Royal Netherlands Navy

Preventing Slamming Impact Injuries

A trip what raised more questions than giving answers in the initial approach and search to probable solutions in handling Fast Raiding Interception and Specialforces Craft FRISC

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HET SCHEEPVAARTMUSEUM

Maritime international developments results in

- Increasingly complex task with new scenarios, where we:
- must go faster, move better, with more range
- must make faster decisions in lesser time
- must act with effective operational force and equipment
- must fulfill our (inter)national task

Fast Raiding Interception Specialforces Craft FRISC characteristics

- Based on MST 1000 Enforcer (9.5 and 12 mtr version)
- 2 crew (coxswain / navigator) and max to 8 pax
- 2 engines 370-475 hp, max speed 40-45 kts
- Range between 200 – 270 mile
- Since 2012 operational
- Total of 48 interceptors

Characteristics of High Speed Boots and environment effects on human acting

- More speed reduce the operational trading time
- The higher the sea state the lower the operational speed and the less time to operate effectively
- Level sea state and speed enforce each other in reducing effective time to act
- Operational environment and mission characteristics appear to determine the amount of physical exposure and risk to injuries

Performance envelope

Sea state	Wave height	Max speed	Pacen	Safe Landing	Ops Time
1	< 0,5 mtr	35 kts	Not possible	No limits	4 hours
2	< 0,5 mtr	35 kts	Not possible	No limits	4 hours
3	0,5 – 1,5 mtr	25 kts	Not possible	Not possible	2 hours
4	1,5 – 2,5 mtr	15 kts	Not possible	Not possible	1,5 hours
5	2,5 – 4,0 mtr	10 kts	Not possible	Not possible	0,5 hour

Physical Effects

- Whole Body Vibration (WBV)
- Repeated shocks (RS):
- Axial forces (up to 20 g depending on seat, sea state, speed)
- Shear forces (gives probably the most problems for the back)
- Lateral forces (less potential to capture it with the body)

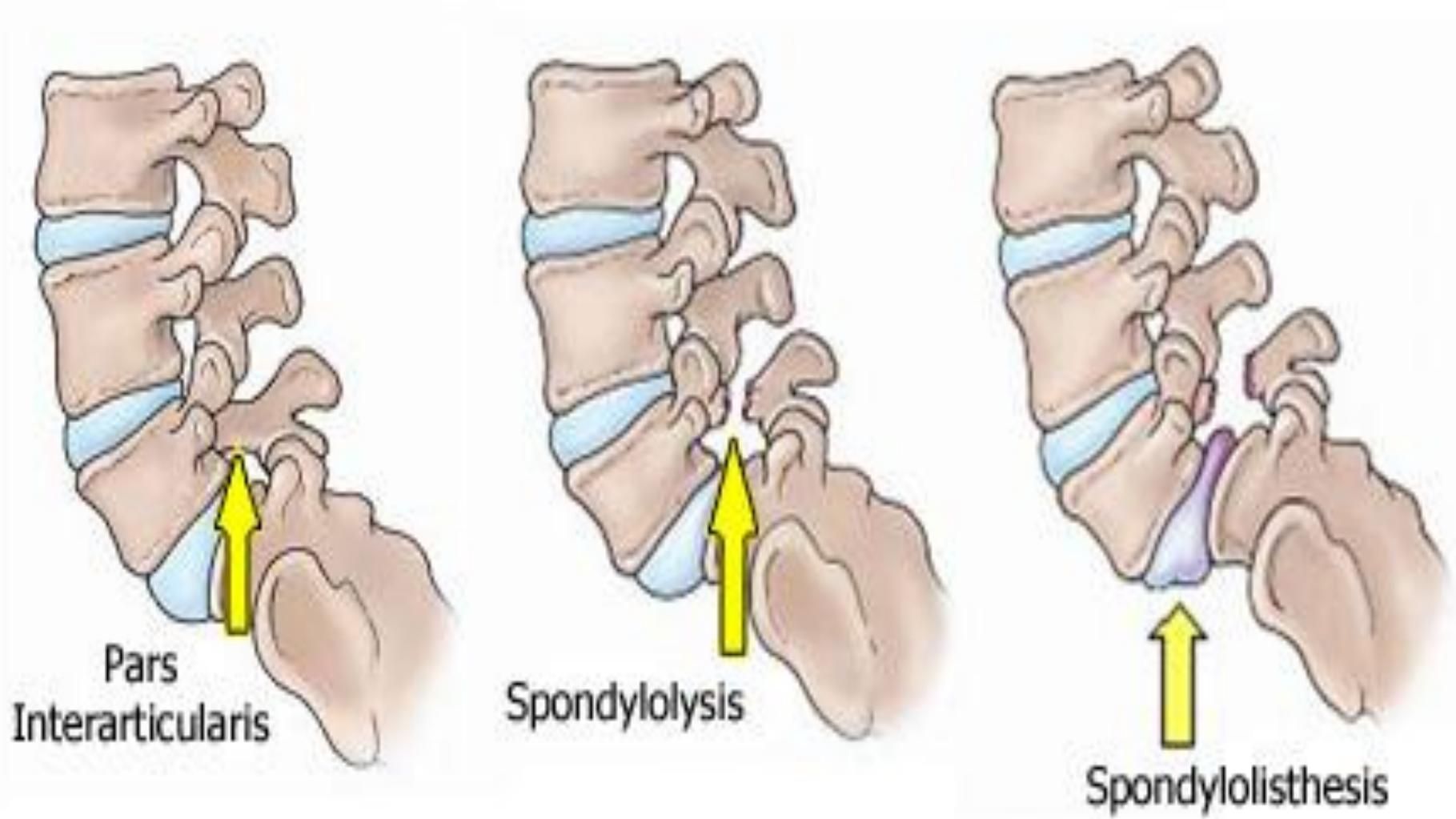
Experienced effects on the body

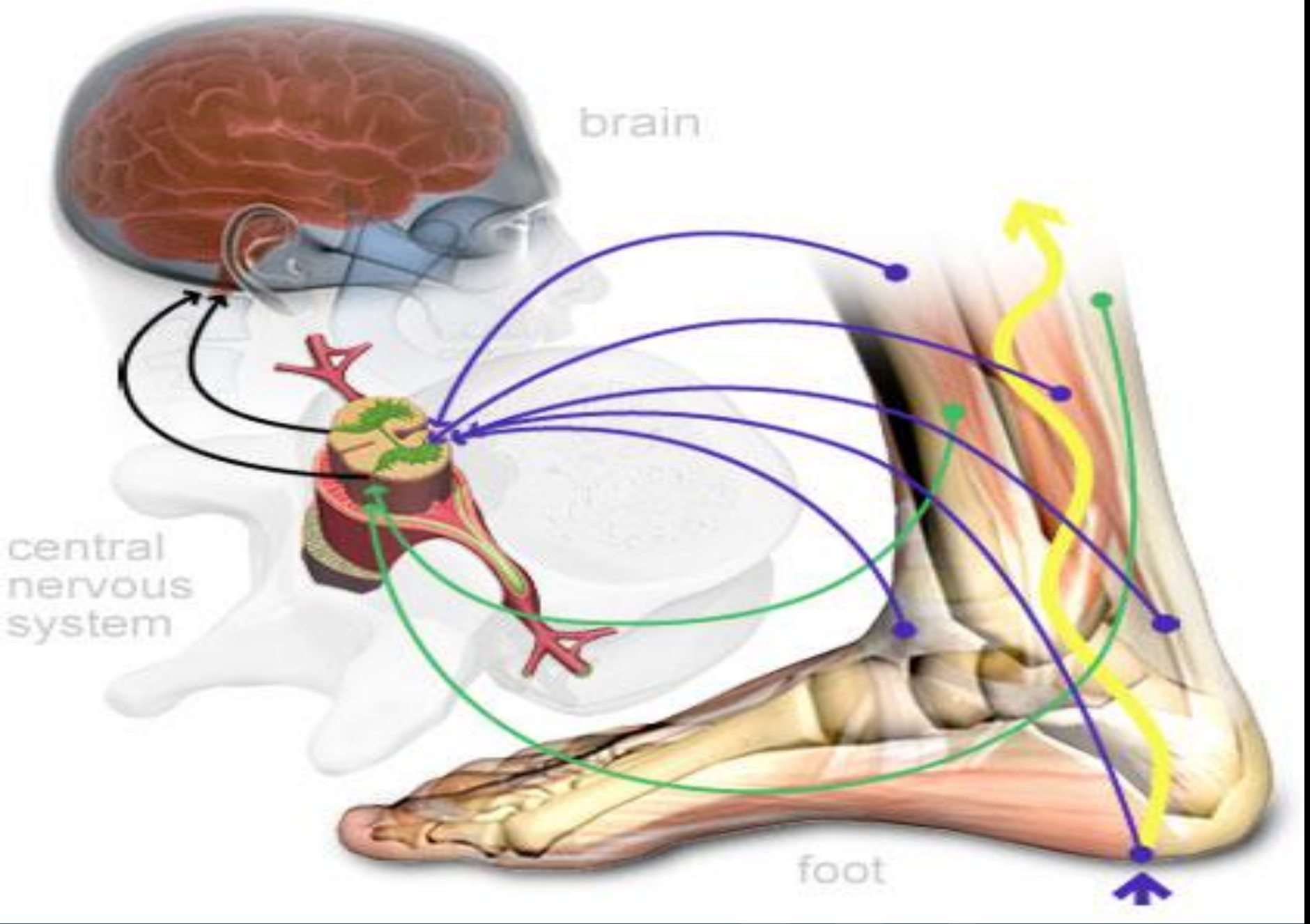
Neuromusculoskeletal neck-shoulder, lower back, knee, ankle

-acute effects: distorsion, ligament strain / rupture, (stress) fracture (vertebra, spondylolysis/-listhesis), whiplash, joint luxation, decreased (post-)transit performance

-subacute effects: joint instability, exhausting of the propio-ceptive and musculoskeletal system and so becoming more vulnerable to (sub)acute effects and decreased (post-)transit performance, spondylolysis, discus complaints, HAV-syndrome

-chronic effects: arthrosis, spondylosis, Traumatic Brain Injury cause of coup-contre-coup mechanism like in boxing?


Pars
Interarticularis
Spondylolysis
Spondylolisthesis


brain
central
nervous
system
foot

Preventing Slamming Impact Injuries 1 several facts

- Being High Speed Boot Crew is like doing TopSport!!
- Operational and mission circumstances create risk which go beyond to legislation and international rules
- Sea and weather conditions are not to influence
- Prevention is a multidisciplinary issue which must have an intervention cycle on several levels from different point of view and knowledge

Preventing Slamming Impact Injuries 2 cycle of intervention

A cycle based on Risk-assessment and an action plan within:

- Management / Employee education: awareness of the physical risk factors and the impact on the human body
- Employee training: focused on strength and -endurance
- RS & WBV Control / Mitigation: need further research and design development
- Health Surveillance: specific monitoring and health check, development of guidelines, inclusion / exclusion criteria

Intervention level employee physical training 1

- Whole body energy expenditure during transit is low
- Musculoskeletal energy expenditure is high cause of continue static and dynamic muscle contraction
- Creatine kinase (CK) is often elevated in the post-transit period, which explains muscle exhausting and/or damage
- Result is a reduced (post-)transit performance state and an erased vulnerability to injury and/or mission failure
- Spec. training in strength and -endurance of the muscle system is needed!

Intervention level employee physical training 2

- An example could be periodic / meso cycle training according to Long Term Athlete Development method
- With eccentric training on strength and strength endurance
- Starting in a block of 12 weeks focused on maximal strength (Fmax) followed with a block in max strength endurance training (Fend)
- With also an aerobe and low-impact cardio-training component and daily core-stability training (appr 30 min)
- Such a specialized HSB training program is still not available

Intervention level employee physical training 3 week schedule example

Day	Core stability	Low impact cardio	Running	Strength training
Monday	X	X		X
Tuesday	X		X	
Wednesday	X	X		X
Thursday	X			
Friday	X		X	X
Saturday	rest / recover	rest / recover	rest	rest / recover
Sunday	X		X	

Intervention level employee physical training 4 practical questions

- What schedule be used and how to integrate this schedule into the educational and the operational training program?
- How to plan into the day-week program of an operational unit
- Should the training program be the same for every employee in relation to their function? (e.g. the navigator is more at risk)
- How to deal with the inter- and intra-individual variations?
- Can in the next future an advanced simulator give an answer to this Q's ?

Intervention level health surveillance 1

- Effects of exposure depends on the individual physical state and condition, sea state, speed and duration of trading and the number of impact counts
- Doing Topsport needs more than only periodic check up
- A personal journal with a total of trading hours and cumulated impact counts is probably necessary
- Amount of exposure needs constant monitoring to get insight to the effects of exposure, the average recover time and give you tools to interfere on time to prevent health problems

Intervention level health surveillance 2 constant monitoring

- Specific Measurable Acceptable Realistic Time-bound tool(s)
- Easy to perform, non-invasive to improve the compliance
- Using questionnaires from apps on smart phones?
- Reproducible, evidence based, which parameters (?)
- If every work situation has an average recover value, is development of an analog to the Dive Tables feasible?

example of dive tables

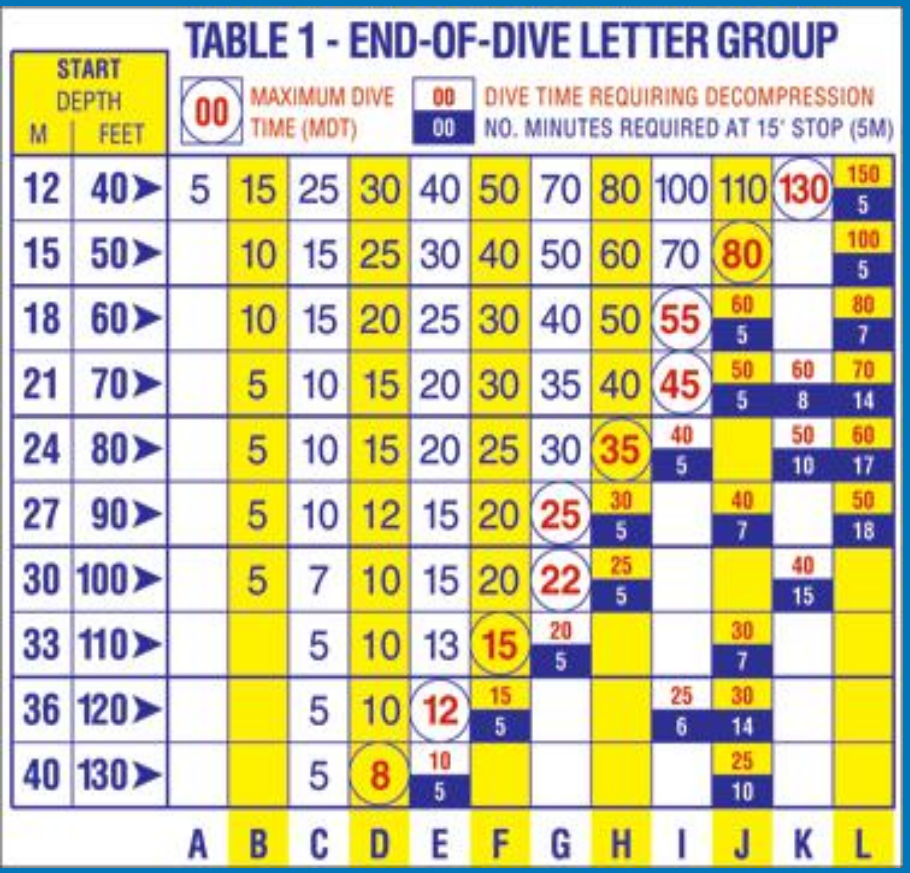


TABLE 1 - END-OF-DIVE LETTER GROUP

START DEPTH M	START DEPTH FEET	A	B	C	D	E	F	G	H	I	J	K	L
12	40	5	15	25	30	40	50	70	80	100	110	130	150 / 5
15	50		10	15	25	30	40	50	60	70	80		100 / 5
18	60		10	15	20	25	30	40	50	55	60 / 5		80 / 7
21	70		5	10	15	20	30	35	40	45	50 / 5	60 / 8	70 / 14
24	80		5	10	15	20	25	30	35	40 / 5		50 / 10	60 / 17
27	90		5	10	12	15	20	25	30 / 5		40 / 7		50 / 18
30	100		5	7	10	15	20	22	25 / 5			40 / 15	
33	110			5	10	13	15	20 / 5			30 / 7		
36	120			5	10	12	15 / 5			25 / 6	30 / 14		
40	130			5	8	10 / 5					25 / 10		

00 = MAXIMUM DIVE TIME (MDT)

00 / 00 = DIVE TIME REQUIRING DECOMPRESSION / NO. MINUTES REQUIRED AT 15' STOP (5M)

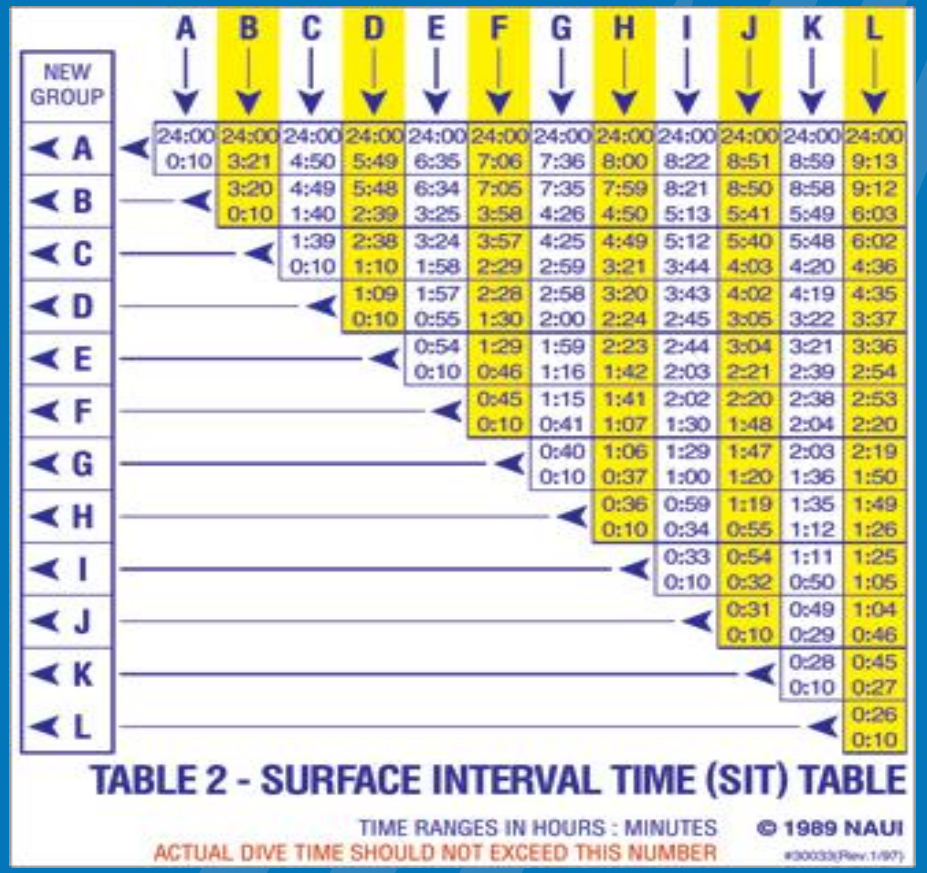


TABLE 2 - SURFACE INTERVAL TIME (SIT) TABLE

NEW GROUP	A	B	C	D	E	F	G	H	I	J	K	L
A	24:00 / 0:10	24:00 / 3:21	24:00 / 4:50	24:00 / 5:49	24:00 / 6:35	24:00 / 7:06	24:00 / 7:36	24:00 / 8:00	24:00 / 8:22	24:00 / 8:51	24:00 / 8:59	24:00 / 9:13
B		3:20 / 0:10	4:49 / 1:40	5:48 / 2:39	6:34 / 3:25	7:05 / 3:58	7:35 / 4:26	7:59 / 4:50	8:21 / 5:13	8:50 / 5:41	8:58 / 5:49	9:12 / 6:03
C			1:39 / 0:10	2:38 / 1:10	3:24 / 1:58	3:57 / 2:29	4:25 / 2:59	4:49 / 3:21	5:12 / 3:44	5:40 / 4:03	5:48 / 4:20	6:02 / 4:36
D				1:09 / 0:10	1:57 / 0:55	2:28 / 1:30	2:58 / 2:00	3:20 / 2:24	3:43 / 2:45	4:02 / 3:05	4:19 / 3:22	4:35 / 3:37
E					0:54 / 0:10	1:29 / 0:46	1:59 / 1:16	2:23 / 1:42	2:44 / 2:03	3:04 / 2:21	3:21 / 2:39	3:36 / 2:54
F						0:45 / 0:10	1:15 / 0:41	1:41 / 1:07	2:02 / 1:30	2:20 / 1:48	2:38 / 2:04	2:53 / 2:20
G							0:40 / 0:10	1:06 / 0:37	1:29 / 1:00	1:47 / 1:20	2:03 / 1:36	2:19 / 1:50
H								0:36 / 0:10	0:59 / 0:34	1:19 / 0:55	1:35 / 1:12	1:49 / 1:26
I									0:33 / 0:10	0:54 / 0:32	1:11 / 0:50	1:25 / 1:05
J										0:31 / 0:10	0:49 / 0:29	1:04 / 0:46
K											0:28 / 0:10	0:45 / 0:27
L												0:26 / 0:10

TIME RANGES IN HOURS : MINUTES

ACTUAL DIVE TIME SHOULD NOT EXCEED THIS NUMBER

Intervention level health surveillance 3
‘High Speed Boot tables’ a new international standard?

- With integration of the performance envelope (action levels)?
- table with ‘end-of-trading’ in relation to action level and what correspond with the max allowed time to trade?
- table with ‘interval recover time’ in relation to new action level?
- repetitive trade time table in relation to an action level?
- A lot of data has to be collect to work this idea out
- The future will probable give us the answers

Intervention level health surveillance 4
Is being HSB Crew a high risk profession?

- If so, is there legislation for employment medical examination?
- In-/exclusion criteria: orthopedic history?, age?, length?, M/F?, weight?, other medical history? which parameters?
- Periodicity of fitness examination? Yearly? Based on a journal where trading time and impact counts are registered?
- How to act with incidents which affect the performance? After rehabilitation and training is a new test-examination needed before becoming active, as in the aviation world?
- How many years is acceptable being HSB Crew? 3-5 yrs?

Conclusion and Message

- Employee training and Health surveillance are essential in preventing slamming impact injuries.
- New standards, tools and products should be developed
- We know still a little, have many questions and some ideas, but a lot got to be answered
- The field is only to discover in a joined settlement
- So we had to share our knowledge, give each other advice, join and work together and go into discussion

Thank you for your attention