

Self-Assessed Preferred Retraining Intervals of Helicopter Underwater Egress Training (HUET)

Charelle Bottenheft; Esther A. P. B. Oprins; Mark M. J. Houben; Ted Meeuwsen; Pierre J. L. Valk

- BACKGROUND:** Royal Netherlands Air Force (RNLAF) helicopter aircrew get Helicopter Underwater Egress Training (HUET) using a Modular Egress Training Simulator (METS™) in order to be prepared for escaping the aircraft when ditching into water. In the current situation the retraining intervals are only chosen on an arbitrary basis for different backgrounds of the crew (maritime and regular flight crew). The frequency of refresher training depends on the expected degree of retention, but evidence-based research on required intervals between refresher courses is scarce. Ideally, training should be based on the amount of retention of acquired competencies.
- METHODS:** Retrospective questionnaires were filled in by 132 helicopter aircrew who followed the HUET course(s) at the Survival Evasion Resistance and Escape (SERE) school in Gilze-Rijen (Netherlands). They assessed themselves on competencies and gave their opinion on the preferred interval.
- RESULTS:** Maritime crew report increasing competence levels with the number of refresher courses followed. According to the opinion of all aircrew, retraining intervals may take longer than 18 (first refresher) to 30 mo (fourth refresher). Maritime and regular flight crew differ in preferred retraining intervals (up to 22 mo and up to 33 mo, respectively).
- DISCUSSION:** This study provides indications to reconsider the retraining interval and to differentiate between maritime and regular flight crew based on aircrew's opinions and self-assessments. As competence levels still increase with the number of courses followed, it is recommended to reconsider the current fixed intervals of once a year or once every 3 yr for maritime and regular flight crew, respectively.
- KEYWORDS:** helicopter underwater egress training, retention, competence, safety, refresher training.

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Flying personnel, such as military pilots, have to develop and maintain a broad set of competencies during their operational career. They should be able to fly an aircraft, to perform an airstrike, to gather information, and to cooperate with their crew. During emergency situations, such as a mechanical failure, military pilots should anticipate and cope with these situations to prevent a crash or to survive and escape after a crash. However, these emergencies rarely happen during regular work, whereas required competencies are not practiced during the normal execution of daily tasks. Because of this lack of exposure, there is a need to specifically train for such unexpected situations for pilots, but also for other crewmembers of the aircraft such as flight surgeons, door gunners, loadmasters, etc. A holistic training approach, that is, whole task training as opposed to part-task training, using high fidelity simulators is usually applied to maximize transfer to the operational environment.¹⁷ Moreover, training these competencies only once in

a lifetime is not sufficient, because it is expected the level of competencies will decrease without exposure. This refers to retention: the maintained level of performance in the long term after certain periods of nonuse or infrequent practice.^{2,3,11} It is self-evident that a skill has to be acquired before it can be retained.¹⁴ Therefore, retention is usually measured as the level of performance compared to the initial level directly after training.⁴ After initial training, refresher training is usually offered during an operational career.¹⁰ The frequency of refresher

From TNO Human Factors, Soesterberg, the Netherlands, and the Royal Netherlands Air Force, Center for Man in Aviation, Soesterberg, the Netherlands.

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Address correspondence to: Charelle Bottenheft, Kampweg 55, 3769DE, Soesterberg, the Netherlands; charelle.bottenheft@tno.nl.

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training depends on the expected degree of retention, but evidence-based research on required intervals between refresher courses is scarce. The majority of empirical research is on relatively simple, procedural skills with relatively short intervals between courses.³ How often refresher training should be provided is difficult to examine because adequate data on incidents in the real-life world are hardly available.

It is known that some types of tasks are more or less sensitive for performance decrement.³ This is of relevance for determining the interval of refresher training and what this training should comprise. For instance, procedural tasks like steps within a drill or sequence of tasks have a relatively higher degree of performance decay than problem solving tasks, like reasoning, in order to identify a problem and identify the correct course of action.^{2,3,6} In addition, the degree of difficulty and complexity of a task is directly related to the degree of decay and the need for repetition.^{1,3} Furthermore, individuals differ in the degree of retention on similar tasks, but this topic is understudied.^{3,10} Identifying specific individual variables that predict performance after periods of nonuse (cf. retention interval) could then be used to identify the individuals who more likely need refresher training and to provide customized training.³

This paper focuses on a specific refresher training for aircrew: Helicopter Underwater Egress Training (HUET). HUET is an example of emergency training where flying personnel learn how to escape from a helicopter after a ditch into the water. A HUET course generally starts with classroom instruction followed by training in the water, both in military and civilian courses.⁸ HUET can be considered as a combination of part-task and whole-task training, with an emphasis on the latter, making use of various types of simulators. Part-task training is, for instance, learning to use emergency breathing systems (EBS), or a basic training to get used to inversions in the water using the Shallow Water Egress Trainer (SWET).¹⁵ Whole-task training in HUET involves training using simulators such as the Modular Egress Training Simulator (METS). This is a helicopter mock-up that is lowered into water and inverted by rotating it 180°, which typically happens in a real helicopter ditch into water. Many differences exist in frequency, content, and organization of HUET courses across various civil and military training centers.^{5,15}

The expectation is that the content, refresher training cycle, skill retention capabilities, and fidelity of the simulated environment may influence the transfer of HUET courses to real situations.¹⁵ Taber argues that many HUET courses are too short.¹⁴ Typically, 24 h are needed for trainees to consolidate the information and skills. They usually do not repeat the skills in between refresher courses. According to Taber and McGarr, evidence-based retention research and the preferred interval of refresher training for HUET is limited to just one study, the study from Mills and Muir with 52 subjects working in the offshore industry.^{9,15} Based on general theories on retention and the rate of decay of procedural skills, they considered 6 mo as the first interval for the next training, given the fact that mainly procedural skills are involved here.⁸ Another study about refresher training from Brooks states that refresher training for

HUET is needed every 3 yr and preferably each year, but this is not based on evidence at all.⁵ Brooks' general guidelines are copied by the majority of training organizations, both civil and military.⁵

The present study focuses on the opinions of maritime and regular flight crew on their preferred intervals between HUET refresher courses related to self-assessed competencies over time. Although only based on self-ratings, their self-assessed competence level achieved after a certain period of nonuse (in between courses) reflects retention to a certain extent. The ratings also provide information about their self-confidence to be able to escape from a helicopter, which is also a goal of the refresher courses. Although this study is not really evidence-based retention research, collecting opinions and self-ratings at least provides relevant data for getting insight into preferred training intervals. This study uses a retrospective questionnaire submitted to aircrew who followed HUET courses at the Survival Evasion Resistance and Escape (SERE) school in the Netherlands. Opinions on their preferred intervals between courses and self-assessments on a set of competences were related to the number of courses followed and the time interval in between courses. The main expectation is that refresher training must be provided more often if retention of competences is relatively low. A corresponding expectation is that the competence level will increase the more HUET courses have been followed. In addition, aircrew's opinion on their preferred interval between HUET courses will differ, dependent on the current frequency of refresher courses. The results of this study will provide generic insights into the issues playing a role in retention that are relevant for HUET courses in general, more than were available up to now.

METHODS

Subjects

A total of 132 helicopter aircrew (130 men, 2 women) filled out the questionnaire (mean age = 36.18, SD = 8.15). In total, 36 maritime crew (15 Pilot Maritime, 10 Tactical Coordinator, 11 Helicopter Sensor Operator) and 96 regular flight crew (68 Pilot Transport/Attack and 28 Loadmaster) participated in the study. Maritime crew follow the refresher training yearly and regular flight crew follow the refresher training once every 3 yr. A total of 69 subjects included in this study had diving experience, 23 subjects had experienced a stressful situation underwater, and 13 subjects had failed the course before.

Measures

HUET training. The SERE school organizes two types of courses: the Initial Survival Equipment Course (ISEC) and the Refresher Survival Equipment Course (RSEC) for cockpit and cabin crew of various types of helicopters such as the NH90, the CH47, the AH64, the AS-532, and the AQ-139. For these various types of helicopters, the composition of crewmembers differs, which is taken into account during the training. The ISEC takes 2 d, with a total of 16 contact hours, the RSEC takes 1 d,

with 8 contact hours. The maximum number of subjects per ISEC or RSEC is six. The training program in both courses start with circa 50% theory followed by circa 50% practical training, with a total of six HUET runs each training. The runs consist of progressive exposures of incremental difficulty.

The HUET is performed in a pool using a high-fidelity METS™. Various types of aircraft can be configured with this simulator. Other training devices used during the part-task training are: the SWET™, which is a basic-low fidelity trainer for getting used to inversions in the water (only during the initial course); the Survival Egress Air bottle, which is an emergency breathing system; a swimming pool (26°C, no waves, clear water); and the dinghy, which is a rubber life raft.

Questionnaire. The first section of the questionnaire, which consisted of 30 items, was a self-assessment of competences. Answers were given on a 4-point rating scale (poor, insufficient, sufficient, good).

In the second section of the questionnaire, the subjects gave their opinion on the preferred interval in months between ISEC and RSEC courses and the interval between courses for the theoretical and practical parts, all in the light of being sufficiently prepared for a real helicopter ditch. The theoretical part consisted of the items: knowledge of emergency procedures, safety rules, diving physiology, flight safety equipment, and signal devices; the practical part consisted of the items: using EBS and practice with METS. For both the theoretical and practical part of the course, preferred intervals were composed by calculating overall means of the corresponding items. Specific questions on the number of HUET courses previously followed and the time elapsed since last course were asked in order to relate this: 1) to the self-assessed competencies, reflecting self-assessed retention after a certain period of nonuse; and 2) to their opinion on the preferred interval between courses.

Procedure

Helicopter aircrew who have followed the HUET course(s) were contacted by email, drafted by their commander. The email contained a link to the information about the study and questionnaire (in Dutch) and forwarded the subject to a secured server. Informed consent was given digitally by starting the questionnaire. Questionnaires (in Dutch) were filled in by aircrew who followed the HUET course(s) at the SERE school of the Center for Man in Aviation in Gilze-Rijen, the Netherlands.

Statistical Analysis

The items of the first section of the questionnaire (the self-assessment of competencies) were assigned to components, further described as competences, using a principal component analysis (PCA) with varimax rotation. Based on the factor loadings after rotation, an item was grouped to a competency when the factor loadings exceeded 0.30. Four competences were derived and had eigenvalues over Kaiser's criterion of 1 and in combination explained 67.36% of the variance. The derived competences are: Knowledge ($\alpha = 0.88$, # items = 7); Skills

($\alpha = 0.95$, # items = 12); Confidence ($\alpha = 0.93$, # items = 9); and Awareness ($\alpha = 0.78$, # items = 2). Examples for each competency are given below:

- Knowledge: "I know the steps of the procedure to survive on water."
- Skills: "I clear the exit in a flexible manner."
- Confidence: "I remain calm when breathing with the EBS."
- Awareness: "I am aware of the dangers when the helicopter hits the water."

All statistical analyses were conducted separately for both function groups and significance level was set to $P < 0.05$. Relations between self-assessed competencies, number of courses followed, time elapsed since last course, and preferred intervals were analyzed using Pearson correlations.⁷ In addition, one-sample *t*-tests were used to determine whether preferred intervals between each course were different from the usual 12 mo for maritime crew and 36 mo for regular flight crew. This implies that the test variable is compared against a "test value," which is 12 mo for maritime crew and 36 mo for regular flight crew. Preferred intervals of the different items of both the theoretical and practical part were analyzed using nonparametric tests (Wilcoxon matched pairs signed ranks), because the level of measurement is ordinal and the data is not normally distributed.

RESULTS

For maritime crew, correlations showed that there was a moderate positive and significant correlation between both the level of Skills and Awareness and the number of RSEC courses followed (see **Table I** for means and standard deviations and **Table II** for correlations). Besides this, self-assessed competencies (Knowledge and Confidence) and time elapsed since last course were negatively and significantly correlated. For regular flight crew, no significant correlations were found.

Correlations were calculated between averaged scores on the theoretical and practical part of the course and the self-assessed competencies. For maritime crew, no significant relations were found. For regular flight crew, moderate positive significant relations were found between the preferred interval for both the theoretical and practical part and the competencies Skills, Confidence, and Awareness (see **Table III**).

Fig. 1 shows mean scores and standard deviations of the aircrew's opinion on the interval of RSEC courses split up for maritime and regular flight crew. As follow-up of the initial course (ISEC), both groups have the opinion that the intervals should increase between the next HUET refresher courses.

Maritime crew prefer a shorter interval between ISEC and the first RSEC [$t(35) = -3.114$, $P = 0.004$] compared to the usual 12 mo (see **Table IV**). No difference in preferred interval between the first RSEC and second RSEC compared to the usual 12 mo between each refresher course was found. Besides this, a longer interval was preferred between the second RSEC and third RSEC [$t(35) = 3.162$, $P = 0.003$] and a longer interval

Table I. Mean and SD of the Number of RSEC Courses Followed, Time Elapsed Since Last Course and the Self-Assessed Competencies for Both the Maritime and Regular Flight Crew.

	MEAN (SD)	
	MARITIME CREW	REGULAR FLIGHT CREW
Number of RSEC courses followed	9.56 (6.61)	3.41 (2.95)
Time elapsed since last course	1.49 (1.54)	2.11 (1.07)
Knowledge	3.69 (0.42)	3.35 (0.41)
Skills	3.69 (0.41)	3.32 (0.49)
Confidence	3.71 (0.45)	3.39 (0.47)
Awareness	3.75 (0.42)	3.47 (0.52)

between the third RSEC and fourth RSEC [$t(35) = 6.679$, $P < 0.001$].

Regular flight crew prefer a shorter interval between ISEC and the first RSEC [$t(89) = -11.407$, $P < 0.001$], between the first RSEC and second RSEC [$t(90) = -5.657$, $P < 0.001$], and between the second RSEC and third RSEC [$t(90) = -3.260$, $P = 0.002$] compared to the usual 36 mo between each refresher course.

Maritime crew indicated that they want to follow the item 'diving physiology' of the theoretical part the least frequently compared to 'knowledge of emergency procedures' ($z = -3.70$, $P < 0.001$), 'safety rules' ($z = -3.26$, $P = 0.001$), and 'flight safety equipment' ($z = -3.64$, $P < 0.001$). Regular flight crew also indicated that they want to follow the item 'diving physiology' the least frequently compared to 'knowledge of emergency procedures' ($z = -4.21$, $P < 0.001$), 'safety rules' ($z = -3.40$, $P = 0.001$), and 'flight safety equipment' ($z = -2.69$, $P = 0.007$). See Table V for median values for each function group. For both groups, no significant differences were found in the preferred interval for the items belonging to the practical part.

DISCUSSION

The main objective of this study was to explore how aircrew experience the current frequency of HUET refresher courses and what they think the intervals should be to retain their competencies over time. Using a retrospective questionnaire, this study is based on the opinions of aircrew who followed these courses in the past years and how their opinions relate to self-assessed competencies. Asking flight crew what would be the best timing for their next HUET training is quite relevant. There is a need for a balance between the amount of training and the training efficacy; the aim is to find the optimal frequency.

Table II. Correlations Between Self-Assessed Competencies in Aircrew with Both Number of RSEC Courses Followed and Time Elapsed Since Last Course with Corresponding Pearson Correlation Coefficient.

	KNOWLEDGE	SKILLS	CONFIDENCE	AWARENESS
Maritime crew				
Number of RSEC courses followed	0.191	0.339*	0.279	0.357*
Time elapsed since last course	-0.485*	-0.314	-0.437*	0.173
Regular flight crew				
Number of RSEC courses followed	0.064	0.012	0.095	0.130
Time elapsed since last course	-0.063	-0.118	-0.080	-0.209

RSEC: Refresher Survival Equipment Course.

* = $P < 0.05$.

more training. Furthermore, it has been found that the level of self-assessed competencies is higher when the time elapsed since the last course followed is shorter. This illustrates the relationship of refresher training and retention.^{3,10} The results of this study suggest that the amount of refresher training is adequate for maintaining competence (cf. retention) for this particular maritime crew, and that the yearly interval between courses is sufficient.

For some highly competent individuals, training on a yearly basis might be too much and is therefore not advisable due to efficiency and costs.^{2,3} However, there is no hard evidence as to what the optimal level of competence should be. Besides this, in this study we cannot derive whether aircrew have a too high level of competence since the results of this study are based on self-assessment and because we do not have hard evidence what the optimal level of competence should be in relation to the investment of the refresher courses. Incidents are rare, thus it is unknown what exactly should be the required competence level to be able to escape from a ditched helicopter.⁵ A comment that must be made is that the number of RSEC courses followed explains between 11% and 13% of the variance of the competencies, which implies a moderate significant relationship. The same applies for the time elapsed since the last course, which explains between 19% and 24% of the variance. This means that the other percentage of the variance explained is a result of other factors, such as individual differences (e.g., not looking forward to the course, stress, anxiety).

For regular flight crew the above-mentioned relationships were not found. Apparently, regular flight crew do not indicate that their competence level improves, but rather stays stable. At least their competence level is not declining, otherwise negative relations would have been found. As regular flight crew follow the refresher course once every 3 years, this frequency might be insufficient and therefore an explanation for why competence levels do not increase.

It should be noticed that the results are only based on self-assessments that might be strongly related to self-efficacy. Literature reveals positive and significant relationships between self-efficacy beliefs and, for example, academic performance.^{9,16} Thus, we might conclude that it is also the aircrew's self-efficacy that increases by

Table III. Correlations Between Self-Assessed Competencies in Aircrew with their opinions on the Retraining Interval of the Theoretical and Practical Part with Corresponding Pearson Correlation Coefficient.

	KNOWLEDGE	SKILLS	CONFIDENCE	AWARENESS
Maritime crew				
Interval theoretical part	0.105	0.176	0.155	−0.072
Interval practical part	0.174	0.173	0.112	−0.039
Regular flight crew				
Interval theoretical part	0.204	0.312*	0.232*	0.223*
Interval practical part	0.175	0.356*	0.250*	0.245*

* = $P < 0.05$.

practice and not necessarily the competence level itself. Since increasing self-confidence is also an important goal of the refresher courses, the fact that self-assessed competence and thus the aircrew's self-efficacy increases over time with more HUET courses taken is a positive result.

Another related finding is that, only for regular flight crew, a moderate positive relation was found between self-assessed competencies and the preferred HUET training interval for the theoretical and practical part. The higher this crew estimate their own competence, the longer they prefer that the interval between courses for the theoretical and practical part should be. An explanation for why this relationship was only found for the regular flight crew is that they are used to following the course not very often, i.e., once every 3 yr. This bias is reflected in their opinion on their preferred retraining interval. Besides this, when training is more often (once every year like the maritime crew), competence levels appeared to be high and shows low variance. This low variance can explain why no effect was found on preferred interval for the maritime crew.

Brooks states that refresher training for HUET is needed every 3 yr and preferably each year.⁵ However, this current study found that both types of aircrew have an opinion on increasing retention of skills with the number of HUET refresher courses taken. The maritime crew prefer an increasing interval between courses up to almost 22 mo with the number of HUET refresher courses taken instead of the usual 12 mo between each refresher course. Interesting is that the regular flight crew prefer a shorter interval between courses than the usual 36 mo between each course, which also increases up to 33

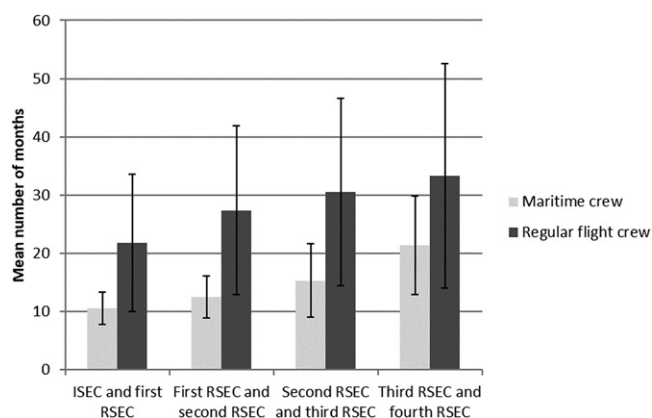
mo with the number of refresher courses taken. In other words, 12 mo seems to be too short, especially for the first refresher course, and 36 mo too long. This means that, according to aircrew, the current fixed intervals between the refresher courses may need to be reconsidered.

The relatively large differences between individuals reflect that

the opinion of flight crew on the retention of skills is individual-dependent and in accordance with the findings of Arthur *et al.*³ This is also in line with the study of Mills and Muir,⁸ who found large differences in individual performance after various intervals of HUET courses. The HUET course interval should be made adaptive and tailored to individuals' needs and should be based on individual performance levels.¹⁷ Ideally, this level is assessed each time a course is started by performing a so called 'golden run', and this information will be used to optimize the training by defining sub-tasks and competencies to be trained. To achieve this challenge, profound and reliable performance measures are indispensable.

Finally, this study showed that opinions on the theoretical knowledge aircrew want to rehearse varies and depends on the subject (e.g., more 'emergency procedures' and less 'diving physiology'). From literature, it is known that particular types of knowledge and skills are more prone to decline than other types; for instance, procedures should be repeated relatively often.^{1,2,6} Knowledge of procedures is more likely to decay more quickly than, e.g., declarative knowledge, while aircrew directly need to apply these procedures in an emergency situation.^{12,13} This does not count for 'diving physiology', which can be considered to be more declarative background knowledge.¹⁷ Therefore, this type of knowledge may not have the necessity to be rehearsed that often and is perhaps the least relevant topic during emergencies.

This study provides indications to reconsider the current frequency of refresher training applied by the SERE school for both maritime crew and regular flight crew. The current status is that this difference between the two types of crew is still

**Fig. 1.** Opinions of maritime and regular flight crew on the mean number of months needed between refresher courses.**Table IV.** One Sample *t*-Tests to Compare Opinions of Flight Crew on the Number of Months They Would Prefer Between HUET Courses.

RETRAINING INTERVAL OF HUET	MARITIME CREW		REGULAR FLIGHT CREW	
	M	SD	M	SD
ISEC and first RSEC	10.58*	2.73	21.79**	11.82
First RSEC and second RSEC	12.50	3.62	27.41**	14.49
Second RSEC and third RSEC	15.33**	6.32	30.51*	16.08
Third RSEC and fourth RSEC	21.42**	8.46	33.34	19.31

Preferred number of months is relative to the 12 mo for maritime and 36 mo for regular flight crew that are currently employed by the Survival Evasion Resistance and Escape (SERE) school in Gilze-Rijen, the Netherlands.

HUET: Helicopter Underwater Egress Training; ISEC: Initial Survival Equipment Course; RSEC: Refresher Survival Equipment Course.

* = $P < 0.05$, ** = $P < 0.001$.

Table V. Opinions of Maritime and Regular Flight Crew on the Preferred Interval in Months (Median) for the Different Items of Both the Theoretical and Practical Parts of HUET Training Courses.

PART & ITEM	MARITIME CREW		REGULAR FLIGHT CREW	
	N	MEDIAN	N	MEDIAN
Theoretical part				
Knowledge emergency procedures	36	15	91	24
Safety rules	36	18	91	24
Diving physiology	36	24	91	36
Flight safety equipment	36	15	91	24
Signaling equipment	36	24	91	36
Practical part				
Use of EBS	36	18	91	24
Practice in the METS	36	24	91	24

HUET: Helicopter Underwater Egress Training; EBS: emergency breathing systems; METS: Modular Egress Training Simulator.

being made, with different fixed time intervals for mandatory currency training. In future, this distinction between crew might fade away as more aircraft types will land on ships and fly over water, especially in watery regions.

A general note is that the composition of aircrew and configuration of the helicopter affects the difficulty of escaping. For example, for crew that sits in the back behind bulkheads, it is relatively more difficult to escape compared to pilots in the front of the helicopter. This is a requirement to take into account when determining the retraining interval of HUET.

Another note to be made is that the research population was not representative for all different functions of aircrew. For example, medical functions were not represented, while 'Pilot Transport/Attack' functions were over-represented. Besides this, only two women participated in this study, which implies that we can not elaborate on possible gender-related effects. Furthermore, the outcome of this study is strongly based on data coming from a retrospective survey and, therefore, is limited to self-assessed competence, strongly related to self-confidence, and are the opinions of aircrew. Right now a longitudinal study is running to evaluate retention over time by competence assessments performed by HUET instructors, combined with self-ratings by helicopter crew during actual HUET courses. This will provide a more complete and objective assessment of performance of aircrew by enabling a self-assessed and instructor-assessed comparison.

This study contributes to existing research on frequency of refresher training based on retention over time by collecting the experiences and opinions of participants of such courses. An important goal of these courses is to increase self-confidence and self-efficacy. This study confirmed that these courses are valuable in achieving this goal. Aircrew showing higher self-assessed competencies were exposed to more HUET refresher courses and prefer shorter retraining intervals. Specifically for the SERE school in The Netherlands, this study provides concrete indications to reconsider the frequency of refresher training and to differentiate between individual flight crew based on their performance. As competence levels still increase with the

number of courses taken, it is recommended to reconsider the current fixed intervals of once a year or once every 3 yr for maritime and regular flight crew, respectively. Ideally, the interval between courses should depend on the number of courses followed and the individuals' performance level. Therefore, the next step is to perform longitudinal research to evaluate retention over time by competence assessment performed by HUET instructors, combined with self-ratings by aircrew. This will provide a more comprehensive and valid representation of the results of HUET courses.

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Authors and affiliations: Charelle Bottenheft, M.Sc., Esther A. P. B. Oprins, Dr., Mark M. J. Houben, Dr. ir., and Pierre J. L. Valk, M.Sc., TNO Human Factors, Soesterberg, the Netherlands; and Ted Meeuwssen, M.Sc., sPTO, Royal Netherlands Air Force, Center for Man in Aviation, Soesterberg, the Netherlands.

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