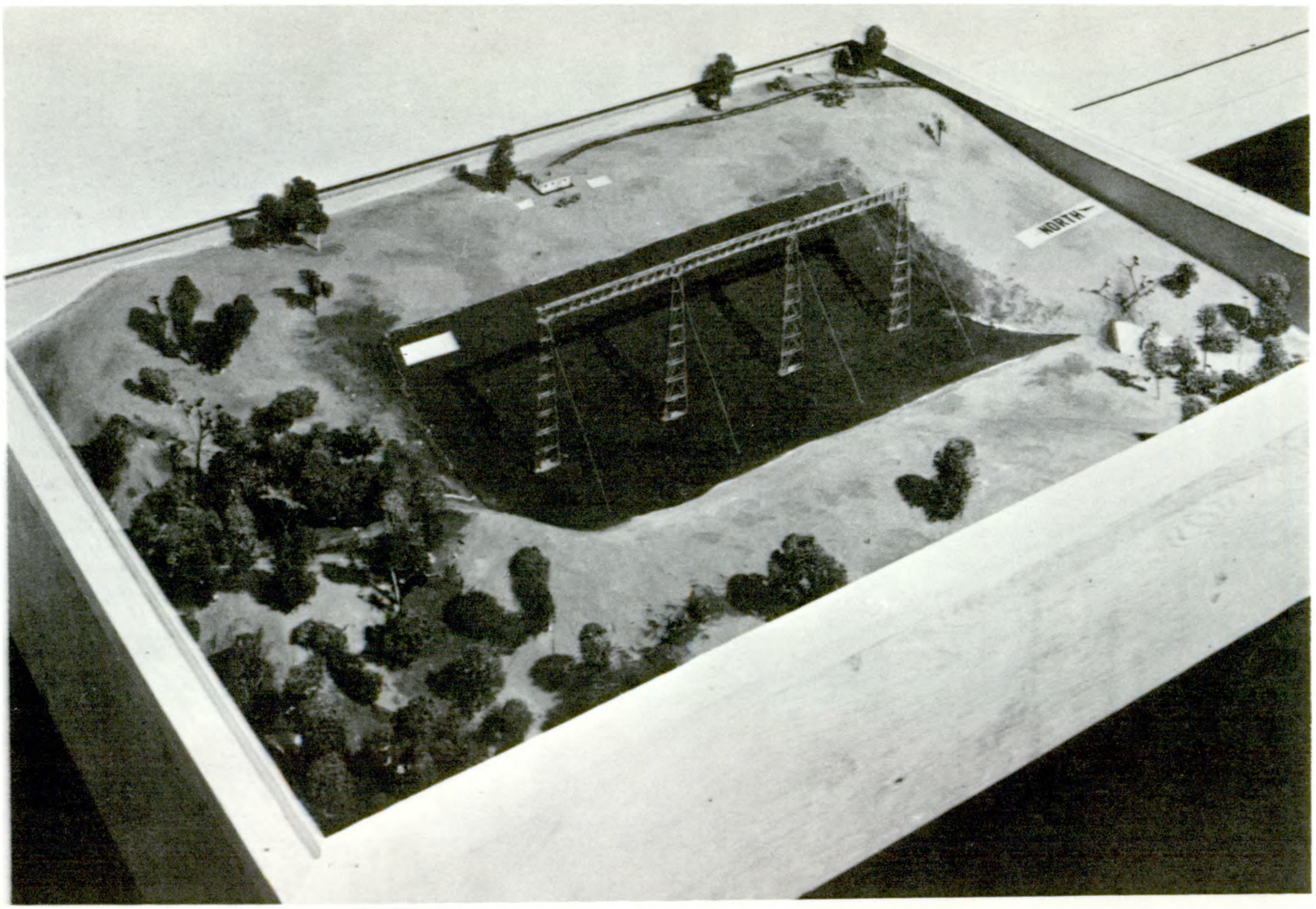
# AVAL RESEARCH REVIEWS

JULY 1960






Student members of the Astronomy Club built this model of the University of Illinois' new radio telescope—now under construction near Danville, Illinois. (See pp. 23 and 24.)

# The Empty Visual Field in the Laboratory and in the Air*

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Many individuals experiencing total darkness for the first time suffer varying degrees of depression, often accompanied by a sensation of the environment closing in. It is not surprising to these individuals, however, to find that they are unable to see anything. When, on the other hand, these same individuals face a well-illuminated visual field and still are unable to see anything, it is not only surprising to them but often quite disturbing. An illuminated field containing no visible objects usually is referred to as a homogeneous field, an empty field, or more generally as a Ganzfeld which literally means a whole or perfect field. Actually, the Ganzfeld rarely is encountered in natural environments. Perhaps the most striking example is the so-called arctic whiteout. This unusual condition may be produced by a number of meteorological phenomena. As a result, the horizon and all visible detail in the visual field are completely eliminated. One present in such an environment finds himeself totally enveloped in ''white nothingness.'' Aviators flying at high altitudes similarly report the feeling of being in a void, particularly when attempting to search for another aircraft against a homogeneous blue sky.

The Ganzfeld is somewhat difficult to describe. An individual placed in a Ganzfeld has the sensation of being ''immersed'' in a foglike atmosphere in which all awareness of depth disappears. He sees various ''hallucinatory and entoptic phenomena''–such as gradations of light and shade, rings of different shapes and sizes, and apparent movement of clouds, and frequently the random appearance of sharply defined spots.† After a relatively short time, these phenomena take on greater interest and the subject becomes increasingly fascinated by the various configurations seen. Such experiences show the extent to which the visual field becomes unstable when there are no visual cues available.

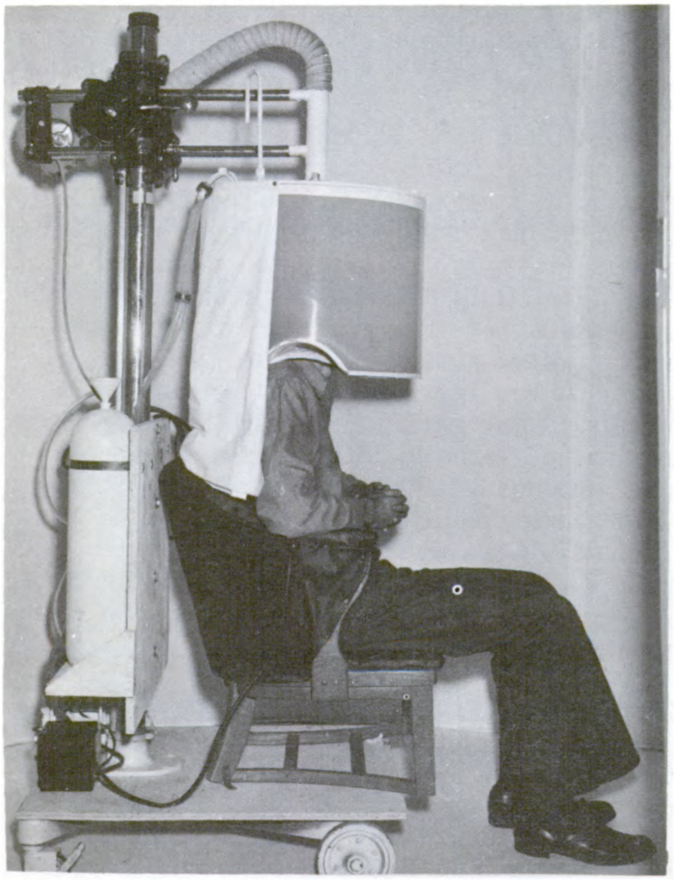
This article describes some of the results of laboratory investigations related to visibility in the Ganzfeld and also a related experiment in which the visibility of aircraft was determined in the air, both with and without the use of artificial contrails (smoke streams).

*This work, supported by the Office of Naval Research, was performed in conjunction with the U. S. Naval School of Aviation Medicine, Pensacola, Florida, while the author was associated with the Kresge Eye Institute, Detroit, Michigan.

†A related but somewhat dissimilar article, ''Nitrogen Narcosis and Its Effects on Performance,'' appears in the December 1959 issue of Naval Research Reviews, pp, 6-12.

## LABORATORY EXPERIMENTATION

Various methods have been utilized to produce a Ganzfeld, such as a hemispherical screen viewed under dim illumination, optical fogging lenses, and halved table-tennis balls. In the method used by the author,



Apparatus employed to produce the homogeneous visual field.

the subject views an evenly illuminated white background, while looking through approximately 2 inches of a diffusing liquid contained in a cylindrical annulus. The purpose of this liquid is to eliminate any visible defects remaining in the background. The subject's visual acuity is reduced only slightly by the fluid itself, thus permitting the presentation of a wide range of test objects, either stationary or while moving, in a virtually unlimited homogeneous visual field.

Preliminary laboratory investigations were conducted in which the task of the observer was to detect the presence of black spherical targets placed randomly within the field. These results revealed a huge variability between subjects regarding their ability to locate the targets. Prior to beginning the experiments, the visual acuity of each subject was measured while he looked through the diffusing fluid in the cylindrical annulus. It was found that the acuity of the subjects was on the order of 20/60 to 20/80 (3 to 4 minutes of arc). In spite of the fact that the smallest targets used were about 12 minutes of arc (20/240), the subjects not only had difficulty in locating the targets but also in keeping "on target." On some occasions it was suspected that the subjects actually were not seeing the test object at all even when they reported that they had. As a check on this possibility, a number of trials without a test object were interspersed with the regular trials. On many such trials the subject reported instantly seeing the test object; yet in others, it took perhaps a full minute before the subject reported positively seeing "something," when indeed there was no test object present at all. Several experienced, highly trained subjects reported spontaneously that the test object appeared exceptionally sharp on trials in which no test object had been presented.

Many subjects found that, in addition to having difficulty in locating targets in an empty field, once located the targets might fade out or disappear and that they would be unable to locate them again. It is interesting to note that if the experimenter assisted the subject in locating the target, it usually would reappear instantly only to fade out again when the assistance was removed.

Following the preliminary investigations just mentioned, mean-acquisition-time experiments were conducted to determine more precisely the relationship between the target size and the time required to locate it (acquisition time). Black, plastic spheres, varying in size from approximately the size of a large pea to the size of a tennis ball, were placed in various locations across the visual field, about 10 feet from the subject. The sizes and locations of the targets were selected randomly prior to commencing the experiments. After positioning the subject and telling him to close his eyes, the target was moved into place. Next, the subject was told to open his eyes and depress a switch, thus activating a timer. When the subject located the target (which was either arbitrarily positioned or moving imperceptibly), he again pressed the switch, stopping the timer. The experimenter, upon seeing the timer stop, moved the target randomly (back and forth from right to left), and the subject was required to call out the directional changes. This procedure was followed as a precautionary measure to make certain that the target actually was seen. In the event that the subject failed to locate the target by the end of 3 minutes, the trial was terminated. Although the experimental procedure was the same, three experimental conditions were utilized. In the first condition the target was positioned and remained stationary; in the second the target was moved imperceptibly; and in the third the field was structured to the extent of placing some vertical lines in front of the subject.

As expected, the mean-acquisition-time results demonstrated that as the size of the test object increased, the length of time required to locate it decreased. The same general relationship appeared to hold for all three experiments. The acquisition time began to increase rapidly when the target size was less than approximately 20 minutes of arc (20/400), which is indeed surprising, in view of the fact that the visual acuity through the fogging solution averaged 20/60 (3 minutes of arc). A subsequent statistical analysis revealed that many targets, although well above threshold, frequently were not found at all. It was found further that the longer one searches, the less the probability of locating the target in a given time interval. This was true even for an object as large as six times the measured visual acuity threshold value. The general feeling among the subjects was that "the longer one is exposed to a uniform visual field the more disoriented one becomes." All test objects in these experiments, as mentioned earlier, were placed on a line approximately level with the eyes; however, due to the fact that when there is no visual reference a subject does not know accurately the position of his eyes, the subjects soon became unaware as to where they were looking. Thus there is a certain element of chance involved in locating a target in a totally homogeneous visual field. Not only does the individual have no accurate knowledge as to where he is looking, but he has no cues as to where he has searched previously.

Interviews with subjects during and after these and other experiments have revealed that there is a great deal of variaion in the methods of search used in locating the test objects. Most subjects search in some sort of a prescribed pattern, or at least this is their stated intent. The results show clearly that efficiency of search in an unstructured field is quite low as compared to that in a well-structured field. This gross inefficiency of search yielded results which were extremely variable. On one trial, a given size target might be seen almost instantly upon opening the eyes, and on a subsequent trial it might not be seen at all in the allotted time. In addition to this, the target sometimes faded out before it could be ascertained whether or not it was the real object which was seen. From an earlier investigation by the author and E. J. Ludvigh, it was concluded that search in a field lacking any visible reference is either tremendously inefficient or random and that more than likely it is a combination of these.

## AIDING THE PILOT IN AIR-TO-AIR SEARCH

Inefficient searching for another aircraft in an empty visual field can be, at times, a very serious problem for the aviator, especially at high altitudes. There are of course many factors involved, such as glare, haze, lack of contrast, division of time between instruments and search, and others. Also, there is the problem of visual disorientation resulting from absence of reference points in the background.

Some of the difficulties encountered, based on reports from jet pilots interviewed at the U. S. Naval School of Aviation Medicine, arise in operations involving rendezvous, gunnery training, avoidance of mid-air collisions, identification, and in-air refueling. On some occasions pilots have reported spending 15 to 30 minutes trying to locate an aircraft at high altitudes and, in a few cases, failing completely even when they were in radio contact and had radar facilities.

The laboratory experimentation just discussed shows that although even relatively large objects sometimes are not found readily, the time required for detection is reduced considerably as the size of the object is increased.

One way in which both the size and contrast of aircraft can be increased effectively is by using artificial contrails, a method military pilots independently have recognized and utilized for some time. On occasions when locating another aircraft is difficult, the pilots may attempt to rendezvous at an altitude at which the aircraft produce genuine vapor trails. Another, more expensive method used by pilots in the fleet is to open the dump valves in the wing tanks when possible, thus ejecting fuel which leaves a trail similar to white smoke. In a discussion of this problem with the Navy's Blue Angel demonstration team, the pilots said that, although the smoke-generating equipment on their aircraft is for demonstration purposes only, occasionally smoke is ejected for purposes of rendezvous.

Although the advantage of using artificial contrails is obvious, their use toward the prevention of aircraft collisions apparently has been neglected by both military and civilian authorities alike. According to A. E. Zeller, smoke puffs and vapor trails have limited value in light or heavy traffic and might well lead to confusion in the latter case. These, however, are not the conditions in which one would expect contrails to be of most value. One would expect them to be most beneficial in situations encountered at high altitudes where, in addition to being confronted with a more difficult search problem, the pilot cannot call as readily upon ground-based radar for assistance.

Some pilots have said that a genuine vapor trail can be seen for distances in excess of 100 miles under ideal conditions at high altitudes. To determine the actual range of visibility with and without artificial contrails, a field study was conducted in the vicinity of Pensacola, Florida, by members of the U. S. Navy Blue Angels serial precision flying team (cover photo), and radar operators and equipment from the U. S. Air Force Base at Dauphin Island, Alabama. Two separate experimental flights were made with three planes on the first flight and two on the second. The first flight was made with one two-seat training fighter (F9F8T) and two single-seat fighters (F11F); on the second flight only the F9F and one F11F were used. The chief observer, an experienced aviator, rode in the spare seat of the F9F. The general flight pattern was determined prior to takeoff, but the planes actually were guided throughout the flight by trained Air Force personnel who operated a ground-control intercept radar system. Also, a tape recording was made of the entire conversation between the radar operator, the pilots, and the observer throughout the flight.

The first of a total of 10 runs made during the two flights was a head-on course, with the planes containing the chief observer at 10,000 feet altitude and the target plane at 11,000 feet altitude. The initial separation was 20 miles and the true airspeed was approximately 425 mph. In other flights, a series of runs was made in which both the target and observer planes flew abreast of each other in the same direction with a lateral separation ranging from 30 to 40 miles. In these flights the target plane, while attempting to maintain a 3 o'clock position with respect to the observer plane, would close in at an attack angle of 45 to 50 degrees. At prescribed intervals, the target plane would release smoke from the tail, and the observer would be asked to indicate when the target was sighted. The pilot in the target plane often verified the sightings reported by the observer. The results show that for the two direct head-on courses, the target plane was not sighted until it was at a distance of only 2-1/2 to 3 miles, even when smoke was used. It is not surprising to find that the smoke is of little value during a head-on collision course inasmuch as the smoke was ejected from the tail. It should be emphasized here that throughout the course of these flights the pilots and observer were being continually informed as to the clock position and distance of the other aircraft by the ground-based radar operator.

The results show further that when other than a head-on approach is made the visibility range is increased from approximately 8 miles without smoke to about 20 to 24 miles with smoke. As shown on the cover, the smoke produced by the F11Fs is not particularly dense. A smoke of higher density undoubtedly would increase further the range of detectability.

It is interesting to note that an object the size of the F11F fuselage, when viewed head-on, should be detectable by an individual with a visual acuity of 20/20 at a distance of 3.6 miles, which closely approximates the distance at which the aircraft was sighted. A visual acuity of 20/20, of course, simply means that the individual can see at 20 feet a separation of two lines subtending one minute of arc. When the visual task is one of determining the presence or absence of an object, detection of objects considerably smaller than one minute can be accomplished readily. Therefore, if it were not for the lack of contrast, haze, and the like, the F11F theoretically should be visible at substantially a greater distance. When considered from a practical standpoint, however, these conditions do exist, and if the observers had not been informed continually as to where to search, it is highly probable that they would not have located the target plane at all. As a matter of fact, during one head-on run, neither aircraft was sighted until one plane was directly over the other—a vertical separation of 1000 feet.

From the foregoing discussion, it is apparent that artificial contrails have certain advantages not afforded by other means of increasing the visibility of aircraft. There are of course situations, as Zeller has pointed out, in which their use could be of little value; however, the installation of smoke-generating equipment in aircraft, in which space and weight limitations are not prohibitive, might soon pay for itself if it enhances the detectability of aircraft in flight and reduces the incidence of midair collisions.

## MOUTH-TO-MOUTH RESUSCITATION POCKET CARDS

The Dental Division, Bureau of Medicine and Surgery, recently completed distribution to all Navy Dental personnel of a pocket card illustrating the mouth-to-mouth method of resuscitation. This method of resuscitation is currently recommended as the preferred and most effective method of providing artificial respiration. The manual methods (back-pressure arm-lift, back-pressure hip-lift, Eve method, Schaefer method) will be taught as alternate methods for use when mouth-to-mouth resuscitation is not possible.--U. S. Navy Medical News Letter.

# A Wind-Measuring System for The Tactical Prediction of Fallout

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In recent years the subject of predicting radioactive fallout resulting from the detonation of nuclear weapons has been studied with the aim of developing adequate prediction methods. The major requirements of fallout prediction are (1) acquisition of adequate wind data and (2) the use of these data together with other pertinent parameters—such as weapon yield, burst location, and height. This last requirement is met by what is commonly called "a fallout prediction method" which is usually employed as the first step in locating the area on the ground that will be covered by "militarily significant fallout." Experience gained from weapon tests indicate that fallout prediction methods are severely limited by large errors in wind data attributable to current wind-measuring systems. These systems use balloons to deliver targets for tracking to desired altitudes but not necessarily to desired locations in the atmosphere. They involve a 2-hour delay after target launching before data become available, Hence, because of the nature of the variations of wind speed and direction with time and distances, the wind data gathered by these methods are not usually representative of the actual winds that affect the radioactive fallout.

This article presents a preliminary evaluation of the wind-measuring problem associated with fallout prediction and proposes a wind-measuring system that offers a marked improvement over current systems for the tactical prediction of radioactive fallout. The proposed wind-measuring system is applicable to other fallout prediction problems, such as those of Civil Defense. Emphasis has been placed on the prediction of fallout from land-surface bursts of nuclear weapons in the tactical yield range—from less than one kiloton to approximately 100 kilotons. Therefore, this evaluation is relevant to tactical operations of the Army, the Marine Corps, and in some cases the Navy. The land-surface nuclear burst is defined as one in which the fireball touches the ground. Ordinarily this type of burst is the most important type for land operations that require fallout predictions. This is because many heavy earth particles come in contact with the radioactive fission products in the fireball and create hazardous close-in fallout. Figure 1 shows the mushroom cloud and stem of a 25-kiloton, near-surface burst in Nevada in which the top of the cloud reached a maximum height of 40,000 feet above mean sea level.

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The opinions or assertions contained in this article are those of the author and are not to be construed as official or reflecting the views of the Navy. This research was supported jointly by the U.S. Army and the U.S. Navy Bureau of Ships.

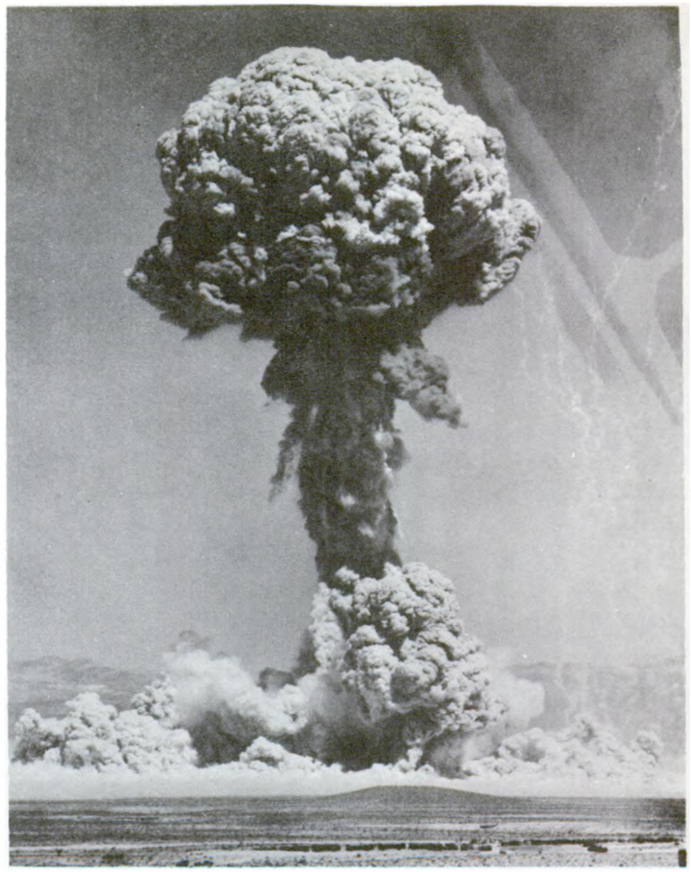


Figure 1—The nuclear cloud and stem from a Nevada near-surface land burst of 25 kilotons.

According to an analysis made of the effect of fallout on troops located one to 4 miles downwind from the burst point of weapons (with yields of from one to 100 kilotons), the average time after burst for the fallout radiation dose (in roentgens) to build up to a dangerous level (200 roentgens) was 20 minutes for light to moderate conditions. Based on this estimate, not more than 10 minutes after a burst can be allowed for acquiring and plotting the wind data necessary for making an area fallout prediction. Thus, there would be an average of about 10 minutes remaining for troop commanders to issue warnings and to carry out countermeasures. Pending further study, this 10-minute interval is established tentatively as a requirement for the tactical prediction of fallout. Consequently, it is strongly indicated that the need exists for a wind-measuring system that can make adequate wind data available not later than 10 minutes after a nuclear detonation. Present wind-measuring systems cannot meet this need—as explained in this acticle.

## LIMITATIONS OF PRESENT WIND-MEASURING SYSTEMS

Acquisition of adequate wind data for the tactical prediction of fallout requires (1) that effective targets be delivered rapidly to locations in the atmosphere near the nuclear cloud and (2) that the wind data resulting from tracking these targets be derived very quickly—all within about 10 minutes. The necessity for these requirements, referred to in the foregoing paragraphs, are given further support in the following subparagraphs, along with reasons why present wind-measuring systems cannot satisfy these requirements.

Time Delay in Acquiring Wind Data. The major weakness of current wind-measuring systems in acquiring wind data for the tactical prediction of fallout lies in the time delay introduced by the use of balloon-borne tracking targets. Most of the time delay is due to the relatively slow rate of rise of meteorological balloons, which average about 1000 feet per minute. Thus, if a balloon were released immediately after the detonation of a nuclear weapon, it would take about 50 minutes to reach the maximum altitude of 50,000 feet altitude near the top of a 100-kiloton nuclear cloud. Even if the balloon ascent rate were doubled, it would still take about 25 minutes to reach this altitude, which would still be too long. As previously pointed out, only about 10 minutes at the most can be allowed for acquiring the wind data.

Variation of Wind with Time and Distance. Since all methods of determing the area on the ground covered by fallout consider both wind speed and direction for selected altitudes, there will be errors in the fallout plots–if either parameter is in error. When balloon-wind data are used for fallout prediction, errors are present owing to the time and distance variations in the winds. Thus, any measurement made by tracking a balloon at a given altitude in the atmosphere will be inaccurate for fallout prediction because it will not be made at the same time (time variation of the wind) and location (distance variation of the wind) as the fallout.

It is very difficult to state the exact effect of the variation of wind with time and distance on the tactical prediction of fallout, largely because the right type of wind statistics are not available. The usual statistics of winds for given altitudes cannot be trusted to give reliable information about the total cumulative influence of wind variations on fallout. The path that a fallout particle takes on its way to the ground is determined by the cumulative effect of all the winds between the ground and the maximum altitude of the fallout particle; this means that in order to determine the ground area where there will be fallout, winds from the ground up to the top of the nuclear cloud at its maximum altitude must be analyzed and integrated. The only available statistics on such integrated winds is F. D. Cluff's study of the time variation of integrated wind from the ground up to various altitudes for the nuclear weapon test site in Nevada. In Cluff's study the mean speed change showed no significant trend with greater measuring thickness; however, the bigger the thickness of the atmosphere considered in forming the integrated wind, the smaller the shift of the wind. In spite of the lack of good integrated-wind statistics, experience gained from weapon tests can be used to indicate the significance of wind variations. To reproduce faithfully the fallout patterns of nuclear weapon tests (according to W. W. Kellogg and others), it is necessary to take into account wind time variations in the rawinsonde system (GMD-1) ballon-wind data. Other test experience has indicated, also, that errors in the wind data attributable to time and distance variations will definitely affect the accuracy of the tactical prediction of fallout. Thus, it follows that the rawinsonde system cannot normally gather wind data that are representative of the actual atmospheric flow affecting the fallout. During actual combat, this system requires about 2 hours to make a balloon run and compute the wind data (as explained by W. Baginsky and others). Furthermore, in attaining higher altitudes, above 30,000 feet, the balloon can drift many miles from above its release point.

As a consequence, then, before the wind data measured by the rawinsonde system can be used to determine the real air motion affecting the fallout, they must be corrected for the wind variations, and the only known procedure for doing this under combat conditions is forecasting. However, forecasting cannot take the variations of the winds into account to a significant extent because forecast winds are usually even further in error. It is indicated that wind-forecasting errors are relatively insensitive to the forecast period. In fact, according to H. W. Ellsaesser, the majority of such errors appear to be present at the zero-hour of the forecast period, at the time of the latest weather-map analysis.

The new remitter system (GMD-2) which may replace the rawinsonde system (GMD-1), will still use balloon-borne tracking targets. Therefore, it will suffer from the same limitations common to the GMD-1 in acquiring wind data. Thus, no marked improvement in the adequacy of the wind data for the tactical prediction of fallout appears possible with the remitter system.

<u>Examples from Weapon Tests</u>. During weapon tests, balloons are used in special upper-air sounding networks to obtain wind data over a limited area that is considerably more reliable and current than that obtained from the routine upper-air network. Generally, these data extend to a higher altitude, but, in spite of this special effort a degree of uncertainty still remains in the data. Thus, even scheduling frequent balloon flights, several hours apart will not guarantee adequate wind data for fallout prediction. Such was the case when an unpredicted shift of winds, shortly after the detonation of a 15-megaton thermonuclear device during Operation Castle Bravo at the Pacific Proving Grounds on March 1, 1954, caused deposition of significant amounts of fallout on four nearby inhabited Marshall Islands and on 23 Japanese fishermen aboard their fishing vessel, the Lucky Dragon. Sixty-four inhabitants of the Island of Rongelap, 105 nautical miles away from the detonation, received the largest fallout—an estimated whole-body, gamma-radiation dose of 175 roentgens. At Operation Greenhouse, during a test conducted at Eniwetok Atoll in the Pacific in 1949, a wind shift brought a portion of the nuclear cloud over the testing area, and the atoll received fallout over a period of several hours. Fortunately, no dangerous radiation doses were received by the task force personnel, and no evacuation was ordered. During Operation Teapot in Nevada in 1955, a review by the U. S. Public Health Service of data on predicted and measured fallout from 11 detonations showed that in five cases the predictions were in substantial agreement with the measured fallout, but in six cases they were in significant disagreement. In one extreme case, fallout actually occurred in a direction 180 degrees from the predicted direction. A typical direction deviation between the predicted and measured axes of the fallout pattern was 30 degrees. These predictions, of course, were made during peacetime under the most favorable conditions.

Thus, we have learned from weapon tests that reliable tactical predictions of fallout cannot be made by using wind data gathered with the aid of ballons.

Adequate wind data—representative of the winds that will affect the falling atomic debris—must be available on short notice. Such is not possible with the current rawinsonde system or the planned remitter system, both of which use balloon-borne targets.

## THE PROPOSED WIND-MEASURING SYSTEM

To meet the requirements for the tactical prediction of fallout, a new wind-measuring system is proposed that uses radar to measure the drift of falling passive targets delivered to pertinent locations in the atmosphere by rockets or gun projectiles. Components applicable to this system are being developed in connection with solving the problem of high-altitude meteorological measurements. These components can best be utilized to improve the capability of acquiring adequate wind data for the tactical prediction of fallout.

Radar Tracking. By far the most effective method of tracking appears to be radar tracking, a slant-range system, in which measurements of slant range, azimuth angle, and elevation angle can be made automatically as the target is tracked. From these measurements and their time derivatives, the wind speed and direction can be readily computed.

Tests have demonstrated that current radar equipment is capable of tracking passive targets at slant ranges up to 300,000 feet, or about 60 miles. This range capability is satisfactory for most tactical applications. The radar system offers quick automatic data reduction; thus, it can make data from a given altitude available almost immediately after the time the target was at that altitude.

Radar Targets. A variety of radar targets that could be tracked for wind measurement is available. In 1954 while at the Naval Research Laboratory (NRL), the author proposed measuring high-altitude winds by tracking strips of metal foil (called chaff or window) ejected from rockets. In June 1955 experiments were conducted in which bundles of chaff weighing from 3 to 6 ounces each were dropped from balloons and tracked by radar at altitudes up to 74,000 feet. Later in 1956, during tests conducted by ONR at the White Sands Proving Ground, chaff delivered by Loki I rockets was successfully tracked by radar at altitudes up to 150,000 feet. Various other tests have demonstrated that winds can be measured reliably at and above altitudes of tactical interest (50,000 feet) by this method.

Chaff is an ideal target for acquisition by radar; however, its use in the troposphere is limited because it usually gives data over restricted altitude ranges owing to its dispersion and low falling rate. Therefore, consideration should be given to nondispersing targets. One such target is metallized cloth—a lightweight material available in weights as low as 1/2 ounce per square yard. This material could be rolled up and placed in the rocket or projectile; after ejection, it could be opened by springs and probably could be tracked nearly to the ground. Another alternative is to make the material into a parachute so that it has a more uniform falling rate and radar echo. The ideal radar target would be spherical in shape so as to give uniform echoes, regardless of its orientation. This type of echo is especially important for long-range tracking. Therefore, the use of a metallized sphere, such as a heavier-than-air balloon, also should be considered for the radar target to be ejected from the rocket or projectile.

Target Delivery. As pointed out, the wind-measuring problem for the tactical prediction of fallout requires that effective targets be delivered rapidly to locations in the atmosphere where fallout is occurring or is expected to occur. The most practical means of delivery for short horizontal ranges (up to 5 miles) appears to be the gun projectile. Successful test have been made at altitudes up to 30,000 feet using chaff ejected from destroyer gun shells. For the greater altitudes and horizontal ranges, rockets will have to be used. At present, the system with the greatest wind-measuring capability appears to be the one based on the Loki rocket—which has been tested rather extensively.

The Loki I (Figure 2) is a relatively inexpensive, small, yet powerful rocket developed by the Jet Propulsion Laboratory of the California Instutute of Technology for the Army Ordnance Department. It can be easily fired from either a rocket launcher or from a gun barrel, carrying a one-pound payload of chaff or other target to any location in the atmosphere within its range in less than one minute. It consists of two parts: the Loki head (Dart) and the booster (rocket motor). The Dart (weight, 6.5 pounds; diameter, 1-3/8 inches; length, 40 inches) is a steel aerodynamic missile with a fitting at the rear for attachment to the head of the booster. The Loki I and II differ only in the type of booster. The Loki I booster (weight, 22.5 pounds, diameter, 3 inches; length, 66 inches) is a high-performance motor, consisting of an aluminum-alloy tube that contains a solid propellant and electric igniter. The Loki II booster (weight, about 28 pounds) is similar in dimensions to the Loki I booster, but it is more powerful.

Maximum altitudes have been achieved by firing the Loki rockets almost vertically—150,000 feet with the Loki I and 250,000 feet with the Loki II; however, as a consequence, the horizontal ranges were quite small. Although horizontal range is very important tactically, it can be increased by sacrificing altitude. Thus, estimates made on the basis of the maximum altitudes achieved indicate that the Loki I can reach 50,000 feet—the maximum tactical altitude of interest—within a horizontal range of 15 to 20 miles and that the Loki II can reach this same altitude within a range of 25 to 35 miles.

Tactical Use of the Loki Wind-Measuring System. The actual combat techniques employed when using the Loki rocket to obtain wind data would, of course, be dictated by the tactical situation, the meteorological conditions, and the equipment capabilities. Whether or not chaff, a parachute, or some other type of target is used for tracking will depend primarily on how soon the wind data are desired and how great

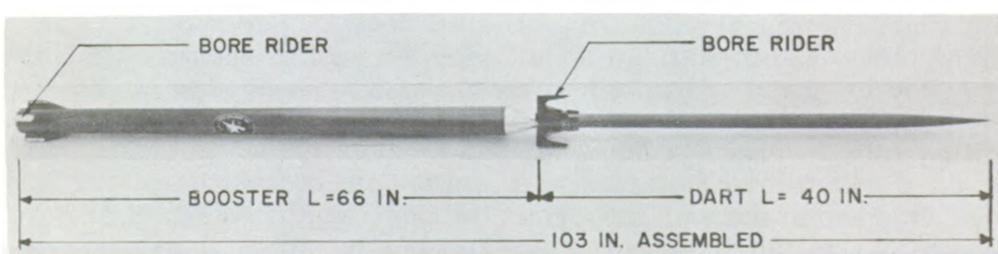



Figure 2—The Loki I rocket.

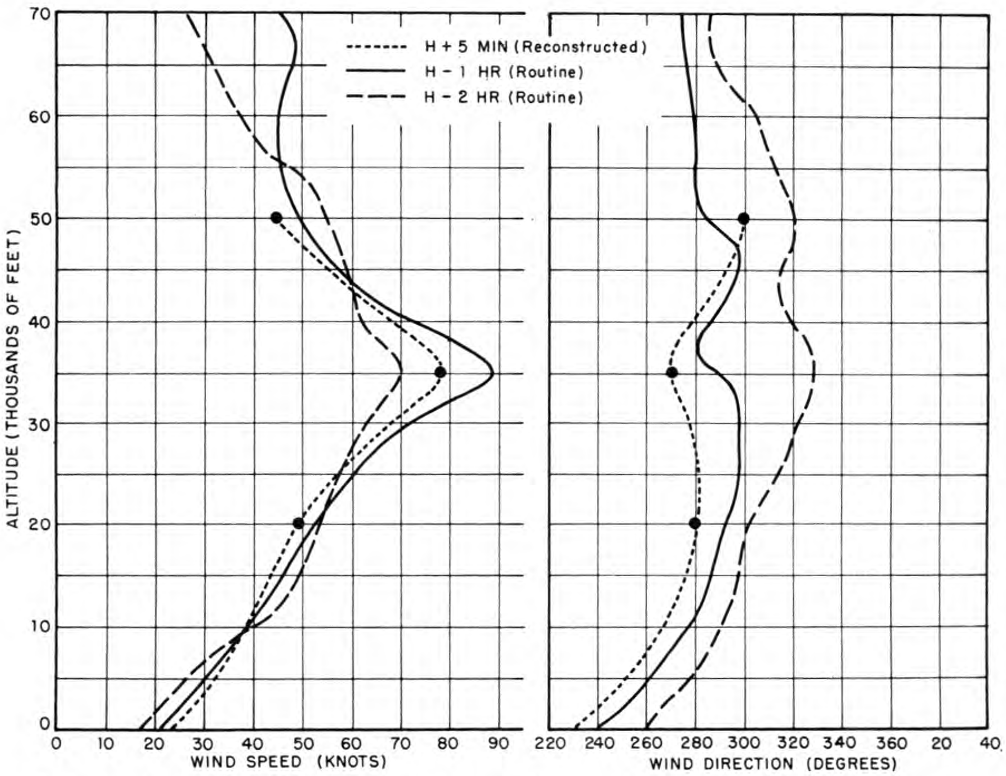



Figure 3—Reconstructed wind sounding using Loki chaff spot winds.

is the altitude range to be covered. Since the chaff disperses and has a low falling rate, it is applicable only over limited altitude ranges. Consequently, in the absence of circumstances demanding immediate action, Loki parachute soundings could be undertaken routinely, perhaps hourly, throughout the tactical area to give continuous wind soundings through the altitude range of interest. Since the altitude range for yields of 100 kilotons or less will be from the ground up to about 50,000 feet, appreciable time will have to be allowed for the parachute to fall. However, during an emergency, when a nuclear weapon is detonated in the tactical area, more rapid acquisition of wind data is imperative. In this case, the best procedure may be to switch to the Loki-chaff combination to make spot checks on the wind at several locations and at different altitudes near the nuclear cloud. These spot-check data could then be used to correct the latest continuous-sounding data for wind variations with time and distance. Such a method for correcting the routine Loki-parachute soundings with spot-checked winds is shown in Figure 3, where wind speed and direction are plotted spearately. The short-dash curves (Figure 3) represent the reconstructed sounding for 5 minutes after burst (H plus 5 minutes), based on (1) the spot-checked winds taken 5 minutes after detonation by Loki-chaff combinations for three critical altitudes (shown as black circles at 20,000, 35,000, and 50,000 feet) and (2) the trends shown by the H minus 2 hours and H minus 1 hour routine continuous Loki-parachute soundings taken from 70,000 feet to the ground. Therefore, such corrected wind data can be employed to make the fallout-area prediction, which should be corrected every half hour or so after detonation while fallout continues by using periodic Loki wind data gathered over the appropriate area.

The ability of the Loki rocket to deliver targets quickly to desired locations in the atmosphere allows corrections to be readily made for wind variations with time and distance. The only major requirement is that the fallout area must be within range of the rocket—which can be met by spacing the launching sites for Loki I rockets about 20 miles apart, and for Loki II rockets about 30 miles apart.

The Optimum System. The proposed wind-measuring system would utilize operational equipment and therefore could be made operational rapidly. Although the proposed system will markedly improve the adequacy of the wind data, it is not the optimum system that could be made available for tactical field use. Specifically, in order to develop the optimum system, more basic information is required on target falling rates, as well as their radar echo characterisitcs and aquisition at various altitudes and under different weather conditions. The dependance of the wind-data accuracy on thickness of the altitude range over which it is gathered and on the target falling rate should be investigated more fully.

The effect of the ejection of the radar target from the rocket must be fully explored, especially for intermediate altitudes where the rocket still has a high speed. Although the use of different radar targets should be considered, chaff and parachutes appear to be the most practicable at present. Otherwise, an extensive target development effort may be necessary owing to the high temperatures (up to 600 C, attributable to aerodynamic heating) and high accelerations (up to 100 G) associated with the Loki rocket. Tests have demonstrated that chaff and parachutes have successfully withstood these effects.

In addition, along with the development of an optimum wind-measuring system, it would be desirable to consider the development of a mechanized device to be attached or associated with the tracking radar that will automatically compute the fallout area from the wind data as they are acquired. As discussed in this article, it appears reasonable that an optimum system can be designed to produce a fallout-area prediction within the period of 10 minutes after a land-surface nuclear burst.

## RECEIVES NAVY LEAGUE AWARD

The Navy League's Admiral William S. Parson's Award for Scientific and Technical Progress for 1960 has been presented to CAPT Ashton Graybiel, MC, USN, Director of Research of the U.S. Naval School of Aviation Medicine, Pensacola, Fla. This annual award was in recognition of Dr. Graybiel's contributions to biospace flights, particularly as medical officer-in-charge of the Able/Baker monkey flights. Dr. Graybiel has earned an international reputation for his work in the fields of Cardiology and Aviation Medicine. In addition, he has written and published more than 140 articles and two books on medicine.

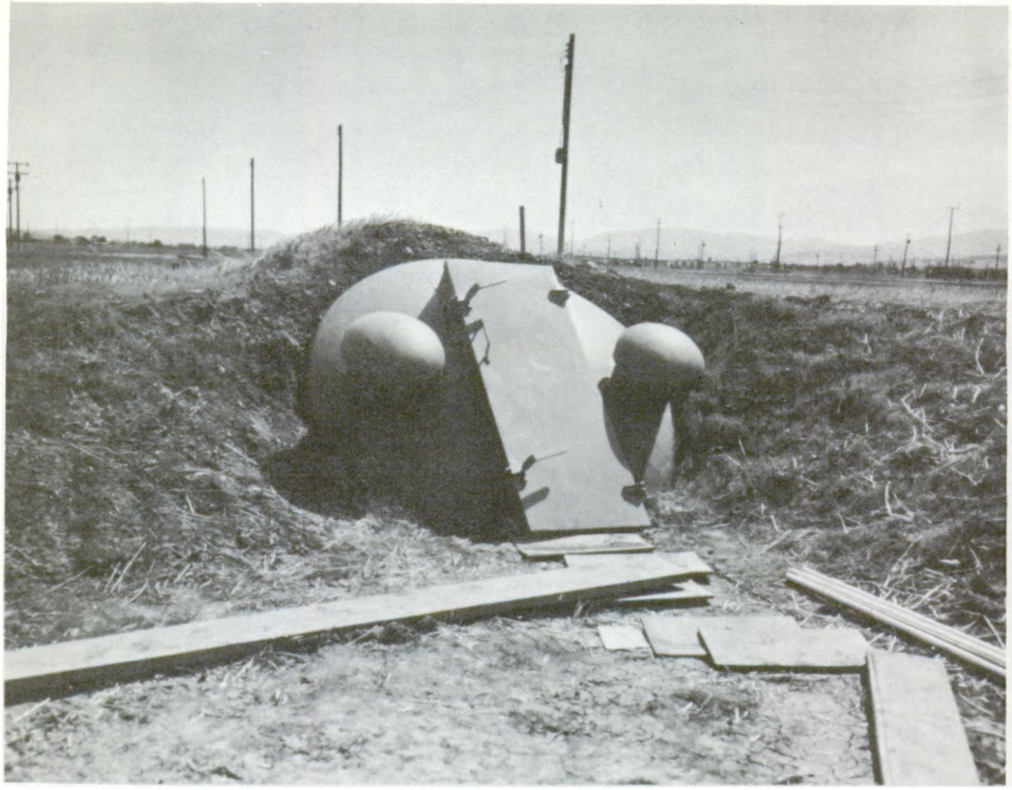
# Medical Aspects of Shelter Survival

This article is based on a report prepared by CAPT H. S. Etter, MC USN, Radiological Defense Director, U. S. Naval Radiological Defense Laboratory, San Francisco 24, California. The shelter experiment was directed by Mr. W. E. Strope, Head, Military Evaluations Division, USNRDL, and the shelter was constructed under the sponsorship of the Office of Civil and Defense Mobilization. Dr. Etter's role was that of Medical Advisor for the two-week occupancy test and as Shelter Medical Officer for one week of this period.

Imagine yourself—if you can—confined in a densely crowded underground shelter for two weeks. One hundred volunteers at the U. S. Naval Radiological Defense Laboratory know what it's like. They lived for 14 days last December in USNRDL's 25- by 48-foot experimental shelter at Camp Parks, near Pleasanton, California, as principals in a shelter habitability experiment. The test provided a unique opportunity to study human response in a confined environment. The subsurface shelter was designed to provide protection against air blast, mass fires, initial radiation, and radioactive fallout from nuclear attack. This article describes the shelter and its facilties, and gives a resume of the environmental, dietary, physiological, and psychological studies conducted.

The USNRDL experimental shelter (see sketch inside back cover) is a corrugated steelplate circular-arch structure with a concrete floor. It is similar in appearance to the bunker used by the Navy for ammunition storage. Twelve feet high in the center, the shelter has a total floor area of 1200 square feet and a gross volume of 11,700 cubic feet, providing each shelteree with 12 square feet of floor area and 117 cubic feet of gross air volume. The shelter, buried under 3 feet of earth to provide shielding against possible nuclear radiation, has a designed capability of being closed off completely from the outside environment for 24 hours. The air-rebreathing system uses Baralyme pellets for removal of carbon dioxide supplemented by oxygen released from bottles.

For this experiment, berthing consisted of 96 stretcher-type bunks (each 76 by 24 inches) arranged in four tiers on each side of the shelter with 12 rows to each tier. The bunks could be easily taken down and stored during the day along the sides of the shelter to make more space for recreational activities. Five collapsible tables and 10 benches were provided to accomodate 50 persons at mealtime and for general utility and recreation. When not in use, the tables and chairs were stored against the shelter walls. Galley equipment was reduced to the barest essentials: a service table at the front end of the shelter, a two-unit hotplate for warming some of the rations, and a coffee urn for heating water for instant coffee. A 1500-gallon water storage tank buried near the shelter entrance provided water for drinking and food preparation. Each shelteree was allowed a little more than one gallon of water per day—for cooking and drinking purposes only.



Shelter entrance showing blast bulkhead, door, and intake ventilators.

Sanitary facilities consisted of two chemical toilets emptying into 415-gallon tanks which were vented through the exhaust ventilator. Canvas curtains provided a measure of privacy. The "wash basin" was merely a table furnished with waterless hand cleaner, paper towels, and a mirror. When the shelter was not buttoned up completely, a forced ventilation system circulated enough air to give each shelteree 16 cubic feet per minute. The blower took in air from the entrance tunnel and blew it through a filter, duct, and diffuser located over the joiner door. The exhaust vent, located at the rear of the shelter in the center of the ceiling, was fixed with a "mushroom cover" that also doubled as an emergency escape hatch. Lighting consisted of five 200-watt lamps over the forward end of the shelter, two 40-watt lamps over the toilet area, and two portable flood lamps to illuminate the rear of the shelter during the day.

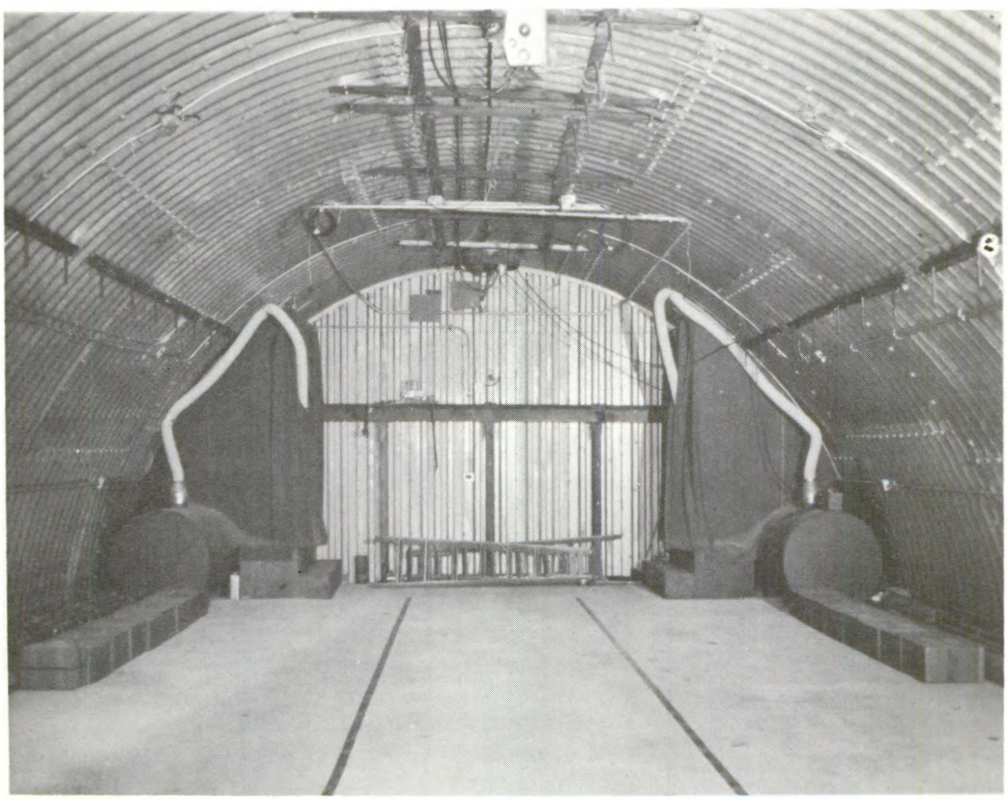
There were 100 shelterees: 92 from the inmates of the Santa Rita Rehabilitation Center, four deputy sheriffs attached to Santa Rita, one deputy sheriff assigned to Civil Defense duties, and three observers from USNRDL who also acted as commanding officer, execuitve officer, and medical officer for the test. The 92 inmates–ranging in age from 17 to 62 years–were selected on the basis of medical and psychological screening from approximately 400 volunteers. They had spent an average of 7 weeks in prison confinement at Santa Rita–a minimum security prison–prior to the shelter test. Their prison time ranged from one day to 31 weeks for offenses ranging from major traffic violations to armed robbery, with alcohol and narcotics charges predominating.

ENVIRONMENTAL STUDIES

Frequent observations were made in the shelter of the oxygen and carbon dioxide concentrations and the noise levels. Carbon monoxide concentrations were recorded continuously on outside instruments. Air samples were analyzed on the final day for concentrations of silica, since many subjects complained of the dusty atmosphere. Continuous temperature and humidity readings were recorded on instruments located outside the shelter. Air temperature and humidity readings were taken at several points inside the shelter, including inlet air, room center air, and exhaust air. The effective temperature of the exhaust air, which may be taken as representative of the shelter environment, remained relatively constant at 68 to 70 degrees. The daily average relative humidity ranged between 36 and 74 percent with a maximum of 80 percent and a minimum of 27 percent. The sound levels averaged 65 to 70 decibels during sleeping hours, attributable to the noisy ventilation system, and 75 to 80 decibels during periods of full shelter activity.

DIET

Three rations, evaluated by this test, were supplemented by one multivitamin tablet daily. For purposes of comparison, the shelterees were divided into two divisions of 50 men each. Division I received Diet



Looking toward rear of shelter with bunks stored along walls.

II for the first 4 days, Diet III for the next 3 days, and Diet I for the final 7 days; Division II received Diet I the first 7 days, Diet III the next 3 days, and Diet II the final 4 days.

Diet I consisted of partial servings of standard Army C-ration heated in water prior to serving. This ration was by no means considered an optimum shelter ration because of its relatively high cost per person daily and its high caloric value (3600 calories per day). Its availability, however, and its proven characteristics as an emergency military ration made it useful for a base-line diet. The partial servings of C-ration provided only two-thirds of the ration per day, or about 2400 calories.

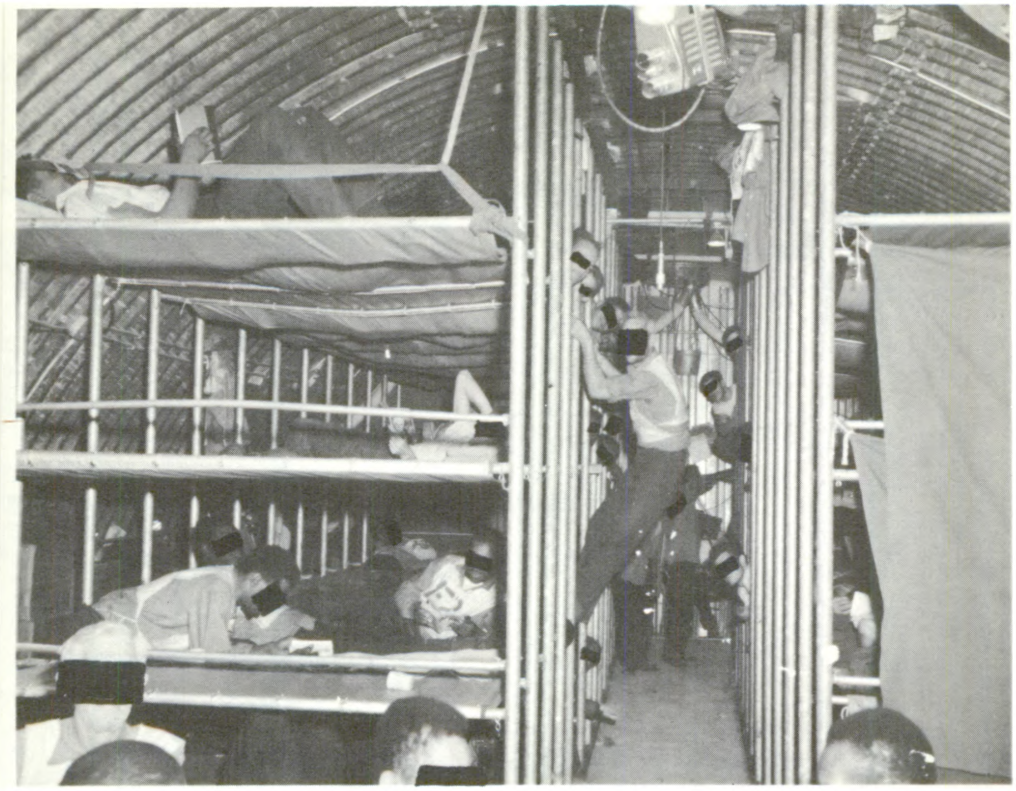
Diet II consisted of a milk formula and peanut bars. A liquid diet containing nonfat milk powder, dextrimaltose, and vegetable oil was prepared by mixing and stirring the ingredients in water, one pint of which provided 1000 calories. This diet is very inexpensive, has the advantage of being usable by persons of all ages, and requires no heating for preparation. Two cups were served for breakfast and one cup for lunch; these were augmented by three jumbo peanut bars, one for lunch and two for supper, providing an additional 1000 calories. The peanut bars are very inexpensive, require little storage space, and no requirements for preparation or serving equipment. They are not usable as an infant diet or for those with poor dental health.

Diet III consisted of a boiled wheat product that is put up in cans. This ration, suggested by the Western Regional Research Laboratory of the Department of Agriculture, is eaten with reconstituted nonfat milk and sugar for breakfast and with heated gravy, chili, or spaghetti sauce for the other meals. Individual packets of cheese crackers, peanut butter sandwiches, and cookies or candy were included to bring the total intake to approximately 2000 calories per day.

No attempt was made to force any person to eat all of any single ration; but if he didn't eat all, no substitutes were served. In general, Diet I was the most acceptable; however, it was the source of the most complaints of constipation. Diet II was the least acceptable of the three diets. It was responsible for the greatest loss of weight, and it was the source of most complaints of diarrhea and gastric discomforts because of the addition of corn oil to the milk formula. It was the least palatable because of the tendency of the oil to separate from the milk, leaving an oily aftertaste; also the peanut bars were very difficult to eat for those shelterees with bad teeth. Diet III which sustained weight best also received the least number of subjective complaints, although it was rated less desirable than Diet I.

## PHYSIOLOGICAL STUDIES

Each shelteree's weight was recorded daily prior to breakfast. At the start of the test, weights of the shelterees ranged between 118 pounds and 241 pounds and the average weight was 161 pounds. The average change of weight was a loss of 3 pounds, ranging between a gain of 2 pounds and a loss of 9 pounds. Body temperatures were taken daily after the evening meal. Except in elevations associated with illness, all temperatures tended to remain normal. No variations attributable to



Bunks in use.

environmental temperatures or humidities were observed. All fluids ingested, including water, coffee, and milk, were recorded daily by counting the cupfuls dispensed. Fluids were permitted as desired and a tremendous variation was realized, ranging between 500 cubic centimeters (cc) to 11,000 cc daily. The average daily intake was 1860 cc. The average daily urinary output was 1100 cc. The shelterees averaged approximately one bowel movement per day. Many individuals on Diet II complained of mild diarrhea, occasionally four to five defecations daily, while those on Diet I complained frequently of constipation.

## SICK CALL

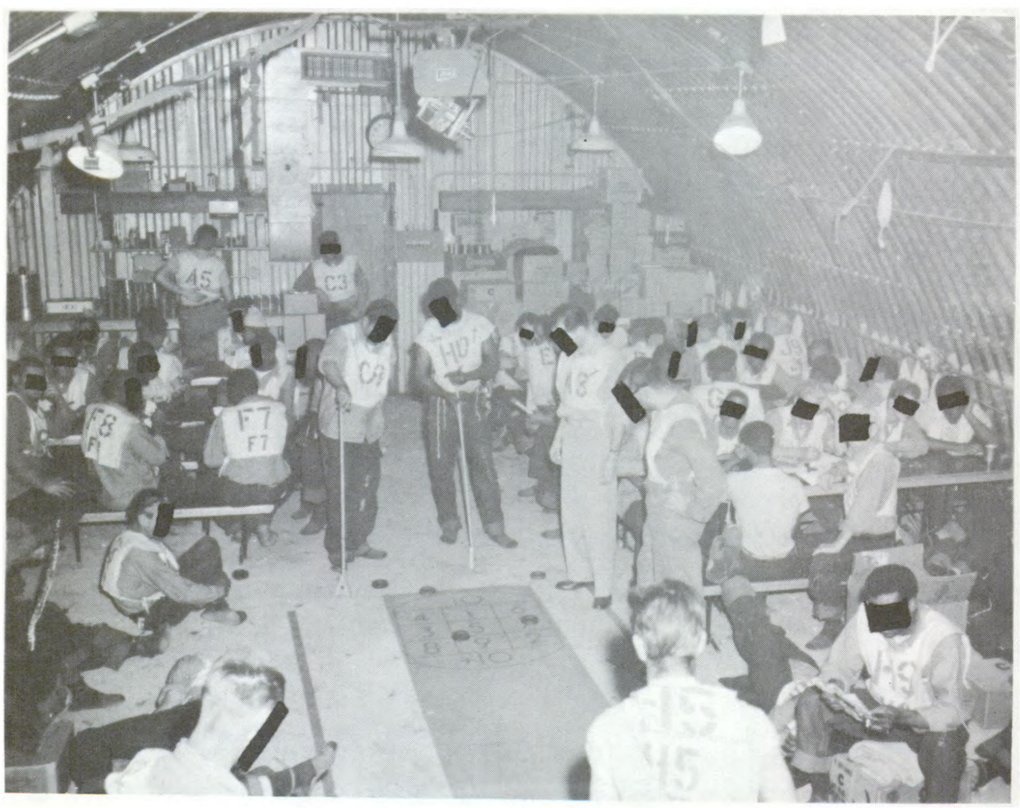
Routine sick call was held after each morning and evening meal. There were fewer complaints than expected and the majority of these were minor. The most frequent complaint was that of constipation, managed by milk of megnesia. Diarrhea resulting from Diet II was managed by bismuth and paregoric. Dull headaches were also a fairly frequent complaint. There were fewer upper respiratory infections than expected, although many complained of a dry cough and slight sore throat, frequently attributable to the dust and tobacco smoke in the atmosphere.

During the middle third of the test, several shelterees developed pimples and ingrown hairs on their faces. These could have been prevented if they had been allowed to shave twice weekly. There were very few complaints of fungus infection of the feet—which was truly remarkable since many had epidermophytosis when the test started, there was no opportunity for washing the feet, and socks were changed only one time. This low incidence of fungus infection is probably due to the use of fungicidal foot powder every other night and the wearing of loose cloth slippers in the shelter.

There were fairly frequent complaints of backache and "tired back," probably because there were no backs to the benches and nothing to lean against while sitting. The bunk design may also have contributed to the back complaints, since it was difficult to lie comfortably in them owing to their narrow width.

## SPECIAL MEDICAL PROBLEMS

Only two individuals had to be removed from the shelter for medical reasons. On the eighth day one volunteer complained of a sore throat and had a temperature of 101.5 F. The following day his temperature was 103.5 F, his tonsils were moderately enlarged, and he had a tender swelling on the neck. The patient was removed from the shelter and subsequently responded promptly to the administration of penicillin. On the morning of the final day the other individual's speech was thick and incoherent, and his gait was staggering and unsteady. Investigation revealed that on the previous night he had been given 1-1/2 grains of seconal and 2 APC's for a severe migraine and inability to sleep; later that night he had requested an additional seconal which was not given to




Looking from rear of shelter during recreation period.

him. On the preceding night seconals had been dispensed to several other shelterees—because of restlessness and insomnia perhaps induced by anticipation of the completion of the test—and it appeared likely that two or three of these seconals had gotten to the apparently intoxicated volunteer. To overcome his condition he was forced to drink black coffee and remain on his feet. But despite these measures, he became uncooperative and intent upon arguing. Thus, he was removed from the shelter approximately 4 hours before completion of the test, going on record as being the only serious behavioral problem during the 2 weeks.

One volunteer received medical aid because he had a small foreign body loosely embedded in his cornea incurred while erecting bunks. There were many complaints of toothache and sore gums while the volunteers were eating peanut bars; several solved this problem by pulverizing the bars before eating them. One of the volunteers attracted attention by drinking excessive amounts of water daily, reaching a maximum of 11,000 cc on the final day. Another volunteer complained of excessive hunger while on Diet I, having lost 5 pounds in 5 days—by far the largest weight loss attributable to that diet. Urine examination showed 3+ sugar. Daily checks afterwards were always negative; his weight stabilized and his complaints of excessive hunger subsided.

## SPECIAL HYGIENE PROBLEMS

As previously mentioned, shelterees were allowed to use water only for cooking, drinking, and brushing teeth. Waterless cleansers were used to wash the hands and several paper towels were required to completely remove the cleanser after each "washing." Commercial "wash and dry" cloths, provided each volunteer on arising in the morning to wash his face, neck, and hands, worked very well. The volunteers were encouraged to brush their teeth daily or to use a brushless tablet dentrifice, one of which was distributed to everyone each morning after the first week. Each volunteer brought one clean pair of socks into the shelter and all changed socks on the evening of the seventh day. At that time feet were cleaned with a "wash and dry" cloth and powdered generously with a fungicidal foot powder. In addition, all volunteers removed their shoes and socks every other night and used foot powder. Alternate head-and-foot sleeping arrangements were enforced for the entire test period to minimize possible spread of respiratory ailments and to distribute the weight on the bunks. No clothing change, other than one pair of socks, was allowed and no laundering was attempted under the conditions of this test. No serious skin disorders developed and no objectionable body odors were noted.

## PSYCHOLOGICAL OBSERVATIONS

There were fewer psychological problems than anticipated. It was originally thought that because of the extreme crowding, restricted use of water, experimental diets, limited activities, and the relative emotional instability of many of the volunteers, many would request release after the novelty had subsided following the first few days. Exactly the opposite was true. No one requested to leave, however several with moderate temperature elevations and upper respiratory complaints were concerned that they might be forced to leave. The desire of all to finish seemed quite remarkable. During the last several days, many were anxious for the test to end; restlessness seemed to increase, but this reaction was no more than could be expected.

The philosophy of shelter organization that encouraged each shelteree to participate and share in the living procedures contributed to the prevailing high morale of the shelterees. Each man realized he had a job to do—however small it might have been. On the eighth day, however, a trivial argument almost resulted in a fist fight. Other minor arguments in regard to card games, etc., were soon forgotten. Around the fifth, sixth, and seventh days, many shelterees mentioned that they were beginning to feel tired and listless and were having difficulty in remembering details. Several members of the cadre section found themselves "falling down on the job" by forgetting routine tasks.

A questionnaire to determine the individual rating of what caused the most discomfort or difficulty was circulated to each shelteree at the time of the diet changes and the morning of the last day. The restricted use of water was rated the most difficult hardship. The implication of this restriction was that no bathing or shaving was possible since no limit was imposed on the amount of water used for drinking purposes. The number-two complaint was lack of space, and was probably influenced considerably by the almost complete lack of privacy, since requests were frequent for at least some individual storage space. There was a minimum of crowding in the shelter, except in the toilet area and corridor in the bunk area during the evening cleanup and bunk assembly. The next four most noted complaints were: seating discomfort, noise, the milk-and-peanut-bar diet, and boredom.

The test showed conclusively that 100 individuals can live relatively comfortably and maintain good health for 14 days under the test conditions. The diets tested were all acceptable from a nutritional standpoint, but additional work needs to be done toward perfecting an ideal diet for shelter use. Facilities for occasional shaving should be provided to decrease skin infections. More comfortable seating facilities should be provided to decrease back discomfort. All individuals should participate in some type of physical activity daily, and some type of mild activity should be mandatory for all shelterees. It would be desirable to limit tobacco smoking to certain periods during the day, thereby reducing a chronic source of irritation to the eyes and upper respiratory tract which was primarily objectionable to nonsmokers and agravated upper respiratory complaints. In the event of marginal ventilation, unlimited smoking could also produce a hazardous concentration of carbon monoxide in the shelter.

## ASSUMES NEW COMMAND

CAPT Walter D. Coleman has assumed command of the Naval Ordnance Laboratory, White Oak, Maryland. CAPT Coleman was relieved by CAPT John A. Quense who will serve as the Executive Officer at the Naval Ordnance Test Station, China Lake, California.

# The Radio Telescope of The University of Illinois

A radio telescope scooped out of the earth, the largest of its type in the world, will go on the air early in the fall near Danville, Illinois. The University of Illinois is responsible for the construction and operation of the massive installation, 600 feet long, 400 feet wide and 62-1/2 feet deep, under the sponsorship of the Office of Naval Research.

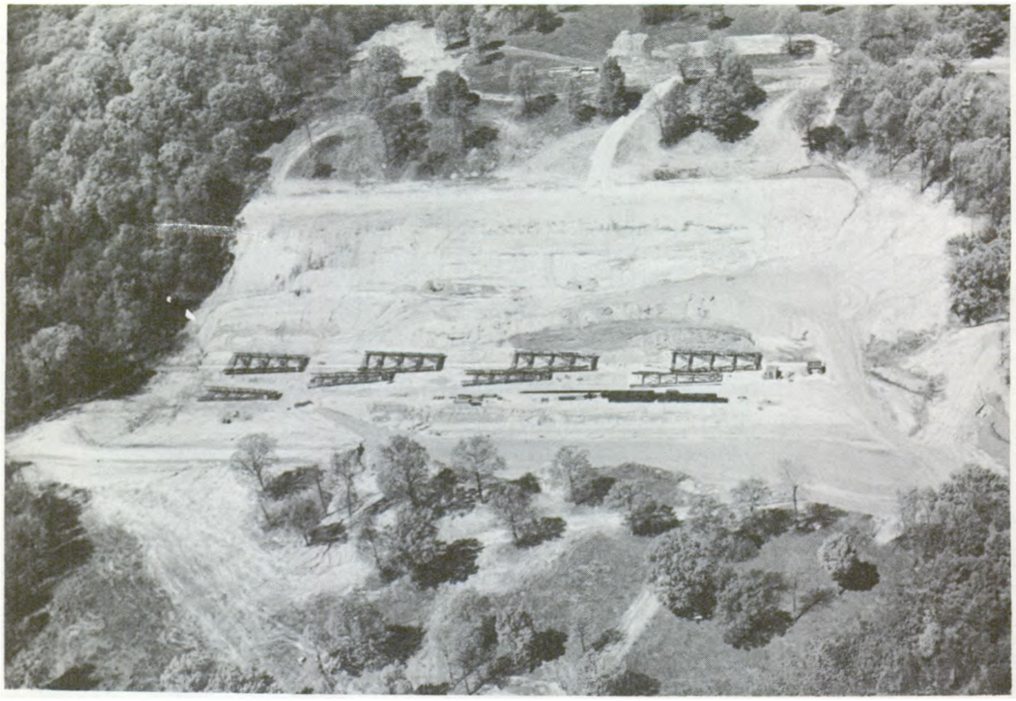
The installation, which covers 5-1/2 acres, has 160,000 square feet of receiving area, more than twice that of the Jodrell Bank radio telescope of the University of Manchester in England. (This giant 250-foot paraboloid or dish-type antenna is the largest steerable radio telescope in existence; its relfector, "as large as a city block," can be turned a full 360 degrees in altitude, and automatic controls drive the telescope at the sidereal rate—the speed at which a star seems to cross the heavens.) The Illinois telescope, unlike the British instrument, is fixed and nonsteerable. The Danville telescope has been specially designed to pick up faint sources outside our own Milky Way galaxy. Its primary mission will be to make detailed maps of the universe which will include celestial objects previously undetected and far beyond the range of the largest optical telescope.

The reflector of the Illinois installation is a trough rather than the usual parabolic dish. Geometrically it is a parabolic cylinder with the axis of the cylinder parallel to the earth and the axis of the parabola vertical. It is being constructed by grading the surface of a small valley to the right shape and size, which will be covered with a prefabricated asphalt liner for erosion control. Over this will be placed a wire mesh to act as the reflecting surface. A catwalk 450 feet long and supported by four wooden towers 165 feet high will carry some 300 feed elements. This type of construction provides a very large radio telescope for a relatively low cost.

Since the scope is not steerable, observers will take advantage of the rotation of the earth to bring objects they want to study over the telescope. Within limits, it also will be possible to shift the angle of the focusing beam by electrical phasing.

The first project for the radio astronomy facility will be to make a detailed map of the sky at the frequency of 611 megacycles (a wave length of 50 centimeters). Navy scientists believe that this frequency includes the largest number of radio sources in space. They expect that the survey, which will cover several thousand objects in the sky, will require 3 to 5 years to complete. Such a map would provide both additional fundamental information for astronomers and also valuable statistics for cosmologists working on theories of the structure and age of the universe. The highly sensitive Illionis radio "ear" could be put to other uses, such as receiving signals from deep space probes, but these would interfere with its primary scientific mission.

The Illinois telescope is the third new Navy-sponsored radio telescope to be placed in operation within 2 years. These instruments form



The University of Illinois' vast radio telescope under construction. Note the wooden towers that will be used to support the facal line.

an integrated part of the Office of Naval Research radio astronomy program. Each is specifically designed with special capabilities to carry out unique research.

It is planned that the Illinois instrument will work in conjunction with the Navy-sponsored, twin 90-foot radio telescope system at the California Institute of Technology. The CalTech system has unusually high resolution, that is, the ability to distinguish between small objects close together. This is achieved by using the two telescopes together as a radio interferometer. After the Illinois instrument detects a faint signal, which may be either a strong source millions of light years out in space or a weak source nearby, the CalTech instrument can be focused to pinpoint its location.

Although the Illinois radio telescope is expected to be the most sensitive in the world, it eventually will be surpassed by the Navy's 600-foot steerable dish now under construction at Sugar Grove, West Virginia.

## DR. DIETZ TO RECEIVE AWARD

Dr. Robert S. Dietz, oceanography and geology consultant at the Navy Electronics Laboratory, San Diego, California, will be awarded the Navy's Superior Civilian Award for his efforts in connection with the bathscaphe TRIESTE.--ONR, Pasadena.

# Research Notes

## Van Allen-Type Radiation Belt Around Jupiter

Research conducted at the California Institute of Technology and supported by the Office of Naval Research has established almost conclusively the existence of a Van Allen-type radiation belt around the planet Jupiter, 100 trillion times stronger than that surrounding the earth. Existence of the belt-believed to be almost 200,000 miles above the surface of Jupiter, itself 85,000 miles in diameter—makes it highly unlikely that man will ever be able to approach closer to Jupiter than perhaps to one of its moons, some of which are more than a million miles away from the planet. The discovery was made with the new CalTech twin 90-foot radio telescopes, constructed in Owens Valley with ONR funds and operated under ONR support. The telescopes detected the radio waves emitted by high-speed electrons trapped in Jupiter's magnetic field. These electrons spin in planes surrounding the planet's magnetic field more or less perpendicular to the lines of force, in what is known as the synchrotron mechanism.

Unexpected high radio emission from Jupiter at a wavelength of 10 centimeters (3.9 inches) was first detected by NRL scientists 2 years ago. This finding was confirmed last year both at CalTech and at the National Radio Observatory, Green Banks, W. Va., at other wavelengths. The synchrotron mechanism from a Van Allen-type belt was immediately suggested as a possible source. The only way of proving that a radiation belt surrounds Jupiter was to determine whether the radio emissions from the distant planet were polarized; this would indicate that their source was moving back and forth as the synchrotron mechanism electrons would appear to be when viewed from the edges of their planes of rotation. Polarization was detected in one experiment, and a second experiment measured the diameter of the radiation belt. These experiments indicated that the axis of Jupiter's magnetic field almost parallels its rotational axis, as does the earth's. This showed that in a direction parallel to the planet's equator the source of radio emission is between 400,000 and 500,000 miles across.

Both measurements were made possible by CalTech's twin radio telescopes. The two dishes, mounted on a railroad track one-third of a mile long, may be used either separately or together. For certain observations both may be used to simulate the effect of a single antenna equal in diameter to the distance between their centers. The individual telescopes are the largest of their type now in operation in the United States and are second in the world only to the 250-foot-diameter dish at Jodrell Bank in England. The Jupiter observations were made by Venkataraman Radhakrishnan of India and Dr. James A. Roberts of Austrailia, currently working on the ONR-sponsored project. Dr. John Bolton is director of the CalTech Radio Observatory. The planets Mercury, Mars, Venus, and Saturn have been examined by radio astronomers with varying degrees of thoroughness for similar radiation, but none has been found to compare with the belt surrounding Jupiter.

## California Coast Not Vulnerable to Tidal Waves

Although seismic sea waves in the far Pacific can set harbor waters sloshing and cause damage to boats and piers, as they did as a result of the recent Chilean earthquakes, damaging effects along the open California coastline are improbable, says William G. Van Dorn, Senior Engineer at the University of California's Scripps Institution of Oceanography. The reason is that the swift, powerful ocean waves set up by underwater earthquakes spend most of their energy crossing the broad and gentle continental shelf. Waves from the Chilean quake were no more than three feet high when they reached the open-shore location of La Jolla, Van Dorn points out. The Chilean quake was one of the most powerful in history. Van Dorn has spent several years in the study of tsunamis, (NavResRev, April 1960), the technical term for seismic sea waves, and has recently devised a new method for forecasting damaging waves.

One of two conditions would have to be met for the California coast to suffer severe damage from a tsunami, Van Dorn says. One would be the occurrence anywhere in the Pacific of a quake greater than any that has occurred in seismic history. A quake 100 times as powerful as that in Chile would stir up waves ten times the height of those received, he says. The other condition would be the occurrence of a very severe earthquake within a few hundred miles off the coast. He points out that geological studies indicate that the only submarine fault zone in the area is off Cape Mendocino. Severe quakes are unlikely elsewhere.

## It's Not the Cold...

It is not the cold, the danger or the hardship that puts a strain on men stationed in Antarctica posts for a year, CAPT Charles Samuel Mullin, Jr., MC, USN, stationed at USNH, Philadelphia, told an American Psychiatric Association meeting in Atlantic City. Three things contribute to the unusual stress experienced, CAPT Mullin said. The most important is the difficulty of getting along in the "tight little society" in which one is placed.

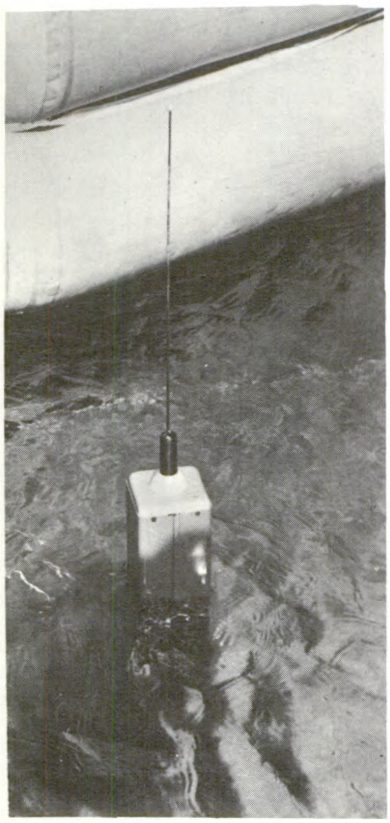
Each man soon learns that he is entirely dependent upon the next man and upon the group. This means that if he becomes angry, he will not show it. Fights are very rare, but headaches are extraordinarily common. The inner tensions from swallowed anger also contribute to insomnia, or the "Big Eye," which is common during the round-the-clock darkness of winter.

The second stress is the sameness encountered by the men—the same few faces, the same surroundings, the same relatively simple routine of life, and the long period of enforced physical inactivity. The third stress is the absence of family and loved ones and of the familiar pleasures of the man's "personal civilization." As might be expected, CAPT Mullin said the men try to make up for the other deprivations by the enjoyment of food. Appetite and consumption are enormous, he reported.

## Radio Beacon Aids Air-Sea Rescue

A California electronic firm, Granger Associates, of Palo Alto, in association with United Air Lines, has developed a completely automatic, VHF, emergency beacon for use by downed aircraft to facilitate air-sea rescue. Now in quantity production, the radio beacon—capable of delivering an immediate alerting-and-locating signal for 50 hours—is standard equipment on all of United's DC-8 jet flights on the California-Hawaii route. Each of the six 25-person liferafts aboard each DC-8 contains the new automatic beacon.

The beacon operates on the international aircraft distress frequency of 121.5 megacycles, and the tone-modulated signal is easily heard on standard VHF receivers aboard both Government and commercial aircraft. Putting one in mind of the familiar WW II "Walkie-Talkie," the ocean-going beacon weighs 9-1/2 pounds and measures 3-7/8 inches square and 29 inches long. The antenna accounts for 20 more inches. When an aircraft is ditched and liferafts are released, the beacon is set free by automatic activation of a water-soluble link within minutes after immersion and without any controls; the beacon is then towed behind the raft by a nylon line as the water-activated battery supplies the 875-milliwatt power output for the crystal-controlled beacon.



The automatic radio beacon.

Flight tests have established the beacon's effective range of 144 miles at a receiving altitude of 10,000 feet; however, increased ranges are possible at higher search altitudes. An evaluation report prepared by United's engineers states that the tests demonstrated a marked reduction in search time, using the beacon either with or without direction-finding equipment, as compared to present methods if searching for high-speed aircraft ditched at sea.—ONR, San Francisco.

## Navy's New Long-Range, Height-Finding Radar

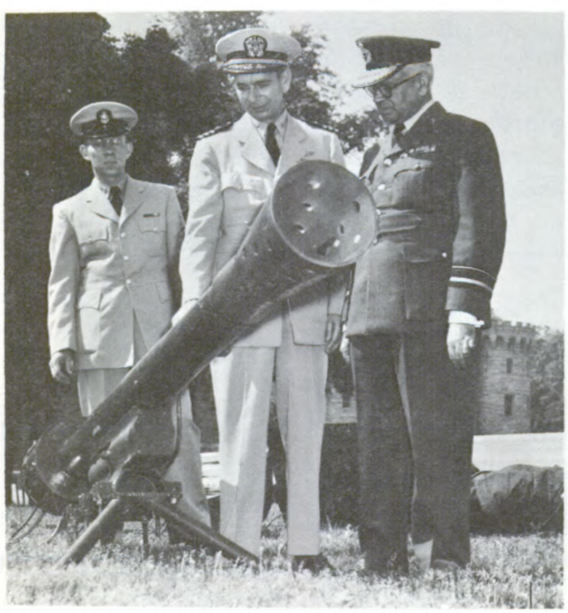
A contract for the production of the Navy's new long-range, height-finding radar units—featuring a three-dimensional capability which simultaneously detects the range, azimuth, and height of a target—has been awarded to the General Electric Company. This lightweight unit (the AN/SPS-30) will be one of the longest range radars in Navy production; it will incorporate many advanced signal-processing methods and circuitry.

## David Taylor ZA-100 Enables Two Computers to Talk to Each Other

An electronic data-processing system—known as a ZA-100 "Computer Language Translator," designed and manufactured by the Electronic Engineering Co. of Santa Ana, California—is making it possible for two computers, "to talk" to each other in a common electronic mathematical language at the U. S. Navy David Taylor Model, Washington, D. C. Located in the David Taylor Applied Mathematics Laboratory, the Translator enables the two computers, the IBM 704 and the Remington Rand Univac, to exchange mathematical data freely or to process raw scientific data. The ZA-100 translates either Univac data into IBM data or vice versa—or it will translate either analog or binary data from hydromechanical and structural tests and spectrum analysis data into either of the two computer formats. This unit performs 13 electronic data translations, and it is the largest yet delivered by the California company.

Because of its capabilities, Admiral E. A. Wright, Commanding Officer and Director of the Model Basin, said operation of the system has been carefully observed by electronic data-processing specialists of the U. S. Army Map Service, Bureau of Census, Wood's Hole Oceanographic Institution, the National Academy of Sciences, and various data offices of aircraft and missile firms having computer centers in the D. C. area.

## Indian Air Chief Visits NAVTRADEVCEN



Indian Air Vice Marshal B. L. Kapur examines a 90-mm gun simulator developed for the Army at the U. S. Naval Training Device Center, Port Washington, N. Y., during a briefing tour of the Center's facilities. Activated by a combination of oxygen and acetylene, and a spark plug, the simulator duplicates the noise and flash of the operational 90-mm gun. On the visitor's right: CDR M. S. Whitener, Special Assistant to the CO and Director, NAVTRADEVCEN, and TDC George Hill.

## Dr. King Receives Distinguished Civilian Award

Dr. Peter King, Associate Director of Research for Materials at the Naval Research Laboratory, was awarded the Distinguished Civilian Award—the Navy's highest civilian award—on May 30 by the Honorable James H. Wakelin, Jr., Assistant Secretary of the Navy (Research and Development). The citation singled out King's contribution "to the development and direction of a long-range detection program that resulted in a system which provided conclusive evidence of the first atomic explosion by a foreign power."

It was on September 3, 1958, that President Truman announced: "We have evidence that within recent weeks an atomic explosion occurred in the USSR." The President was referring to the analytical system, developed by the NRL scientist, that identified the bomb material from rainwater samples collected at stations around the world and fixed the approximate time of Russia's first atomic explosion as August 1959. Earlier public recognition of Dr. King's contribution to national defense was not possible because of security restrictions.

Dr. King began work at NRL in 1939, being assigned to the research of paints, varnishes, and other protective coatings. He became Head of the High Polymer Branch, Chemistry Division, in 1944 and the next year was appointed Division Superintendent with the responsibility of a broad research program in basic and applied chemistry and related physics. He assumed his present position as Associate Director of Research for Materials on January 6, 1957.

He is a member of the American Chemical Society, the Washington Academy of Science, and he serves on the Board of Governors of the Research Society of America. He is also the author and coauthor of numerous technical papers. His Ph. D. degree in Chemistry was conferred on him by the Catholic University of America in 1942. His dissertation was entitled "Reaction of Free Radicals at Metallic Surfaces."

## "Blue Angels" TV Scripts: Ideas Wanted

Your ideas--new ideas--are wanted for TV scripts to be used on a television series featuring the famed "Blue Angels," the Navy's flight demonstration team. The series will consist of 39 episodes, which will provide a vehicle through which millions of TV viewers may be made more aware of the mission, roles, and activities of Naval aviation. Development, production, and distribution of the series will be handled commercially, with broadcasts beginning nationally in October. In submitting your new ideas, tell the story briefly, and indicate the available documentary material to be used authenticating and filling out the details. Address correspondence to Chief of Information, Department of the Navy, Washington 25, D. C.

The "Blue Angels" F11F's releasing artificial contrails for the Navy visibility study (beginning on page 1) are featured on this month's cover of Naval Research Reviews.

# On The Naval Research Reserve

## ONR Seminar

The Twelfth Annual Naval Reserve Research Seminar—sponsored by the Office of Naval Research and conducted by Naval Reserve Research Company 5-8—convened for two weeks in Washington, D. C., on 5 June. One hundred and twenty reserve officers of all three services were brought up to date on research-and-development activities in the Navy and were briefed on the probable future in these fields. CAPT William M. Richardson, USNR, of NRRC 5-8, was the chairman of the seminar.

Seminar sessions were divided into two categories: (1) four days of general meetings with addresses by distinguished speakers on topics of broad scientific and naval interest and (2) six days devoted to specialized group sessions with addresses by technical experts and visits to nearby laboratories. RADM Bennett, USN, Chief of Naval Research, who welcome the reserve officers during the first session, said that the current competition with the USSR had brought about a drastic reduction of the time interval between the conception and utilization of ideas, and a change in weapon emphasis from brute force to sophistication. He further emphasized that the Navy should maintain a pool of scientifically trained talent upon which to draw in time of emergency and that every effort must be expended to keep the Research Reserve in a high state of readiness.

RADM Bennett introduced the Assistant Secretary of Navy (Research and Development), the Honorable James H. Wakelin, Jr., who described the mechanics of the formulation and approval of an R&D budget. VADM John T. Hayward, USN, Deputy Chief of Naval Operations (Development), spoke on "Research and Development Concepts in OPNAV." RADM John B. Colwell, USN, Military Assistant to the Director of Defense (Research and Engineering), addressed the group on the Navy role in space research. The Polaris Program was discussed in detail by RADM William F. Raborn, USN, Director, Special Projects Office, Bureau of Naval Weapons.

Other topics of interest were discussed at the general sessions by representatives from ONR, the Office of the Chief of Naval Operations, and the Bureau of Naval Personnel. Among the subjects discussed were the following: Objectives and Programs of ONR; The Research Philosophy of ONR; ONR's Patent Responsibilities for the Navy; the U. S. Naval Research Laboratory; Navy Long Range Objectives; Atomic Energy in the Navy; Astronautics in the Navy; Logistics; Warfare (Amphibious Strike, Air Strike, Submarine, and Antisubmarine); Intelligence for Research & Development; The Role of Operational Test & Evaluation Force in Weapons Development; Naval Leadership; and Reserve Promotion and Mobilization Plans.

For the specialized sessions, the participating reserve officers separated into four groups: Group I, "Frontiers of Navy Physics," under the chairmanship of Mr. Frank B. Isakson, Head of the ONR Physics Branch; Group II, "On the Control Systems Research," under Dr. Thomas W. Williams, Technical Director, Air Programs, ONR; Group III, "On the Perimeters of the Naval Operating Environment," under Mr. Gordon G. Lill, Earth Sciences Advisor, ONR; and Group IV, "Naval Problems in the Life Sciences," under CAPT Joseph P. Pollard, MC, USN, Special Assistant for Medical and Allied Sciences, ONR.

At the final general session, CAPT J. W. Jockusch, Jr., USNR, Special Assistant to the Chief of Naval Research (Research Reserve), spoke on recent developments in reserve legislation, and CDR R. N. Jennings, USNR, Training Officer for the Research Reserve, spoke on training opportunities for Research Reserve Officers. The seminar chairman concluded the seminar by presenting a summary of the activities during the two-week period.

Among the laboratories visited by the participants were: the Naval Laboratory; Bureau of Standards; David Taylor Model Basin; Johns Hopkins Applied Physics Laboratory; USN Hydrographic Office; Biological Warfare Laboratories, Fort Detrick, Maryland; the IBM Space Center; Maryland Point Radio Observatory of NRL; Chesapeake Bay Annex of NRL; Joint Numerical Forecasting Center; the Naval Medical Center at Bethesda, Maryland.

## Research Reserve Officers Selected for Advancement in Rank

Thirty officers of the Research Reserve Program were among 3691 Reserve officers selected for promotion to the grade of Lieutenant by the selection board which convened on April 12, 1960. The names of those selected are given below:

| | | | |
|---|---|---|---|
| Barr, Edward S. | 11-5 | Mackin, Louis B., Jr. | 6-3 |
| Baughman, Charles S. | 4-9 | March, Richard J. | 4-3 |
| Boecker, Fred Jr. | 4-8 | McClain, Albert M. | 6-10 |
| Coppola, Gregory J. | 5-8 | Mickelberry, William C. | 9-7 |
| Denman, John B. | 1-1 | Minges, Charles H. | 5-6 |
| Devaney, John J. | 1-1 | Over, John J., Jr. | 5-9 |
| Dooley, John W. | 8-5 | Parady, James R. | 9-3 |
| Foster, Paul E. | 3-6 | Ryan, Theodore V. | 5-8 |
| Fritz, Paul J. | 6-2 | Schulz, Edmund F. | 9-12 |
| Gordon, Lyle J. | 13-1 | Stewart, Alva T. | 12-5 |
| Harrison, William P. | 5-2 | Strain, James E. | 6-3 |
| Hill, Carroll H. | 12-5 | Taylor, Robert B. | 3-4 |
| Jenkins, Thomas W. | 9-16 | Turina, George R. | 13-1 |
| Kane, John F. | 8-8 | Weston, Hugh A., Jr. | 5-9 |
| Lee, William W., Jr. | 6-3 | Williams, Douglas H. | 3-4 |

Four Medical Corps officers were promoted to the grade of Lieutenant Commander by the selection board which convened April 26, 1960:

| | | | |
|---|---|---|---|
| Clarke, Francis M., Jr. | 5-3 | Schweid, Abraham I. | 12-1 |
| Lindsay, James I. | 8-3 | Wax, Sandor H. | 1-7 |

The following four Medical Service Corps officers were selected for Lieutenant Commander by the selection board which convened April 26, 1960:

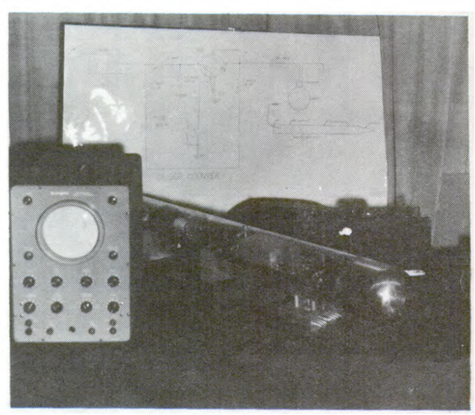
| | | | |
|---|---|---|---|
| Bryan, Douglas E. | 8-13 | Johnston, Muriel E. | 12-5 |
| Cleveland, Sidney E. | 8-4 | Seelinger, Phillip E. | 5-8 |

The selection board for the Dental Corps convened April 26, 1956, selecting three Research Reservists to the grade of Lieutenant Commander:

| | | | |
|---|---|---|---|
| Ewen, Earl A. | 6-16 | Riedel, Donald F. | 13-3 |
| Kessler, William B. | 9-11 | | |

The selection board for Supply Corps convened on April 26, 1960, selecting LT James C. Hall, USNR, NRRC 6-2, to the grade of Lieutenant Commander.

LCDR B. J. Jaskoski, USNR, Commanding Officer of Naval Reserve Research Company 9-1, Chicago, Illinois, presents the First Place Navy Science Cruiser Award to Paul Leif at the Chicago Public Schools' Science Fair held in the Museum of Science and Industry on 9, 10 April.



Winning Navy Science Cruiser project: HYDROSPACE.



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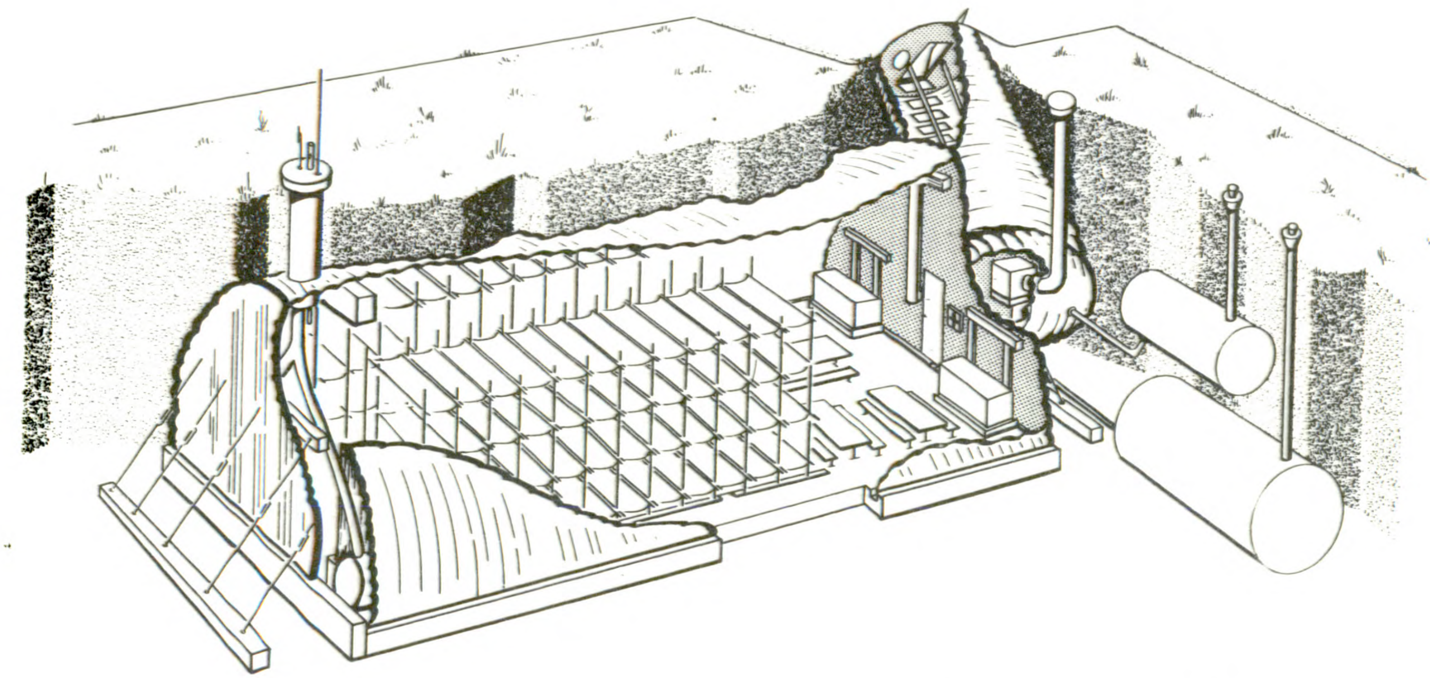

Cutaway sketch of USNRDL's underground survival shelter. (See pp. 15-22.)

# IN THIS ISSUE



**NAVAL RESEARCH** reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. The magazine is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. Changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. Use of funds for printing this publication was approved by the Director of the Bureau of the Budget, February 12, 1958.

"Blue Angels" F11F's releasing artificial contrails for the Navy visibility study described on Page 5.