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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) CASTLE was an atmospheric nuclear weapons test series held in the Marshall Islands at Enewetak and Bikini atolls in 1954. This is a report of DOD personnel in CASTLE with an emphasis on operations and radiological safety.		

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## FACT SHEET

CASTLE was a six-detonation nuclear weapon test series (see table) held at the Atomic Energy Commission's (AEC) Pacific Proving Ground (PPG) in Spring 1954. The PPG consisted principally of Enewetak\* and Bikini atolls in the northwestern Marshall Islands in the Central Pacific Ocean.

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Date	Assigned Name	Location	Magnitude
1 March	BRAVO	Bikini; sandspit off Nam Island	15 MT <sup>a</sup>
27 March	ROMEO	Bikini; barge in BRAVO crater	11 MT
7 April	KOON	Bikini; surface of Eneman Island	110 KT
26 April	UNION	Bikini; barge in lagoon off Iroij Island	6.9 MT
5 May	YANKEE	Bikini; barge in UNION crater	13.5 MT
14 May	NECTAR	Enewetak; barge in MIKE <sup>b</sup> crater	1.69 MT

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### Notes:

<sup>a</sup>One kiloton equals the approximate energy release of the explosion of one thousand tons of TNT; one megaton equals the approximate energy release of the explosion of one million tons of TNT.

<sup>b</sup> 10.4-MT IVY series detonation in 1952.

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### HISTORICAL BACKGROUND

The CASTLE series was held to test large-yield thermonuclear, or hydrogen, devices. Work on this class of devices had progressed through the GREENHOUSE, GEORGE experimental shot in 1951 and the IVY, MIKE shot of 1952. MIKE was the first device that generated a substantial explosive energy from the fusion, or joining, of hydrogen atoms. These explosive

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- The spelling of Marshall Island place names has changed in recent years in order to more accurately render the sounds of the Marshall Island names using English spelling.

devices were developed by the AEC, the civilian agency authorized to perform this activity by the Atomic Energy Act of 1946.

The devices were tested at the PPG by a joint military and civilian organization, designated as Joint Task Force 7 (JTF 7). This was a military organization in form, but was populated by military, civil service, and contractor personnel of the Department of Defense (DOD) and AEC. The commander of this force was the appointed representative of the AEC and reported also to the Joint Chiefs of Staff (JCS) and the Commander in Chief, Pacific (CINCPAC). The peak DOD numerical strength at CASTLE was approximately as follows:

Uniformed military	9,800
DOD civil servants	250
DOD contractors	60
	<hr/>
Total personnel	10,110

Numerous technical experiments were carried out in conjunction with each of the six detonations. These experiments measured the power and efficiency of the devices and attempted to gauge the military effects of the explosions. DOD personnel participated in this test operation as individuals whose duty stations were at the AEC design laboratories, as units performing separate experiments, and as units performing various support roles. The CASTLE operations placed almost all of the Navy support group at Bikini, where its ships provided living space for personnel who were evacuated from the islands for the first test and then could not return to live there because of the potential radiation exposure.

An extensive radiological safety program was instituted whose objectives were:

1. Maintenance of personnel radiation exposure at the lowest possible level consistent with medical knowledge of radiation effects and the importance of the test series.
2. Avoidance of inadvertent contamination of populated islands or transient shipping.

The program established an organization to provide radiological safety (radsafe) expertise and services to the separate components of the task force who were responsible for personnel safety within their commands. Personnel were trained in radiological safety, and standards governing maximum permissible exposures (MPE) were established. Film badges were provided to a large portion of the participating personnel. Persons likely to be exposed to radiation were badged as well as a representative group of the remainder. An extensive weather forecasting group was established in order to predict wind directions and areas of potential fallout. Personnel were evacuated from danger areas before each detonation and re-entry to contaminated areas was restricted to the personnel required to retrieve important data. The amount of radiation exposure for these personnel was monitored.

#### TEST OPERATIONS AND EXPOSURES

The first event of this series, designated BRAVO, had a yield of 15 MT and was the largest device ever detonated in atmospheric nuclear testing by the U.S. Government. Significantly exceeding its expected yield, BRAVO, detonated at Bikini Atoll, released large quantities of radioactive materials into the atmosphere, which were caught up in winds that spread the particles over a much larger area than anticipated. This resulted in the contamination and exposure of some individuals either stationed or residing on distant atolls or aboard various vessels. Acute radiation effects were observed among some of these people.

A limited number of JTF 7 personnel received radiation exposures considerably in excess of the initially established CASTLE MPE. This operational limit was established at 3.9 roentgens (R) gamma within any 13-week period of the operation. In particular, three members of the U.S. Navy Bikini Boat Pool had heavily exposed badges with readings from 85 to 95 R, and 28 Army and Air Force personnel had film badge exposures that read as high as 78 R. All these men were medically evaluated at Kwajalein. Subsequently, follow-up on 29 of them was done at Tripler Hospital in Hawaii.

The results of these medical observations were reported as "essentially negative" or "generally negative."

BRAVO fallout on some Navy ships also resulted in additional personnel who had exposures approaching or exceeding the CASTLE MPE of 3.9 R. To allow for operational completion of the remaining CASTLE shots, it became necessary to issue a number of waiver authorizations permitting exposures of as much as 7.8 R. In a limited number of cases, even this level was exceeded.

As a result of BRAVO, 21 individuals on the USS Philip (DDE-498) and 16 on the USS Bairoko (CVE-115) sustained small skin lesions resembling burns that were definitely classified as beta burns. The affected personnel received radiological contamination while on the weather deck or stationed near ventilation blowers. These all healed without complications. The USS Patapsco (AOG-1), a Navy gasoline tanker, which was approximately 180-195 nautical miles (333-360 kilometers) northeast of BRAVO's ground zero at the time of detonation, received fallout as it returned to Pearl Harbor. Exposure estimates as high as 18 R are possible, assuming an individual was on deck 24 hours a day with the ship retaining 100 percent of all fallout radioactivity and using the highest reading from radiation surveys. For an individual who spent only 8 hours a day on deck and 16 hours a day inside, and assuming that the storm conditions washed off 50 percent of the activity en route, the estimated dose is 3.3 R.

The other five CASTLE detonations, though extremely important as weapon tests, did not produce significant, unexpected personnel radiation exposures.

While small numbers of personnel at CASTLE did receive exposures in excess of imposed standards, by far the largest portion did not. In fact, the radiation exposure for JTF 7 personnel at CASTLE averaged about 1.7 R. The recorded CASTLE exposures are summarized in the table on the following page.

### CASTLE Exposures

Service	No. of Persons Badged	Dose Unavail	Exposure Range (R)						High Recorded (R)
			Zero <sup>a</sup> Exposure	0.001- 1.000	1.001- 3.000	3.001- 5.000	5.001- 10.00	Over 10.0	
Army	1,503	8 >1% <sup>b</sup>	27 2%	1,276 85%	121 8%	60 4%	8 >1%	3 >1%	78 <sup>c</sup>
Navy	6,255	35 >1%	113 2%	3,544 57%	1,945 31%	453 7%	157 3%	8 >1%	96
Air Force	844	15 2%	12 1%	494 58%	208 25%	59 7%	25 3%	31 4%	52 <sup>d</sup>
Marine Corps	193	2 1%	13 7%	67 35%	78 40%	29 15%	4 2%	0 0%	5.510
Other Govt Contractor	2,175	170 8%	86 4%	1,221 56%	323 15%	292 13%	81 4%	2 >1%	27.825
Totals	10,970	230 2%	251 2%	6,602 60%	2,675 24%	893 8%	275 3%	44 >1%	96

Notes:

<sup>a</sup>Zero doses were not recorded in the Consolidated List of CASTLE Radiological Exposures for many units.

<sup>b</sup>Percent of total service personnel in each group.

<sup>c</sup>Three unbadged Army personnel on Rongerik Island originally were assigned a dose of 98 R, which was taken from a badge mounted on a tent pole.

<sup>d</sup>The high value comes from badges worn by Air Force personnel on Rongerik. The U.S. Air Force has assigned an estimated total dose of 86 R to each member of its Rongerik group.