival on the surface pending rescue.
Para 2.2 b	Adequate design to enable the user to vomit without aspiration into their airway, if seasick on the surface.	Question from the UK equipment supply chain…..Is this protection from the vomit going back into the escapee's mouth i.e. enough space in the hood to prevent that happening?
Para 2.3	The SESSPE must be conspicuous and brightly coloured to aid visual detection.	Move this up from section 2.3 to 2.2f as it is important to emphasize this, noting that it is an example of a 'suitable location aid' that is described in the point above

SUBMARINE ESCAPE AND SURFACE SURVIVAL PERSONNEL EQUIPMENT (SESSPE)

Specific comments on content:

Para ref	Existing content	Proposed
Para 2.2 g	To reduce the incidence of hypothermia, the suit shall have means of minimizing fluid accumulation within the SESSPE due to urine production.	How do you achieve this? How can you produce a suit that (a) prevents seawater ingress and (b) prevents urine egress? Agree with the concept but unsure how this is achieved. For discussion…
Para 2.3 e	Fully usable within 5 minutes of withdrawal from storage and must not immobilize the wearer,	UK have moved away from this language in our recent suits SOR. We have removed “able-bodied user must be able to don the suit within X minutes” to “able-bodied user must be able to put the suit on unaided in the dark with minimal internal/external snagging hazard”. Is a time limit required?
Para 2.3 g	Keep the user dry during both ascent phase and at the surface.	Important feature which hasn’t been articulated so far in this chapter

SUBMARINE ESCAPE AND SURFACE SURVIVAL PERSONNEL EQUIPMENT (SESSPE)

Specific comments on content:

Para ref	Existing content	Proposed
Para 2.3	Addition of text.	There should be a means of: Self-righting capability to prevent drowning.
Para 2.3	Addition of text.	The life raft should be: Equipped with a drogue or sea anchor,

MEDICAL STANDARD FOR SUBMARINE ESCAPE TRAINING TANK CANDIDATES

Specific comments on content:

Para ref	Existing content	Proposed
Chapter 3 Para 3.A.4 (6)	Chest X-ray, inspiration, PA not older than 12 months.	UK query - Is this still a requirement? Especially in non-pressurised SET training? Maybe specify 'for pressurised training'?
Annex 3c Para 16	FEV1/FVC should exceed 75 %. If these values are not reached, the candidate should be reassessed, and if the values continue to remain less than threshold values, the patient should be referred to a chest physician.	UK MOD diving cut off is 70%
Para 21 g	If variability that is not attributable to occupational exposure is 15 % or greater then the candidate should be made unfit for SET training .	Any occupationally related issues require further investigation before a fitness decision can be made.

MEDICAL STANDARD FOR SUBMARINE ESCAPE TRAINING TANK CANDIDATES

Specific comments on content:

Para ref	Existing content	Proposed
Annex 3c Para 28	Abnormalities found on cardiovascular examination, such as murmurs, and on ECG must be investigated to an appropriate extent before a decision on fitness is made.	Including exercise testing where appropriate?
Para 41	HIV positive candidates should be dealt with in accordance with host and client nations policies.	UK comment - Is this necessary? If so should all Blood borne virus (BBVs) be mentioned? If not, should just AIDS illness be mentioned as this IS incompatible but HIV is not a concern?

MEDICAL STANDARD FOR SUBMARINE ESCAPE TRAINING TANK CANDIDATES

Specific comments on content:

Para ref	Existing content	Proposed
Annex 3c Para 45	Asymptomatic sickle cell trait is not a contraindication to pressure exposure and individuals with frank sickle cell disease will be unfit for entry into military service. Routine testing for sickle cell disease is thus not required. Haemoglobin electrophoresis may be carried out if required at the initial medical.	Is there a risk of exertional heat illness in SET?