

Revised 6-22-73
TMC

410289

ATOLLS UPON WHICH SIGNIFICANT NUCLEAR FALLOUT COULD HAVE OCCURRED

FROM THE

PACIFIC PROVING GROUNDS

DURING

ATMOSPHERIC TESTING

DRAFT

intend resettlements

In light of [redacted] on BIKINI and ENIWETOK atolls it is prudent that some consideration be given to fallout from the Pacific Proving Grounds which may have been carried to other atolls during the period of atmospheric testing. *(19--19--)*

Fallout patterns and *exposure measurements* [redacted] on the *Pacific Proving Ground* nuclear tests are very limited. However, hodographs are known for nearly all of the tests conducted in the Pacific. These hodographs and available fallout patterns have been [redacted] studied to discern which events may have had fallout on Pacific atolls. Those hodographs and fallout patterns which [redacted] [redacted] have positive indications or suggest significant fallout on these atolls are indicated, as well as the source of such information.

Due to the intensive fallout from the CASTLE BRAVO event on RONGELAP and UTIRIK atolls, some effort was made in the past to investigate the radioactive deposition on these and a few other atolls in the fallout pattern. Unfortunately, the utility of these investigations is limited due to the *small number of* atolls visited, the *crude* treatment of the samples (gross gamma, gross beta, and other crude evaluations), and age of the survey. Only on RONGELAP, BIKINI and ENIWETOK atolls have any recent studies been undertaken. The rest of the fallout area *apparently, has become of limited funding* [redacted] been ignored.

Utilizing various reports, fallout patterns and hodographs, this investigator has evaluated the data available, *(omit)* [redacted] and suggests that [redacted] fallout has occurred on several atolls which [redacted] *may* have been investigated previously. This fallout, or the hodographs suggesting it, is presented as figures with other pertinent information presented in tabular form for brevity.

COMMENTS ON SOURCE INFORMATIONFallout Patterns

The source documents (^{listed} ~~██████████~~ the References portion of this report) indicate the ^{exposure} ~~██████████~~-rate contours for the fallout patterns have been drawn to show the gamma ^{exposure} ~~██████████~~ rate in roentgens per hour, three feet above the ground, in terms of the one hour after burst reference time. The $t^{-1.2}$ approximation was used when no actual decay data was available to adjust radiation measurements to the one hour reference time. It is important to recognize the H + 1 hour is used as a reference time, and that only the contours from low yield were complete at one hour after burst. For high yield weapons, fallout over some parts of the vast areas shown did not commence until many hours after burst.

Where several fallout patterns were available for a particular event, each has been presented.

Hodographs

The hodographs were drawn for a constant balloon rise rate of 5,000 ft/hr and are presented because other, more meaningful, information is not available. Several hodographs are ^{presented} ~~██████████~~ for the H plus times indicated by the number at the end of the arrow. This number is in H plus hours.

It is recognized that fallout did not necessarily follow the hodographs presented herein. However, a simple comparison of the CASTLE BRAVO hodographs with the actual or modeled fallout patterns will show the merit of their consideration.

FINDINGS

~~_____~~ There are eleven nuclear tests which may have deposited radioactive materials in significant amounts greater than world wide fallout on several of the Pacific Atolls. These events and the atolls they may have contaminated are indicated in tabular form in Table 1. Additionally, the fallout pattern, if available, or several hodographs are indicated in Figures through , for each contaminating event. ~~_____~~ For immediate reference, the habitation of the atolls under discussion is indicated, with population figures and remarks, where applicable, in Table 2.

It is pertinent to note that in addition to ENIWETOK, BIKINI, AILINGINAE, RONGELAP, RONGERIK, BIKAR, TAKA, ~~_____~~ UTIRIK, and LIKIEP atolls, which have been ~~_____~~ ^{investigated} by others at some time in the past, several other atolls are indicated: AILUK, JEMO, KWAJALEIN, LAE, MEJIT, TAONGI, UJAE, UJELANG, WOTHO ~~_____~~ and WOTJE. Since the utility of the studies ~~_____~~ ^{of} BIKAR, TAKA, LIKIEP and possibly AILINGINAE, ~~_____~~ RONGERIK, and UTIRIK, is somewhat limited, these may also added to ~~_____~~ ^{these not included} above. This would mean that, including the "source" atolls of ENIWETOK and BIKINI, a total of 19 atolls may have been contaminated with ~~_____~~ ^{greater than world wide fallout quantities} of radioactive materials. Only on three, ENIWETOK, BIKINI and RONGELAP, possibly four if UTIRIK is included, is there any ~~_____~~ ^{measurable} radiological data.

^{Evaluation Method} Since actual fallout patterns are lacking for ~~_____~~ ^{of} of the ~~_____~~ ^{highly probable} events, an ~~_____~~ ^{attempt} was made to weigh the potential of each event. ~~_____~~

~~_____~~ ^{As} the fallout pattern of the CASTLE BRAVO event is well known (actually there are three different ^{concluding?} fallout patterns available) this deposition potential was normalized to ~~_____~~ ^{CASTLE BRAVO} this ^{The results of} treatment ^{are} presented in Table 3. The potential expressed here is really a factor, or multiplier, of the CASTLE BRAVO fallout. It may be applied simply by taking the CASTLE BRAVO deposition at a distance from the GZ ~~_____~~

similar to the distance from GZ, along the hodograph, of the event ~~_____~~ ^{being considered,}
~~_____~~ and multiplying it by the "potential" factor. The result should
be a "ballpark" estimate of what fallout may have occurred at the location
in question. Obviously, there is no claim to any precision or accuracy with
this method. It is only offered as a ~~()~~ mechanism to estimate ~~_____~~ possible
deposition in the absence of actual data. ~~_____~~

TABLE 1. POSSIBLE SIGNIFICANT NUCLEAR FALLOUT FROM PACIFIC PROVING GROUNDS, SUSPECTED ATOLLIS

EVENT	ATOLL	BLACK - POSITIVE	RED - POSSIBLE
SANDSTONE ZEBRA	5/49	ENIWETOK, BIKINI, AILINGINAE, RONGELAP, RONGERIK, TAKA, BIKAR, UTIRIK	
GREENHOUSE DOG	4/51	ENIWETOK, UJELANG	
GREENHOUSE GEORGE	5/51	ENIWETOK, BIKINI, AILINGINAE, RONGELAP, RONGERIK	
IVY KING	11/52	ENIWETOK, UJELANG, *	
CASTLE BRAVO	2/54	BIKINI, AILINGINAE, RONGELAP, RONGERIK, TAKA, BIKAR, AILUK, LIKIEP, JEMO, UTIRIK, WOTHO, KWAJALEIN, WOIJE	
CASTLE UNION	4/54	BIKINI, AILINGINAE, RONGELAP, RONGERIK, TAKA, BIKAR, TAONGI, UTIRIK	
CASTLE YANKEE	5/54	BIKINI, AILINGINAE, RONGELAP, RONGERIK, BIKAR, TAONGI	
REDWING ZUNI	5/56	BIKINI, AILINGINAE, RONGELAP, RONGERIK	
REDWING LACROSS	5/56	ENIWETOK, BIKINI, AILINGINAE, RONGELAP, RONGERIK, BIKAR, TAONGI	
HARDTACK MAGNOLIA	5/58	ENIWETOK, UJELANG, *	
HARDTACK MAPLE	6/58	BIKINI, AILINGINAE, RONGELAP, RONGERIK, WOTHO, UJAE, LAE, KWAJALEIN	

* This hodograph indicated that the fallout pattern could have extended southwest as far as Ponape and other nearby atolls.

TABLE 2. HABITATION OF ATOLLS UNDER DISCUSSION

ATOLL or ISLAND	INHABITED (Pop.) yr.	BEING REINHABITED	UNINHABITED	REMARKS
ABLINGINAE			X	Visited by Rongelapese
AILUK	(395) 1962 ¹			
BIKAR			X	
BIKINI		X		
ENIWETOK		X		
JEMO			X	
KWAJALEIN	(> 1000) 1973 ²			
LAE	(133) 1962 ¹			
LIKIEP	(662) 1962 ¹			
MEJIT	(203) 1962 ¹			
RONGELAP	(208) 1962 ¹			
RONGERIK			X	Visited by Rongelapese
TAKA			X	Visited by Utrikese
TAONGI			X	
UJAE	(146) 1962 ¹			

TABLE 2. Continued

ATOLL or ISLAND	INHABITED (Pop.) yr.	BEING REINHABITED	UNINHABITED	REMARKS
UJELANG	(340) 1973 ³			
UTIRIK	(319) 1962 ¹			
WOTHO	(56) 1962 ¹			
WOTJE	(463) 1962 ¹			

1 _____, SAILING DIRECTIONS FOR THE PACIFIC ISLANDS, H. O. Pub. No. 82, Vol. I., U. S. Naval Oceanographic Office, 1964, (Chapter 5, Marshall Islands), Change 4 Incorporated, 5 December 1970.

2 Henderson, John W., et. al., AREA HANDBOOK FOR OCEANIA, U. S. Government Printing Office, Washington, 1971, p. 503.

3 Tobin, J. A., THE ENEHETAK ATOLL PEOPLE, Special Report for the Radiological Survey of 1972-1973, Majuro, 20 April 1973, p. 10.

TABLE 3. DEPOSITION POTENTIAL NORMALIZED TO BRAVO

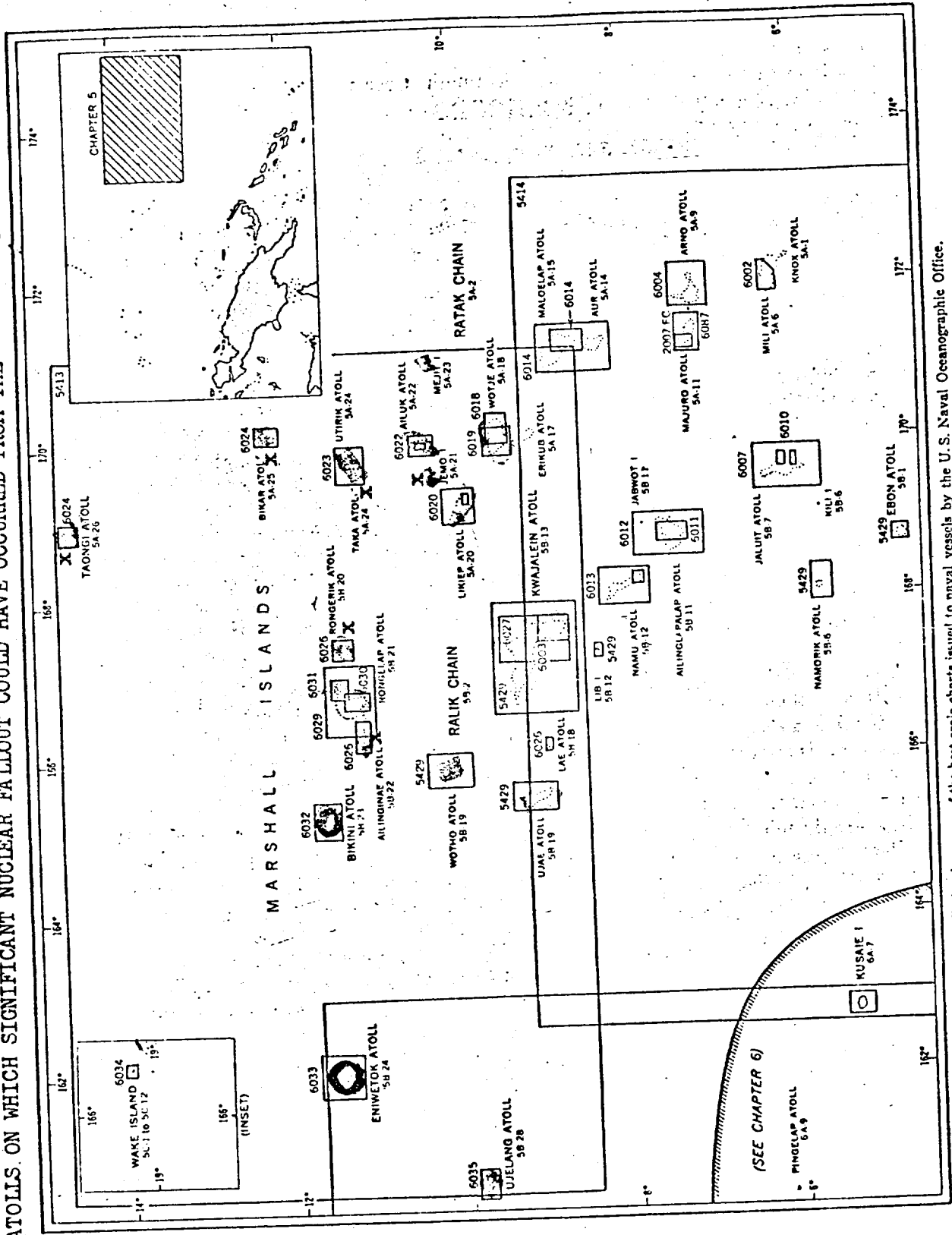
EVENT	POTENTIAL
SANDSTONE ZEBRA	0.002
GREENHOUSE DOG	0.010
GREENHOUSE GEORGE	0.025
IVY KING	0.069
CASTLE BRAVO.	1.000
CASTLE UNION	0.720
CASTLE YANKEE	1.050
REDWING ZUNI	0.070
REDWING LACROSS	0.005
HARDTACK MAGNOLIA	0.007
HARDTACK MAPLE	0.027

TABLE 4. NORMALIZED DEPOSITION POTENTIAL APPLIED TO EACH ATOLL BY CONTAMINATING EVENT

EVENT	ATOLL WOTUK	WOTHU	UTIRIK	UJELANG	UJAE	TADWGI	TACH	ROWGOCIK	ROWGOCAP	MESIV	LIMFIP	LAE	KWATALEIN	JEMO	ENIWEZON	BIKINI	BIKAR	AILUK	AILINGINAE	
SANDSTONE ZEBRA																				
GREENHOUSE DOG																				
GREENHOUSE GEORGE																				
IVY KING																				
CASTLE BRAVO																				
CASTLE YANKEE																				
REDWING ZUNI																				
REDWING LACROSS																				
HARDTACK MAGNOLIA																				
HARDTACK MAPLE																				
TOTAL																				

Disturbance factor?
 a D.F. x D.P.?

ATOLLS ON WHICH SIGNIFICANT NUCLEAR FALLOUT COULD HAVE OCCURRED FROM THE PACIFIC PROVING GROUNDS



x = uninhabited

Chart limits shown are of the best scale charts issued to naval vessels by the U.S. Naval Oceanographic Office. Numbers refer to the section in the text describing a designated locality.

CHAPTER 5--GRAPHIC INDEX

GRAPHIC INDEX
ATOLLS ON WHICH SIGNIFICANT NUCLEAR FALLOUT COULD HAVE OCCURRED FROM THE PACIFIC PROVING GROUNDS

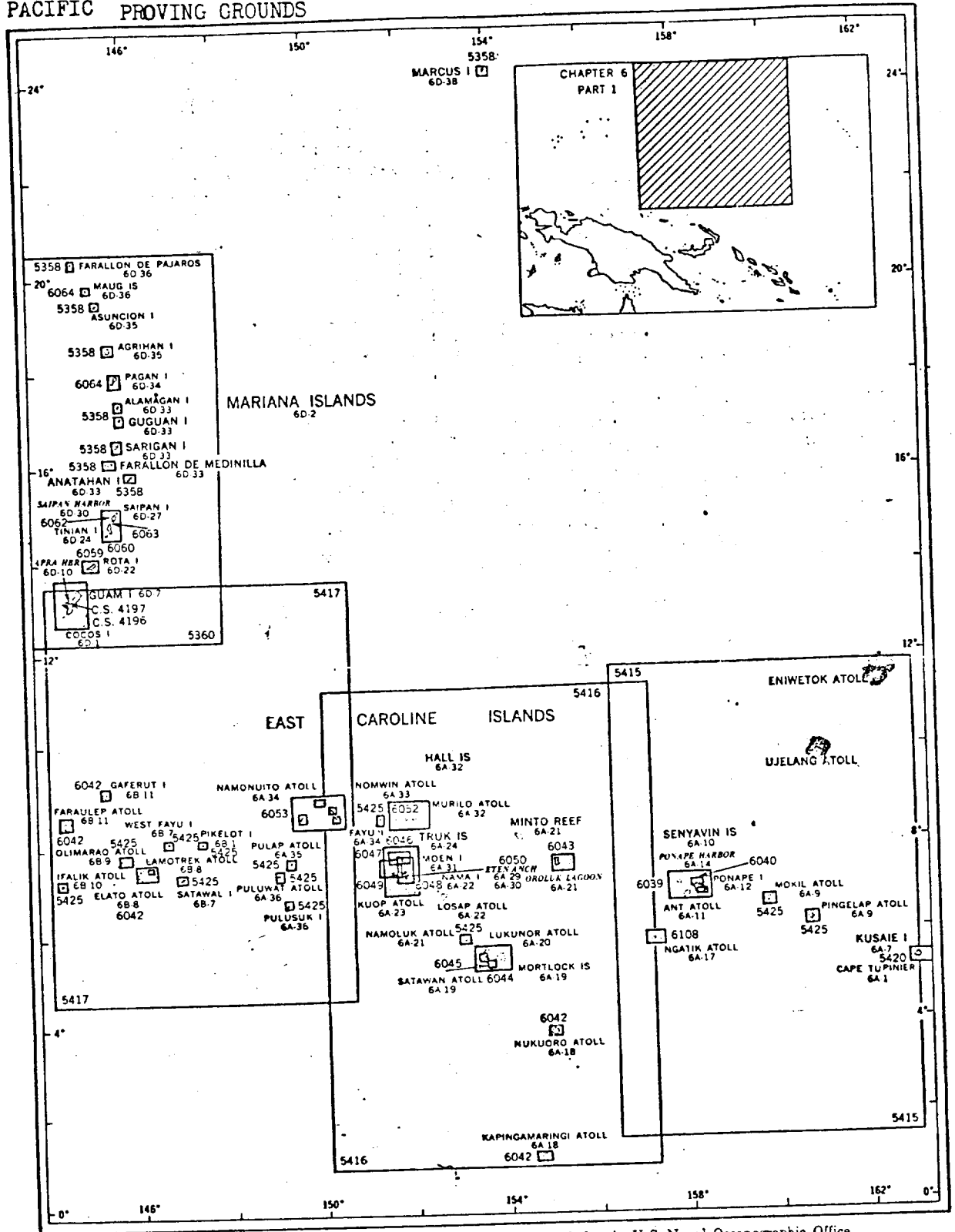


Chart limits shown are of the best scale charts issued to naval vessels by the U.S. Naval Oceanographic Office. Numbers refer to the section in the text describing a designated locality.

CHAPTER 6, PART I, GRAPHIC INDEX

ATOLLS EVALUATED BY DUNNING, AUGUST 1957

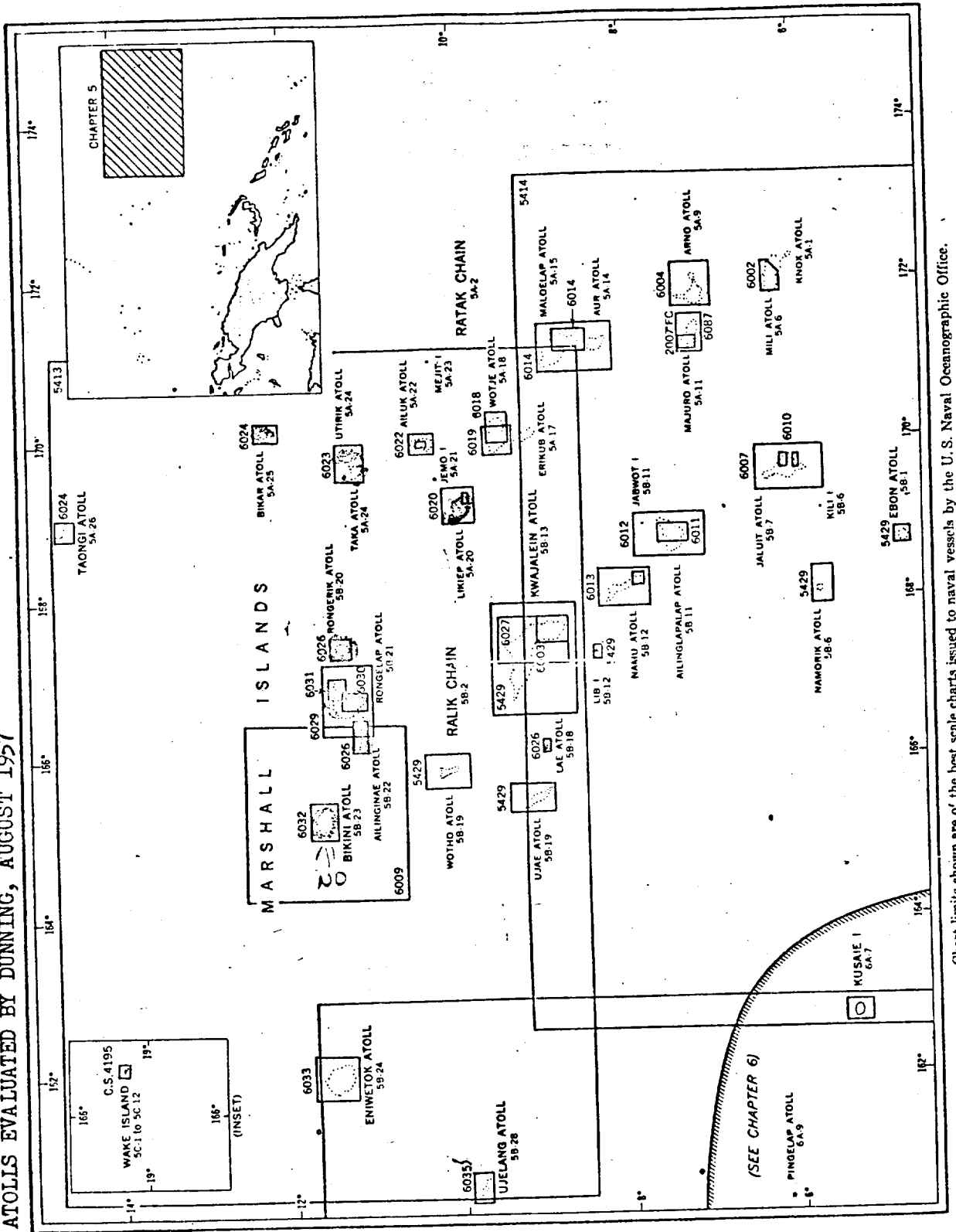
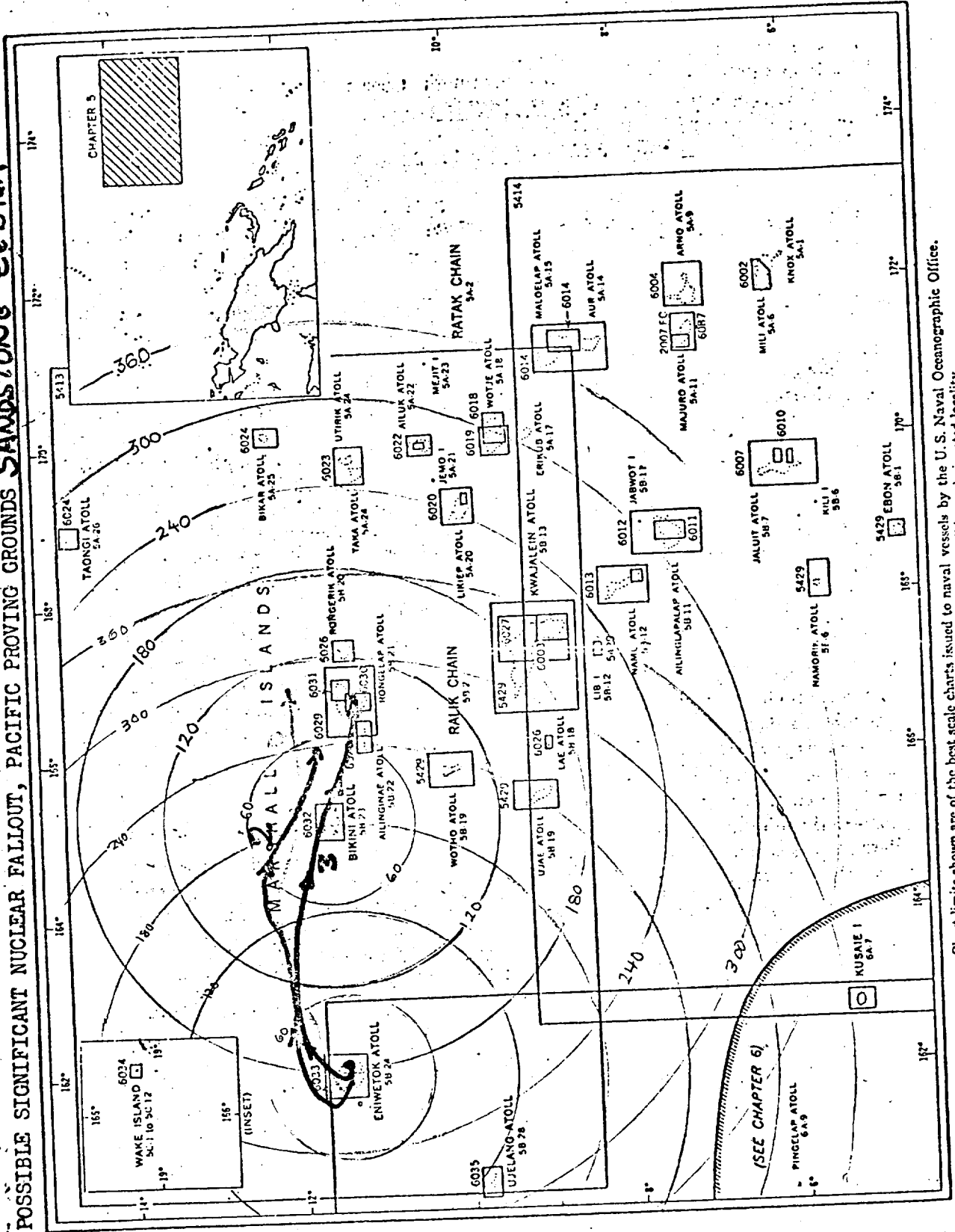


Chart limits shown are of the best scale charts issued to naval vessels by the U. S. Naval Oceanographic Office. Numbers refer to the section in the text describing a designated locality.

CHAPTER 5—GRAPHIC INDEX

POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS SANDSTONE ZEBRA

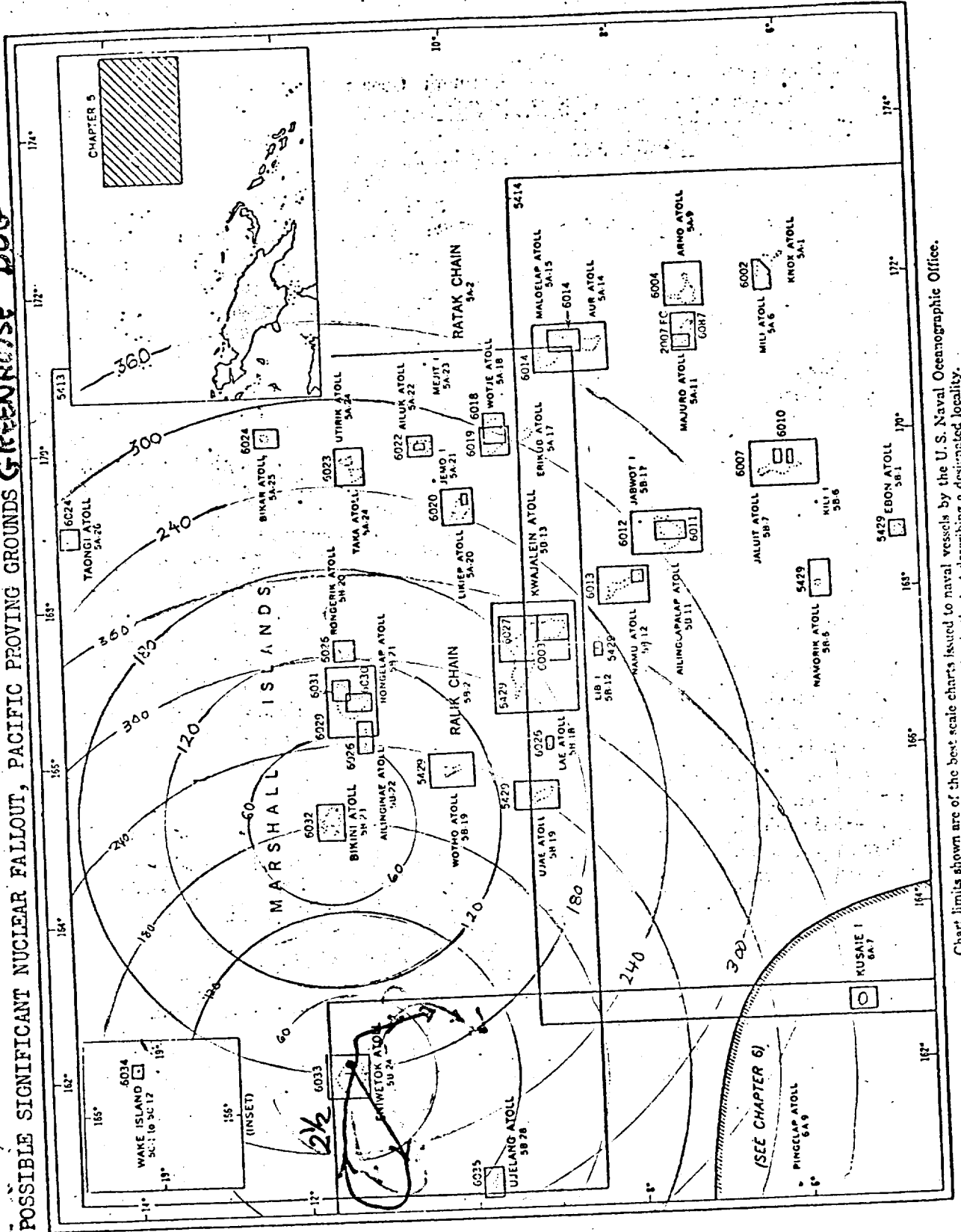


CIRCULAR DISTANCES
IN UNITS OF 60 N.M.
APPROXIMATE HODOGRAMS
OR FALLOUT PATTERNS
SHOWN

Chart limits shown are of the best scale charts issued to naval vessels by the U. S. Naval Oceanographic Office.
Numbers refer to the section in the text describing a designated locality.

CHAPTER 5—GRAPHIC INDEX

POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS GREENWICH DOG

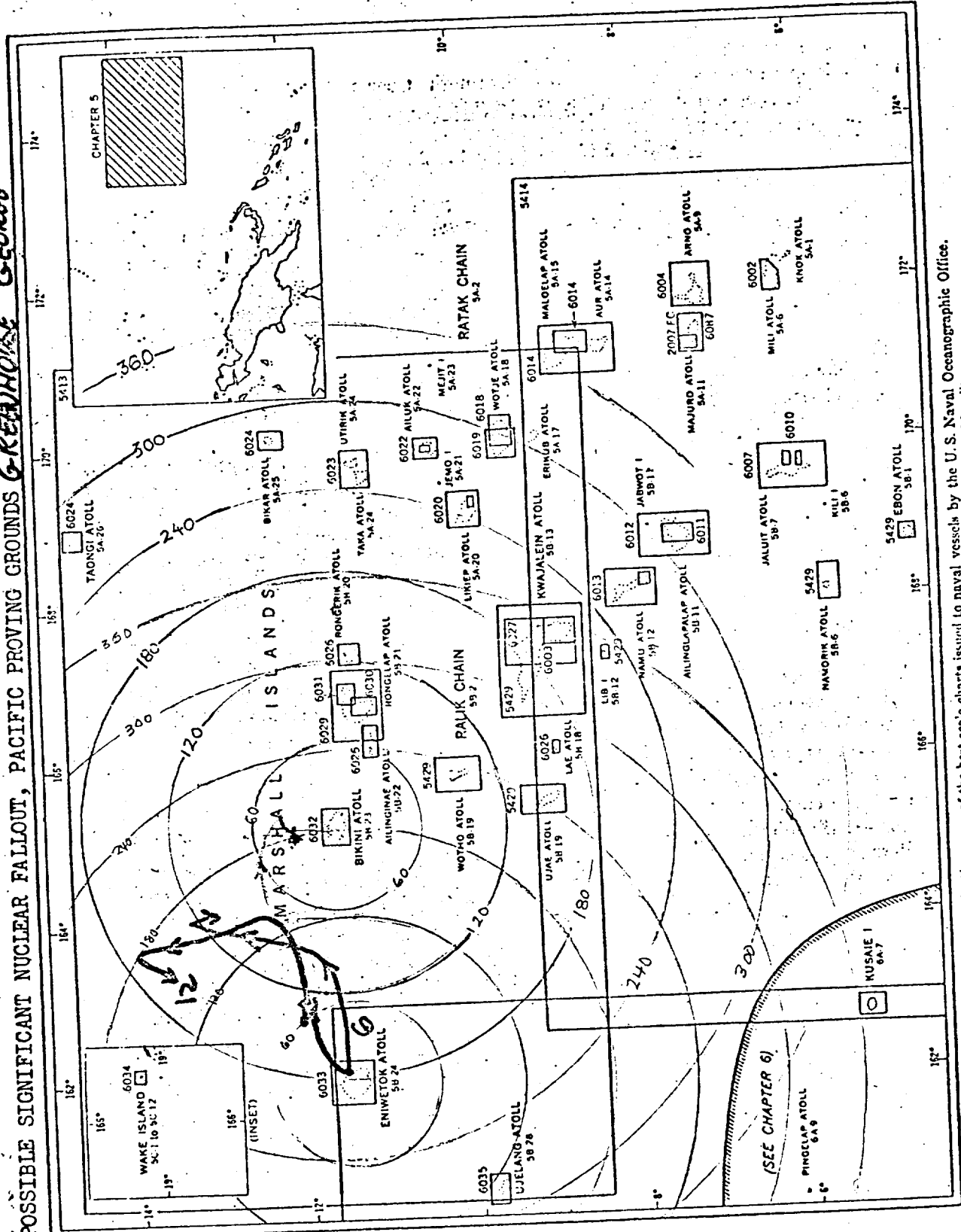


CIRCULAR DISTANCES
IN UNITS OF 60 NM.
APPROXIMATE HODDGRASS
OR FALLOUT PATTERNS
SHOWN

Chart limits shown are of the best scale charts issued to naval vessels by the U.S. Naval Oceanographic Office. Numbers refer to the section in the text describing a designated locality.

CHAPTER 5—GRAPHIC INDEX

POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS ~~GREENHOUSE~~ **G-60066**



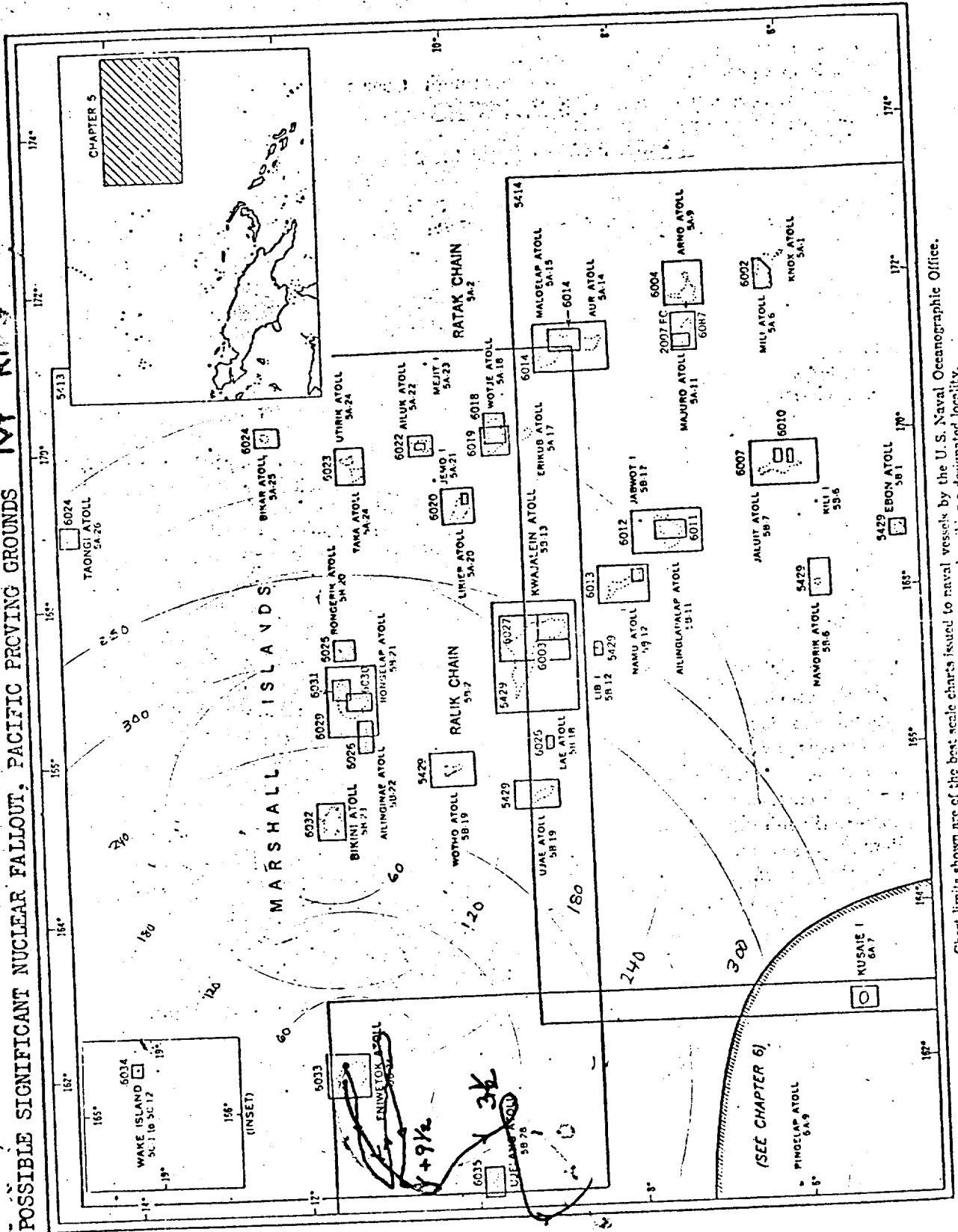
CIRCULAR DISTANCES
IN UNITS OF 60 N.M.G.

APPROXIMATE HODOGRAMS
OR FALLOUT PATTERNS
SHOWN

Chart limits shown are of the best scenic charts issued to naval vessels by the U. S. Naval Oceanographic Office. Numbers refer to the section in the text describing a designated locality.

CHAPTER 5—GRAPHIC INDEX

POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS IYI KING



REGULAR DISTANCES
UNITS OF 60 NM.
SYMBOLIC HODOGRAFS
FALLOUT PATTERNS

Chart limits shown are of the best scale charts issued to naval vessels by the U.S. Naval Oceanographic Office. Numbers refer to the section in the text describing a designated locality.

CHAPTER 5--GRAPHIC INDEX

POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS **IVY KING**

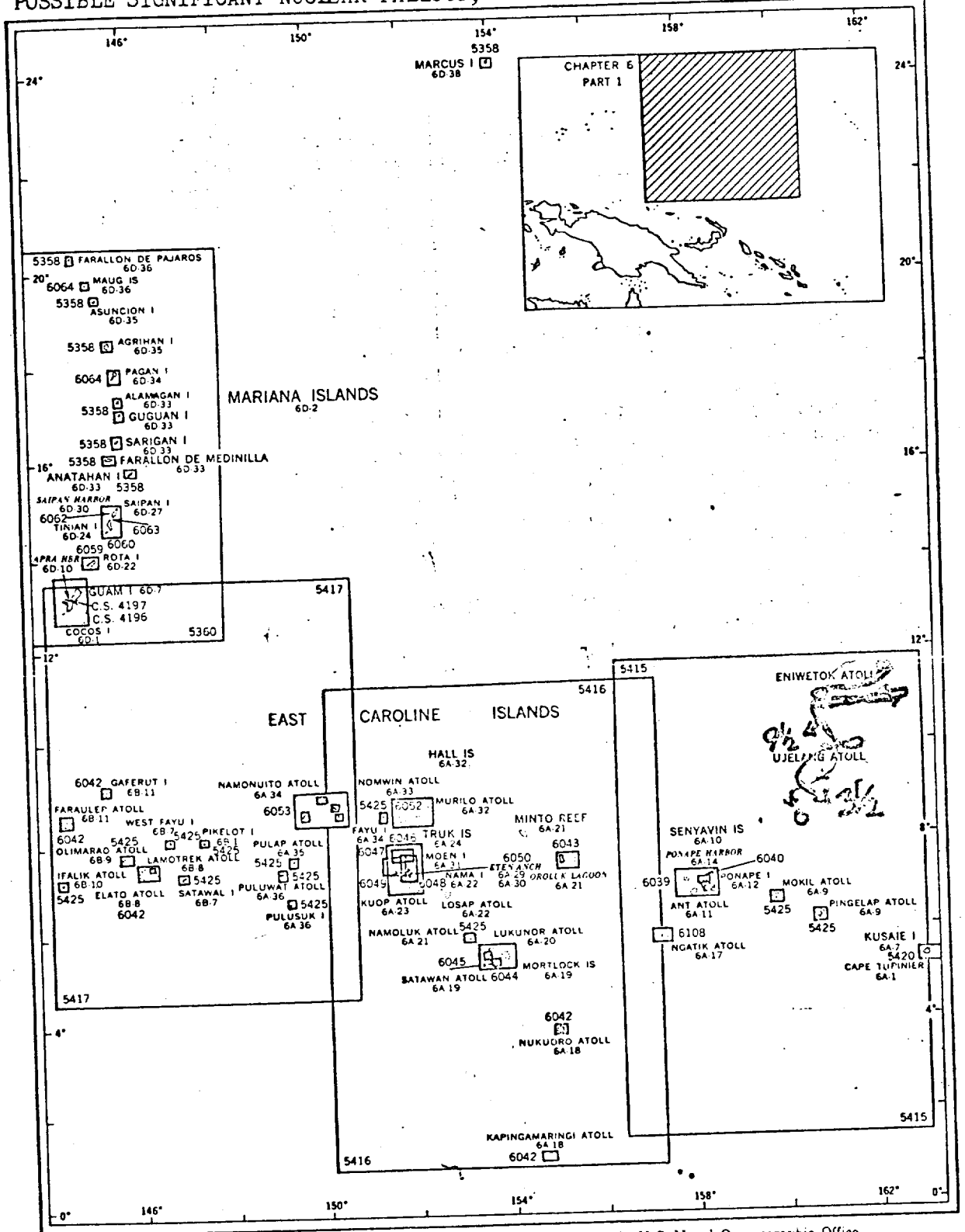
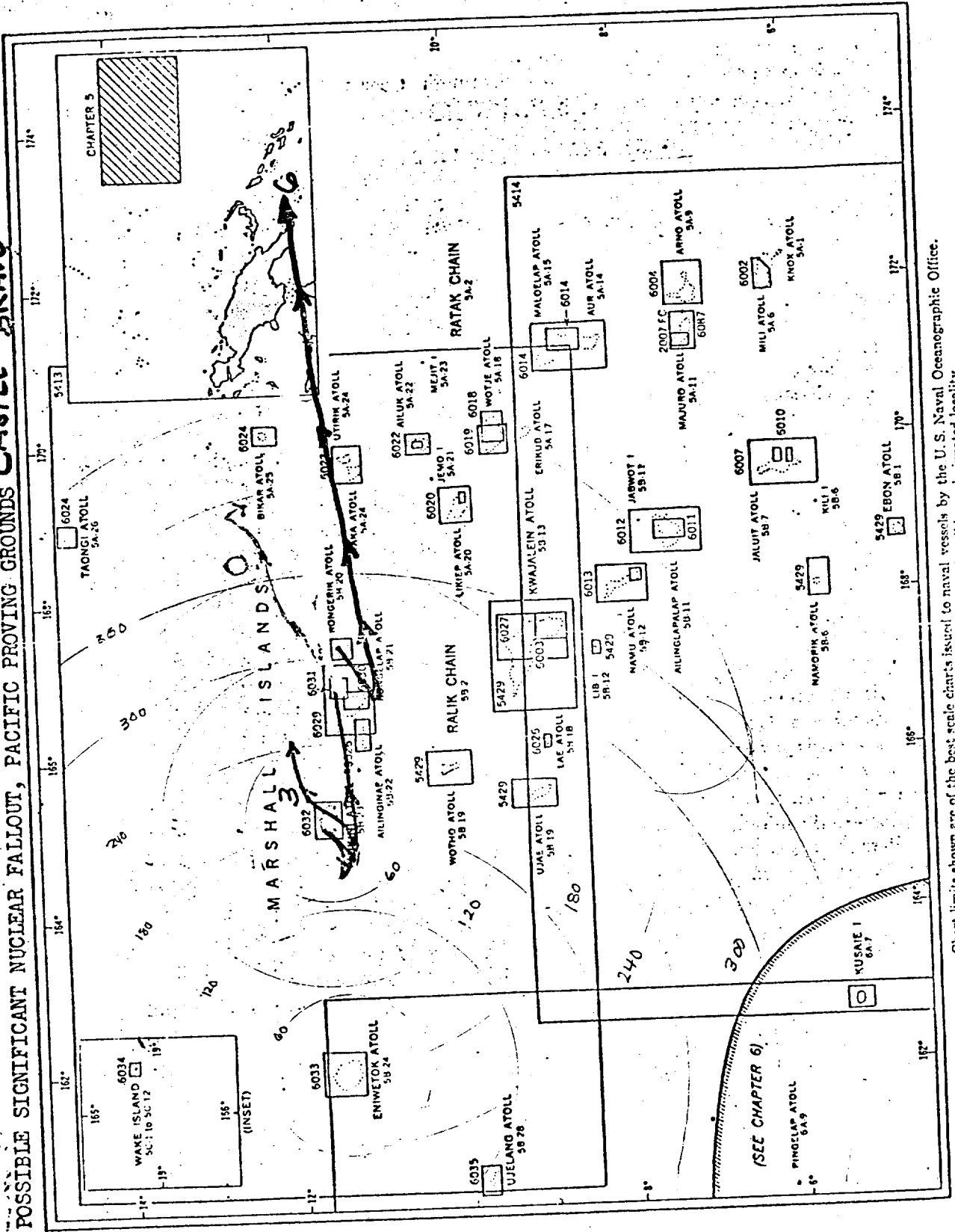


Chart limits shown are of the best scale charts issued to naval vessels by the U.S. Naval Oceanographic Office.
 Numbers refer to the section in the text describing a designated locality.

CHAPTER 6, PART I, GRAPHIC INDEX

POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS CASTLE BRAVO



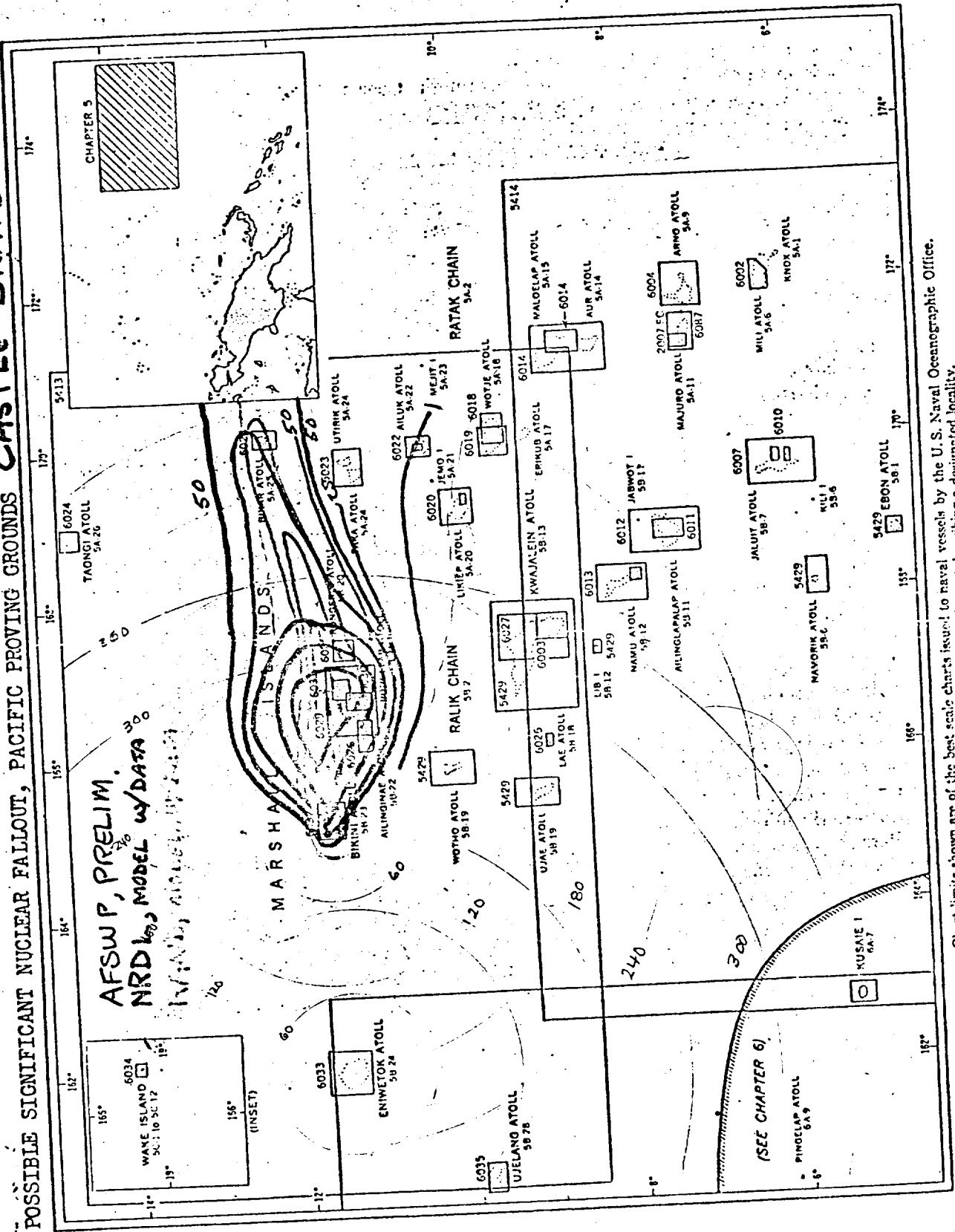
SLUR DISTANCES
 UNITS OF 60 NM.
 WIND PATTERNS
 FALLOUT PATTERNS

Chart limits shown are of the best scale charts issued by the U.S. Naval Oceanographic Office.

Numbers refer to the section in the text describing a designated locality.

CHAPTER 5--GRAPHIC INDEX

CASTLE BRAVO



POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS

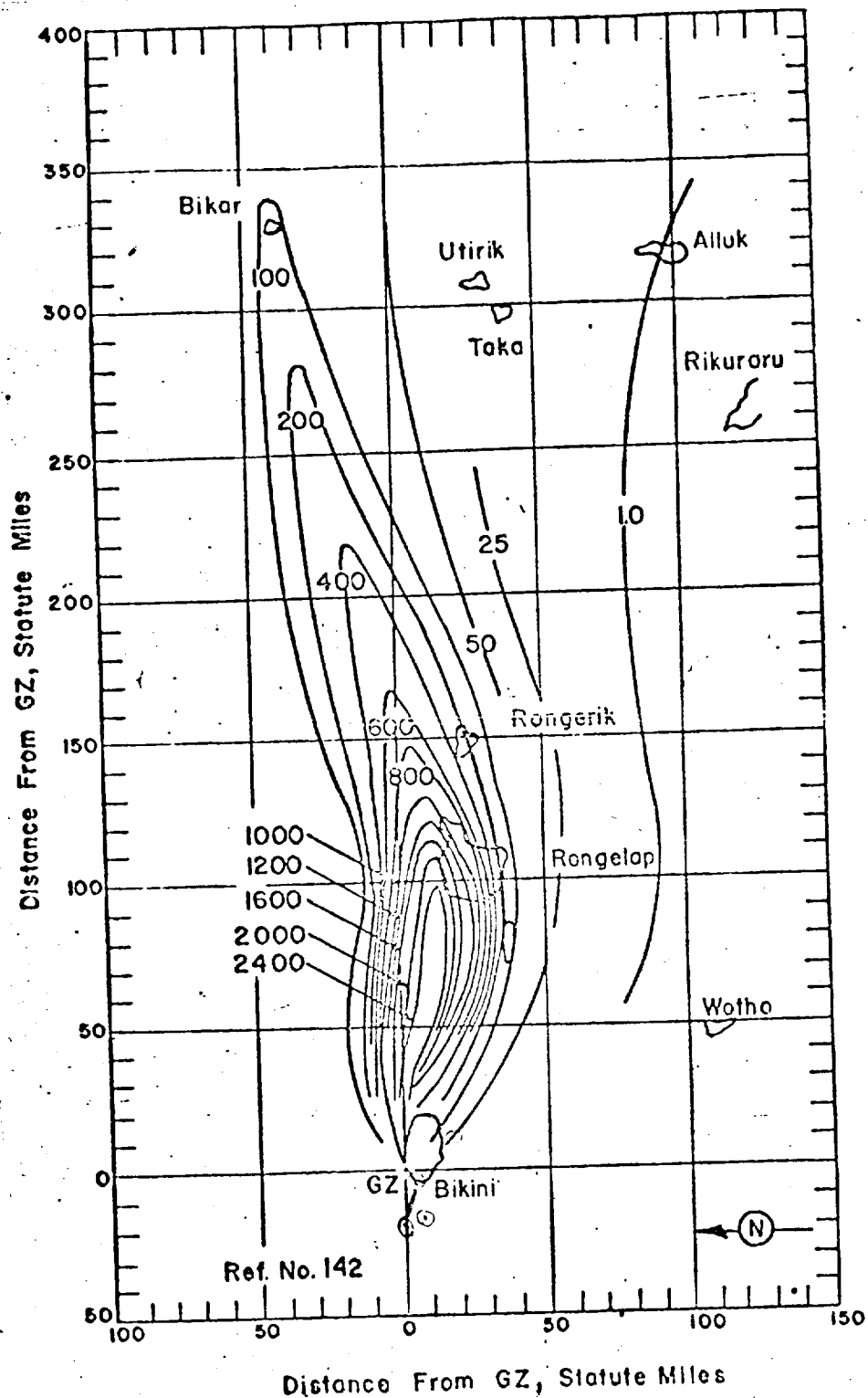
AFSWP, PRELIM.
NRDL, MODEL w/ DATA

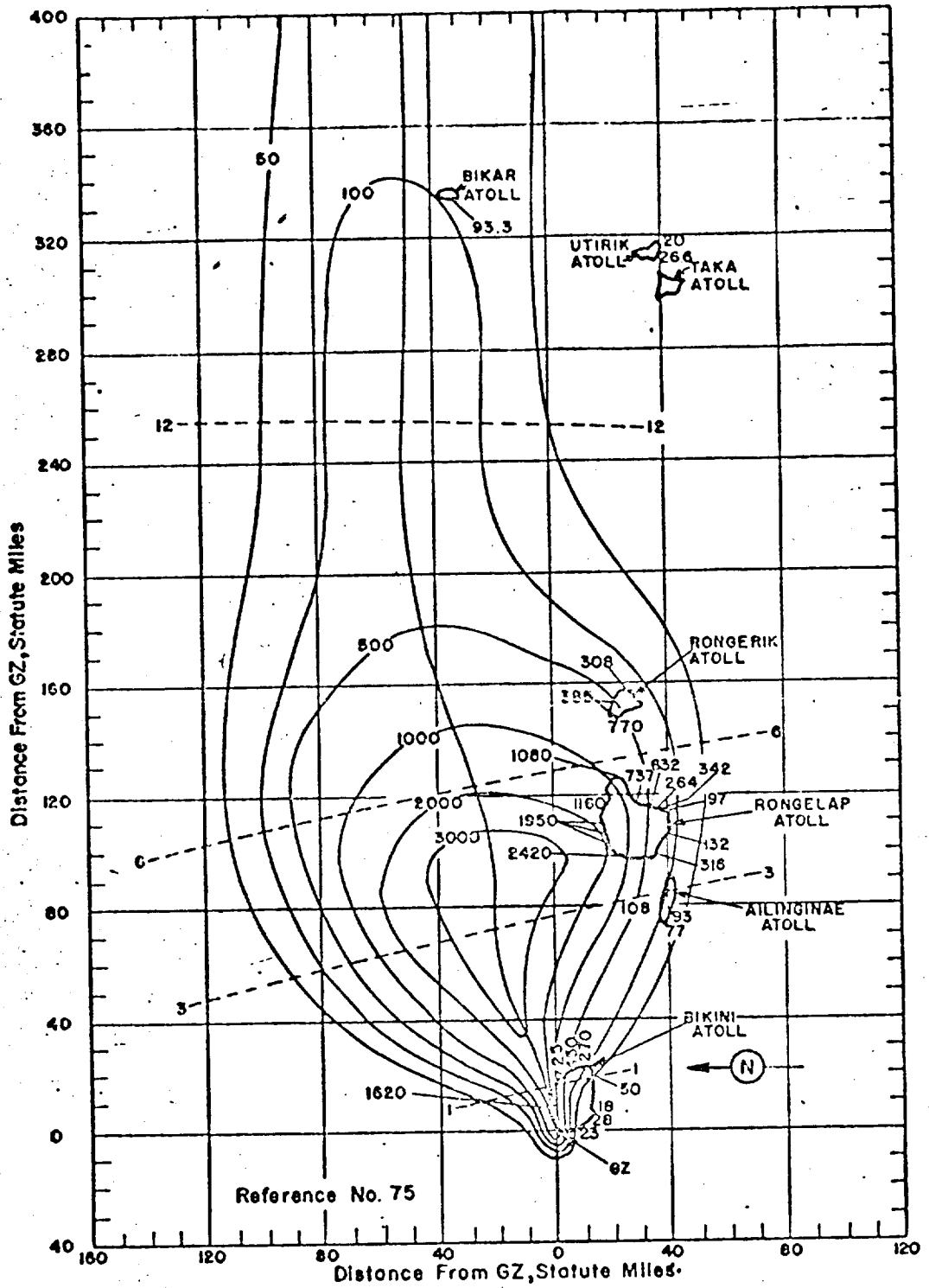
REGULAR DISTANCES
UNITS OF 60 NM.
APPROXIMATE HODOGRAMS
FALLOUT PATTERNS

R/h of 1.0

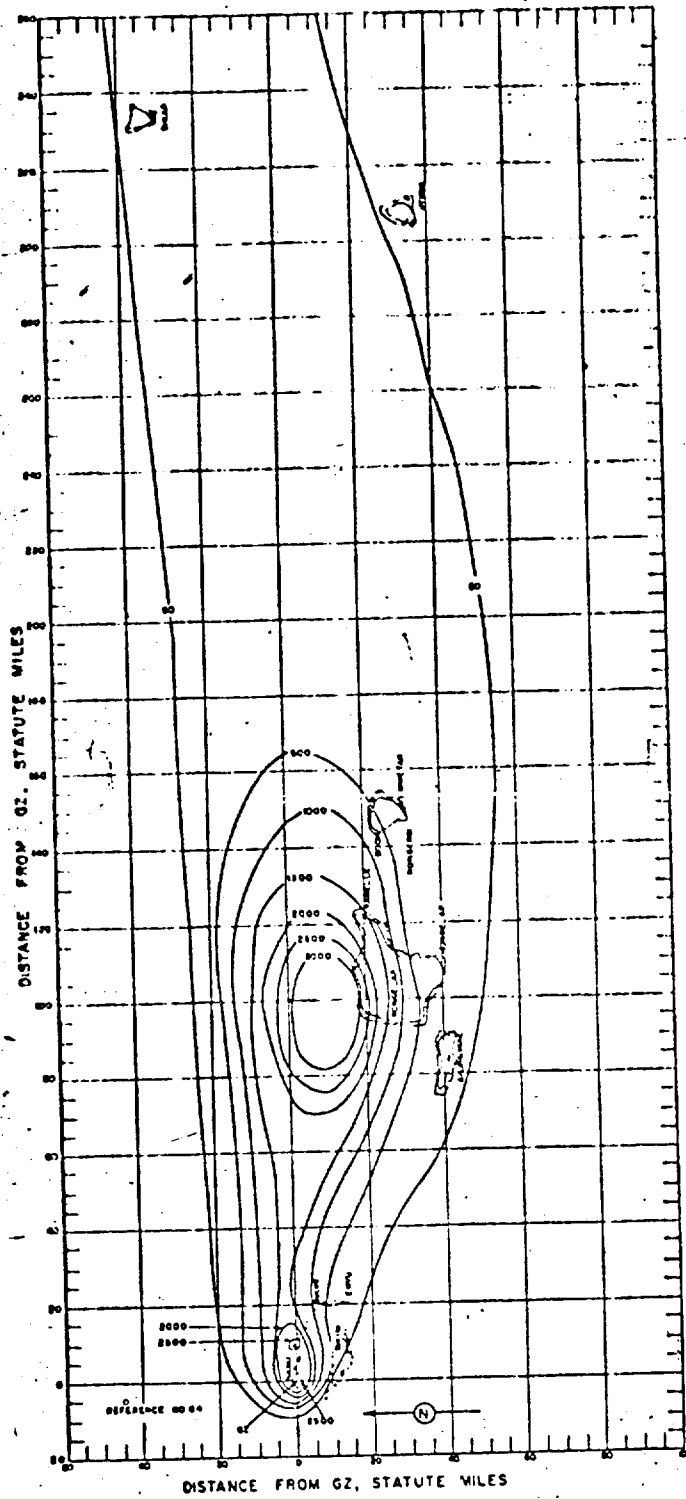
Chart limits shown are of the best scale charts issued to naval vessels by the U.S. Naval Oceanographic Office.
Numbers refer to the section in the text describing a designated locality.

CHAPTER 5--GRAPHIC INDEX



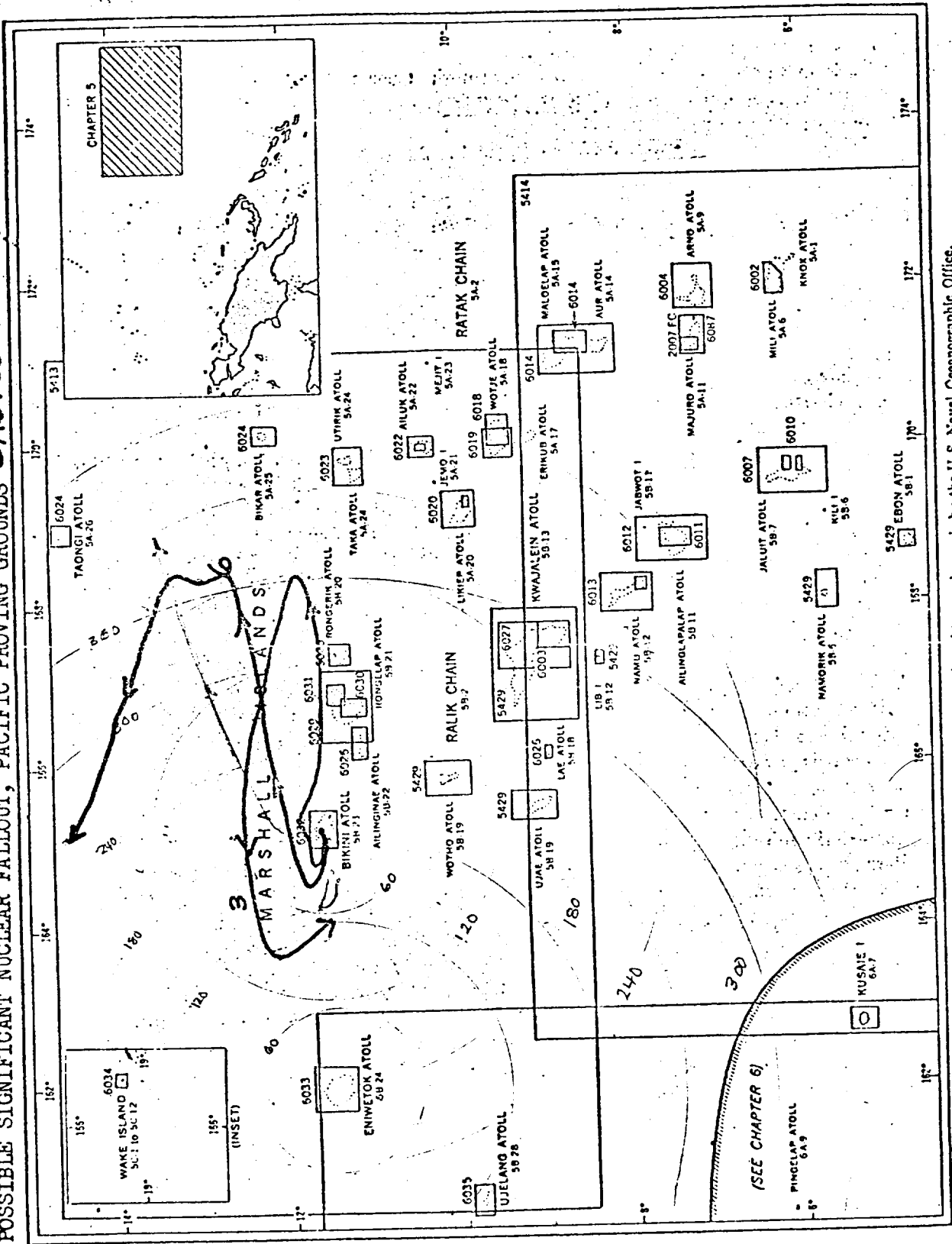


Operation CASTLE - Shot 1 - Bravo.
 Off-site dose rate contours in r/hr at H+1 hour (NRDL).



Operation CASTLE - Shot 1 - Bravo.
 Off-site dose rate contours in r/hr at H+1 hour (RAND).

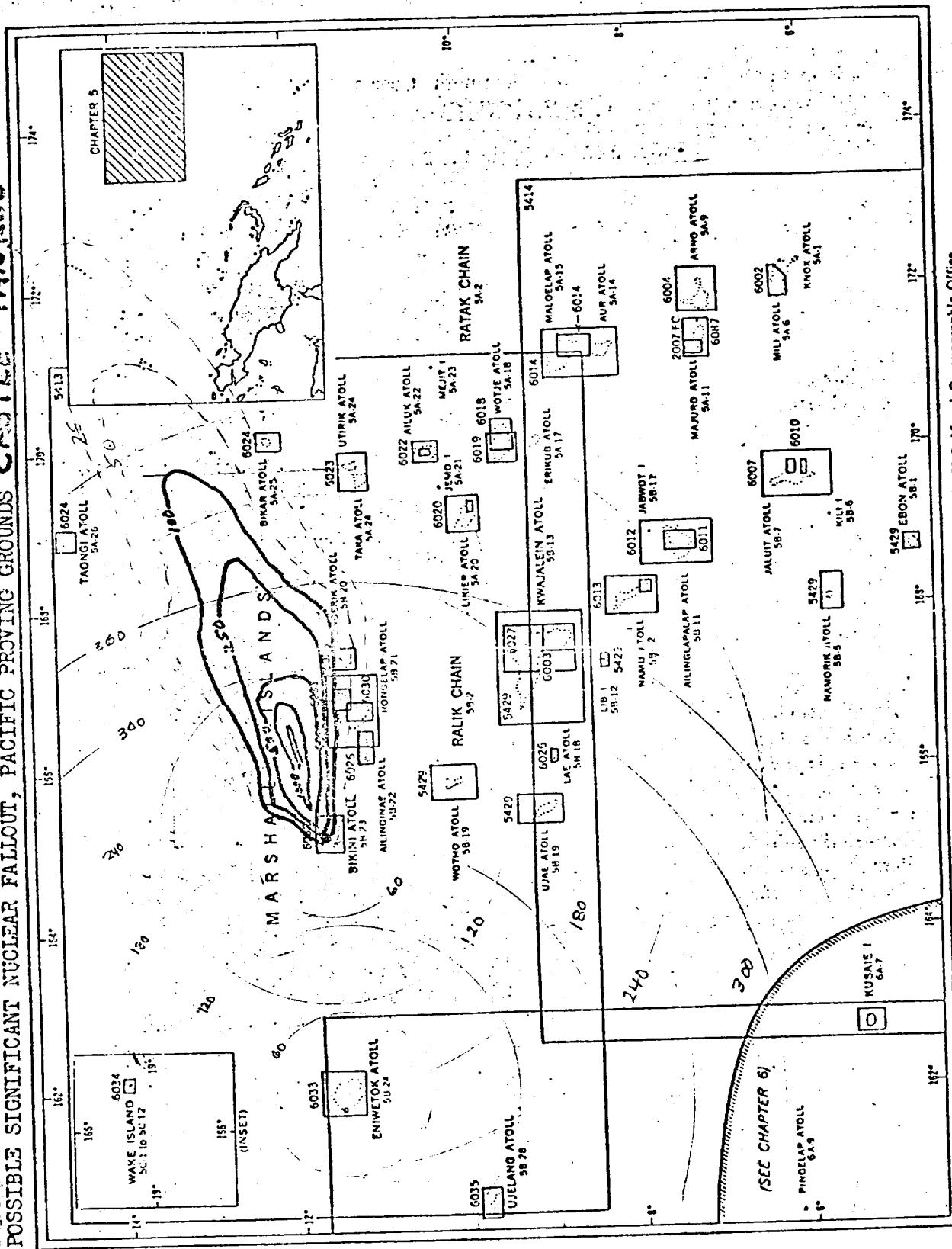
POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS CASTLE UNION



IRREGULAR DISTANCES
 OF UNITS OF 60 NM.
 APPROXIMATE HODOGRAMS
 OF FALLOUT PATTERNS
 SHOWN

Chart limits shown are of the best scale charts issued to naval vessels by the U.S. Naval Oceanographic Office. Numbers refer to the section in the text describing a designated locality.

POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS CASTLE YANKEE



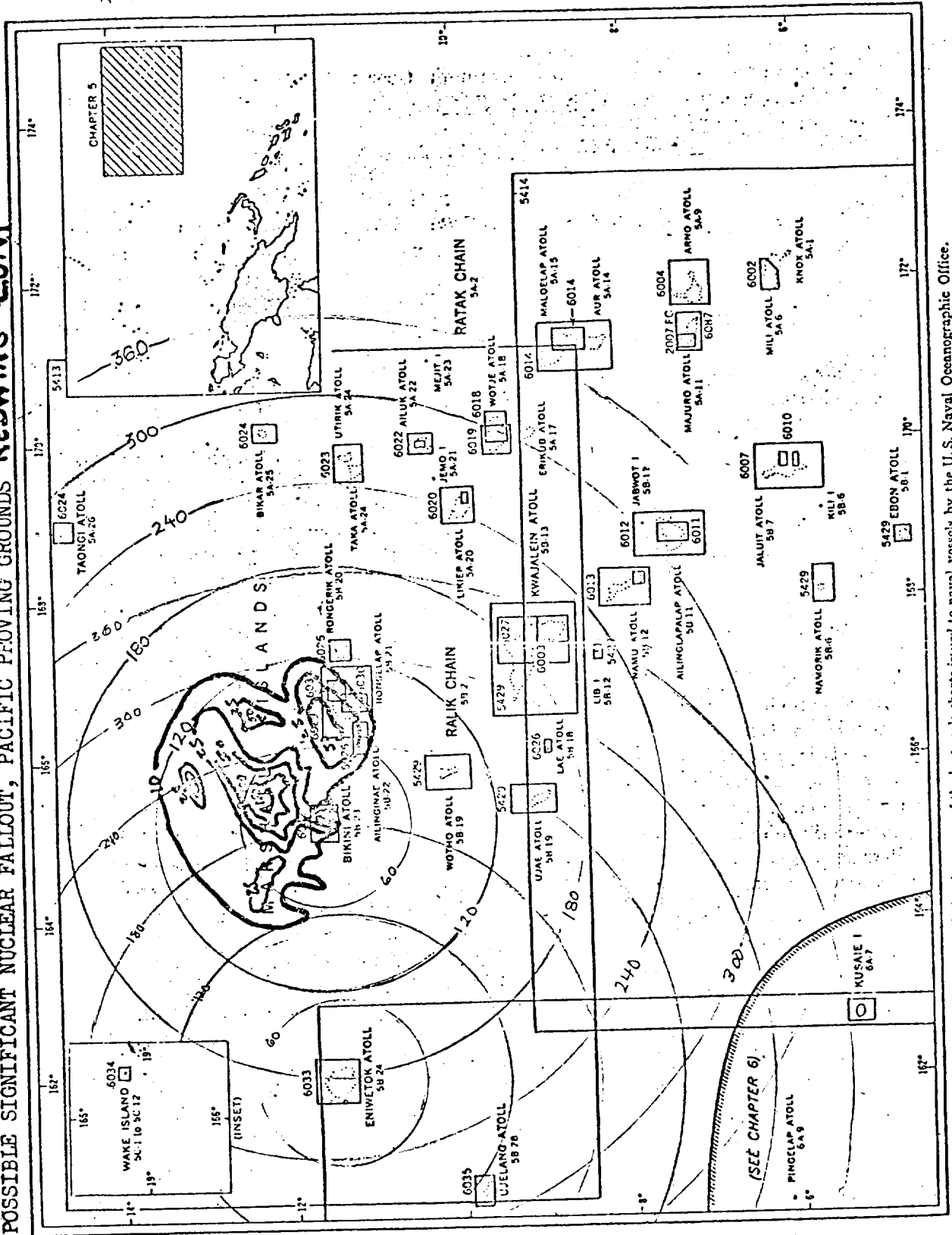
SQUARE DISTANCES
UNITS OF 60 NM²
PRESSURE HODGWAYS
FALLOUT PATTERNS
3000

R/k 1.0

Chart limits shown are of the best scale charts issued to naval vessels by the U.S. Naval Oceanographic Office. Numbers refer to the section in the text describing a designated locality.

CHAPTER 5—GRAPHIC INDEX

POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS REDWING ZUNI



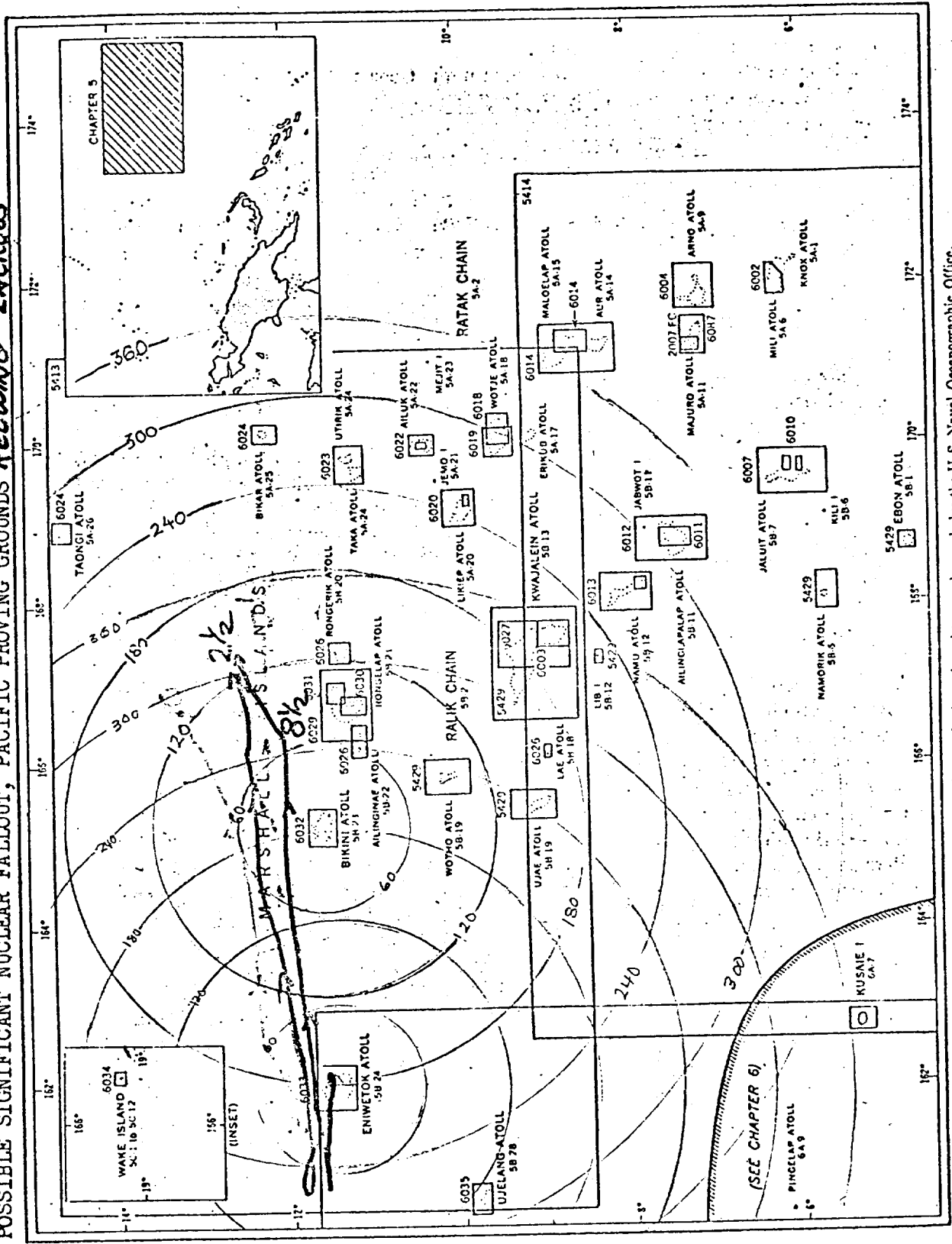
CIRCULAR DISTANCES
IN UNITS OF 60 N.M.

APPROXIMATE HODOGRAPHS
OF FALLOUT PATTERNS
SHOWN

R/h 1.0

Chart limits shown are of the best scale charts issued by the U. S. Naval Oceanographic Office.
Numbers refer to the section in the text describing a designated locality.

POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS REDWING LACROSS

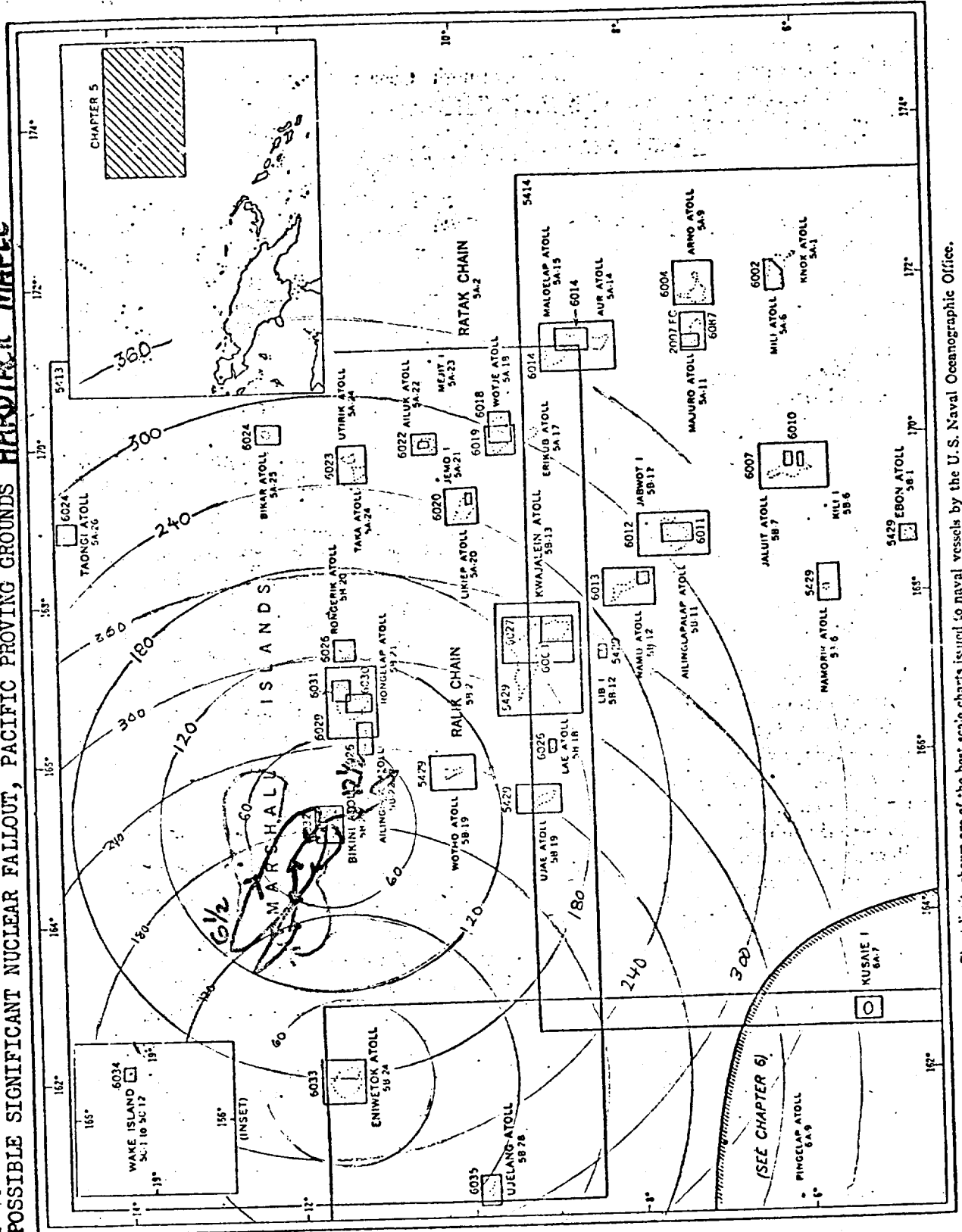


CIRCULAR DISTANCES
IN UNITS OF 60 N.M.G.
APPROXIMATE HODOGRAPHS
OR FALLOUT PATTERNS
SHOWN

Chart limits shown are of the best scale charts issued to naval vessels by the U.S. Naval Oceanographic Office. Numbers refer to the section in the text describing a designated locality.

CHAPTER 5—GRAPHIC INDEX

POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS **HARDYCK MAPLE**

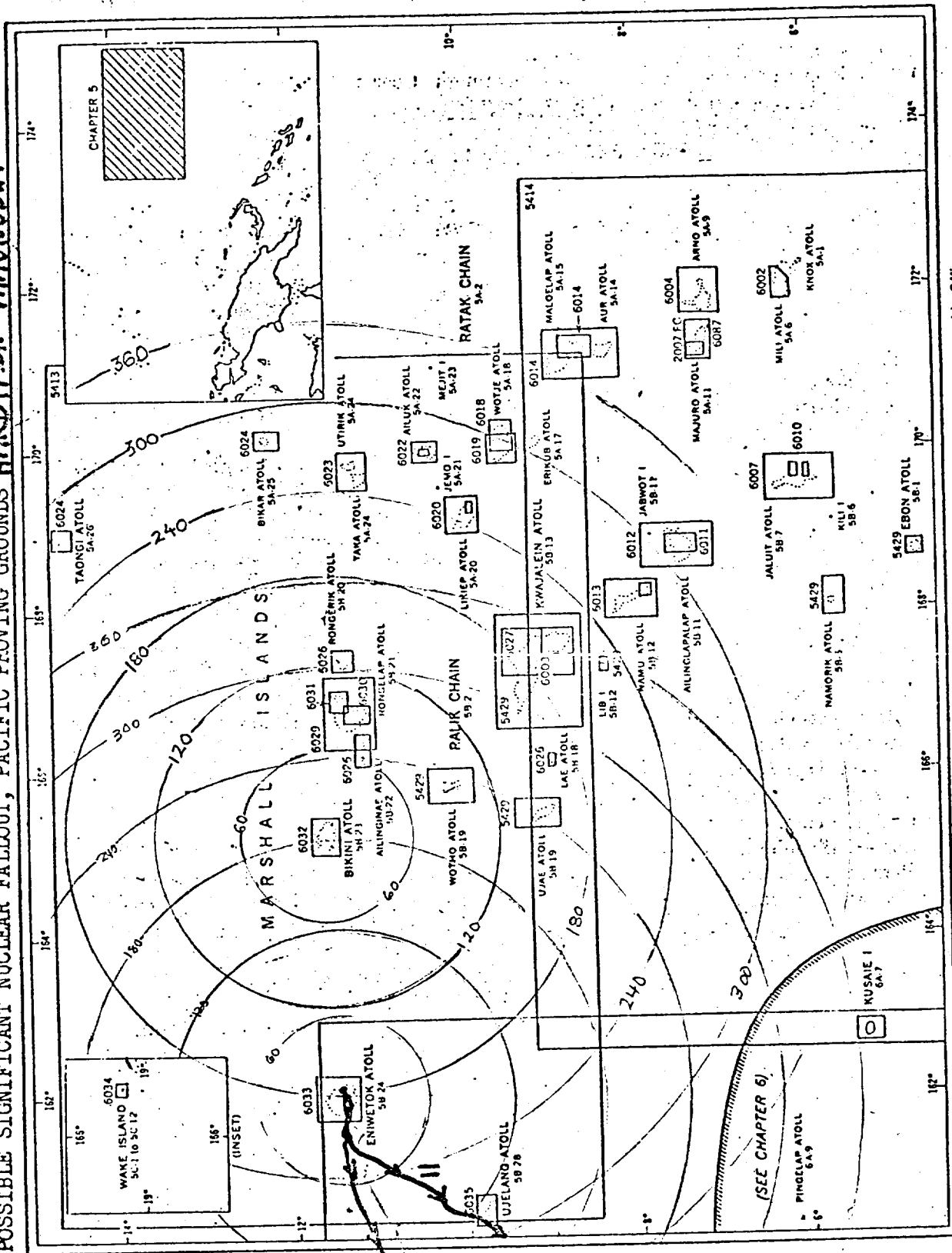


CIRCULAR DISTANCES
IN UNITS OF 60 N.M.
APPROXIMATE HODOGRAMS
OR FALLOUT PATTERNS
SHOWN

Chart limits shown are of the best scale charts issued to naval vessels by the U.S. Naval Oceanographic Office. Numbers refer to the section in the text describing a designated locality.

CHAPTER 5—GRAPHIC INDEX

POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS HARDTACK MAGNOLIA



CIRCULAR DISTANCES IN UNITS OF 60 NM.
APPROXIMATE HODOGRAMS OR FALLOUT PATTERNS SHOWN

Chart limits shown are of the best scale charts issued to naval vessels by the U.S. Naval Oceanographic Office. Numbers refer to the section in the text describing a designated locality.

CHAPTER 5—GRAPHIC INDEX

POSSIBLE SIGNIFICANT NUCLEAR FALLOUT, PACIFIC PROVING GROUNDS

HARD TACK
MAGNOLIA

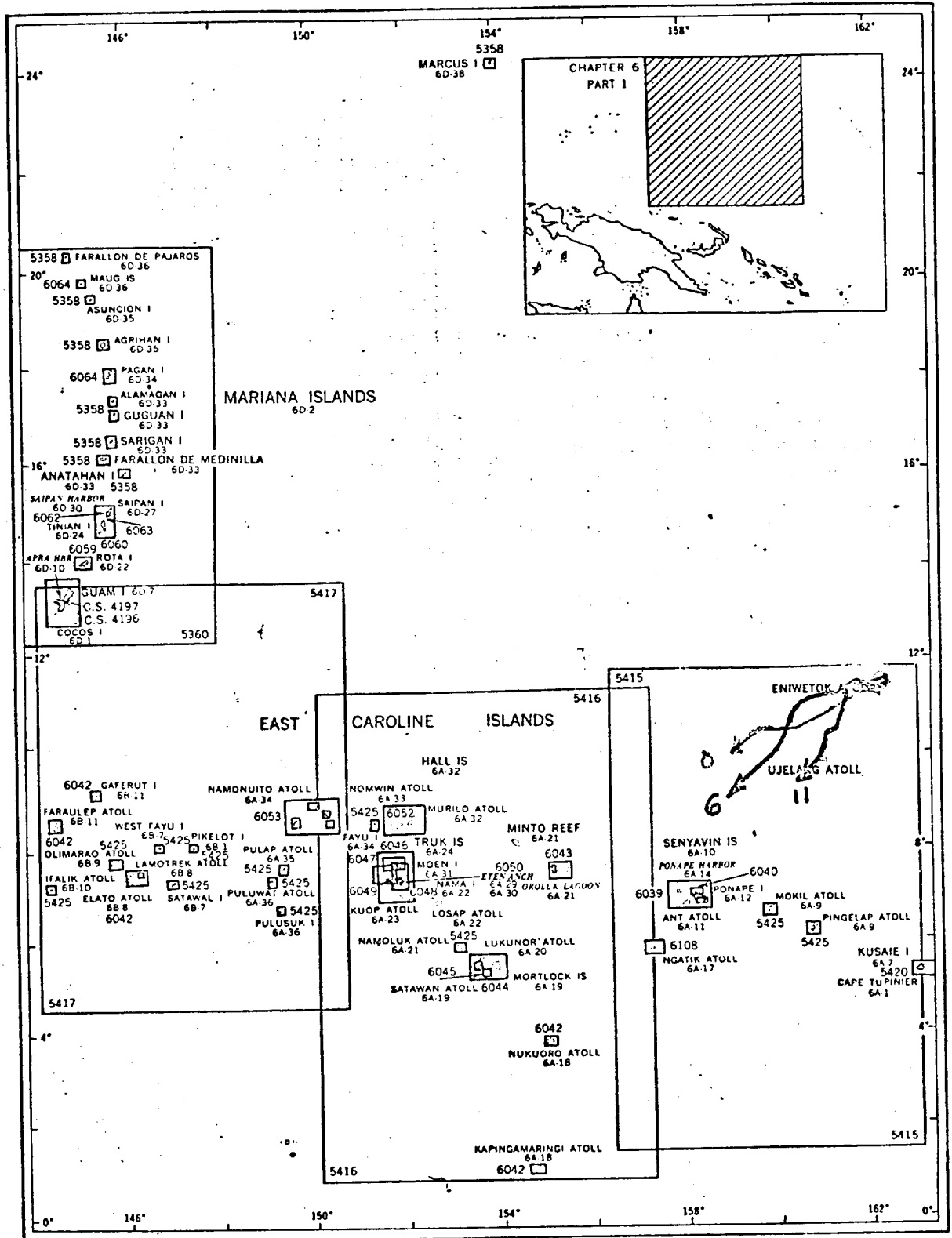


Chart limits shown are of the best scale charts issued to naval vessels by the U.S. Naval Oceanographic Office. Numbers refer to the section in the text describing a designated locality.

CHAPTER 6, PART I, GRAPHIC INDEX