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MEDICAL RESEARCH LABORATORY



U. S. Naval Submarine Base
New London

NIGHT LOOKOUT
TRAINING AND TESTING DEVICE

developed at
THE UNITED STATES SUBMARINE BASE
NEW LONDON, CONNECTICUT

MEDICAL RESEARCH LABORATORY REPORT NO. 8

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AUTHORIZATION

The construction of the Night Lookout Testing and Training Device was undertaken in accordance with a directive by the Commander Submarines Atlantic Fleet, dated May 25, 1941 and the present device embodied the British methods together with several refinements originated at this Base.

This chamber was completed on 15 July 1941, and since that date it has been in almost constant use for the training of personnel attached to ships operating out of this Base.

APPARATUS

The layout of the darkroom with its full equipment is shown on the enclosed blueprint.

The ship models which are employed include two models of each of the following Japanese types:

- Aircraft carriers
- Battleships
- Heavy cruisers
- Light cruisers
- Destroyers
- Seaplane tenders

These scale models were obtained from the Attack School, and are built on a scale of one inch to 41 to 44 feet, depending on the particular type. In the present apparatus, this scale gives the illusion of ships at a distance of approximately four miles. In use, the models are placed on the back edge of the table, except when "hull down" positions are desired. In this case, the models are placed on the forward sloping portion of the table.

Briefly, the device and method employed reproduces in a testing room the situation confronting the lookout. A realistic horizon, simulating an arc of 90 degrees from dead ahead to 45 degrees on port and starboard bows, is provided upon which the trainee is required to sight and identify ship models. The apparatus provides also for reproduction of distant gunfire, of moonlight, and of recognition lights. Its advantages as a training and testing device lie in its realism, and in the interest which it arouses in the men.

PROCEDURE

Throughout the period that tests of night vision employing the artificial horizon described above have been conducted, the procedure has been held constant. It has proven remarkably satisfactory for the dual purpose of instruction and testing.

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The group to be tested is ushered into the lighted darkroom, and is called over to a high table on which the ship models are placed. Here they are allowed to examine carefully the models which they will later be called upon to identify. The men are permitted to handle them at will. After a short period, the men are seated on the benches and the instructor sketches a diagram of the cross section of the human eye upon a blackboard and briefly explains its function and why it functions differently in a condition of bright light than it does in dim or poor light, --why we see an object better by looking directly at it during daylight or bright light and why we see better in poor light if we look to the right or left or above or below an object. Best place to look: ten degrees above the object you suspect is there.

At this time the instructor emphasizes the vital necessity of becoming familiar with relative bearings, and familiarizes the men with their use with the assistance of the relative bearing board which is placed in a position where all of the men can see it. He explains that a lookout who is not familiar with the bearings may become confused when attempting to report an object in its proper bearing and report it in such a manner as would indicate that the object is abaft the beam when it is really forward of the beam. This would delay the Officer of the Deck in picking up the object and taking necessary action. Stating that time does not permit him to give all hands a full course of instruction in the use of all bearings, he urges them to ask the assistance of their quartermasters in learning them. When this procedure is completed the instructor explains the area represented on the table by placing a ship model at the dead ahead position and then moving it to each ten degrees on either side. This procedure is advisable when recruits are present to be sure that they visualize the area that they will be assigned to cover during the test. If this is not done, the men being tested may delay reporting the object sighted until he figures out the proper bearing, thus destroying the possibility of getting a true check on his efficiency as a lookout. The instructor then approaches the control panel, snaps on the main and horizon switches and turns up the horizon light to one degree on the rheostat scale. The reason for this will be explained in the lecture. Overhead lights are extinguished and the following lecture is given, (as developed by Chief Signalman Deloury).

LECTURE:

"It will be necessary to remain in darkness for a period of about thirty minutes. The reason for this period is to give our eyes a chance to become dark-adapted. This is necessary in order to obtain a true check on your night vision efficiency. If we were to start the test now, the results would tell us nothing. I have shown you a cross section of the human eye and explained that its function is vastly different in strong light than it is in dim or poor light. While this room was lighted our day eyes were functioning, and now that darkness is upon us they no

longer operate and our night eyes must do the work of seeing. Research has proven that after exposure to strong light, our night eyes will not function at their maximum best for at least thirty minutes. In a sense, we are totally blind at this moment, that is why we must wait that long before we start to the test. I am going to prove the necessity of this, to your satisfaction, in about fifteen minutes. Look around you and I'm sure you will all agree that this room is completely blackened out, that you cannot see a glow of light any place. Surprising as it may seem to you, there is a glow of light spreading over the entire horizon represented on the testing table. We cannot see it now, but in the course of fifteen minutes you will all see it very dimly and if I were to leave the light on for another fifteen minutes the glow would appear to increase in intensity until it becomes quite bright. Please let me know when you can see the glow. Now, since it is necessary for our eyes to go through this adaptation period before starting this test, isn't it reasonable to assume that if a lookout were stationed on watch immediately after coming on the topside from a lighted compartment, that that man will not see at his maximum best for at least the same period of time that it requires you to see the glow of light that exists in this room? Stationing men on lookout watch during peace times without this period of adaptation was not alarming but now that we are in a state of war and enemy men-o'-war are lurking around outside waiting for a chance to catch us off guard, our lookouts must be able to see efficiently from the moment that they are stationed on watch. For this reason, it has been recommended that men going on night lookout watch should be called at least fifteen minutes sooner than was customary during peace times. If this is being practiced aboard your ship, you may have been feeling a little resentful and considered it an unnecessary hardship, but now that you understand something about the function of the night eyes, you surely realize that it is a mighty good idea and will perhaps some night save your ship and the lives of many of your shipmates. I might also add that a lookout, quartermaster, or Officer of the Deck should never expose the night eyes to light after adaptation has been attained. The flare from a lighted match or an unscreened flashlight will destroy adaptation for at least a few minutes and the night eyes lose their efficiency until it is complete again. Quartermasters require some light to make entries in their notebooks or writing up their log each hour. At such a time, he should wear a patch over one eye so that adaptation of that member is not disturbed. When the patch is removed that eye will do a good job of seeing over quite an area and about ten minutes later the other eye will be back on the job.

"We have been devoting this adaptation period to a discussion on the reason for this chamber, the responsibility of a night lookout, and the proper method of standing the watch. Please pay strict attention to remarks made here because it is very possible that some of them may prove valuable to you later on.

"Eye specialists have discovered that many people are afflicted with a decided deficiency in night vision and some are totally night blind. These people may have perfect day vision and are normal in every respect but the night eyes just won't function. This condition may be caused by the lack of Vitamin "A" in the system and eating plenty of foods rich in that vitamin, such as carrots, peas and other greens may build the night eyes to normal. By this test it is possible to determine whether any of you men are so afflicted and should you be, do not feel too much concerned about it. Realizing as we do that some people are night blind, it would seem foolish to consider every man in the service capable of assuming such a responsible duty as night lookout, until after they have proven their ability to see well at night. That is the reason you are here now.

"The purpose of this chamber is twofold. After all, it is not enough that we ascertain the night vision efficiency of our lookouts -- we must be sure that every man fully realizes how important that job is, so that he will be constantly alert from the very moment that he takes over the watch. If our lookouts are not alert, they may as well be blind, because they certainly won't see anything. We who have stood night lookout watches over a period of years during peace times, realize that it is not a pleasant duty. Most lookouts had already done a day's work and when called in the middle of the night to stand a watch, they were tired and perhaps feeling generally miserable -- in fact, I might say that a man's morale is quite low at that time. We considered it as a sort of extra duty. After all, there wasn't much to be concerned about. Perhaps we might have run across some floating obstruction that might damage the ship or a fisherman steaming around with improper running lights which we might collide with, but that happened so rarely in the history of our Navy that we were all sure it would not happen during our particular watch. Therefore, we were somewhat careless and our officers were considerate of us. Well, times have changed and if our lookouts don't realize it, we may have to pay a costly price for their lack of sense of responsibility. When a man is stationed, he is assigned a definite sector. On small ships that sector may cover anything from 90 to 180 degrees. He, and he alone, is responsible for seeing and reporting everything that appears in that area and if he doesn't see it, nobody else will. In the case of most submarines, three lookouts are assigned to keep constant watch on 360 degrees of arc, which is the entire horizon. In other words, each man is responsible for 120 degrees; that is a lot of territory. In addition to the three lookouts our submarines have on the bridge an Officer of the Deck and a Quartermaster. The Quartermaster and the Officer of the Deck assist the lookouts by looking around the horizon, but the responsibility for the sectors mentioned is that of the lookout assigned to that sector. I have mentioned that you have a total of five men on you topside. Your ship's complement of officers and men is anything from forty to seventy, depending on what type of submarine you are serving in. The men who are on watch on the topside have to realize that the lives of the balance of the crew, men who are on watch in the engine room, etc., are depending on the alertness, the efficiency of five men. It will be well if every man standing lookout watch

would bear that thought in mind. He should decide that it would be well for him to stand his watch in the same manner he hopes his relief will stand his. Assuring ourselves that a lookout is physically efficient and assuring ourselves that the lookout is fully aware of his great responsibility is not enough. We must also be sure that the men understand the relative bearings as I have pointed them out to you; that he understands how to make a report properly.

"Now we will dwell on the making of reports. Due to conditions outside, slapping of the seas up against the ship's sides, wind blowing, and the natural noises about the ship, the Officer of the Deck would not be likely to hear a mumbled report, or at least he would not understand the report given. Therefore, call the report out in a good loud, distinct tone so that it will not be necessary for the Officer of the Deck to question any report given. Should it become necessary to question the report there is a loss of time, and the loss of even a second or two may be the difference between your coming back in or staying out. I don't believe I have to qualify that remark.

"There are several methods of making a report of an object sighted and I shall now try to illustrate the most popular methods. Should you sight an object in any given bearing -- say twenty degrees -- and you cannot make the object out, you report in this manner: "Object twenty degrees, I cannot make it out, sir." Should you identify the object as a battleship, cruiser, aircraft carrier, etc., then you will report it as such in this manner: "Aircraft carrier twenty degrees, sir." You see, you have employed very few words, but they are sufficient to give the Officer of the Deck all the necessary information. Always make sure that the Officer of the Deck acknowledges every report. Realize that the first and the most important duty of the lookout is to sight the object and report to the Officer of the Deck. Determining what the object happens to be is secondary in importance.

"During the course of any watch, a lookout on his toes will have occasion to report objects that don't exist. He reports an object "broad on the starboard bow." The Officer of the Deck looks and see nothing. Half an hour later the same thing happens -- he reports an object sighted; the Officer of the Deck sees nothing. The lookout becomes embarrassed and decides he is going to be very sure the next time that the object actually exists before he makes the report. That is a sad error. You continue to report whenever you sight an object -- the fact that it doesn't exist doesn't do anybody any harm. Just the time you hesitate reporting the object may be the time you meet the enemy. He perhaps has seen you and has not hesitated to report your presence. He gets the first shot, which places you at a decided disadvantage.

"A common error that a lookout usually makes is that, after reporting an object to the Officer of the Deck, he concentrates on that object. The object sighted covers a very small fraction of one degree of the arc for which the lookout is responsible. As soon as the report is given the Officer of the Deck immediately searches the horizon in the bearing given and

acknowledges picking up object reported. The lookout has done his job. There is nothing more he can do about that particular object. If the Officer of the Deck and the lookout concentrate on the object, the rest of his sector is unwatched. Where one object is sighted, in the case of an enemy, it is very probable that there will be two or three in the same area. If an enemy capital ship, such as an aircraft carrier or battleship is sighted, you can be sure that that craft is being escorted by destroyers, and one or more of them may slip in on you from the unwatched part of the sector, and your ship wouldn't stand a chance if they were not seen. When you are assigned lookout watch, bear this in mind and after the Officer of the Deck acknowledges your report of an object, you look away from it and immediately keep a sharp watch on the rest of your sector.

"We must realize that our competition is keen, if the discipline in the Axis navies is anything like what we have heard and believe it to be. Those boys are right on their toes. A British officer who was here a short time ago remarked that when two enemies meet at sea, every condition being equal, that is, same type of ship, same number of guns, torpedoes and so on, the ship having the most efficient lookout is the ship that will be victorious. I am sure you will agree that sounds very logical. You have all heard that old saying, -- a chain is as strong as its weakest link. An inefficient lookout may well be the weak link in an otherwise powerful fighting ship and ship's company. Your ship is the very best of its type that sails the seas, -- the best that modern science and engineering can devise. Your captain and officers have devoted years of their lives to study and training in all tactics, preparing themselves to handle your ship in a manner that will defeat the enemy when contact with him is made. Nothing is being left undone in the training of your crew so that you can all do your job in an efficient manner. One blind or inefficient lookout may nullify all of this and bring you defeat, and possible death. The first shot or torpedo may be the decisive one and the lookout must do his part toward giving his ship the chance to fire that first shot.

"For the past twenty-four years our Navy has been kept at its present high point of efficiency by conducting one Fleet problem after another, pretending we were at war. We practiced meeting every conceivable wartime contingency and learned how to meet various situations. There is one possibility, however, that we cannot anticipate, the very serious one of having an inefficient, inalert lookout on watch when we come within gun or torpedo range of the enemy. Let us realize the responsibility we assume when we take station as lookout, and we will surely do a good job."

At the close of the lecture the Officer in Charge of the men being tested and trained is asked if he has any comments or additions which he may care to make.

The instructor now illustrates various light conditions that may be experienced from dusk at night to dawn in the morning and explains the best method of keeping an alert and efficient lookout watch. He cautions the men as follows: "Please pay close attention because, although you may have very good night eyes, you must learn how to cause them to work at their maximum best."

He then turns up the horizon light very gradually until dawn in pretty well in. He explains how a lookout should look slightly above or below the horizon and why he will see an object much sooner and better just to the left or right of where he is actually looking. To demonstrate this, a model is placed in a position about three points on the port bow of the training table on a crossing course with the bow projecting over the back edge of the table so that the horizon light reflects on it. The horizon light is then gradually dimmed until only the illuminated bow of the model can be seen very faintly. The instructor then suggests that the men look directly at the light until it has apparently disappeared, then immediately shift their gaze to a dead ahead position. He then turns down the rheostat to the desired point and, as a rule, all men agree that they no longer see the light when they look directly at it, but it reappears when they shift their gaze to about one point on the bow. The model is then moved to another position on the table and the horizon light brought up to a point where model is barely visible. The men are advised to scan the area rather than stare at it, because the night eyes are very sensitive to movement. This demonstration is very effective and much better results are obtained during the test.

Demonstrations are now given of the following: distant gunfire, recognition signals, vessels moving into moonlit areas, and ships "hull down" to different degrees. Any of the models may be used in these demonstrations.

The horizon light is next gradually turned up, and the ship models are placed on the table, one in each point of the arc from broad on the starboard bow through dead ahead to broad on the port bow. The instructor points out the various characteristics so that the men can easily identify them. The light is then cut off completely, and then gradually brought up in intensity, so that the men can see the silhouettes taking form as dawn breaks. The instructor now turns rheostat to zero, removes all but one of the models from the table, and places that model in new position, with the following instructions to the men: "I am going to gradually "break dawn", and any man sighting the object will please report it in its proper bearing."

As soon as the object is sighted and correctly reported, a reading of the graduated rheostat scale is made. If the reading indicates that adaptation is complete the lights are extinguished and the test begins. (On the apparatus described here, a scale reading of 2.2 or 2.3 indicates satisfactory adaptation).

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During the tests, results of the sighting of large models only (battle-ships, heavy cruisers, aircraft carriers) are used. Occasionally, however, smaller models are also placed on the table during the tests. Results on sighting these last are not recorded; they are used only for increasing and maintaining the interest of the men.

Different models of approximately the same size are used during the actual testing of the men; the models used are changed for each pair of lookouts, and the position of the models is also shifted.

(For advanced training and testing of men who have reported for further instruction, pairs of the smaller models may be employed. It is important to note, however, in the interests of accurate scoring, that all lookouts in any group should be tested with models of the same approximate size).

Two men are tested at a time; the instructor stations a "starboard lookout" and a "port lookout" at the points indicated on the floor-plan. Each lookout is instructed to confine his report to objects sighted on his own side; experience indicates that with failure to specify this, the starboard lookout will perhaps report the object on the port side, destroying the opportunity to run the port lookout, which makes an extra run necessary. He is further instructed to report the bearing on the object sighted, and to identify it as soon as he is able.

When directions have been given, the examiner gradually turns the rheostat, producing the "breaking of dawn". Two readings are taken for each man -- (a) the rheostat reading when an object is correctly sighted and reported and (b) the reading when correct identification is made. As each pair of lookouts completes the run, it is ordered back to the seats to observe while the rest of the men are run, and the next pair is placed in position.

Occasionally, particular men will give the instructor difficulty. Some, seeking to avoid extra duty, deliberately make bad scores. When this seems to be the case, the instructor gives a brief talk to the group stressing the point that in critical situations, where personnel is for some reason short, any man may be called on for lookout duty, and his ability may make the difference between life and death for both him and his shipmates. Others, too anxious to obtain a good score, guess the model's bearing before they see it. A few runs without the presence of a model on the table eliminate this difficulty.

After a group of men has been tested, interest can invariably be maintained by the following demonstration:

A small model is placed on the table in a "hull down" position. The instructions are given: "There is a ship out there and there is an electrical storm on. Lightning will flash. Whoever sights the ship in the flash should call out the bearing of the object." A quick on-off turn of the rheostat reproduces the lightning flash, and a great amount of competition occurs among the men in sighting her.

This apparently superfluous demonstration has been effective in maintaining the interest of the men in the situation. Earlier groups tested were somewhat apathetic, but the development and use by Chief Signalmen Deloury of such demonstrations have eliminated any difficulty on this score. Later groups, having heard of the test, come in interested, alert, and ready to compete in the situation. The men like the test, their officers like the test and the resultant interest has played no mean role in the effectiveness of the night lookout training.

SCORING AND RESULTS

The test scores obtained by each man, one for sighting object, and one for identifying object are converted by Table I into Navy scores.

TABLE I

<u>SIGHTING OBJECT</u>		<u>IDENTIFYING OBJECT</u>	
<u>Rheostat Reading</u>	<u>Navy Score</u>	<u>Rheostat Reading</u>	<u>Navy Score</u>
2.5	2.7	4.5	2.5
2.4	2.8	4.4	2.6
2.3	2.9	4.3	2.7
2.2	3.0	4.2	2.8
2.1	3.1	4.1	2.9
2.0	3.2	4.0	3.0
1.9	3.3	3.9	3.1
1.8	3.4	3.8	3.2
1.7	3.5	3.6	3.3

These conversion tables were set up on the basis of the distribution of the first groups of men run.

Up to date, approximately 1325 men, from thirty ships have received training. Scores made are distributed as shown in Table II.

TABLE II

<u>Navy Score</u>	<u>Sighting (No. of cases)</u>	<u>Recognition (No. of cases)</u>	<u>Navy Score</u>	<u>Sighting (No. of cases)</u>	<u>Recognition (No. of cases)</u>
0.5	1	2	2.6	8	47
1.0	1	1	2.7	46	67
1.1	1	0	2.8	143	154
1.2	0	0	2.9	278	256
1.3	0	2	3.0	460	468
1.7	1	0	3.1	260	217
1.8	0	0	3.2	100	56
1.9	2	0	3.3	6	5
2.0	2	0	3.4	0	2
2.1	1	2	3.5	1	3
2.2	3	3	3.6	0	0
2.3	0	6	3.7	0	0
2.4	1	17	3.8	2	2
2.5	4	18	3.9	0	0
			4.0	1	1

This does not include a large number of men who were run on an earlier form of the apparatus.

CREDIT AND SUGGESTIONS

Chief Signalman E. H. Deloury, USN, who has supervised the construction and done all of the testing with this apparatus here at the Submarine Base has the following suggestions for its improvement: (1) The training table should, if possible, be extended so that it covers 180 degrees rather than the present 90 degrees. A semi-circular table, with the lookouts stationed at the center would not only improve the realism of the situation, but also permit the simultaneous testing of a larger number of lookouts. (2) A mechanism should be provided for the manipulation of ship models. Moving ship models will increase realism still further, and provide for more thorough and advanced training and testing. The addition of such a mechanism would greatly increase the utility of the moonlight source which is not, at the present time, of any value for testing, despite its importance in actual lookout duty. (3) Submarines should be added to the collection of models. These would be valuable for advanced training where more difficult situations are presented to the men.

The Board of Medical Examiners for Night Vision has acted constantly in an advisory capacity. It is their objective to develop this training stage into a useful screening device for the classification of night lookouts. An extensive revision of the present night lookout stage has been formulated and is now being built at New York for the Commander of the Eastern Sea Frontier under the supervision of Chief Signalman Deloury.