6551. (a) Unless conditions of IFF silence are prescribed, ships and aircraft may operate IFF at discretion subject to existing directions.

(b) The IFF Mark III system operates in the same frequency band as the air search radar equipment. It, therefore, may be considered as comparable in security to that of radar except that the power used is smaller and therefore its transmissions cannot be received as far. The OTC, in declaring IFF silence, must weigh the advantages and disadvantages incurred by placing restrictions on identification. For the above reasons the conditions of radar silence prescribed SHALL NOT apply to identification equipment.

6552. The following conditions of IFF silence are prescribed for use as directed by the OTC.

CONDITION 1. All shipborne transpondors de-energized.

CONDITION 2. Ships designated to keep transpondors energized.

CONDITION 3. All shipborne transpondors energized.

CONDITION 4. All interrogator-responsors de-energized.

CONDITION 5. Ships designated to use interrogator-responsors.

CONDITION 6. Ships may use interrogator-responsors at discretion.

CONDITION 7. Use shipborne IFF equipment as directed by current operation order.

CONDITION 11. All airborne transpondors de-energized.

CONDITION 12. Use airborne IFF equipment as directed by current operation order.

CONDITION 13. All airborne transpondors energized, interrogator-responsors used as necessary.

6600. **Countermeasures Doctrine and Instructions.**

6610. **Fleet Countermeasures Doctrine is established to provide for:**

(a) The coordination of countermeasures with radar and other elements of combat efficiency within each Combatant Unit; and

(b) The joint use of countermeasures, defensive and offensive, by ships operating together in various tactical organizations.

6620. **Basic Doctrine.**

(a) Countermeasures are jamming and deceptive operations against the enemy and measures taken to prevent similar enemy actions from restricting or confusing our own use of radio or radar.

(b) Jamming implies deliberate emissions with the object of impairing reception.

(c) Interference implies reception which is impaired by atmospherics, unwanted signals (not known to be deliberate) or the effects of electrical equipment.

(d) Deception is a method whereby the radiation or reradiation of electromagnetic waves is used for the specific purpose of deceiving.

6621. **Basic Policies Governing Radio and Radar Deception and Jamming.**

(a) Except as in paragraph (b), below, only the senior commander in an Area of Operations or commanders specially designated by CinCPac, may authorize radio or radar deception or jamming. Area Commanders shall have due regard to the possible effect of their use of deception or jamming upon the plans of commanders in other areas and insofar as practicable keep those commanders concerned appropriately informed.

(b) The OTC of large units, when in actual contact with the enemy, may authorize the practice of radio and radar deception and jamming of such a nature as might affect only the tactical situation in their area. Prior to employing jamming or deception, the OTC must weigh the local advantage against enemy reactions which may affect the operations in adjacent areas. Special care should be observed not to employ devices in one area that may prejudice the broader use of countermeasures in other areas, or give advance data concerning our devices that will be worth more to the enemy than the small local advantage. Radio and radar deception will be practiced only when the circumstances are favorable and the information at hand is complete enough to make the operation effective. Timing is important in the use of radio and radar deception.

(c) An exception to the above is the case of radio jamming in the H.F. band (3000 to 30,000 kc.). Such jamming or deception will not be undertaken without obtaining the express authorization of the Commander in Chief, Pacific Fleet. Area Commanders should submit proposals for such jamming activities as far in advance as possible. A situation may arise, however, when the OTC is unable to communicate with CinCPac and rigid adherence to this order may endanger the success of his mission. In these circumstances only, he would be justified in taking the necessary action, later informing the Commander in Chief, Pacific Fleet.

6622. To provide proper coordination for the employment of offensive and defensive jamming and deception, except radar anti-jamming, all countermeasures information obtained from radar intercept stations and other control stations should be communicated promptly to Combat Information Center, where it can be quickly evaluated and disseminated to the flag and commanding officers and other control stations over interior communication circuits, and to other ships and aircraft via external communication facilities.

6623. Internal communication facilities from countermeasures stations to CIC must meet the requirements of this doctrine.

6624. Enemy jamming and deception should be reported at once to the OTC on the appropriate communication channel. The immediate reporting of interference (refer 6620(c)) is neither required nor desired.

6625. Radar Countermeasures teams must be organized to meet the following requirements:

(a) Intercept enemy use of radar.

(b) Jam enemy radar when ordered.

(c) Release or operate radar deceptive devices when ordered.

6626. When reporting enemy countermeasures the following information is desired:

(a) **Deception (Radar).**

(1) Range Limits
(2) Bearing Limits
(3) Frequency Affected
(4) Type of Echo
(5) Other pertinent information

(b) **Jamming.**

(1) Frequency and Frequency bandwidth
(2) Type
  (a) CW
  (b) Low frequency modulated CW
  (c) High frequency modulated CW
  (d) Pulses or railings
  (e) Random noise
(3) Bearing Limits
(4) Range Limits
(5) Relative effectiveness
(6) Other pertinent information

6627. **Radar Intercept Doctrine.**

When contact with the enemy is likely, radar intercept guards covering the most probable enemy radar frequencies shall be established. It should be noted that it is possible to detect enemy radar transmissions with search receivers well beyond the maximum range at which enemy radar can detect the presence of a target. Operators of search receivers must be thoroughly conversant with all radar and VHF frequencies in use in their own task force.

6628. **Enemy Radar Information.**

When reporting enemy use of radar the following is desired:

(a) Frequency
(b) Pulse rate
(c) Pulse width
(d) Beam width
(e) Rotation rate
(f) Whether or not lobe switched
(g) Strength of signal as determined by output meters
(h) Bearing
(i) Other pertinent information

6629. **Employment of Deception.**

The employment of deception has many more possibilities and chances of success when used expertly or in combination with jamming than has jamming alone. Deception

against early warning devices may confuse the enemy as to number of own forces or direction of approach but its use will not prevent the enemy from obtaining early warning of our approach.
Deception and jamming should be used against enemy fire control systems whenever such use will not excessively reduce the effectiveness of our radar systems.

6630. **Jamming.**

(a) Before jamming is commenced it must be positively determined that the enemy is using radar.

(b) Much of the success of radar jamming will depend on its surprise feature. It is, therefore, of extreme importance that our new systems or methods as well as our intention to jam not be disclosed to the enemy prematurely.

(c) Radar jamming will have little effect on the radars which are operating outside the immediate area.

(d) When jamming is employed, the possibility of the enemy using our jamming signals to obtain a bearing and thereby extending the effective range of his equipment must be considered.

(e) Jamming from aircraft is normally more effective than from surface forces. This is primarily due to the advantages which are gained through height, coverage, and position.

6631. **Defense Against Jamming.**

(a) Learn to expect jamming.

(b) Keep working the equipment. Skillful use of radar controls and anti-jamming devices can reduce and in some cases nullify the bad effects of jamming. Also as the range to the target gets shorter the echoes from the target get stronger much more rapidly than the jamming signals. There will be a minimum range where jamming becomes ineffective.

6938. Radar rendezvous.

Radar equipped planes can rendezvous at night on a group by radar providing the altitude is pre-determined. Lights as necessary should be used for final closure. Such rendezvous by radar can easily be made from 5 or 6 miles, and can be especially valuable after an attack where the ships' radar cannot be used to expedite a rendezvous.

6940. Radar ranges.

The minimum effective range for search is about one half to three-quarters of a mile up to about 2000 feet altitude. Above this altitude it increases with altitude to about two miles at 10,000 feet. It must be pointed out that minimum range considerations are unimportant except in low level bombing. For searches conducted at optimum altitude a target is nearly always detected long before it closes to the minimum range. As the target is approached, the altitude should be reduced to reduce the minimum range of the set.

6941. The following table gives the maximum ranges on various types of targets to be expected from airborne search radar in good operating condition manned by trained operators. The altitudes given represent and approximate optimum level for search. These are not critical.

Target	Max. Range	Optimum Altitude
Land—high, steep	50-70 mi.	3000-5000 ft.
—high, sloping	40-60	3000-5000
—low, hilly	25-45	3000-3500
—low, flat	15-25	2500-3500
Ships		
Task force, convoy	30-40	2500-3500
5000-10,000 tons	25-35	2500-3500
Destroyer size	15-20	2000-3000
PC and similar	10-15	1000-2000
Wooden ships	5-10	1000-2000
Submarines, surfaced	10-15	500-1500
conning tower awash	5-8	500-1500
periscope up	1-3	500-1500
Aircraft—multi-engined	10-15	
—carrier type	6-8	
Buoys	1-2	500-1500
Weather phenomena (cloud, rain-squalls, cold fronts)	1-3	

6934. Torpedo attack with illumination.

This attack proceeds in much the same form as the bombing attack except that it is necessary that target angle be considered. One of the illuminating group should make a low pass by radar to determine approximate course and speed of the target visually and inform the attack planes of course and speed data by radio. Additional passes should be made as necessary to determine changes in course. Illumination is placed so that the attack can develop from the head of the target group. Attacking group should fly parallel to target's course until it is determined by the radar, or visually if possible, that the target is abaft the beam. Assuming that the illumination is proper, the planes should break-off-singly and proceed to attack at properly spaced intervals. As soon as the torpedo is released the plane proceeds upon the agreed upon course to the rendezvous point. The breakup for the attack is made only when the target and illumination are in approximately the correct position. More than one approach may be necessary before the attack is delivered. The point of torpedo release is determined from the radar range, which is far more accurate than visual estimate, particularly at night.

6935. Daylight Torpedo Attacks.

The radar can be used to advantage in two ways. First, to locate the target and determine the starting point of the attack in case the target is under cloud cover, secondly, to determine the point of drop. Accurate preliminary calibration of the radar is essential, but with such it can remove the errors inherent in visual estimate. The operator should inform the pilot as he passes the 2000 yard mark, then the 1500 yard mark, so that the pilot can estimate closely when he must cease evasive tactics preparatory to releasing.

6936. Glide bombing through cloud cover.

This type of attack can be used successfully when the lower layer of a cloud cover is at 3000-4000 feet. The aircraft gets into position by radar above, and out of visual contact with, the target. Pushing over at a previously determined radar range, from the target, the operator "homes" the pilot onto the target, at the same time giving the range at every mile. Having previously determined a desirable rate of descent, e.g. 1000 feet/mile, the pilot is able to control the dive by means of the radar ranges and the altimeter. Upon breaking through the cloud cover, final corrections are made and the drop accomplished visually. Considerable practice in good visibility is necessary to perfect this technique, but once mastered it can provide a means of surprising an enemy vessel even in daylight. The use of radar for offensive action demands much pilot and operator training and practice on simulated attacks. The advantages of the cover afforded by darkness and cloud are obvious. Squadrons should give an adequate amount of time to preparations for these types of attacks.

6937. Navigation.

Radar can be used to navigate an aircraft near land, while following a coastline, passing through channels, or entering bays or harbors. Under many conditions harbor installations or installations upon small islands can be successfully attacked under full radar control. Using the radar to fly parallel to the coastline, the coastal bearing and the contour can be used to locate position on a chart. An efficient radar operator can, by means of radar, map and the plane's compass, direct the flight and track it at all times on coastal or "island-to-island" navigation.
On longer overwater flights, the radar can be used to obtain checks from known land masses. When navigation must be entirely by dead reckoning, the aircraft may fly at 500 feet altitude and a skilled operator may estimate the surface wind direction from the appearance of the radar "sea-return" with a fair degree of accuracy.

(3) Intercept radar equipment in good condition, the operation, interpretation, and limitations of which must be thoroughly understood by the pilot and fighter direction officer.

(4) Thorough understanding, constant practice, and teamwork between the FDO and the pilot.

6923. The doctrine for controlled interception at night or under conditions of reduced visibility is well covered in the section on fighter direction and need not be repeated herein. The problem of night interception is about eighty per cent one of accurate fighter direction supported by adequate surface radar.

6930. Tactical Uses of Airborne Surface Search and Weapon Control.

6931. Radar search.

Radar search for surface ships is carried out in much the same manner as normal visual contact scouting. The area to be searched is divided into sectors, the size of each sector depending upon the reliable range of the radar at the selected scouting altitudes and the type of targets expected. There should be an overlap of about 5 miles between the radar range of adjacent planes. Advantage should be taken of cloud cover including solid overcast.
The scouting altitude should depend on the type of target and the area to be covered. Anti-submarine patrol should be flown at about 1000 feet altitude, while a search for a task force or convoy should be conducted at 3000 to 4000 feet.
Having established the position of an enemy force, it should be kept under surveillance by radar shadowing plane until the attack is made.

6932. Radar controlled bombing attack.

There should be more than six planes in an attack group though more than one such group may attack at intervals. The attack group should proceed to a point within 5-6 miles of the target, move into echelon, and break off so as to proceed into the attack singly at 1000-1500 yard intervals. The attack should be carried out at an altitude of 250-300 feet. The radar operator directs the pilot into the target and releases the bombs at the proper point as indicated by the radar. After making the attack each plane proceeds on a given course and speed to rendezvous at a given altitude and distance from the target. The success of such an attack depends almost entirely upon the skill of the radar operator in giving directions and in releasing the bombs, and in the pilot's ability to maneuver at high speed and to hold a pre-determined altitude and ground speed for the bomb release. The present minimum range of the radar is around 400 yards at low level. This is not a minimum range for search but represents the closest approach that can be made to a target with the echo still visible on the screen. Since this is approximately the bomb release point for bombing at 250-300 feet altitude the disappearance of the echo can be used as a point at which to release the bomb. A radio altimeter is an absolute necessity for such an attack. With selected personnel and a high degree of training, such an attack group should be able to score 50-75% hits with comparative safety and ease. This type of attack is made to order for a pre-dawn hit-and-run attack designed to cripple and slow up an opposing task force.

6933. Bombing with illumination.

In this case, an illuminating group loaded with flares precedes the main attack group and disposes its flares by radar so as to provide sufficient illumination. The attack should be carried out at low level after a shallow glide. The attack group should hold formation until the break-off for the attack and must follow rendezvous doctrine carefully. The illuminating group should keep a flare pattern set up according to a pre-determined plan. With careful timing and illumination control, one flare group can provide illumination for several waves of attacking aircraft.

6914. Attitude of Aircraft.

It is necessary for efficient radar operation that the aircraft be in level flight, particularly for accurate, low-level homing runs. Turns should be banked sharply and the turn completed as soon as possible except where radar equipment is gyro-stabilized.

6915. Weather phenomena.

There are some indications that weather conditions affect radar performance. Indications are that radar operation is best under conditions where there is a definite humidity gradient between sea level and 2000 feet. Since this variable cannot be controlled, it is mentioned so that operators can be prepared for variations in operational efficiency independent of the equipment or the operators. Normally ordinary clouds, fog and darkness have no effect.

6916. Maintenance and Operation.

Too frequently limitations due to poor maintenance and operation far outweigh inherent limitations in the equipment. Careful and frequent maintenance checks are necessary. Radar has not yet reached the stage at which it will operate at high efficiency for long periods of time, and proper maintenance is of utmost importance. The skill of the operator in adjusting the indicator properly and reading the screen accurately is a highly important factor in performance. It is well known that a skillful operator can increase the effective range by as much as 50% over that found by an inexperienced operator, merely by knowing how to look for and detect echoes from distant targets. Proper training and constant practice are necessary before an operator can gain the maximum effectiveness from his radar.

6917. Pilot-operator Team.

Efficient use of the radar demands constant and complete cooperation between pilot and operator. They should train as a team, operate as a team, and be kept intact as much as possible. Each should have a good knowledge of the other's job. The operator must understand the limitations of instrument flying. He must understand the principles of aerial navigation, particularly drift and relative movement. He should be able to use map and compass with ease, and be able to compute and use approximate ETAs. The pilot on the otherhand, should thoroughly understand the capabilities and limitations of the radar. The pilot can be of great help in training the operator by requesting him for radar information during daylight flights, then verifying or correcting the information given.

6920. Aircraft Intercept Radar.

6921. Fighter aircraft equipped with intercept radar essentially work hand-in-glove with surface radar and fighter director units. Due to the limit of the range of present intercept equipment (3 miles in fighter aircraft; 7 miles in larger types) it is necessary that the fighter plane be placed by surface radar and fighter direction in close enough proximity to the aircraft to be intercepted for its equipment to become effective. From the time the target is picked up by the pilot on his intercept screen, the remainder of the approach and attack is conducted by him.

6922. Fighter pilots, familiar with fighter direction doctrine and adept at sight contact interceptions, are already well prepared to train for instrument interceptions at night or under daylight conditions of reduced visibility. The general requirements of instrument interception are as follows:

(1) A pilot capable of operating his airplane on instruments for protracted periods. He must be able to fly accurate courses and hold assigned altitudes and be able to change course or altitude or both expeditiously and accurately.

(2) A fighter director officer and radar equipment capable of placing the interceptor no more than 3 miles behind the target, headed on the targets course, and approximately at the targets altitude and speed.

6900. Air-borne Radar Doctrine.

6901. General.

This doctrine sets forth the tactical uses for which air-borne radar may be employed as well as permits the development of new fields of employment as their practicability becomes apparent and as material equipment improves.

6902. In general, airborne radar equipment is divided into two operational fields, viz., aircraft intercept equipment and air to surface search and attack equipment. The aircraft intercept equipment is primarily installed in aircraft designed and equipped for interception of enemy aircraft under condition of reduced visibility or darkness. This field is fairly well defined because it contains a single mission viz., the interception and destruction of enemy aircraft. Also, the type of plane suitable for this duty is limited to existing fighter interceptor types. However, in the larger types of aircraft it has been found expedient to install intercept equipment together with the surface search and attack equipment.

6903. The air to surface search and attack equipment is employed to perform the following functions:

(1) Radar controlled bombing and gun laying under all conditions of visibility.

(2) Radar controlled torpedo launching as in (1) above.

(3) Scouting, search, and tracking operations under all conditions of visibility.

(4) Anti-submarine and convoy escort operations.

(5) Navigation and homing operations.

6910. Factors affecting radar performance.

6911. The highly specialized design of intercept equipment for a single use limits its performance to short range work. It is essentially a radar fixed gun sight and within its scope of operation its utility is limited only by its material condition and the skill of the pilot employing it. The factors affecting radar performance discussed herein apply primarily to the surface search and attack equipment installed in service aircraft.

6912. Type of target.

In general, the larger the target the greater the range at which it can be detected. However, the actual determining factor is the amount and kind of reflecting surface that is normal to the radar beam. Hence, a ship broadside to the beam can be detected at a greater range than a ship bow-on. A steel ship reflects better than a wooden ship, and rocky land better than land covered with vegetation. A submarine fully surfaced can be detected at greater range than with conning tower awash.

6913. Altitude of aircraft.

For long range search, i.e., for targets that can be expected to be found at ranges above 25-30 miles—the optimum altitude is 1500-2000 feet. These figures are not at all critical, however. The early equipment is not designed to operate at high altitude and falls off in efficiency above 10,000-12,000 feet, as well as being liable to "high voltage breakdowns" above these altitudes. For homing runs on ship targets, accuracy and ease of operation increase right down to masthead heights.

With antennas which are fixed in elevation the beam has a tendency to "over-shoot" objects nearly underneath the aircraft. Also, at altitudes above 1500′ the "sea-return" tends to rise on the screen, blanking out close-by objects. For working with nearby targets, a safe rule is to keep the altitude of the aircraft less than one-tenth of the range to the target.

VII—COUNTERMEASURES AND DECEPTION EXERCISES

Exercise 19(A)—RADAR INTERCEPT TRACKING—SURFACE.

(1) The purpose of this exercise is to give ships practice in tracking a target (employing radar) without the use of their own radars. The target may be either a ship or aircraft.

(2) Target take station about 40,000 yards from force (50 miles for aircraft target); at designated time make radar approach on the force using various courses and speeds; record all movements for comparison.

(3) Ships track target using radar intercept receivers and directional antennas only; record data for comparison.

(4) Ships participating submit brief reports to the Type Commanders with direct copies to CinCPac and OinC PacFlt Radar Center.

Exercise 19(B)—RADAR INTERCEPT TRACKING—AIRCRAFT.

(1) Same as Exercise 19(A) except air group(s) make closing run on force, tracking the force radars with radar intercept receivers and directional antennas only.

Exercise 20(A)—RADAR JAMMING—SELF SCREENING.

(1) The purpose of this exercise is to give ships practice in tracking a target which is screening itself by radar jamming. The jammer may be carried either in a ship or aircraft.

(2) Target (jammer) take station about 40,000 yards from force (50 miles for aircraft target); at designated time intercept and jam specified type of radars; close force on various courses and speeds; maintain a record of all movements for comparison.

(3) Ships attempt to track target with the specified type of radars; maintain record of all data obtained; note particularly range at which jamming becomes ineffective; record all adjustments made to minimize effects of jamming; obtain scope pictures and sketches where practicable.

(4) Submit brief report as for Exercise 19(A).

Exercise 20(B)—RADAR JAMMING—OFF-TARGET.

(1) Same as Exercise 20(A) except that jamming ship or plane attempts to screen other targets (ships or planes) which are being tracked by the force radars.

Exercise 20(C)—RADAR JAMMING—FORCE-SCREENING, SURFACE.

(1) Jammer-equipped ships form screen for force in direction of attack group; intercept and jam attack group radars of specified type.

(2) Attack group take station about 40,000 yards from force; at designated time make closing run on the force; using information from the specified type of radars only attempt to determine the course, speed, and disposition of the force, and gain favorable attack position.

(3) Submit brief report as for Exercise 19(A).

Exercise 20(D)—RADAR JAMMING— FORCE-SCREENING, AIR.

(1) Same as Exercise 20(C) except that attack group consists of planes, making closing run on the force from about 50 miles using information from specified type of airborne radar only.

Exercise 21(A)—WINDOW—AIRBORNE.

(1) The purpose of this exercise is to give ships practice in tracking planes employing Window as a screen.

(2) Three or four planes of a squadron make closing run on the force, at designated time, dropping Window as necessary to jam specified type(s) of radars; remainder of squadron make attacks through the Window.

(3) Ships of the force attempt to track attacking planes through the Window using specified type(s) of radars only; obtain scope pictures and sketches where practicable.

(4) Submit brief report as for Exercise 19(A).

Exercise 21(B)—WINDOW—ROCKET OR SHELL, OFFENSIVE.

(1) Attack group equipped with rocket or shell Window take station about 40,000 yards from force; at designated time close the force, dispensing Window as necessary to screen self against specified type(s) of radars.

(2) Ships of the force attempt to track attacking ships through the Window screen.

(3) Submit brief report as for Exercise 19(A).

Exercise 21(C)—WINDOW—ROCKET OR SHELL, DEFENSIVE.

(1) Ships equipped with rocket or shell Window form a screen for the force in the direction of the attack group; screen force by dispensing Window as necessary to jam specified type(s) of radars.

(2) Attack group form about 40,000 yards from the force; at designated time close the force, attempting to gain favorable attack position using information from specified type(s) of radars only.

(3) Submit brief report as for Exercise 19(A).

Exercise 22(A)—RADAR DECEPTION—DECOYS, OFFENSIVE.

(1) The purpose of this exercise is to give ships practice in distinguishing between echoes from decoys and those from actual targets, and to gain experience in the tactical employment of radar false echo reflectors (other than Window).

(2) Attack group equipped with radar decoys take station about 40,000 yards from force; at designated time close force and employ decoys, towed, captive, or free, attempting to gain favorable attack position.

(3) Ships of force track attack group with specified type(s) of radars; attempt to distinguish between actual attacking force and decoy ships.

(4) Submit brief report as for Exercise 19(A).

Exercise 22(B)—RADAR DECEPTION—DECOYS, DEFENSIVE.

(1) Same as Exercise 22(A) except force employs radar decoys in an effort to evade attacking group; attack group use only specified type(s) of radars and attempt to intercept force and gain favorable attack position.

Exercise 22(C)—RADAR DECEPTION—MOONSHINE.

(1) Air group(s), with three or four planes equipped with Moonshine, take station about 75 miles from force; at designated time commence closing force; employ Moonshine-equipped planes from various directions; make actual attack with major force from a different direction.

(2) Ships of the force track air group(s) with specified type of radars; Force Fighter Director attempt to intercept main attack group with Combat Air Patrol, using information from the specified type of radars only.

(3) Submit brief report as for Exercise 19(A).

Exercise 22(D)—RADAR DECEPTION—PETER.

(1) Attack group, equipped with Peter, take station about 40,000 yards from force; at designated time close force employing Peter; use own radars to keep an accurate relative plot on designated ship(s) of the force for comparison.

(2) Ships of the force attempt to track attacking group using specified type of radars only; record complete tracking data for comparison.

(3) Submit brief report as for Exercise 19(A).