DNA 6032F

OPERATION CROSSROADS

1946

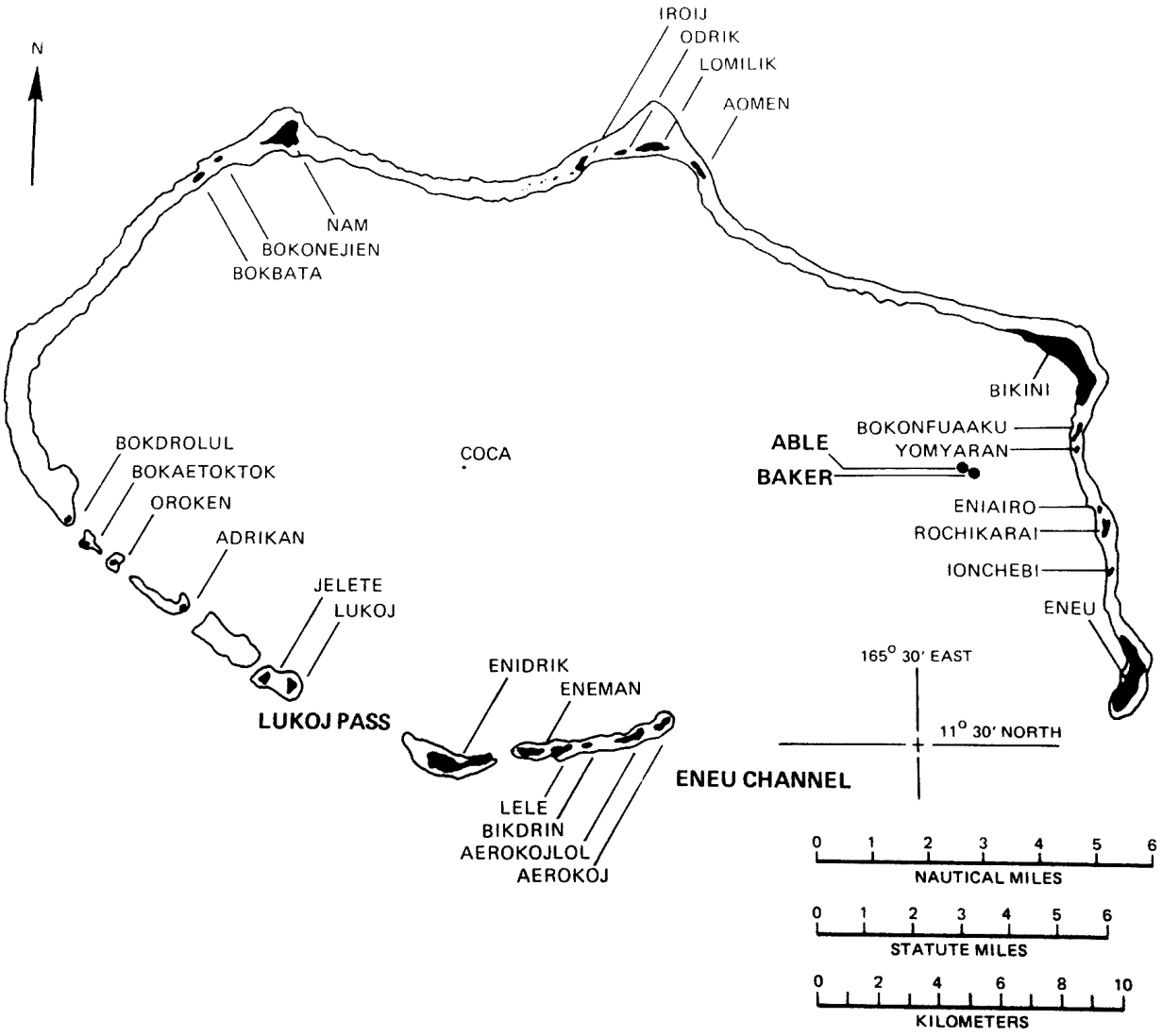
United States Atmospheric Nuclear Weapons Tests
Nuclear Test Personnel Review

Prepared by the Defense Nuclear Agency as Executive Agency
for the Department of Defense

Excerpts from DNA 6032F
OPERATION CROSSROADS
as it pertains to the
USS SHANGRI-LA (CV-38)

USS *Shangri-La* underway, with crew on parade
17 August 1946

Transcribed May 2010 by Michael Cassera



Bikini Atoll, 1946, showing ABLE and BAKER test sites.

FACT SHEET

Operation CROSSROADS was an atmospheric nuclear weapon test series conducted in the summer of 1946. The series consisted of two detonations, each with a yield of 23 KT:

- ABLE — detonated at an altitude of 520 feet (158 meters) on 1 July.

- BAKER — detonated 90 feet (27 meters) underwater on 25 July.

It was the first nuclear test held in the Marshall Islands.

The series was to study the effects of nuclear weapons on ships, equipment and material. A fleet of more than 90 vessels was assembled in Bikini Lagoon as a target. This target fleet consisted of older U.S. capital ships, three captured German and Japanese ships, surplus U.S. cruisers, destroyers and submarines, and a large number of auxiliary and amphibious vessels. Military equipment was arrayed on some of the ships as well as amphibious craft that were beached on Bikini Island. Technical experiments were also conducted to study nuclear weapon explosion phenomena. Some experiments included the use of live animals.

The support fleet of more than 150 ships provided quarters, experimental stations, and workshops for most of the 42,000 men (more than 37,000 of whom were Navy personnel) of Joint Task Force 1 (JTF 1), the organization that conducted the tests. Additional personnel were located on nearby atolls such as Enewetak and Kwajalein. The islands of the Bikini Atoll were used primarily as recreation and instrumentation sites.

Before the first test, all personnel were evacuated from the target fleet and Bikini Atoll. These men were placed on units of the support fleet, which sortied from Bikini Lagoon and took safe positions at least 10 nmi (18.5 km) east of the atoll.

In the ABLE test, the weapon was dropped from a B-29 and burst over the target fleet. In BAKER, the weapon was suspended beneath an auxiliary craft anchored in the midst of the target fleet.

ABLE operations went smoothly except that the test weapon was dropped between 1,500 and 2,000 feet (457 and 610 meters) off target. The radioactivity created by the burst had only a transient effect, and within a day nearly all the surviving target ships had been safely reboarded. The ship inspections, instrument recoveries, and

remooring necessary for the BAKER test proceeded on schedule. Five ships were sunk as a result of the test.

The crews of the target ships that had been remanned following ABLE were evacuated before BAKER to the support fleet east of the atoll. BAKER sank eight ships and damaged more ships than ABLE. The detonation caused most of the target fleet to be bathed in radioactive water spray and radioactive debris from the lagoon bottom. With the exception of 12 target vessels anchored in the array and the landing craft beached on Bikini Island, the target fleet remained too radiologically contaminated for several weeks for more than brief on-board activities.

The inability to complete inspections on much of the target fleet threatened the success of the operation after BAKER. A program of target vessel decontamination was begun in earnest about 1 August. This involved washing the ships' exteriors using work crews drawn from the target ships' companies under radiological supervision of monitors equipped with radiation detection and measurement devices. Initially, decontamination was slow as the safe time aboard some of the target ships was measured only in minutes. As time progressed, the support fleet itself had become contaminated by low-level radioactivity in marine growth on the ships' hulls and seawater piping systems.

By 10 August, a decision was made to stop work in Bikini and tow the surviving target fleet to Kwajalein Atoll where the work could be done in uncontaminated water. The move was accomplished during the remainder of August and September. A major task at Kwajalein was to offload ammunition stored aboard the target ships. This work continued into the fall of 1946. Personnel continued to work on target ships at Kwajalein into 1947.

Eight of the major ships and two submarines were towed back to the United States and Hawaii for radiological inspection. Twelve target ships were so lightly contaminated that they were remanned and sailed back to the United States by their crews. The remaining target ships were destroyed by sinking off Bikini Atoll, off Kwajalein Atoll, or near the Hawaiian Islands during 1946-1948.

The support ships were decontaminated as necessary and received a radiological clearance before they could return to the fleet. This decontamination and clearance process required a great deal of experimentation and learning at Navy shipyards in the United States, primarily at San Francisco.

Finally, a formal resurvey of Bikini Atoll was conducted in the summer of 1947 to study long-term effects of the CROSSROADS tests.

All CROSSROADS operations were undertaken under radiological supervision intended to keep personnel from being exposed to more than 0.1 roentgen (R) per day. At the time, this was considered to be an amount of radiation that could be tolerated for long periods without any harmful effects on health.

Radiological supervision included predicting areas of possible danger, providing trained personnel equipped with radiation survey instruments to act as guides during operations involving potential exposure, and elaboration of rules and regulations governing conduct in these operations. Personnel were removed for one or more days from areas and activities of possible exposure if their badges showed more than 0.1 R/day exposure.

About 15 percent of the JTF 1 personnel was issued at least one of the 18,875 film-badge dosimeter during CROSSROADS. Approximately 6,596 personnel were on islands or ships that had no potential for radiation exposure. Personnel anticipated to be at greatest radiological risk were badged, and a percentage of each group working in less contaminated areas were badged. The maximum accumulated exposure recorded was 3.72 R, received by a radiation safety monitor.

Lacking complete radiation exposure data, reconstructions have been made of personnel exposures for unbadged crewmembers of the ships involved. These calculations have considered the several sources of radiation at work in Bikini, such as the low-level contamination in the lagoon water, living aboard support ships, and boarding the contaminated target ships. The calculations relied upon radiation measurements recorded by radiation safety personnel in 1946. This data was used in a computer model that includes such factors as the radiation-shielding properties of ships' hulls and realistic patterns of daily personnel activity on weather decks and below. The actual movements of each ship were then used to reconstruct a dose for the crew. Calculated exposures range from 0 to 2.5 rem (gamma) for support ships. Exposures for target ship crews that reboarded their ships after BAKER were higher than those for support ship crews. A summary of film badge readings (in roentgen) for July and August, when the largest number of personnel was involved, is listed below:

Actual Film Badge Readings:

(R gamma)

	Total	0	0.001-0.1	0.101-1.0	1.001-10.0
July	3,767	2,843	689	232	3
%	100	75	18	6	<0.1
August	6,664	3,947	2,139	570	8
%	100	59	32	9	0.1

USS SHANGRI-LA (CV-38)

Crew Size: 1,935
Bikini Atoll Arrival: 5 June 1946 (Roi Namur)
Bikini Atoll Departure: 25 July 1946
Shot ABLE Location: 43 nmi (81 km) SE
Shot BAKER Location: 40 nmi (71 km) SE
Final Clearance: By 22 November 1946

Task Unit and Function

The aircraft carrier Shangri-La was a member of TU 1.6 (Navy Air Group). Shangri-La was responsible for training personnel and preparing equipment for atomic bomb tests. Four drone aircraft (F6Fs) flew from Shangri-La and were used to collect radioactive samples from the nuclear cloud; the drone-control aircraft remained safe distance from the detonation while directing the drones via radio control. In addition, a complete aerological unit, which took radar upper wind soundings at Bikini, was aboard Shangri-La.

Shot ABLE (1 July, 0900)

30 June

1625	Underway from Roi Anchorage, Roi Island, Kwajalein Atoll, in company with USS Turner (DD-834) and USS Charles P. Cecil (DD-835).

1 July

0714-0750	Launched four drone and sixteen drone-control aircraft.
0756	Launched two TBMs.
0901	Observed ABLE explosion.
0956-1004	Landed nine F6F aircraft.
1534	Anchored in berths A-7 and B-5, Roi Island.
1546-1556	Catapault-launched 12 F6F aircraft.

2 July

1627	Underway from Roi to Bikini with Turner and Cecil.

3 July

0550	Entered Bikini entrance to channel.
0631	Anchored in berth 285. Bikini.
1628	Underway from Bikini to Roi with Turner and Cecil.

4 July

0630	Anchored at Roi.

8 July

0847	Catapaulted two TBMs for Roi Island.

11 July
1025-1543 Received aboard three drone aircraft from a lighter.

13 July
1627 Underway from Roi Island for air rehearsal of BAKER.

14 July
0737-0800 Launched 12 F6F drone-control aircraft and 3 F6F drones.
0925-0931 Landed six F6F drone-control aircraft.
1313 Anchored in berth 228, Bikini.

15 July
1626 Underway for Roi Island from Bikini with Turner and Cecil.

16 July
0802 Anchored between berths B-5 and A-7, Roi Island.

17 July
1100-1130 Self-propelled barge moored alongside with three F6F drones from Roi.

18 July
1628 Underway to point Tare with Turner and Cecil for William Day rehearsal.

19 July
0723-0842 Conducted flight operations; launched and landed 12 F6F aircraft.
1243-1244 Launched two TBMs.
1559 Anchored between berths A-7 and B-5, Roi.

20 July
0940-1000 Launched 12 F6F drone-control aircraft.

21 July
0900-1000 Self-propelled barge alongside to deliver three F6F drones.

23 July
1631 Barges carrying one TBM alongside at #1 crane.

Shot BAKER (25 July, 0835)

24 July
1630 Underway with Cecil and Turner from Roi to Point Tare for BAKER test.

25 July

0724-0810	Launched 12 F6F drone-control aircraft. 3 F6F drones, and 2 TBMs.
0909-0913	Recovered two F6Fs.
0932-0935	Launched three TBMs.
1354-1403	Recovered nine F6Fs and four TBMs.
1700	Anchored between berths B-5 and A-7, Roi Island.

26 July

1515	Self-propelled barge tied up alongside with two F6F planes to be transferred aboard.
1602	Self-propelled barge alongside to transfer two F6Fs on board.

27 July

0955	Self-propelled barge came alongside to deliver one TBM and one F6F drone.

28 July

1240	Received barge from alongside to deliver two TBM aircraft.
1455	Received barge alongside to deliver two TBM aircraft
1520	Received barge alongside to deliver one SNB aircraft.
1657	Underway from Roi Island to Pearl Harbor.

2 August	Arrived Pearl Harbor. Moored to pier Fox 12-13, Ford Island, Pearl Harbor.

Table 16. Units in Task Group 1.6, CROSSROADS.

Task Unit 1.6.1 — Drone Carrier Unit

Task Unit 1.6.11 — USS Shangri-La (CV-38)

Task Unit 1.6.12 — Commander Destroyer Division 5

Destroyer Division 51

USS Turner (DD-834)

USS Charles P. Cecil (DD-835)

Task Unit 1.6.13 — Field Recovery Unit (NAB Roi)

Task Unit 1.6.14 — Carrier Drone Air Unit (detachment from Air Development Squadron-2 (VX-2)

26 F6F—3K drones

31 F6F-5 drone control planes

Task Unit 1.6.15 — Drone Boat Control Air Unit[a]

6 TBM-3E

Note:

[a] Transferred to Saidor on 10 June.

Source: Reference C.9.206, p. VII-E-Appendix III.

Note: Excerpt of Table 16 as it pertains to USS Shangri-La (CV-38)

NAVY AIR GROUP (TASK GROUP 1.6)

Composed of ships and aircraft, TG 1.6 was involved in a variety of support missions during CROSSROADS. Elements of the task group were operated from two aircraft carriers and from two island bases, Roi and Ebeye at Kwajalein. Table 16 gives TG 1.6 composition.

Task Unit 1.6.1 (Drone Carrier Unit)

This Unit was based on USS Shangri-La (CV-38). It was responsible for training personnel, preparing equipment for atomic bomb tests, conducting aircraft operations for drones engaged in collecting air and water samples in target areas on ABLE and BAKER days. It operated the carrier and plane guard destroyers as necessary to carry out air operations of embarked units (Chapter 4) (Reference C.9.206, p. VII-(E)-14).

Personnel and equipment of the Drone Carrier Unit (TU 1.6.14), the Drone Boat Control Unit (TU 1.6.15), and the Field Recovery Unit (TU 1.6.13) were transported overseas aboard Shangri-La. An extensive program of takeoffs and recoveries was initiated while en route from Hawaii to Roi Island, Kwajalein. The units arrived at Dyess Field, NAB Roi on 5 June. Training was given en route in navigation, homing, fighter direction, general communications, and the ABLE day Air Operations Plan (Reference C.9.206, p. VII-(E)-118).

Practice for ABLE day using the drones occurred on 10, 20, and 24 June. The practices included all Navy and Army aircraft. For each of these joint rehearsals, 4 drone F6Fs, 16 control F6Fs, and 2 air-sea rescue TBMs were launched from Shangri-La near Orbit Point Tare (40 nmi [74 km] from the center of Bikini Island). Orbit points for ABLE are summarized in Table 8. During each rehearsal, the carrier drones operated as follows (Reference C.9.206, pp. VII-(E)-199 and VII-(E)-120):

- Four primary drone-control flights (Red, White, Blue, Yellow) of two F6Fs each were launched and rendezvoused over Shangri-La to await the launching of the four F6F drones (Red, White, Blue, Yellow)

- As each of the four F6F drones were launched (each carrying a safety pilot for the rehearsals only), the corresponding color-coded flight of the primary drone-control aircraft assumed control of the aircraft and directed it to its station over Bikini Lagoon.

- Four secondary drone-control flights (Red, White, Blue, Yellow) of two F6Fs each then took off and proceeded to their stations opposite the point where it was expected that the drones would be directed into the atomic cloud on ABLE day by the correspondingly color-coded primary control aircraft

- Each of the secondary drone-control flights then took control of its drone after its passage through the area of the expected cloud column and guided it approximately 175 nmi (324 km) to Roi Island, where the drones were landed by the Field Recovery Unit

- The primary control aircraft returned to the carrier, and the secondary control aircraft landed on Roi Island.

The drone unit was not successful in carrying out all the details of the plan for the first two rehearsals, but the Queen Day rehearsal was almost perfect (Reference C.9.206, p. VII-(E)-120). The control aircraft were equipped with Geiger counters to enable the pilot to detect the presence of radiation.

SHOT ABLE. On 30 June at 1625 Shangri-La, accompanied by plane guard destroyers USS Turner (DD-834) and USS Charles P. Cecil (DD-835), departed Roi Island to take station within 15 nmi (28 km) of reference Point Tare (bearing 135°T, 40 nmi [74 km] from the center of Bikini Island) (Reference C.9.206, p VII-(E)-162). Earlier, final inspection of aircraft and special equipment had been initiated. At 1005, the drone unit in Shangri-La began a deck checkout of each drone and drone-control aircraft and bench checkouts of all identification, friend or foe (IFF) equipment on them. In addition, all special equipment on the aircraft, such as Geiger-Mueller counters, air filters, cameras, and recording devises, was given final tests. By 2130 all aircraft to be launched the next morning for ABLE were on the deck ready to be launched (Reference C.9.206, p. VII-(E)-163).

Between 0714 and 0717 on 1 July, two F6Fs from each of the four primary drone-control flights took off from Shangri-La. The eight primary control F6Fs rendezvoused over the carrier in position to intercept the drones. The Red, White, Blue and Yellow drones took off, in that order, between 0725 and 0745. The primary control flight established control over each airborne drone. By 0828 all drones were at their respective stations, bearing 312°T, 20 nmi (37 km) from target center, flying at the following altitudes: Red at 28,000 feet (8.5 km), White at 20,000 feet (6.1 km), Blue at 15,000 feet (4.6 km), and Yellow at 10,000 feet (3.0 km). Meanwhile, the four secondary drone-control flights of two F6Fs each were launched between 0747 and 0750. By 0830 all were corresponding to the drones

and primary drone-control flights across the center of the target axis (Reference C.9.206, p. VII-(E)-167). Two air-sea rescue TBMs (Dagger-1 and Dagger-2) were launched at 0757 from Shangri-La and stood by over the carrier until 1150 (Reference C.9.206, pp. VII-(E)-167 and VII-(E)-168).

No problems in launching the drones or in controlling them to station occurred. However, after the Red drone arrived on station, a stuck aileron caused it to go out of control and it crashed in the sea at 0850. Consequently, the Red primary and secondary drone-control flights were ordered to return to base at 0900 (Reference C.9.206, pp. VII-(E)-167 and VII-(E)-168).

All pilots in the controlling planes had adjusted their darkened goggles to shield their eyes from the blinding flash of light at the instant of detonation. Since the pilots had expected a much stronger flash than actually occurred, they were momentarily unsure whether the burst had occurred on schedule. However, no serious delay resulted. The primary control flights commenced controlling the drones toward the cloud column, entering as follows: at 0906 the Yellow drone at 10,000 feet (3.0 km), at 0909 the White drone at 20,000 feet (6.1 km), and at 0910 the Blue drone at 15,000 feet (4.6 km). As the drones passed through the cloud column, the White drone increased altitude from 20,000 feet to 26,000 feet (6.1 to 7.9 km), probably due both to the strong upward currents within the cloud and the White drone having a slight nose-up altitude when the primary drone-control flight released it. The secondary drone-control flights successfully completed the interceptions as follows: Yellow at 0923, Blue at 0924, and White at 0953. The control aircraft recaptured the White drone over Wotho Atoll and returned it to Roi without damage. All drones landed safely at Roi between 1028 and 1046, and all control aircraft returned to the base aboard Shangri-La or at Roi between 0957 and 1056 (Reference C.9.206, pp. VII-(E)-171 and VII-(E)-172). All 16 pilots wore film badges, and 16 were readable. The average exposure was 0.02 R (gamma), with a maximum of 0.03 R (gamma).

Following completion of drone flight operations, radiological samples were removed from the F6F drones after they landed at Roi. Soon after, all other drone and drone-control aircraft from Shangri-La were flown to Roi Island where they were later checked and flight-tested. On 9 July one drone and its safety pilot were lost on a routine test flight off Roi Island when the drone, under the control of the field unit, rolled over at a very low altitude and spun into the sea. (Reference C.9.206, p. VII-(E)-188).

Between 0910 and 0918 four drone boat control TBMs (Bucko-1, Bucko-2, Bucko-3 and Bucko-4) of TU 1.6.15 were launched from Saidor.

Immediately after takeoff, Bucko-1 and Bucko-3 proceeded to their stations 5 nmi (9.3 km) upwind from the drone boats Factory-1 and Factory-3. Bucko-2 and Bucko-4 stood by circling the carrier as replacements. When Bucko-1 reported a hydraulic leak shortly after takeoff, Bucko-2 replaced it. At 1015 Bucko-4 replaced Bucko-3, which had developed generator trouble. The TBMs remained about 5 nmi (9.3 km) upwind from the drone boats. The TBMs controlled the drone boats' courses as they moved through the radioactive target area. The TBMs also reported on the levels of radiation in the area in which they were flying. Bucko-2 and Bucko-4 completed their missions and were out of the area by 1238 (Reference C.9.206, p. VII-(E)-172).

SHOT BAKER. The air operation plan for shot BAKER provided for the active use of only three drones with twelve control aircraft: Red drone at 14,000 feet (4.3 km) at B+6 minutes, White drone at 9,000 feet (2.7 km) at B+10 minutes, and Blue drone at 5,000 feet (1.5 km) at B+12 minutes. The Yellow control flight remained in readiness as a replacement in case any control flights developed trouble. The primary drone-control aircraft were at Orbit Point Victor, bearing 315°T, 20 nmi (37 km) from the target center. The secondary drone control aircraft were at Orbit Point Sugar, bearing 135°T, 20 nmi (37) from target center (Reference C.9.206, p. VII-(E)-213).

Some safety restrictions were relaxed since airborne radiation from the underwater shot would be less than for ABLE, and the control group was brought closer to the target area. One flight in each group was positioned to be in sight contact of the drone at all times. The amber shield over the cockpit greenhouse and the blue goggles were discarded (Reference C.9.206, p. VII-(E)-187). The White drone had been modified to include the installation of a Mitchell camera, and a K-17 type aerial camera had been installed on the Red drone.

On 13 July all drones and drone-control airplanes were transported by barge from Roi to Shangri-La, which then proceeded to Bikini to participate in the first air rehearsal on 14 July. A second air rehearsal on 19 July was cancelled because of foul weather (Reference C.9.206, p. VII-(E)-188).

At 1610 on 24 July, Shangri-La, accompanied by destroyers Turner and Cecil, left Roi Island to assume their positions 40 nmi (74 km) from the center of Bikini Island (Reference C.9.206, p VII-(E)-208). On 25 July at 0723, launching of the three F6F drones and twelve F6F drone-control aircraft began. By 0814, the three drone groups were on station. First the two F6Fs of each primary drone-control flight were launched, followed by the drones and the secondary drone-control flights. All aircraft rendezvoused over Shangri-La before proceeding to their assigned stations. At H-hour the primary drone-control

flights were orbiting with their drones at Orbit Point Victor, bearing 315°T, 20 nmi (37 km) from the target center at the following altitudes: Red at 14,000 feet (4.3 km), White at 9,000 feet (2.7 km), and Blue at 5,000 feet (1.5 km). The secondary drone-control flights took up their positions on the opposite side of the target axis at Orbit Point Sugar, bearing 135°T, 20 nmi (37 km) from the target center, at altitudes corresponding to the other elements of their respective groups (Reference C.9.206, pp. VII-(E)-212 and VII-(E)-213). Orbit points for BAKER are summarized in Table 10 (Chapter 4).

The primary drone-control flights and the drones moved toward the target array after detonation. The Red drone entered the cloud column at 0841 from 14,000 feet (4.3 km), the White drone at 0845 from 9,000 feet (2.7 km), and the Blue drone at 0847 from 5,000 feet (1.5 km). The secondary drone-control flight reported the drones at approximately the same altitudes as follows: Red at 0850, White at 0847 and Blue at 0849. Since the cloud of water and steam did not reach the altitude expected, the Red and White drones at the higher altitude passed over the top of the cloud, and the Blue drone at 5,000 feet (1.5 km) flew through the upper portion of the column (Reference C.9.206, p. VII-(E)-216). Radioactivity was detected on the Blue drone only. Maximum reading was 7 R/24 hours (Reference C.7.6). All drones were guided to Roi Island and landed without damage between 0950 and 1006. All air filters, cameras and other special installations operated satisfactory except the camera installation in the Red drone (Reference C.9.206, p. VII-(E)-217). All pilots wore film badges. The 12 badges averaged 0.05 R (gamma) and the maximum was 0.08 R (gamma).

At detonation, the four drone boat control TBMs (Bucko-1, Bucko-2, Bucko-3, Bucko-4) were standing by aboard Saidor ready for launching. All four took off between 0846 and 0849. Bucko-2 and Bucko-4 stood by in the air over the carrier as replacements while Bucko-1 and Bucko-3 proceeded to a position upwind from drone boats Factory-1 and Factory-3. Remaining approximately 5 nmi (9.3 km) upwind of the drone boats, Bucko-1 at 2,300 feet (701 meters) and Bucko-3 at 2,600 feet (792 meters) conned the courses of Factory-1 and Factory-3 by voice radio as the boats moved through the radioactive waters near the target area (Reference C.9.206, pp. VII-(E)-217 and VII-(E)-218). Bucko-1 completed its conning assignment at 1055 and Bucko-3 at 1105. In the afternoon between 1508 and 1574, similar conning assignments were carried out by Bucko-2 and Bucko-4. Bucko-3 stood by in the air over Saidor as a replacement (Reference C.9.206, p. VII-(E)-218). The three F6F drones and half the control aircraft landed at Roi after the test and radiological samples were removed. On 26 July, two drones were returned by barge to Shangri-La. The following day the remaining F6Fs were transferred to Shangri-La.

Table 8. CROSSROADS. Test ABLE aircraft orbit points.

Orbit Designation	Bearing From Surface Zero (°)	Horizontal From Surface (nmi)	Range[a] Zero (km)
Able	50	20	37
Charlie	170	15	28
Dog	80	15	28
Easy	90	25	45
King	125	15	28
Love	315	30	56
Nan	0	20	37
Peter	240	35	65
Sugar	135	20	37
Tare	135	40	74
Uncle	40	30	56
Victor	315	20	37
William	270	20	37
Yoke	45	20	37
Zebra	0	40	74
I.P.	225	30	56

Note:
[a] Slant ranges of aircraft vary with aircraft orbiting altitudes. Orbiting altitudes were from 1,000 feet (305 meters) to 31,000 feet (9.5 km).

Table 10. CROSSROADS. Test BAKER aircraft orbit points.

Orbit Designation	Bearing From Surface Zero (°)	Horizontal From Surface (nmi)	Range[a] Zero (km)
Able	45	20	37
Charlie	180	10	19
Dog	330	9	17
Easy	90	20	37
King	225	10	19
Love	315	30	56
Sugar	135	20	37
Tare	135	40	74
Victor	315	20	37
William	270	20	37
Yoke	45	7	13

Note:
[a] Slant ranges of aircraft vary with aircraft orbiting altitudes. Orbiting altitudes were from 500 feet (152 meters) to 30,000 feet (9.1 km).

Source: Reference C.9.206, p. VII-(E)-194.

References:

C.9.206 Report on Atomic Bomb Tests ABLE and BAKER, Operational Report, Volume I
January 1947 XRD-206
NTIS AD 473 986*

*Available from NTIS; order number appears before the asterisk