Dr. Robert Conard, Brookhaven National Laboratory.
(ented at Inter-Agency Meeting Sept. 19, 1975

410424

A REVIEW OF PERSONNEL MONITORING AT BIKINI

As a result of the recent meeting at Kili by Trust Territory, ERDA and Micronesian Legal Service officials concerning restrictions on rehabilitation of Bikini it is apparent that there are several points of misunderstanding in the minds of the Bikini people concerning statements I have made regarding the radiological safety of Bikini. Before reviewing the radiological monitoring obtained on the people living at Bikini I would like to clarify some of the confusion. First, at the time of the Ad Hoc Committee meeting, the visit of the Trust Territory and AEC officials to Kili in 1968 and my visit to the island in 1969, the statements made about the radiological safety of Bikini were justified based on the survey data compiled at that time. Subsequent analyses of personnel monitoring data on the people living at Bikini showed low levels of radioactivity in the people confirming the original conclusions. In all sincerity, I disclosed this as additional assurance to the people living there. Based on these findings I would not hesitate to live in one of the houses on Bikini. I am sad about the statements a few people made about me at the Kili meeting. I have great friendship and respect for the people of Bikini and in no way and at any time have I tried to mislead them. From the beginning there were certain restrictions concerning rehabilitation of Bikini. It is only very recently that radiological survey data has made it necessary to impose further restrictions.

I would like to clear up another point of confusion regarding "medical" examinations. We have never done medical examinations on the Bikini people for possible radiation effects. The reason is that the radiation levels are so low that such examinations are not necessary. For this reason it is wrong for anyone to accuse us of using the people living at Bikini to study radiation

effects. Radiation there is too slight for medical studies to be of interest since no radiation effects would likely be detectable. The urine collection and measurements of the body for radioactivity are not medical procedures and are done by technicians. These measurements are important since they form the basis for reassurance of the people living on Bikini regarding their radiological safety. Though we are not doing medical examinations if our doctors are at Bikini, as in the past, we will always be glad to see, treat and prescribe for any people that are sick - but only at the request of the individual or the health aide. Unless requested by the people, it is not even necessary for our doctors to go to Bikini.

In 1969, personnel monitoring procedures were begun on a group of 30 workmen at a work camp on Eneu Island. By 1972 about 3 Bikini families had moved back (about 50) and also about 25-30 workers and agriculturists. Radiological monitoring at Bikini has been carried out annually since 1969. The size of the population has not changed much since 1973.

In order to assess the radiological hazard the following personnel monitoring procedures have been carried out:

1. Radiochemical analyses on urine samples: (individual 24 hour and pooled samples). These analyses require complicated chemical procedures and are done for us by the ERDA Health and Safety Laboratory in New York City. Such radiochemical analyses have also been carried out on water and local food products.

2. Direct measurement of radiation in the people by gamma spectrographic analysis: To do this tons of radiation-free lead bricks were shipped to the Marshalls and a shielded counting facility set up in one of our air-conditioned trailers and transported to Bikini on our vessel (LCU-Liktanur).

The measurement of body radiation by such analysis is very sensitive and requires complex electronic equipment and personnel highly trained in electronics from Brookhaven National Laboratory.

3. Personnel exposure to gamma radiation: Gamma levels on the island were derived from data furnished by other radiological survey groups.

MONITORING DATA

The results of the personnel monitoring data on people living at Bikini since 1969 are presented in the accompanying tables. The data on urine analyses are presented on Table I. Note that average pCi/liter for Bikini urine compared with Rongelap was for ^{90}Sr 2.5/3.8 and for ^{137}Cs 638/3360. Based on standard guide lines (International Congress of Radiation Protection - ICRP) these isotopes have been well below maximum permissible levels. Reassuring also is the virtual absence of plutonium in the samples. Levels for internally absorbed ^{137}Cs as measured by spectrographic analyses are presented in Table 2. Note the average values for males and females on Bikini compared with those on Rongelap (in nCi/pg body weight) was 1.4/6.4, again well below the maximum permissible levels. The graphs in figures 1 and 2 show that body burden (extrapolated) for ^{90}Sr and ^{137}Cs in the Bikini people are well below the peak values noted in the Rongelap people. The Rongelap people reached a peak of 6-11% of the maximum ^{90}Sr permissible level (for general populations) and of about 22% for ^{137}Cs. These low values for internally absorbed radionuclides is in accord with the fact that the people on Bikini have been subsisting mainly on imported foods. The contribution of gamma radiation to the people on Bikini is somewhat greater than on Rongelap.

Table 3 compares the total bone marrow dose (the critical organ for somatic radiation effects) for people living at Bikini, Rongelap, Utirik, Long Island, New York and Denver, Colorado. Since the people living at Denver have a considerably higher natural radiation and medical, dental contribution, the exposure to the people living there is probably higher than people living on Bikini. The estimated dose to people on Long Island is somewhat less than Bikini doses, also it might be noted that many thousands of people living in areas of South America and India are exposed to higher levels than indicated for Bikini due to high thorium content of the soil. There have been no reports of increased cancer or other illness in Denver or these other high level populations that might be related to their increased radiation exposure.*

More recent data from radiological surveys last June at Bikini showing higher than expected radiation levels in the interior of Bikini and higher levels in pandanus and breadfruit have resulted in some further restrictions on the future living patterns of the Bikini people. At the time of the Ad Hoc Committee meeting it was not known about plans for building houses in the interior of Bikini Island. Recommendations to put the first village and food crops on Eneu were not followed, nor was the recommendations to remove topsoil from planting sites of pandanus and breadfruit on Bikini followed. The recommendation for the addition of powdered milk to the diet of the people is being implemented. The restriction regarding consumption of pandanus and breadfruit may eventually be removed following investigation on growth of these plants at Eniwetak. Table 4 shows results of analyses of water samples from Bikini. Based on these findings the well water is in the permissible range. Catchment (rain) water is very low in activity. With the

* There have even been reports that the Cancer incidence is lower in the Denver Plain area

construction of new cisterns and mending of leaking ones there should be ample catchment water for drinking and cooking. Consumption of marine life offers no radiation problem. Coconut crabs (see Table 5) appears to be high enough in activity to be avoided. They are quite scarce in any event. Further analyses of local products (pigs, chickens, vegetables, etc.) have not been completed. However, it is reassuring that the present consumption of available local foods and ground water based on these findings, have not raised body burdens of radionuclides above the low levels reported.

The direct measurement of radiation levels in the people living on Bikini is the critical test of radiological safety. The exposure of the people there, based on the present living pattern, are in the permissible range and as pointed out lower than some other communities in the world. As was pointed out radiation exposure is so low on Bikini that medical effects would not be discernable in this population (see ERDA letter of June 27, 1974 from Mr. J. Liverman to Mr. Chips Barry for estimated effects). We believe that continuation of personnel monitoring is important, however, to maintain a close check on the radiological status of the people. Also negative findings are important reassurance for the people living there.

Robert A. Conard, M.D. Sept. 19, 1975

RAC:im

TABLE 1.

Radiochemical Analyses of Coconut Crabs From Bikini (Data in pCi wet weight)

Year	Wet wt., g	% Ash	g Ca per kg wet wt.	^{90}Sr	^{137}Cs	^{238}Pu	^{239}Pu
1970	1161	23.3	81	23,000	11,800	0.06 ± 50%	1.5 ±10%
	1930	18.5	61	24,800	14,800	0.001±100%	0.07±37%
1971	1812	17.8	60	132,000	11,100		
	1827	21.5	72	412,000	8,600		
1973	1190		63.5	45,700	9,290		
				X=123,360	10,178		

TABLE 2.

Radiochemical Analyses of Well Water From Bikini (Data in pCi/liter)

Year	Sample	Vol., ml	^{90}Sr *	^{137}Cs **	^{3}H	^{238}Pu ^{239}Pu
1971	"good well"	1830	6.0 ±17%	600 ±1%	770±40%	0.04 ± 2%
	"bad well"	1830	25 ± 3%	850 ±1%	1040±30%	0.05 ± 20%
	"good well (closed)	1810	103 ± 2%	1044 ±1%		0.058± 13%
	"good well" (opened)	1980	125 ± 3%	818 ±1%		5.76 ± 9%
	drinking water (camp area)	3580	0.46± 4%	1.53±8%		0.004±10%
1972	well water	1000	15.4 ± 9%	800 ±1%		
	drinking water	1960	0.61± 6%	1.8 ±8%		
1973	new well	60	52	600		0.38 ± 30%
	B-1 well	225	11	724		0.08 ± 50%

*MPC 4×10^{-6} μCi/ml
** MPC 2×10^{-4} "

TABLE III

Estimated Dose to Bone Marrow (mrem/yr)*

SOURCE	BIKINI	ENEU	RONGELAP	UTIRIK	USA DENVER	USA LONG ISLAND
Natural	80	80	80	80	325**	190
Medical - Dental	0	0	10	10	70	70
Contamination Gamma	165	7	20	7		
Internal	21	21	68	31		
TOTAL	266	108	178	128	395	260

* Dose on Marshall Islands based on personnel and environmental data collected to date

** As high as 480.

TABLE 4

Radiochemical Analyses of Urine (Data in Average pCi/liter)

Year	No. in group	Av. vol., ml	Av. Ca, mg/liter	^{90}Sr	^{137}Cs	^{238}Pu	^{239}Pu	$^{239,240}Pu$
Rongelap								
1970	20	895.5	152.4	3.5	2700.			
1971	15	534.5	336.1	3.7	2400.			
1972	18	460.8	120.3	2.4	2600.			
1973	11	249.6	247.2	6.5	4600.			0.21
1974	14	557.9	706.8	2.8	4500.			
				X 3.6	3360			
Utirik								
1974	11	542.5	734.9	1.3	1300.			
Bikini								
1970	Pooled		120.0	1.2	0115.	0.003	0.003	
	Urine G	1100.0		2.2		0.013	0.020	
	Urine M	930.0		1.9		0.015	0.024	
	HASL* control	3000.0	160.0	1.0	0012.	0.003	0.003	
	HASL control	1000.0		1.6		0.014	0.022	
1971	Pooled	2670.0	84.5	1.7	.0183.			0.004
1972	Pooled	2700.0	204.0	4.2	0910.			
1973	14	293.9	173.5	6.7	1500.			
1974 (Spring)	11	141.4	310.0	2.0	1100.			0.02
				2.5	638			

*US AEC Health and Safety Laboratory, New York, N.Y.

TABLE 5

Mean Cesium-137 Levels Obtained by Whole-Body Counting, 1974

	Male			Female		
	No.	nCi	nCi/kg body wt.*	No.	nCi	nCi/kg body wt.*
Bikini	8	128	1.84 (0.43-5.11)	13	73	1.15 (0.22-3.26)
Utirik	9	262	4.05 (2.64-6.84)	13	133	2.13 (0.96-3.85)
Rongelap	22	475	7.76 (4.37-16.3)	24	304	5.13 (2.71-13.46)
8 NL med. team	4	2.93	0.0352 (0.0134-.0791)			

* MPC 43 nCi/kg.

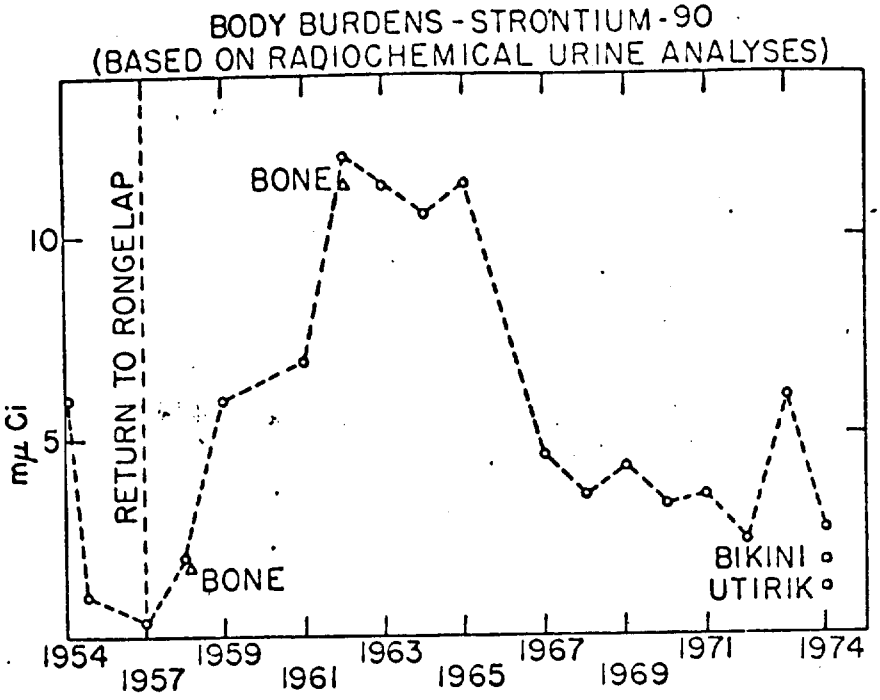

BODY BURDENS - STRONTIUM - 90
(BASED ON RADIOCHEMICAL URINE ANALYSES)
RETURN TO RONGELAP
BONE
BONE
BIKINI
UTIRIK
mμ Ci
10
5
1954
1957
1959
1961
1963
1965
1967
1969
1971
1974

Fig. 1

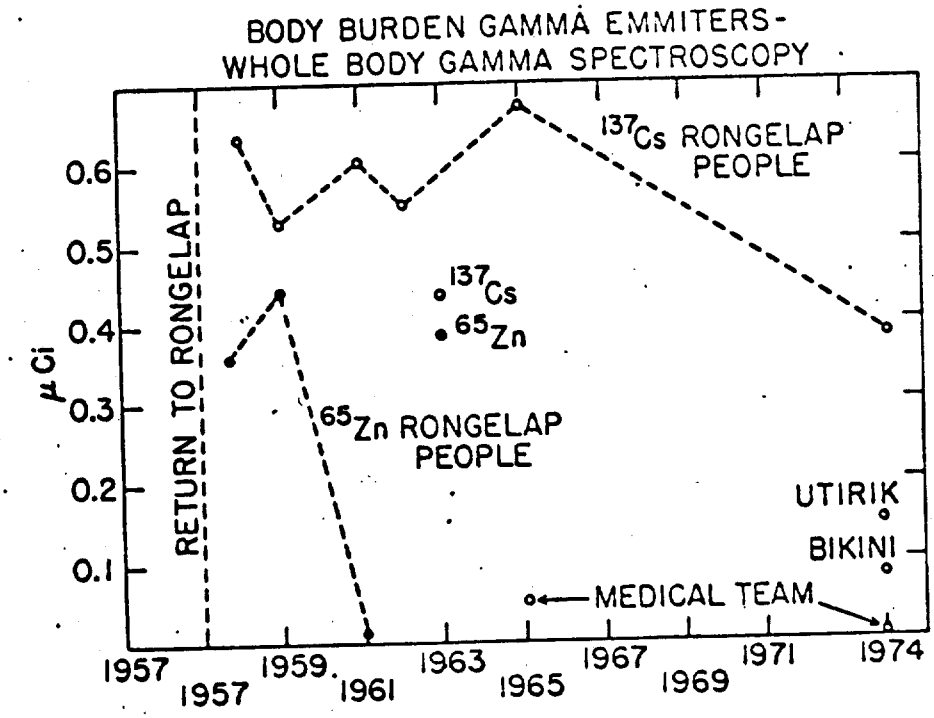
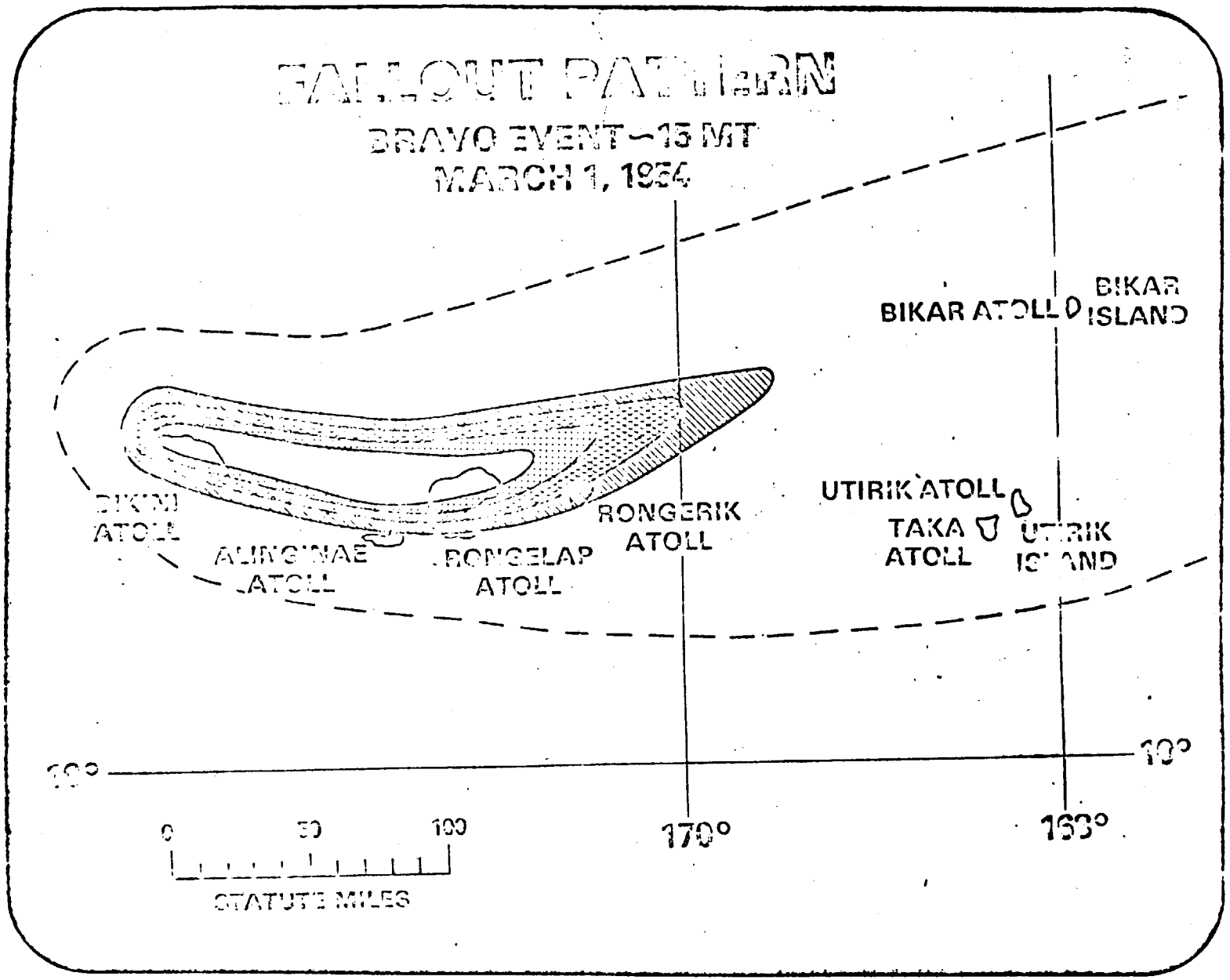

BODY BURDEN GAMMA EMMITERS -
WHOLE BODY GAMMA SPECTROSCOPY
^{137}Cs RONGELAP PEOPLE
^{137}Cs
^{65}Zn
^{65}Zn RONGELAP PEOPLE
RETURN TO RONGELAP
UTIRIK
BIKINI
MEDICAL TEAM
μCi
0.6
0.5
0.4
0.3
0.2
0.1
1957
1957
1959
1961
1963
1965
1967
1969
1971
1974

Fig. 2

"APPENDIX C"

PROBLEMS FROM PACIFIC WEAPONS TESTING

1. RADIOACTIVE FALLOUT THROUGHOUT PACIFIC ISLANDS.
2. RADIATION INJURY TO RONGELAP PEOPLE.
3. MAINTAINING RADIATION DOSE OF BIKINI AND ENEWETAK PEOPLE WITHIN STANDARDS.
4. OIL AND EXPLOSIVES - BIKINI LAGOON BOTTOM (11 SHIPS).
5. CONSEQUENCES OF RADIOACTIVE DEBRIS IN ENEWETAK CRATORS.
6. RADIOACTIVITY IN COPRA AND COPRA PRODUCTS.


FALLOUT PATTERN
BRAVO EVENT—15 MT
MARCH 1, 1954
BIKAR ATOLL
BIKAR ISLAND
UTIRIK ATOLL
TAKA ATOLL
UTIRIK ISLAND
RONGERIK ATOLL
ALINGINAE ATOLL
RONGELAP ATOLL
BIKINI ATOLL
10°
170°
163°
0
50
100
STATUTE MILES

FALLOUT FROM PACIFIC TESTS

EVENT	LOCATION	DATE	ISLANDS AND ATOLLS IN FALLOUT AREA
SANDSTONE - ZEBRA	ENIWETOK	5/48	AILINGINAE, RONGELAP, RONGERIK
IVY - KING	ENIWETOK	11/52	UJELANG
CASTLE - BRAVO	BIKINI	2/54	AILINGINAE, RONGELAP, RONGERIK, TAKA, LIKIEP, UTIRIK, BIKAR, WOTHO, JEMO, AILUK
CASTLE -UNION	BIKINI	4/54	AILINGINAE, RONGELAP, RONGERIK
CASTLE - YANKEE	BIKINI	5/54	AILINGINAE, RONGELAP, RONGERIK, BIKAR
HARDTACK - MAGNOLIA	ENIWETOK	5/58	UJELANG
HARDTACK - MAPLE	BIKINI	6/58	AILINGINAE, WOTHO

NEED FOR DETAILED SURVEYS

- BIKINI SURVEYS USED 1960 TECHNOLOGY
- MODERN TECHNOLOGY IDENTIFIES SPECIFIC ISOTOPES
- KNOWLEDGE FROM ENEWETAK SURVEY
- LOCATION OF HOUSES AND CROPS
- PRESSURE TO MATCH ENEWETAK SURVEY
- REQUEST FOR STATUS OF BRAVO FALLOUT ISLANDS
- LIKELY TERMINATION OF TRUST AGREEMENT
- U.S. OBLIGATION TO DOCUMENT CONDITIONS

AERIAL RADIOLOGICAL SURVEY

- FASTER
- CHEAPER
- BETTER DEFINITION OF CONTAMINATION CONTOURS
- ISOTOPIC DEFINITION
- COMPLETE COVERAGE OF ISLANDS AND REEFS
- UNIFORM AUTOMATIC DATA HANDLING