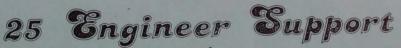


# **CORAL REEF CHANNELS RECONNAISSANCE REPORT**

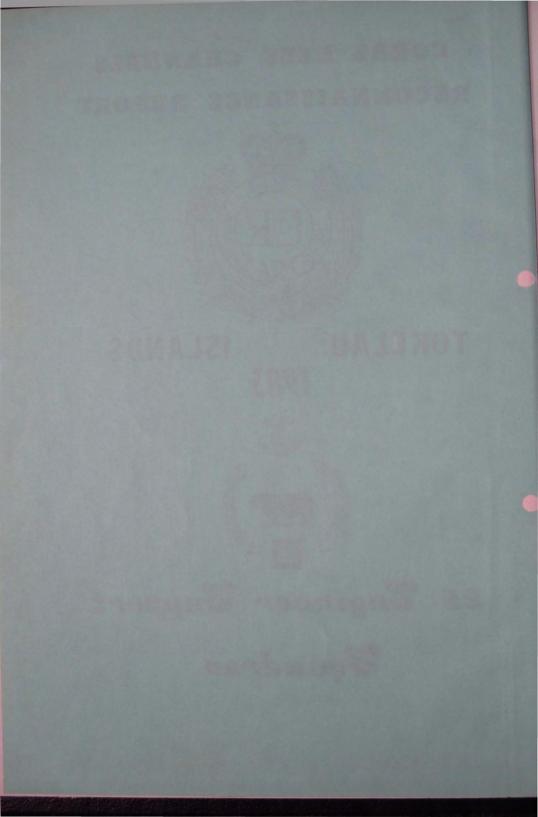


# **ISLANDS** TOKELAU 1985





Squadron



# ENGINEER RECONNAISSANCE REPORT

ON ENGINEER WORKS REQUIRED

TO IMPROVE THREE EXISTING REEF CHANNELS

ON TOKELAU ISLANDS

Renecal Dolling of Asport

FOR: Chief Engineer

BY:

Lieutenant A.M. Skinner, RNZE

AT: 0800 hours

Ε.

F.

ON: 10 May 85

References: A. NZ Def Army 3304/1/CE LBC/KQE of 070337Z Feb 85

- B. Terms of Reference for Tokelau Islands Reconnaissance, Chief Engineers Office 3304/1/CE dated 15 Feb 85
- C. Ministry of Foreign Affairs 118/13/109/1 dated 20 Feb 85

D. Notes of a Meeting with Mr Gotfred Shuma dated 19 Mar 85

Report on Reef Blasting at Fakaofo Island Tokelau Group 14 May - 24 Sep 63 by Lieutenant D.W.S. Maloney, RNZE

Report on Further Channel Development at Fakaofo during mid 1964 by Warrant Officer Class Two D.H. Roberts, RNZE

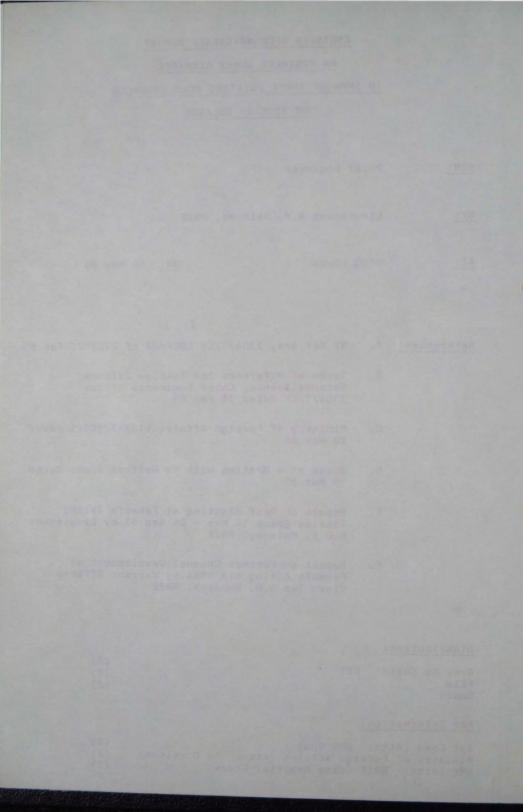
NEUROPE :

Disbribution:

Army GS (Attn:	CE)	(3)
File	,	(2)
Sparp		(2)

For Information:

Spt Comd (Attn: SO1 Ops)(2)Ministry of Foreign Affairs (Attn: Ms D. Almao)(2)SME (Attn: RNZE Corps Memorial Clerk)(1)



# SUBJECT

Order for the Report

# Introduction

General Outline of Report

Tokelau

Geography Economy Population Climate Administration Language Local Government Work Force Food Stores Supply to Tokelau Medical Religion Education Postal Recreation

Communications

# Part I: Summary

Aim

Works Required for Improvements

Time and Space

Finance

Machinery

Manpower

Stores

Accommodation and Rations

Reef Channels

Local Resources

Conclusions

Page 1

### SINSINGS.

TOBLEGS

Drdar for the August

nal\*zeboiini

irneral Qutline of Regarts

-uslaxol

Audus Dang

at introlotant

S SELLONS

Long Langer

SOLOT STOR

and a

States Supply to Tol

ledical

Religion

noliscub3

LBJ BC

noi pastask

Communication

yrammu2 :1 3ammary

1726

derks Required for improvements

Time and Space

France

Maghinery

1 awagnat

201012

Accommodiation and Rational

Ciscosna tees

SCTUCESS FROM

anoteuteen

- 2 -

Recommendations	
	Page
Part II: Main Body	1
General	1
Timetable of Events	1
Channel Reconnaissance	2
Previous Survey	3
Design Parameters	3
Nature of Coral Reef	4
MV Avondale	4
Ship to Shore Transport	4
Surveying	4
Work Problems	5
Natural Channels	5
Accuracy of Survey	6
Infill of Fines	6
Work Periods	6
Previous Work Undertaken	6
Channel Revettment	7
Local Labour	7
Local Attitude Offered Towards Assistance	7
Ministry of Works and Development Design	8
Overview	8
Drilling Pattern	8
Lighting for Night Work	9
Selection of Drilling Equipment	9
and the second	9
Additional Information	9
Transport of Drilling Equipment	9
Power	

CONTRATO.

ammandatigea <u>5 II: Main Sody</u> exal stable of Events

annel Heronnalsaande sviews Survey sign Paraditare

atora af Carel Reaf V Avandele

Surveying Work Problems Watural Channels

Accuracy of Survey. Infill of Floca Mork Periods

Ehannel Ravattment Lecal Labour Local Attitude Offered Touerde Reelatance

Dverview Dverview Drilling Pattern

mission of Brilling Equipment

ditional Information amagunt of Drilling Equipment

# - 3 -

					Page
Finance					9
Payment o	f Loc	als			10
Food					10
Medical					10
Gifts					11
Manning					11
Footwear					11
Security					12
Task Prog	ress	Reports			
Pre-Deplo					12
vie sepie	ymerro	. I d I l I l I g			12
Time and	Space				12
Removal o	f Fin	es			12
Removal o	f Roc	k			13
Blasting					14
Total Tim	e Req	uired for Tasl	k		15
<u>Priority</u>	of Wo	<u>rk</u>			16
<u>Conclusio</u>	ns				16
Recommend	ation	5			18
Annexes:	Α.	'Terms of Re	feren	ce' (CE Office,	
		Army GS		Lans Isual os 1 Crisses Back	
	в.	'Terms of Re of Foreign A		ce' (Ministry s)	
	С.	Maps			
		Appendices:	1.	Pacific	
			2.	Tokelau	
			3.	Atafu	
			4.	Nukunonu	
			5.	Fakaofo	

Drawings

/D.

- - -

ayaant of Loopin ood tfts tfts totuan cotuan sk Prograss Reports

Time and Space Removel of Fines

Blasting Total Time Required for Task

at \_\_\_\_\_\_

Recommendations

A. 'Terms of Reference' (DE Diffee
 G. 'Terms of Reference' (DE Diffee
 G. 'Terms of Reference' (Ministre
 G. 'Terms of Reference' (Ninistre
 G. 'Terms of Reference' (Ninistre

- 4 -

Annexes:	D.	Drawings from	Prev	vious Survey
	Ε.	Typical Coral	Cros	ss-Section
	F.	Boat Specifica	ation	ns
	G.	Shipping Sched	ule	
	н.	Notes from a l	Meet	ing with Mr Gotfred Shuma
	Ι.	Atafu Reef Ch	annei	Standard Parteble Consensation
		Appendices:	1.	Plan View
			2.	3D Plan View
*		Transport of	3.	Detailed Cross-Sections
			4.	Longitudinal Cross-Sections
			5.	Survey Sheets
			6.	Centre-line Levels
		POL MAQUITEN	7.	Volume Calculations
	J.	Nukunonu Reef	Cha	nnel mai laciused in eli departe)
		Appendices:	1.	Plan View
			2.	Detailed Cross-Sections
			3.	Survey Sheets
			4.	Volume Calculations
	к.	Fakaofo Reef	Chan	nel
		Appendices:	1.	Plan View
				3D Plan View
			3.	Detailed Cross-Sections
			4.	Longitudinal Cross-Section
			5.	Survey Sheets
			6.	Centre-Line Levels
			7.	Volume Calculations
	L.	Explosive Cal	cula	tions
		Appendices:	1.	'Molanite'
			2.	'Molanite Watergels' ICI

10

/3. Explosives

## STRBIND

Explosives

CONTRACTOR AND A DESCRIPTION OF A DESCRI

A TRUTHER WITCH STUTIET

Annexes: L. Appendices: 3. Explosives in Action ICI

4. 'Flexicord' ICI

M. Drilling Equipment

Appendices: 1. LM-100 Crawlair Drill

2. P375 Portable Compresor

- 3. Standard Portable Compressor
- 4. IR 38 PSI-RAL Steel and Button Bits
  - N. Transport of Drilling equipment Calculations
- D. Suggested Stores Required
  - P. Suggested Manning
- Q. Explosive Costing
  - R. POL Required and Costing

are reached and an and an area al.

Enclosures: 1. Photograph Album (not included in all Reports)

a. 14 x photographs of Atafu,

b. 4 x photographs of Nukunonu, and

c. 19 x photographs of Fakaofo.

2. Ingersol-Rand Information Folder on LM-100 Airtrack Drill

3. ICI Explosives Information Folder

Annex & requests an aplinian to be made on the Mannance shannel, which was reported by he ar herisfactory wight but may require despending at the share.

Alber Contlargations

The final decigns for each anapoint and the apprintions
 Security entries on a factor by a ministry of Borts and Development
 Entries this Englisher.

The fulling asistence and mineral

Annaxan: L. Appendices: J. September in Action 161

Appendices: 1. LM-100 Crewlair Deily

2. PJ75 Portable Compresser

atandard Portable Congressor

A. IR 30 FSI-RAL Starl and Button 81ts

. irenaport of Drilling equipment Calculations.

barlupse state Stores Required

P. Suggested Manning

Q. Explosive Costing

R. POL Required and Costing

Enclosures: A. Photograph Sibum (not included in all Reputs)

. a. 14 x photographs of Atalu,

c. 19 x photographs of fakaofo.

 Ingersol-Rand Information Folder on UM-100 Alstrack Drill

. ICI Explosives information folder

### ENGINEER RECONNAISSANCE REPORT

### ON ENGINEER WORKS REQUIRED

# TO IMPROVE THREE EXISTING REEF CHANNELS

### ON TOKELAU ISLANDS

# ORDER FOR THE REPORT

### Origin

1. Quarter Master, 25 Engineer Support Squadron, received a Tele Printer Message Order to conduct a reconnaissance to Tokelau Islands. The date/time group of the Tele Printer Message was 070337Z Feb 85 and the reconnaissance was to be carried out during the period 23 February - 24 March 1985.

#### Aim of Report

2. The aim of the report is to determine the work required to improve the existing reef channels on Tokelau Islands to the standards laid down in the specifications. See Annexes A and B.

# Specifications (See Annex B)

- 3.
- As detailed:
- deepening and widening to 7 8 m, the reef channel at Atafu;
- b. deepening and widening the Nukumonu reef channel; and
- c. removing rubble from the existing channel at Fakaofo (Fale) and, either:
  - (1) realigning, widening by 7 8 m and deepening it, or
  - (2) developing the nearby natural channel.

4. Annex A requests an opinion to be made on the Nukunonu channel, which was reported to be of satisfactory width but may require deepending at the shore.

# Other Considerations

6.

5. The final designs for each channel and the appropriate improvements were to be done by a Ministry of Works and Development Construction Engineer.

The following guidance was given:

INGINEER GEODUNALSSANCE REPORT ON ENGINEER MONIS REDOTED D INFORME TOPER RAINTING REF CHANNELS OF TOMELAU ISLANDS

180939 3HT 803 93080

#### alpini

1. Quarter Master, 25 fediness Superir Squedren, received a Telm Printer Message Order to conduct a reconnelseance to Tokelau Islands. The date/time group of the Tele Printer Message was 0703777 Feb. 85 and the reconversame was to be partied out during the pariod 23 February - 24 March 1963.

#### Atm of Report

 The sin of the report is to determine the work required to improve the existing rest channels on Takelau Islands to the standards told down in the specifications for Annexes 4 and 9.

#### Specifications (See Annex B)

- :03116360 aA
- to despending and widening to 1 0 m, the left despendent
  - by deepening and widening the Mukumonu real channels
  - c. removing rubble from the existing conner at Fakado (Fale) and, gither:
- (1) realigning, sidening by 2 8 m and despiring
   (1) realigning, sidening by 2 8 m and despiring
  - (2) developing the nearby necessi (name).

Annex A requests an opinion to de mene de charmel, which was reported to be of metlefectory width but mey require despending at the shore.

#### Diner Considerations

3. The final designs for each channel and we had been the final designs for a Ministry of Works and Developeent Construction Engineer.

inavio ssu apoablup onluciini ad

- any local knowledge pertaining to the reef channels а. and sea action on and around the reef was to be sought; and
- the wishes of the Council of Elders' must be b. respected.

# Composition of Reconnaissance Team

7. The following personnel were detailed to conduct the reconnaissance:

- a. Team Leader. Mr B. Prendergast, Ministry of Works and Development (Airfield reconnaissance).
  - Mr P. Asher, Ministry of Works and Development b. (advice on channels and proposed airfield sites).
  - Mr W. Hill, Ministry of Works and Development C . Environmentalist (Aifrield reconnaissance).
- d. Mr P. Lawless, Commission for the Environment (Airfield reconnaissance).
  - Lieutenant A.M. Skinner, RNZE (Channel reconnaisе. sance).
- f. Chief Petty Officer J. Kearney, RNZN (Ship wreck reconnaissance).

 The above were to depart Tokelau 2 March 1985 except subparas d., and e., who were to depart Tokelau 16 March 1985. Completion

9. The report is to be handed to Chief Engineer, Chief Engineer's Branch, Army General Staff on 13 May 1985.

transitive. The small converting of Copy supported to Menters Summe by dodawantes families, and walk of mondicingfus and summers all provide a small parameters of manager to want publicate. I be used

- and and solitan on and stound the soil yes to be
  - b. the wishes of the Council of Siders' aust to

#### Composition of Reconnaiseancy Toom

7. The following personnal wars defailed to conduct the reconnaissance:

- lass Leader. Mr B. Frandergaut, Ministry of Solve and Development (Airfield reconnelssance).
  - Mr P. Asher, Ministry of Marks and Development (advice on channels and proposed sirflaid sites).
    - Environmentalist (Affricial reconnaissance)
    - Mr P. Lawless, Consistion for the Environment (Airfield reconnaissance).
  - Ligutement A.M. Skinner, 6026 (Unamer reconnais-
    - Chief Patty Stficer J. Hearney, RAZE (Ship wreck reconcel.

B. The shove were to depart locates 2 March 1965 except subpares d., and a., who were to separt locates 16 March 1985.

#### Completion

9. The report is to be handed to Chief hogineer, on 18

# ENGINEER RECONNAISSANCE REPORT

# ON ENGINEER WORKS REQUIRED

# TO IMPROVE THREE EXISTING REEF CHANNELS

# ON TOKELAU ISLANDS

## INTRODUCTION

# General Outline of Report

1. The report has been written to assess the work required to improve three reef channels. The Introduction describes life on Tokelau. The remainder of the report is divided into two parts:

a. Part I: Summary; and

b. Part II: Main Body.

Part II is then divided into Section A, Section B and Section C to enable an individual study of each channel.

# Tokelau

2. <u>Geography.</u> Tokelau is a New Zealand dependancy in the South Pacific Ocean, comprising three coral atolls. It is situated between 172030'W and 1710W, and 8030'S and 9030'S. approximately 500 km north of Western Samoa and 1,000 km east of Tuvalu. Tokelau is of volcanic origin and the remaining circular coral reefs enclose a deep lagoon. The three atolls are Atafu (northern most), Nukunonu and Fakaofo in the south, 100 km and 50 km apart respectively. The average width of the reef is 600 m and this descends steeply into very deep water on the seaward side. The reef is dotted with numerous islets rising to a maximum elevation of 4.0 m and up to 6.0 km in length. All islets are caused by wave action building up loose coral rock towards the lagoon side of the reef. This leaves an expanse of up to 400 m of reef from the islet to the open sea. There is no access for large shipping into the lagoons and depressions in the reef top (natural channels) are used by the locals for access across the reef for small fishing boats. These natural channels provide drainage for reef top water and lagoon spillage, thus maintaining a sensitive equilibrium between the lagoon water and the ocean.

3. <u>Economy</u>. Tokelau does not have an established export industry. The small quantities of Copra exported to Western Samoa by individual families, the sale of handicrafts and stamps, all provide a small amount of finance to each village. Financial assistance is received from New Zealand and is essential for the Tokelau population.

Population. Figures from the latest census of 19
 October 1984 are as follows:

ENGINEER RECOMMUSICANTS REACH

IN ENGLISEER MOARS DECLINER

TU INPROVE THREE EXISTING REEP CHARMED

CONAJOI DELINDI. M

#### ANT FOULD THE

tropes To entitud larange

to improve three real channels. The introduction describes life on Toxelsu. The restricter of the report is divided into two parts:

- A. Part I: Summary: And
  - Part II: Mala Body.

tart il la then divided into Saction 4. Section 3 and Section 1

#### Tokelau

2. Mesography, Tokelaw is a Baw Scalard dependency in the South Paolfic Obsam, comprising three corel stalls. It is attracted between 1720300 wh and 1710W, and 3030'S and 4030'S, at a sport, and approximately 500 wh corth of Western Stands and 1,000 wh want of corelar to the transition of the tra

 <u>Evonomy</u>. Tokalau does not have an aniphianah about Industry. The small quantities of Capta experied to bestern all provide a small amount of finance to each village. Financial assistance is reserved from New Zealand and is examptial for the Tokelau gogulation.

4. Population. Figures from the latest rensus of 13 Detuber 1934 are as follows:

	Male	Female	Total
Atafu	297	292	589
Nukunonu	205	211	416
Fakaofo	315	307	622
Total	817	810	1627

5. <u>Climate.</u> The mean average temperature is 28°C. February is the coolest month and May the warmest. The daily rainfall, of up to 80 mm, is heavy but irregular.

6. Administration. The administration of Tokelau is controlled by a Ministry of Foreign Affairs representative, the Official Secretary, who works for the Office for Tokelau Affairs in Apia, Western Samoa. Currently the appointment is held by Mr A.H. Macey and the Chief Administration Officer is Mr Kasimilo Perez. Other official appointments held on Tokelau are as follows:

а.	Ataf	J			
	(1)	Faipule	-	Mr	Amusia Perez
	(2)	Pulenuku	-	Mr	Lokeni Malaki
	(3)	Administration Officer	-	Mr	Maka Toloa
	(4)	Doctor	-	Dr	Semo Koro
	(5)	School Principal	-	Mr	Tenise Atoni
	(6)	Pastor	-	Rev	Iosua Faamaoni
	(7)	President of the Aumaga	-	Mr	Tiu Kalolo
b.	Nuku	nonu.			
b.	<u>Nuku</u> (1)	<u>nonu.</u> Faipule	-	Mr	Tauanau Kele
b.		tan making The Family that		Mr Mr	Tauanau Kele Fatia Perez
b.	(1)	Faipule	1 1 1		
	(1) (2)	Faipule Pulenuku	1 1 1 1	Mr	Fatia Perez
b.	(1) (2) (3)	Faipule Pulenuku Administration Officer	1 1 1 1 1	Mr Mr	Fatia Perez Henry Joseph
b.	<ul> <li>(1)</li> <li>(2)</li> <li>(3)</li> <li>(4)</li> </ul>	Faipule Pulenuku Administration Officer Doctor •	1 1 1 1 1 1	Mr Mr Dr	Fatia Perez Henry Joseph Tekie Iosefo
b.	<ul> <li>(1)</li> <li>(2)</li> <li>(3)</li> <li>(4)</li> <li>(5)</li> </ul>	Faipule Pulenuku Administration Officer Doctor • School Principal		Mr Mr Dr Mr	Fatia Perez Henry Joseph Tekie Iosefo Luciano Perez

/c. Fakaofo.

- 2 -

5. Climate. The mean average temperature to 2002. February 14 the coolest month and May the usrues. The deliver reinfail, of up to 80 on, is heavy but irregular.

6. Administration. The administration of foreign is controlled by a Ministry who with foreign affairs representative, the Official Secretary, who works for the Office for Tokalou affairs in Apia, Mestern Samos. Currently the appointment is neld by Mr A.H. Macey and the Chief Administration Officer is Mr Mariailo Parez. Other official appointments held on Tokalou are as follows:

AtaTu.

(1) Faigula
(2) Fulanuku
(3) Fulanuku
(4) Fulanuku
(5) Fulanuku
(6) Fuseration Officer
(7) Faigula
(8) Fuseration of runa hunaga
(9) Faigula
(1) Faigula
(1) Faigula
(2) Fulanuka
(3) Faigula
(4) Footat
(5) Fulanuka
(6) Faigula
(7) Faigula
(7) Faigula
(8) Fulanuka
(9) Faigula
(9) Faigula
(9) Faigula
(10) Faigula
(11) Faigula
(12) Faigula
(13) Faigula
(14) Faigula
(15) Faigula
(16) Faigula
(17) Faigula
(18) Faigula
(19) Faigula
(19) Faigula
(10) Faigula
(10) Faigula
(10) Faigula
(10) Faigula
(11) Faigula
(11) Faigula
(12) Faigula
(13) Faigula
(14) Faigula
(15) Faigula
(15) Faigula
(16) Faigula
(17) Faigula
(18) Faigula
(19) Faigula
(19) Faigula
(10) Faigula
(10) Faigula
(11) Faigula
(12) Faigula
(13) Faigula
(14) Faigula
(15) Faigula
(16) Faigula
(17) Faigula
(18) Faigula
(19) Faigula
(19) Faigula
(10) Faigula
(11) Faigula
(11) Faigula
(12) Faigula
(13) Faigula
(14) Faigula
(15) Faigula
(15) Faigula
(16) Faigula
(17) Faigula
(18) Faigula
(18) Faigula
(18) Faigula
(19) Faigula

Faka	ofo.			
(1)	Faipule	-	Mr	Faafoi Sakaria
(2)	Pulenuku			Tu Matini
(3)	Administration Officer	-	Mr	Pio Tuia
(4)	Doctor	-	Dr	Elekana Sakaria
(5)	School Principal	-	Mr	Sosene Galo
(6)	Catechist	-	Mr	Pio Tuia
(7)	Pastor	-	Rev	Tui Sopoaga
(8)	President of the Aumaga	-	Mr	Peleni Apolo

7. Language. Tokelauan is the principle language and is used for all official and unofficial correspondence, both written and oral. English is spoken well by all Administration Officers, Doctors and Principals, the younger population can, generally, understand English.

8. Local Government. Each atoll has a Council of Elders (Taupulega), which acts as the Government and decision making body. It is presided over by the Faipule and his Deputy is the Pulenuku. Generally, the Taupulega consists of the village elders and the heads of each family group. The Faipule has the role of Island Chief and the Pulenuku is the 'Mayor' of the village.

9. <u>Work Force.</u> Two work forces exist on each atoll; Public Works (about 12 men) overseen by Director of Works in Office for Tokelau Affairs, Apia and the Aumaga. All men over the age of 18 years automatically become members of the Aumaga and are employed by the President of Aumaga on local tasks. These are generally, on village improvements which are directed by Pulenuku. Generally, the men work two weeks on, two weeks off, and are paid approximately NZ\$10.00 per week.

10. Food. Tokelau's food resources are extremely limited due to the lack of top soil. The food that is produced on the atolls is coconuts, breadfruit, Lu (a broad leafed shrub), bananas, pawpaw and pandanas (which is only chewed for its flavour). Fish around Tokelau is extremely abundant. Pigs and chickens are kept by the villagers but are only eaten on special occasions. A small amount of tinned food, rice, sugar and flour, is brought and used to supplement the diet.

11. <u>Stores Supply to Tokelau</u>. The only transport to and from Tokelau is aboard a cargo ship, the "MV AVONDALE", which runs from Apia to Tokelau return once every six weeks approximately. This is the only form of resupply available.

12. <u>Medical.</u> A modern hospital is established on each atoll and has the capacity for minor surgery and theatre operations. A qualified Doctor and two Registered Nurses are employed at each

С.

at President of the Aunope - Mr Pristers (a

7. <u>Canguage.</u> Takelawan is the principal derivation of the set works and the set and unofficial derivation derivation derivation derivation derivation derivation derivation. Destors and Frincipale. The younger population can, generally.

B. Local Government. Each stoll has a doubten asking (Taupulaga). which acts as the Reservant, and daoiston asking body. It is presided over by the Felpula and his browty is the Polenuku. Generally, the Taugulege consists of the village eldors and the needs of each feally group. The scipule has the role of Island Chief and the Fulenuxu is the 'Kayor' at the role of Island Chief and the Fulenuxu is the 'Kayor' at the

9. Mork Force. Two work forces all works in Public Works (about 12 men) everyean by Director of works in Office for Tokelau Affairs. Apis and the Almaga. All men over the age of 18 years automatically become sempera of the Aumaga and are employed by the President of Aumags on local basks. These are generally, on village improvements which are sizeres by Pulanuku. Generally, the men work two weeks do, two weeks by Pulanuku.

10. Food. Takeleo's food resourced in provised in the due to the lock of top soil. The food that is provised in the stalls is cocondid, breadfuit, to (a broad leafed should the second and candanas (which is only chaused for its the source). Flat around Tokeleu is extremely abordant. Figs and oblickers are kept by the villagers but are only sated on special colickers. A small second of timed food, rice, such an flaur.

11. Stores Sopply to Tokelay. True Tokelay is sportd a cargo ship, the sew averable, which true tree Apis to Tokelay Isture once every six years aneroxinately. This is the only form of rewapply evaluated on each sto hately.

12. Medical. A modern non-party and theatre motors at seen and the separate for almost average are unployed at seen mustified bootor, and two Neglestered Norses are unployed at a

hospital. The staff is supplemented by approximately six enrolled nurses. The only dentist in Tokelau is on Fakaofo.

- 4 -

13. <u>Religion.</u> Religion plays a major role in village life. Each atoll has a large concrete church built during the late 1800s/early 1900s by Anglican or Roman Catholic missionaries. Atafu is totally Protestant, Nukunonu is all Roman Catholic and Fakaofo has both denominations, each with a separate church. Sunday is always observed as a reverent day and no work is allowed to be done (including cooking). Everyone is expected to attend a church service at least once during the day.

14. <u>Education.</u> Schooling is provided on each atoll and is compulsory for children up to 14 years old (4th form). A few children then complete 5th form overseas, mainly in New Zealand. English is taught at each school as a compulsory language.

15. Postal. All mail and written correspondence is transported by the cargo ship.

16. <u>Recreation.</u> Tokelau provides for excellent diving, fishing and boating. The Aumaga play a "form" of cricket in the village centre every Thursday afternoon. Tennis and volleyball are played a lot in the school grounds. The women play a lot of cards and dominoes.

17. <u>Communications.</u> A poor radio telephone system is employed between each atoll and back to Apia. This produces a very distorted reception and has caused some confustion in the past. A modern telephone system is about to be installed.

surfaces how this and 772 bitter other ine vite. Sta for how and

nospital. The staff is augulamented of approximately sis entoling nurses. The only contlat in Tokalow is up forcolo.

13. Maligion: Naligion plays a sajor fair is village late Each stoil has a large concrete course built during the late Atafu is totally Protectent. Muturna is all forms introles and fakanto has both demonstration. Such aith a belarate church. Sunday is sluage observed as a reverent day and no work is allowed to be done (including cosking). Everyone is expected to estend a church service as losst ance during the day.

14. Education. Sensoling is provided on each atoricand is compulsory for children up to 14 years old (win form). A fou children then complete 5th form overseus, wethly in New Sestand. English is taught at such school as a compulsity innguoge.

19. Postal. All mail and waitten correspondence to their

16. Recreation. Takelau provides for excention of attaket in the rishing and boating. The surage play a "rore" of attaket in the village centre every Thursday afternoon. The some side valleyball are played a lot in the school grounds. The some play a lot of cards and deminors.

17. Communications. A poor radio telephone system is employed between each atoll and back to Apis. This produces a very distorted reception and has caused some confestion in the very distorted reception and has because to be installed.

# ENGINEER RECONNAISSANCE REPORT

# ON ENGINEER WORKS REQUIRED

TO IMPROVE THREE EXISTING REEF CHANNELS

# ON TOKELAU ISLANDS

# PART I: SUMMARY

Aim

 The aim of this Report is to determine the engineer works required to improve three existing reef channels on Tokelau Islands.

# Works Required for Improvements

2. The following is a summary of the work necessary to improve the channels:

- a. <u>Atafu.</u> Widen LHS and RHS of the channel at the entrance and deepen the channel to achieve a depth 1.2 m at Low Tide. This involves approximately 500 m<sup>3</sup> of fines to be removed by local labour and approximately 900 m<sup>3</sup> by drilling and blasting All deepending required involves the removal of fines.
- b. <u>Nukunonu</u>. Deepening of channel to achieve a minimum depth of 1.2 m at Low Tide. This involves the removal of approximately 1450 m<sup>3</sup> of fines by local labour. There is no requirement for Army tasking at Nukunonu.
  - c. <u>Fakaofo</u>. Widen the channel on the LHS and achieve a depth of 1.2 m at Low Tide. This involves the removal of approximately 1000 m<sup>3</sup> of fines by local labour and approximately 1500 m<sup>3</sup> of rock by drilling and blasting. All deepening required involves the removal of fines only.

# Time and Space

3. All calculations for the time required to complete the tasks is based on the time available for work to be conducted on the reef. This is during low tide. The work period is five hours every 12 1/2 hour tide cycle and is from 2 1/2 hours before Low Tide to 2 1/2 hours after Low Tide. The following is a summary of total time required to complete the improvements on the reef channels at Atafu and Fakaofo (see TIME AND SPACE):

a. <u>Drilling.</u> Atafu - 7 days Fakaofo - 11.5 days

b. <u>Blasting.</u> Atafu - 29 days Fakaofo - 47 days THOTHER RECOMMAINSANCE REPORT

AN ENGTHEER WORKS REQUIRED

THERDYE THREE EXISTING

OR TOKELAN ISLAND

YRASHUE IF TRAN

the single and this Report is to determine the engineer

.ebnsisi

Aldamavorami tal bartinenti

The following is a summary of the sum

aprove stafu. attan Li

depth 7.2 s at Low Times to be removed by loost metaly sou a of Fines to be removed by drilling and labour and approximately son a by drilling and labour and approximately sou a by drilling and biseting All

Mukundnu. Deepening of abannel to stide involves minimum depth of 1.2 m at tow ride. This involves the removal of sparakimotely 2.50 al of fines by the removal of sparakimotely 2.50 al of fires by incel labour. There is on requirement for krey incel labour.

Fakaofo. Widen the chemics on time time the achieves a depth of 1.2 m at the time time too a involves the removal of spectrumically 1900 at of these by local labout and aparoximetaly 1900 at of these by deliling and biasting. All despendence of rece by deliling and biasting. All despendence of rece by deliling and biasting.

Atafu - 29 days Fakato - 47 days

- 2 -

- d. <u>Travelling Time/Stores Handling.</u> 22 Days.
  - Total Time Required to Complete Work in Tokelau. 154 Days.
  - f. <u>Total Time Out of Country.</u> 174 Days, approximately 5 1/2 months.

## Finance

е.

4. The following is a summary of costs expected to be incurred:

- a. Explosives (see Annex Q) \$15545.52.
  - b. POL (see Annex R) \$10191.94.

### Machinery

5. The only machinery required is involved in drilling and blasting. (LM-100 airtrack drill and a 375 CFM compressor) (see Annex M).

#### Manpower

6. The task requires a small team of highly trained personnel. The manning is at Annex P and consists of one x officer and nine x ORs, including one x vehicle mechanic and one x cook.

### Stores

7. Sufficient stores are required to be taken to Tokelau to enable the team to remain in location and work totally self sufficient (see Annex O).

### Accommodation and Rations

8. While in Tokelau, the team will be accommodated in European style 'Guest Houses'. A cook has been included as a member of the team and will provide meals from stocks of fresh/tinned food taken to Tokelau and that locally obtained. It is suggested that a commercial pattern refrigerator approximately 2 m<sup>3</sup> capacity c/w 6.5 KVA generator are also taken.

### Reef Channels

9. The three reef channels reconnoitred have been summarised later in the Report (see blue pages - Atafu, pink pages - Nukunonu and yellow pages - Fakaofo).

- Contingentias. Atelu 23 days

- Total Time But of Ecuntry. 174 Days, sparosi-

#### Finance

4. The following is a summary of costs expected to be incurred:

- . Explosives (see Annex Q) \$15545.52
  - ... POL (sec Annex #) \$78191.94.

#### .VianinasM

5. The only machinery required is invelved in defining and plasting. (LM-100 sintrack defini and a 175 GeW apaperator) (see Annax M).

#### Manpower

6. The task requires a shall tesk of nighty trained personnel. The manning is at Annex P and consists of one x officer and nine x ORs, including one x vehicle machanic and one x cook.

#### 891072

 Sufficient abores are required to de taxes to foreity self to enable the team to remote in location and work totally self sufficient (ave fonex D).

#### Accommodation and Ration

8. While in Tokelau, the teen will be access included as a European style 'Europ Houses', a contrained to a member of the team and will provide near included of Tranh, suggest fait a team relative and that locally obtained. It is suggested that a teammercial pattern refrigerator seprovinetaly and cased that of a 5.3 kVA generator are wisd taken.

#### Rear Channels

 The three reef channels recommitted makes - Rubunonu later in the Report (see blue pages - Atofu, pink pages - Rubunonu and veliou pages - Fakaofu).

# ENGINEER RECORDERING ALCOUNT

#### Local Resources

10. Local labour will be responsible for the removal of all fines and infill of the channels prior to the team commencing any tasks. The only local resources that can be relied upon for use are:

- a. local labour; and
- b. local food, when necessary or desired.

### Conclusions

с.

# 11. The following are conclusions:

- a. The Atafu reef channel requires widening on both LHS and RHS at the channel entrance.
- b. The channel at Nukunonu requires deepening, but this involves the removal of fines only and is not considered an Army task.
  - The Fakaofo channel, at Fale, requires widening on LHS.
- d. Atafu and Fakaofo channels also require the removal of fines from the channel bottom, this is not considered an Army task.

### Recommendations

12. It is recommended that a RNZE team deploy to Tokelau for an extended period (5 1/2 months) to undertake the improvements required at Atafu and Fakaofo as stated in paragraph 11. The acceptance of the task should only be given on the understanding that the removal of fines is not an Army responsibility.

INNERT

(A.M. SKINNER) Lieutenant Quarter Master

10 May 1985

#### Local Resources

10. Local labour will an restonable for the removal of all fines and infill of the channels arias in the team companying any tanks. The only local requires that out the values upon for use are:

- ons proved labol ..
- b. local fund, when management or desired.

#### Canalusions

- ing following are conductors.
- LHS and RHS at the channel requires videning on both
  - The channel at Mutumonu requires drepening, but this involves the removal of fines only and is not considered an Army task.
- c. The Fakaofu channel, at Fale, requires widening
- Ateru and fakaofa channels also require the removal of fines from the channel battam, this is not considered an Army task.

#### anor septemmedes

12. It is recommended that a MAR term deploy to invelse for an extended period (5 1/2 months) to undertake the improvements required at Atafu and Fakaofo we stated in paragraph 11. The acceptance of the tesk should only be given on the understanding that the removal of fines is not an Aray responsibility.

Cuarter Master

# ENGINEER RECONNAISSANCE REPORT

# ON ENGINEER WORKS REQUIRED

# TO IMPROVE THREE EXISTING REEF CHANNELS

# ON TOKELAU ISLANDS

# PART II: MAIN BODY

#### General

1. The reconnaissance party left New Zealand on 23 February 1985. The party consisted of personnel from three Government Departments. These were:

- a. Ministry of Defence, (Army and Navy);
- b. Ministry of Works and Development; and
- c. Commission for the Environment.

2. The 'Terms of Reference' (see Annex A), proved to be of great assistance in detailing specific responsibilities and enabled a sound working relationship to be established amongst the members of the party. It did, however, have to be used from time to time to pursuade reluctant members of the team to impart their knowledge for the benefit of others.

### Timetable of Events

3.

	Date		Activity	Remarks		
	(a)	19. 2.	(b)	(c)		
23	February	1985	Auckland - Apia	Arrive 22 February 1985, Western Samoan time		
23	February	1985	Apia - Tokelau	MV Avondale		
24	February	1985	En-route to Tokelau	MV Avondale		
25	February	1985	Airfield reconnaissance Fakaofo	Arrive 250530		
26	February	1985	Airfield reconnaissance Fakaofo	Depart 261730		
27	February	1985	Airfield reconnaissance Nukunonu	Arrive 270600		
28	February	1985	Channel reconnaissance Nukunonu	Depart 281900		

ENGINEER RELIGINATERANCE REPORT

ON ENGINEER WORKS REQUIRED

B LAPROVE TAREE EXISTING REEF CHARVELS

ON TURELAU ISLAND

YODB MIAN :II INAN

Istaung

 The reconnelseance party left hew Sealand on 25 February 1985. The party consisted of personnel from three Government Departments. These weres

- a. Ministry of Opfence, (Army and Mavy)
- b. Ministry of Warks and Development: and
  - Commission for the Environment.

2. The 'Terms of Herterence' (see annex 4), proved to be at great assistance in detailing specific responsibilities and anabled a sound working relationship to be established amongst the members of the party. It did, however, base to be warm from the to time to pursuade reluctant members of the term to impair their boundados for the bonefit of others.

Timetable of Events

Date	Activity	Remarks
(a)	(b)	(c)
1 March 1985	Airfield reconnaissance Atafu	Arrive 010630
2 March 1985	Airfield reconnaissance Atafu	MWD and Commission for Environment personnel depart D201730
3-11 March 1985	Channel reconnaissance Atafu	Depart 111700
12 March 1985	Enroute to Fakaofo	Arrive 120500
13-15 March 1985	Channel reconnaissance Fakaofo	Depart 151900
15-18 March 1985	Enroute Apia	Arrive 181200
18-22 March 1985	Apia	Depart 221900
23 March 1985	Auckland	Arrive 232300

#### Channel Reconnaissance

4. <u>Outline of Problems.</u> As described in paragraph 1., of the Introduction, the Tokelau atolls descend approximately 600 fathoms to the ocean floor. The mooring of any ocean going vessel is impossible at Tokelau and, as in the case of the supply ship MV AVONDALE, the ship drifts approximately 500 m off shore whilst loading and unlaoding cargo. The transport of stores/ passengers from the ship to land is by the use of large aluminium boats (see Annex F). The outboard motors are grossly under powered for the loads carried and generally the boats are 'carried by the waves', rather than steered into the channels. The edge of the coral reef is extremely treacherous for boating due to the waves building up and then breaking across the reef. On all three atolls, the channels have been built utilising existing natural channel entrances.

- a. <u>Atafu.</u> The channel at Atafu is correctly alligned to the breaking waves but is too narrow at the entrance for safe negotiation. During the reconnaissance, boats were overturned at the entrance with stores and equipment lost. Atafu has an excellent concrete wharf at the end of the channel and enables efficient handling of cargo on and off the Island.
- b. <u>Nukunonu.</u> The Nukunonu channel is a very wide channel correctly aligned at 90° to the waves. It is a natural channel that has had minimal work done on improving it. It is very rare that any

#### Channel Reconnelseence

4. <u>Outline of Problems</u>. As described in principles, i. of the Introduction, the lowelau stolis dimensions to purpose fathers to the ocean fluor. The mean of a purpose weeked is impossible at lowelau and, as in the second of the supply whils to adding and unleading cargo. The remaport of stores, boots (see Annax F). The outboard softre are grossly under powered for the loads carried and generally the transport of stores, by the uswes, rather then attered into the transport of stores. The uswes outliding us and then breacherous for boats are 'certing of the uswes outliding and then attered into the to boats of a stores. The uswes outliding and then breacherous for boating due to attere atolite, the and then breacherous for boating due to attered a stoliding and then breacherous for boating due to the uswes outliding and then breacherous for boating due to attered a stoliding and then breacherous for boating due to attered atolite, the asserted when built utilizing attered attered atolite, the asserted and see how built utilizing attered attered because the astrones have been built utilizing attered attered becaused and then breacher base built utilizing attered attered becaused at the astrones have built utilizing attered attered beatered.

state. The channel at Atatu is contractif to the breaking waves but is too narrow at the entrance for ants argonistion. During the reconnaisence, books were overtuined at the antisance with starge and equipment lost. Ataru has an excellent concrete wharf at the and of the channel and enables afficient hundling of cargo on and aff the laland.

Measurons. The Mukunonu channel is a series, it channel correctly sligned at 900 to the waves, it is a netural channel that has had minimal work done on improving it. It is very rare that any

boating accidents occur here due to the relatively calm nature of the sea and waves. It does have a problem of silting up with coral sand from the beach due to wave action.

The channel at Fale on Fakaofo is the Fakaofo. most developed channel of the three. It has an easily accessible concrete wharf built at the same level as the surrounding reef, concrete side walls and a newly constructed 2.0 m high sea wall. Its major failing is that it is incorrectly aligned to the breaking waves. The Fale channel was purposely aligned at an angle to the waves so that there would be no risk of waves surging the length of the channel unimpeded. This proved to be incorrect. It was found that breaking waves loose 75% of their momentum after travelling 100 m across the reef. Numerous boating accidents occur at Fale as the boats attempt to 'dog leg' in the surf at the entrance of the channel (see Annex K).

## Previous Survey

с.

5. An accurate survey has never been conducted on any of the reef channels at Tokelau. However, a survey was undertaken in February and May 1976 by Mr P. Benfell. He recorded his results, on rough sketches. These are at Annex D. These drawings show that, on an average, there has been an increase of 0.5 m in channel bottom centre line height. Undoubtedly, the fines build up far quicker than 0.5 m/9 year period, but it would suggest that the infill of each channel is relatively slow. Periodic maintenance has not been conducted on any of the channels during the past three years.

#### Design Parametres

The specific designs for each channel are laid down in 6. the respective Sections to Part II for each channel (see Section A - Atafu, Section B - Nukunonu, Section C - Fakaofo). Annexes A and B stress the requirement to determine whether any of the channels need to be deepened. In consultation with local Elders, Mr P. Asher and Mr B. Prendergast, it was decided to establish a constant for the minimum depth of any channel. The constant is as follows:

Low Tide Level - 1.0 m = channel bottom depth. A further depth of 0.2 m was added for contingencies such as in fill of fines and wave swell and surge. Therefore constant is:

> Minimum Channel bottom depth = Low Tide Level - 1.2 m = Spring Low Tide Level - 1.0 m

(it was found that at all three channels, the difference in height between LT and SLT = 0.2m). cals mature of the set and takens. It day fave a problem of the set and takens. It day fave a problem of slitles up with taken. sets free the basch due to wave action.

reactions of the comment of the contracts is in most developed channel of the trees. It ness an addet sector solution contract whith at the asset level as the sufrounding real Adart units at the asset and a neath constructed 2.0 s by annel if is and a neath constructed 2.0 s by annel and to the breaking waves. The fair of the waves to purposely sligned at an angle in the waves to that there would be no time of usies singling the levent of the second to an angle in the stoved an loose 753 of their womentum the stoveling 100 s at fair set the second build that the stoveling 100 s at fair set the second build the stoveling 100 s at fair set the second build the stoveling 100 s at fair set the second store the store of the stoveling 100 s

#### Previous Survey

5. An accurate survey has never seen conducts on any of the reef channels at Takelau. However, a survey as undertaken to February and May 1935 by Ma P. Benfell. He recorded his results, on rough sketches. These are at Annex D. These drewings show that, on an average, there has been an increase of 0.5 m in charnel motion mentra line height. Undoubtedly, the fines build that the infill of dach shownel is relatively slow. Periodic maintenance has not been conducted an any af the bannels during the past three years.

#### Design Parametres

But the specific designs for such channel are laid from his the respective Sections to Part II for each channel (are faction A - Atofo, Section 8 - Musunanu, Section C - Fekedol, Annexes a and 8 stress the requirement to detain a untitue of the channels need to ne despend. In consultation with ideal finers, Mr. P. Ashar and Mr & Prendergast, it was desided to satabilish a constant for the minimum depits of any channel. The constant is as follows:

Low Mide Level - 1.0 2 - channel bottom centingenoish a further depin of 0.2 e uss added for contingenoish such as in full of fines and uses swell and surge. Therefure constant la:

Minimum Dhannel bottum degth - Low 1200 a

(it was found that at all three countries, and all - 0.2m).

All drawings (at Annexes I, J and K), and the calculation of volumes of material to be removed have been completed using this constant. It will be seen that any deepending required involves the removal of fines only.

#### Nature of Coral Reef

7. Coral is a living organism and as such dies. This dead coral forms a detritus layer of soft, broken, and in cases, powdery material. It varies from 0.3 - 1.0 m below the top of the reef and is between 0.3 - 0.75 m in depth (see Annex E). This layer may cause problems when drilling and blasting.

#### 'MV Avondale'

8. The 'MV Avondale' is a 33 year old cargo ship approximately 100 m in legnth and about a 2,200 ton displacement. It is chartered by the Office for Tokelau Affairs for approximately 10 journeys a year from Apia to Tokelau return. At Annex G is the 1985 schedule including passenger fares. The owner company is WARNER PACIFIC SHIPPING LTD. The ship is registered in Tonga and has an entirely Tongan crew. The ship has a large cargo capacity and is licenced to carry explosives and inflammable cargo. Although the life saving equipment is sufficient for 120 passengers at times up to 250 are taken aboard as "deck cargo", (this often means life boats are taken off to make more room for passengers). The length of journey from Apia to Tokelau is 36 hours at seven knots.

#### Ship to Shore Transport

9. As mentioned in paragraph 4., the locals use aluminium boats with small outboard motors for the transportation of stores, personnel and live stock to and from the ship (see Annex F). Typical loads, for example, are:

a. 24 x people c/w hand luggage/suit cases;

b. 12 x people and 20 x pigs;

c. 10 x 44 gallon drums of fuel;

d. 30 x bags of cement and 12 x bags of flour.

10. The average distance from the reef edge to the ship drifing at sea is 500 m.

## Surveying

11. <u>Reconnaissance Team</u>. The reconnaissance team that conducted the surveying of the reef channels was:

a. Observer/Booker. Lieutenant A.M. Skinner, RNZE.

/b. Staffman.

- 4 -

volumes of security in the removed have been identified of the constant. It will be need that any demanding termination sais the the removal of fines only

#### Mak Latol To Stujen

corel forms a detritue layer of very broken, and is such dime. Into dead poutery metricial. It warten from 0.1 - 1.0 a below the tag. of the reaf and is below the tag. of the reaf and is below the tag.

#### "My Avondale'

motely 100 m in legath and about a 2,200 ten dispisatered. It is chartered by the Office for lakelau arraits for social ately 10 journeys a year from Aola to lakelau return. At socar 5 is the rest schedule inclusing parasenger fates. The sunst combany is has an entirely Jongen craw. The sain is registered in Ionge and and is licenced to carry explosives and infimmatic company is atthough the life saying equipment is uniticiant for soceoners at theses up to 250 are taken off to dake our room for parasengers. The infit heats are taken off to dake our room for parasengers). The infit is a journey from Spis to Take and the interference of the soceoners.

#### Sulp to Shore Iransport

boats with small outboard matrix for the incals use eluminium personnel and live stock to and from the whip (and fonex F). Typical loads, for example and

issand flughapappul bran who signed x an

tools x 05 bos sidesd a 210

ilent to amush molice de x Di

30 x bass of casent and 12 v hand a Of

the average distance from the reaf edge to the anip

#### Burveying

11. Reconnetosance Team. The reconnetseance team that conducted the surveying of the reef grannets was:

Ubserver/Bouker. Lieutenant A.H. Stinner, AR25.

b. Staffman. Chief Petty Officer J. Kearney, RNZN.

c. <u>Chainman.</u> Matulino (local from Nukunonu).

12. <u>Survey Equipment Used</u>. The survey equipment used throughout the reconnaissance was:

a. Wild NK-2 level, c/w tripod;

- b. 4 m metric staff, 2 x extensions;
- c. 30 m tape;
  - d. 100 m tape; and
  - e. compass prismatic.

All equipment used performed well, although the staff proved to be heavy, clumsy and cumbersome in these conditions. Problems with serviceability due to constant exposure to salt water, increased as the job progressed.

13. <u>Survey Grid.</u> At each channel a datum was established and reduced to RL 100.00. Using the datum, a Survey Control Line was established approximately parallel to the channel. Readings were taken at 10 m intervals and given a letter. These points in turn became the control points for the cross-sectional survey across each channel (see Annexes I, J and K). It was intended to place permanent survey marks in the coral using plastic discs and bridging spikes for future reference, however, the coral was found to be too hard and only bent the bridging spikes when hammered.

#### Work Problems

14. Problems did occur from time to time when conflicting views were expressed by members of the reconnaissance team with regards to degree of detail and accuracy of the survey work.

15. Short manning for this task was overcome when it was discovered that a man on Nukunonu, Matulino, was a qualified surveyor, having spent 12 months in Fiji training. He was of great assistance and also found the surveying practice of benefit. Tokelau does not have any survey equipment.

#### Natural Channels

16. Natural channels occur on the reef as slight depressions in the reef top. These are used by the locals as an expedient access, when necessary, across the reef, but can not be relied upon in all weathers. The natural channels enable an equilibrium to exist between the lagoon water and the sea water. The natural channels provide an 'overflow' for the lagoon and help drain surface water from the reef.

- 5 -

staffman. Chief Perry Distant J. Hearney, NYIN

Chainenn. Marallen (ludel ford Reardant.

12. Burvey Squipment Used. The survey equipment used

thesizi wib . Lavel S-ME bill

the a n matrix staff. 2 s av

Indian in the line

Stremetty soudwop .....

All squipment used performed well, mithough the staff proved in be heavy, clummy and combersons in these conditions. Prohime with encylosebility due to constant exponence to sait units. Increased as the job progressed.

13. Survey Brid. At mach channel a datum was established and reduced to AL 100.00. Haing the datum, a Survey Control Line was retabilished approximately parallel to the channel. Readings were taken at its ministry parallel to the cross-cartional points in turn became the control points for the cross-cartional intended to place permanent (see Annexes L. 3 and a). It was intended to place permanent survey marks in the cords-cartional plastic discs and bridging spikes for future reference, housver, the coreal was found to be too hard and only tent the bridging apilets when hammered.

#### Work Problems

14. Problems did occur from time to the when contricting views ware expressed by members of the reconnuiseance tean with records to degree of detail and scorecy of the survey work.

18. Short manning for this tesk was swrtcome then it tak discovered that a men on Aucunomu. Matulitat, was a qualified surveyor, having spent 12 months in fils training. He was of fourist association and also found the surveying procitics of menafit. Tablesu data not have any survey equipment.

#### Natural Ghannels .

16. Natural abanuals scars on the reef as slight depresented in the reaf top. These are used by the locals as an expedient access, when necessary, across the rear, but on not he relief upper in all womthers. The natural commence an equilibrium to exist between the lagoon water at the isoner and help grain channels and help grain.

The Elders of Atafu and Fakaofo are eager to ensure that 17. the natural channels do not get disturbed or altered in any way. Accuracy of Survey

The survey was conducted as accurately as possible. Not 18. all of the cross-sections were able to be surveyed, but were measured instead. This was due to the swell and surge of waves across the reef, thus causing the level to become unsteady. The cross-sections that were unable to be surveyed are detailed in Sections A, B and C to Part II.

#### Infill of Fines

19. The depth of fines infill in each channel could not be determined accurately, however, local knowledge suggests that it is a minimum of 1.2 m deep. An accurate record has not been kept of changes in channel bottom depth. Therefore no information is available to suggest the rate at which the channels are filling with fines. This is due to the lack of an accurate survey ever havino been done.

20. The local people have a very slack attitude towards the channels and subsequently do not conduct any form of routine maintenance. Periodic routine maintenance would include the removal of fines and obstructions. Each channel has been used as a convenient disposal source for all sorts of rubbish. The type of refuse found in the channels is as follows:

- a. numerous coconut shells;
  - b. iron reinforcing rods;
  - c. fishing nets;
- d. cooking pots; and
- e. even the frame of an old bike (at Atafu).

## Work Periods

21. At both Atafu and Fakaofo, the only period when the reef is accessible for any form of work is for 2 1/2 hours before Low Tide to 2 1/2 hours after Low Tide, therefore work period is five hours/12 hour tide cycle. south and the same new long strong to the

### Previous Work Undertaken

22. When previous blasting work has been undertaken at any of the channels, removal of rubble has proved to be no difficulty. Large boulders have been either:

a. man handled onto the reef top and used for reclaimation; or

17. The states of high and Bakara at stored in any new

#### ACCULACY OF SURACY

18. The servey are conducted as rectificily as possible. Not all of the cross-sections were able to be surveyed, but ante measured instand. This was due to the survey and surge of vevee across the reat, thus causing the layer to be surveyed are detailed to cross-sections that were unshift to be surveyed are detailed to Sections A. 8 and G to Part II.

#### Infill of Fines

19. The depth of from loffil in each channel could not be determined securately, mnuever, incal knowledge vogenets that is of changes in change in data accurate record has not here is available to support the rate of which the channels are filling with fines. This is due to the lack of an accurate survey ever having been done.

20. Ine local people have a very clock stillude course the channels and subsequently do not conduct soy form of fautine maintenance. Periodic routine maintenance would include the manal of fines and obstructions. Each channel has been wood as a convenient disposal source for all sorts of roblish. The type of refuse found in the channels is as rollows:

aliste Junpopo gupranuat

b. iron reinforcing toda;

C. flaming metal

new system needland the

(Disk set and ore of aners and have

#### DRIZES NIDH

#### averiant stop short stard

22. When previous blasting work has been unbitable at any of the channels, removal of rebuik has proved to be no difficulty. Large boulders have been cliner:

a. was handled onto the rest top and used the

## b. rolled off the edge of the reef into deep water.

During the 1963 construction of the Fakaofo channel, two sea walls, 2.0 m high x 3.0 m wide and 100 m long, were constructed from the rubble. All man han handled into place. These walls have since disappeared and been used for reclaimation around the island.

23. An air winch-drag line was in use at Fakaofo approximately 10 years ago for the dredging of the channel during further construction and proved to be very efficient. It has since disappeared without any knowledge of its whereabouts. Annex H makes comment of the advantages of employing this type of equipment.

#### Channel Revettment

The concrete produced on Tokelau by local labour consists 24. of New Zealand cement (generally PORTLAND) and coral sand (due to the impracticalities of getting builders mix ashore). This concrete proves to be of mediocre quality and weathers relatively quickley when constantly subjected to salt water. The locals believe that each channel should be revetted with concrete side walls to stop the gradual infilling of the channels with kilikili. This is totally unnecessary due to the assumed slow rate of infill. None of the channels require any form of retaining walls to stabilise the sides. At Fakaofo, where concrete revettment/ retaining walls were constructed in 1963, the result of subsequent sea action has been that the concrete walls are being undermixed and, in places, have collapsed into the channel. The natural coral channel sides have proved to be very stable and resistant to erosion.

# Local Labour

Local labour on Tokelau is readily available through the 25. Aumaga. When considering the removal of fines in the channels to achieve the desired minimum depth, the Official Secretary (Mr A.H. Macey) was approached with reference to the locals undertaking this task. Mr Macey said that he is prepared to direct the locals to clean the channels of fines and also ensure that the respective Aumaga establish a programme of routine maintenance. He also agrees that because the locals believe all work associated with the reef channels is not their responsibility but is the task of foreign aid teams such as the Army, the channels should be cleaned out prior to any aid work commencing. The report has been written on the understanding that the removal of fines is not an Army responsibility. Nukunonu Reef Channel is no longer considered a potential Army task because it involves the removal of fines and infill only. Drawings and calculations have been done on Nukunonu for the benefit of Ministry of Foreign Affairs overseeing the local labour.

### Local Attitude Towards Offered Assistance

26.

The local people, particularly the Elders who are part

#### appen cont that and the the sale of the assist

During the 4362 mensionation of the Fakania emphasis, the sea yealth, 2.0 A wigh x 3.0 x wide and 100 x long, when constructed from the robbies All non non hendled into place. Foury walls have almost disappeared and been weed for reclainstion around the island.

23. An wir winnh-drug line was in one at following mentalimethivits years age for the dradging of the shannel furing almes construction and growed to be very sticlast. It was almes disappeared without any knowledge of the warranged. Annex H makes comment of the advantages of employing tale type of equipment.

#### Channel Revettmont

21. The concrete produced on terrism by tocal tandom constants of New Instand common (generative monification) and const tank (due to ather targeticalities of getting builders als manors). Talk quickley when constantly subjected to sait water. The locals walls to stup the gradual infiliting of the thermole with siliciti this is totally unnecessary due to the assumed slow rate of inrill: None of the chennels require any form of residence to stabilize the sides. At farsoined in 1963, the residence resident was excluded in 1963, the residence of and its of a places. As and the concrete walls of action resident is a stabilizer the some the terminal with siliciti resident is a stabilizer the some the terminal of an and a stabilizer the sides. As a concrete walls are delay and resident to sconta to be an the terminal of a stabilizer and the terminal stabilizer of the second of the second of a concrete walls are constant to the some term of a stabilizer and the stabilizer the some that the concrete walls are delay and and the stabilizer of a stabilizer of the stabilizer of the stabilizer and the stabilizer of a stabilizer of the stabilizer of the stabilizer and the stabilizer of a stabilizer of the stabilizer of the stabilizer and the stabilizer of a stabilizer of the stabilizer of the stabilizer and the stabilizer of a stabilizer of the stabilizer of the stabilizer and the stabilizer of the stabil

#### LOCOL LODOUR

25. Local isonir on Tevelar is reactly drives in the second of the second secon

#### sound pertrude Iquarge Hffored Lassistance

The local sevels, particularly the timers who are

- a. the employment of any offered aid or assistance; and
- b. the improvements necessary or tasking required.

In the past, this attitude has caused problems for the aid teams, particularly when the opinions and wishes of the locals are not feasible nor the best solution for that specific problem. They believe that what they desire to have done is, in fact, what is required to overcome the problem. This has often proved to be incorrect. However, if the solution to the problem recommends work that differs from that which the locals believe is required, they will not agree to that work being done.

#### Ministry of Works and Development Design

27. As detailed in Annex A, the Ministry of Works and Development were to submit a confirmed and recommended design for improvements required for each reef channel. This has not been received and, subsequently, the report has been written without this guidance.

#### Overview

28. The work required to achieve the necessary results will be awkward and perhaps frustrating. The reef surface is extremely slippery and requires two persons to support each other, arm-in-arm, when moving by foot from place to place. The efficiency of borehole drilling will be a major factor in determining the length of the task. It was hoped during the reconnaissance, to do a test drill and blow of the coral, but the necessary equipment was unable to be taken to Tokelau.

29. In the report by Lieutenant D.W.S. Maloney, it states that the drilling of boreholes on the reef edge was extremely slow and tedious due to:

- a. the inefficient production of drilling with hand drifters; and
  - b. men working in the surf zone and on a slippery surface

On the occasions that large waves broke on the reef, the men were forced to hang on to each other, letting go of all their tools, while the force of the wave dissipated. This proved to be extremely dangerous and inefficient.

#### Drilling Pattern

30. The drilling patterns used by Lieutenant Maloney, during the construction of Fale (Fakaofo) channel varied as sub-surface coral conditions altered. The hand drifters proved to be very

#### of the Isubulago, datids amonget themselves:

### isonatelane to ble anazito you to inservations an

#### barlupst palient to ytpshaan itnessvotoni and

In the past, this stitute has carend problems for the sid terms, particularly when the pointons and where of the ideals are not balleve that what they dustion for that here in fact what is required to overcome the problem. This has after proved to be incorrect: However, if the solution to the problem strongeness unrk that differs from that which the locals belows is required. they will not agree to that work being done.

#### Ministry of Marks and Development Decion

27. As detailed in Annex A, the Ministry of Morka and Development were to submit a confirmed and recommented design for improvements required for each reef channel. This has not been received and, subsequently, the report new been written without this guidence.

#### Walview

28.: The work required to achieve the necessary results will be sokward and perhaps frustrating. The rest surface to attarn arm-in-arm, when noving by foot from place to place. The efficiency of berehole division will be a major factor in determining the length of the test. It was hoped during the reconnelessance, to do a test divis and blow of the caral, but the necessary equipment was unable to be taken to Tokeley.

29. In the report by Ligutemant 0.2.5. Heloney, it states that the drilling of marcholas on the reef adge was extremely elow and tediums due ter

the inefficient predection of drilling with name

men working in the surf cone and on a slingery

On the socialize that large waves brake on the rest, the san were forces to heng on to such store. Letting go of all their tools, while the force of the wave dissipated. This proved to be extremely dangerous and instrictmet.

#### Drillling Pattern

10. The drilling astterns used by Liedrenant Hartaner the construction of Fale (Faknofa) channer varied as sub-surface carel conditions eltered. The hand drifters proved to be very inflexible because they could not have the speed of rotation adjusted independant to the drilling force (they do not have independant-rotation). Subsequently, a lot of drill jamming and braking of steels occurred.

#### Lighting for Night Work

31. Whilst researching the possibility of of night work on the reef, no company was found that produced the desired power generation and lighting equipment suitable for the type of task proposed at Tokelau. The considerations were:

- a. distance of the work area to the closest possible site of generator on reef (approximately 50 m);
  - b. generator unable to be floated on a boat due to breaking waves;
- c. reticulation of power from generator to task site above water; and
- d. anchorage of lights and tripods on coral in wave surge.

#### Selection of Drilling Equipment

32. Ingersol-Rand was the only rock drilling company contacted with reference to the supply of an air track drill and compressor for the task at Tokelau. This was done on advice from the Ministry of Foreign Affairs, and is the reason that no other products from any other companies are considered.

#### ADDITIONAL INFORMATION

#### Transportation of Drilling Equipment

33. There may be a requirement to construct a raft from local resources to transport drilling equipment from the ship to the shore.

#### Power

34. Each atoll has a 26 KVA diesel generator. This produces more than enough power in the Village and is in operation daily during the hours of 1900 - 2300. Night work was considered as optional but was disregarded. This was due to problems that would arise in supplying power to the edge of the reef, for sufficient lighting to enable work to continue.

#### Finances

35. <u>Allowances.</u> The allowance advance provided for the Ministry of Defence personnel was initially issued through the Ministry of Defence. As it turned out, the inflaxible because they could not nove the speed of fotation adjusted independent to the detiling force (they so not neve independent-rotation). Subsequently, a lob of davii jensing and bröking of steels accurred.

#### Lighting for hight war

31. Whiles treeworthing the providelity of of night work an the reaf, no company was found that produced the desired power generation and lighting equipment suitable for the type of tesk proposed at Toksiau. The considerations were:

- distance of the work area to the closest possible alte of generator on reaf (approximately 50 m):
  - generator enable to be floated on a boat due to breaking waves;
- reticulation of power from generator to task site
- anchorage of lights and triands on cotal in veve

#### Selection of Orilling Equipment

12. Ingersol-Rand was the only rork drilling company contacted with reference to the supply of an air track drill and concressor for the task at Takelau. This was done on advice from the Ministry of Foreign Affairs, and is the reason that no other products from any other sompanies are considered.

#### ADDITIONAL INFORMATION

#### Transportation of Orilling Equipment

33. There may be a requirement to construct a fire the which local resources to transport drilling equipment fire the which to the shore.

#### 10009

14. Each stall has a 26 www diseas generation daily more than anough power in ane Willack and is in operation daily during the hours of 1900 - 2100 Might work was considered as would arise in auchylong power to the udge of the rest, for aufitideal lighting to anable work to continue.

#### Finances

15. Allowances. The allowance advance block through the Ministry of Detence personnel was initially issued through the Ministry of Detence. As it turned out, the

advance was under estimated due to inter-departmental differences in terminology. To date, the allowances have still not been finalised.

#### Payment of Locals

36. As mentioned in paragraph 25, the Office for Tokelau Affairs is in favour of the locals clearing fines from channels and providing a manual labour workforce to assist any aid project team. Prior to the employment of any local labour, an hourly rate of pay must be established by the Tokelau Administration and money made available for expenditure as payment for workers. This form of payment would also be required if casual female labour is provided for employment in 'pot walloping' type tasks.

#### Food

37. It became obvious from the locals' way of life, lethargy and ability to sleep for large portions of the day, that the local food available lacks any real energy providing substance. Whilst surveying, it was found that the New Zealanders could withstand longer periods of work and more time in direct sun light. The Tokelau people live a subsistence lifestyle, working and eating only sufficiently enough to stay alive. The locals can work extremely hard for short periods of time, for example:

a. climbing a coconut tree and cutting off nuts, or

b. unloading boats.

The food proved to be relatively tasteless and very monotonous, though more than enough was always provided.

## Medical

38. Although each atoll has a modern hospital and resident Doctor, it would be advisable to take a comprehensive medical kit. Medical dissorders encountered during the reconnaissance were:

- a. numerous coral cuts;
- b. headaches, from heat and glare;
- c. 'coconut bum' continuous bowel motion due to excessive consumption of coconuts;

/39. It

- d. sunburn;
- e. shaving rash; and
- f. minor cuts (non-coral).

in terminatory. To date, the situation artil of terminated

#### Payment of Locala

Jb. As mentioned in paragraph 25, the Diffice for Tokelau affairs is in favour of the locals elements fines from themesia and providing a menual labour workfores to assist any ald hoorig rate of pay must be astablished by the local inbute, an hoorig rate of pay must be astablished by the local inbute, an univers. This form of payment would also be required if canual workers. This form of payment would also be required if canual female isbour is provided for employment in 'oot walloping' type tasks.

#### Faad

37. It became abvious from the locals' usy of life, latharquities and shility to slaup for large portions of the day, that the uncel food available latks any real summer previous substance, whilet surveying, it use found that the May lashadara could witheles aurveying, it use found that the May lashadara could light. The locks periods of work and more time in direct sum and sating only sufficiently enough to stay alive. The local for available for sample light unreasting only sufficiently enough to stay alive. The local for available for should be substance of the local set used and a sample light. The local periods of the day for available to use and sating only sufficiently enough to stay alive. The local for available to use and the stay alive.

a. climbing a coconst tree and cutting off nuta, or

The food proved to be relatively tenteless and very monolonous. though more than enough was slways provided.

#### Medical

38. Although each stoll has a modern hospital and resident Doctor, it would be advisable to take a comprehensive medical kit. Medical discorders ancountered during the reconneissence.

- ; sjub letop subtemun .
- b. neadaches, from heat and glare
- - A DESCRIPTION OF THE OWNER OWNER OF THE OWNER OWNER OF THE OWNER OWNE
  - a ideala and second
  - and then for anish .
  - along cuts (non-corsi),

- 11 -39. It was found that any open wound took an extremely long time to heal. This was due to:

a. the damp humid weather; and

b. flies, which swarm around uncovered wounds.

#### Gifts

40. There is a requirement for any aid team to go to Tokelau with sufficient ornaments and gifts to give to the Elders, Administration and people. This will save certain embarrassment when, undoubtedly, the locals with their excessive generosity, will give away their handcrafts to the aid team. It is suggested that the gifts taken to Tokelau have an association with the military. Gifts presented to the locals during the reconnaissance included Squadron plaques and Corps badges mounted on native timber ornaments. These were keenly accepted and appreciated.

#### Manning

41. Due to:

- a. the type of task;
- b. working conditions;
- c. period away from home; and
- d. at times, frustrating pace of life,

the personnel required for the task must be carefully selected to ensure a compatible team is established. These personnel should be conversant with modern blasting and quarrying techniques including the use of delay detonators and the layout of drilling patterns. Personnel should also be selected on the following criteria:

- e. health and fitness;
- f. family situation; and
- q. leadership qualities.

#### Footwear

42. Footwear trialed on the reconnaissance were:

- a. jandals, (wore out extremely quickly on coral);
- b. sand shoes, (were found to be extremely uncomfortable when worn in water due to fines causing chaffing); and

c. "KD" sandals, (plastic, worn by majority of locals, proved to be tough, durable and comfortable). These sandals are also an issue item through RNZN. time to heat. This was not the appen sound took an extrant toom

an again almon dans and

become bours stars distant

3720

with sufficient drammars and office to give to the fatele instruction and membre and office to give to the Elders, Addin undoubtedly, the invalue will sove serial numbers office office their numbers to the sid feem. If is suggested the the office presented to the induits during the recommission will the Gifts presented to the induits during the recommission of inducted squadron plaques and Corps badges mounted on native timer office ments. These ware trendy accepted and appreciated

oninneM

the type of task;
 working conditions;
 period sway from home; and

recorded required for the tack must no received

to encore a compatible team is established. These personnal should be conversant with modern alesting and quarrying techniques including the use of delay detonators and the levout drilling patterns. Personnel should also be selected on the following driteria:

teasnill and filmssit.

ine inclicuits vituation .

.... isadership qualities.

18901001

column bristed of the reconnersance

a. jandals, (wore but extremely pulckly on porely.

D. sand shoes. (were found to be extremely unconfortable when warn in unter due to fines cousing chaffing): and

"KO" semisis. (plastic, worn by majurity of incels proved to be tough, durable and comfortable). Three mondald are wise an lowue itsm through Rick.

#### Security

43. A 24 hour standing patrol at the magazine will be required.

## Task Progress Reports

44. It is suggested that a SITREP format be established prior to deployment for use in reporting task progress. This could be communicated through the new telephone system to Apia, then to New Zealand.

#### Pre-Deployment Training

45. It is suggested that a programme of training be planned to prepare the team for the deployment. This could include:

- a. stores preparation;
- b. trade training (explosives and drilling);
- c. medical lecture; and
- d. local customs and language lecture.

### TIME AND SPACE

#### Removal of Fines

46. The following calculations are for the benefit of the Office for Tokelau Affairs in determining work required to clear fines for channels and removal of rock piles (using Lieutenant D.W.S. Maloney's report for constant, for removal of fines from channel  $m^3/man/day = 0.5 - 0.75 m^3/day$ ).

a. Atafu.

Total fines to be removed - 1350 m<sup>3</sup> (550 m<sup>3</sup> in channel, 800 m<sup>3</sup> in rock rubble piles) so 550 m<sup>3</sup> @ 0.5 m<sup>3</sup>/day/man

so 550 m<sup>3</sup> @ 0.5 m<sup>3</sup>/day/man 800 m<sup>3</sup> @ 1.0 m<sup>3</sup>/day/man

27 men for 40 days clear channel and
 20 men for 40 days move rock piles

#### b. Nukunonu.

Total fines to be removed only for area shown on drawing at Appendix 1 to Annex J - 1450 m<sup>3</sup>.

/c. Fakaofo.

∴ 73 men for 40 days clear channel 37 men for 80 days 20 men for 145 days

- 12 -

47. A 24 hour stabding materia at the magezine will a required.

#### Task Prograss Reports

44. It is suggested that a Silker former as stanilated prior to deployment for use in reporting task progress. This obvio be communicated through the new telephone system to Acia, then to New Zenland.

#### Pre-Deployment Training

15. It is suggested that a programme of training be planned to areast the teem for the deglowment. This could include:

- incilsingsig sorola .
- :(dufiting pus ashicoldxa) butureri apada
  - ons intuins! Laciben .
  - local customs and language lecture.

#### TIME AND SPACE

#### Removal of Fines

46. The following calculations are for the densitient to clear Office for Intelay Affairs in determining work requires to clear fince for promotic and removel of rock plips (using lisutenant D.W.S. Maloney's report for constant. For removal of fines from chemel affaories at 2.5 - 0.75 m<sup>2</sup>/day).

At BILLS

Total fines to be removed. - 1000 a in ruck rubhi (550 a in channel, 800 a in ruck rubhi pilos)

> ao 550 m<sup>3</sup> # 0.5 m<sup>2</sup>/day/man 800 m<sup>3</sup> # 1.0 m<sup>2</sup>/day/man

27 sen for 40 days clear chesnel and

#### - PUOGRANN -

Total fines to be removed only for area and

. 73 men for 10 days clear channel 37 men for 88 days 20 men for 145 days

COBNET VI

с. Fakaofo.

> Total fines to be removed - 1240 m<sup>3</sup> (1000 m<sup>3</sup> in channel, 240 m<sup>3</sup> in rock rubble piles)

so 1000 m<sup>3</sup> @ 0.5 m<sup>3</sup>/day/man 240 m<sup>3</sup> @ 1.0 m<sup>3</sup>/day/man

- 13 -

.. 25 men for 80 days clear channel (50 men for 40 days) and 24 men for 10 days move rock pile

47. All further calculations of timings have been done assuming local labour will remove all fines required for channel improvements.

#### Removal of Rock

48. Drilling. Timings for drilling are based on the figures shown at Annex M.

> а. Atafu.

> > Total number of holes

= 762

Overall time per 1.4 m deep hole = 4.7 mins (see Annex M for definition of 'Overall time per hole')

Total time for drilling

= 59.69 hours sav = 60hours

sav = 4

Hours per day available for drilling

hours per cvcle

(5 hours of work per 12.5 hourly tide cycle)

No night work so 12 hours drilling per 2 days (assuming one 4 hourly work period available for drilling per 2 days is lost due to Low Tide occurring during darkness).

Total days required for drilling = 5 days + 25% for drill jamming, breakdowns and

adverse weather say = 7 days

ь. Fakaofo.

> Total number of holes = 1269 Overall time per 1.4 m deep hole = 4.7 mins (see Annex M for definition of 'Overall time per hole') = 99.41 hours Total time for drilling Hours per day available for hours per

say = 4drilling

cycle

(5 hours of work per 12.5 hourly tide cycle)

Faksafs.

Total Finan to be removed a TALD at (1000) at in channel, 240 at in rock subble (asi)

namigabila 0.7 g La Dis

(50 man for all days) and 24 mon for 10 days when rock dila

47. All further calculations of timings mays area done assuming local labour will remove all fines required for chemnel improvements.

#### Removal of Rock-

48. Drilling. Fisings for drilling are grand on the rightes

, UTBIA

Total number of holes - 762

Overell time per fit a deep hole . 4.2 etne (see Annax M for definition of 'Overell time per hole')

Tatal time for drilling any = 50 m

Hours per day available for drilling

(5 nours of work per 12.5 hourly tide syste)

(assuming one & hourly work period availants for drilling per 2 days is lost due to Low Tice accurring during darkness).

Total days required for defiling drill jameing.

sysh y = yss

Faxeofa: Intel number of noise Diversali time nor 1.4 a deep hole = 4.7 ains (see Annex M for definition of "Overall time per nois") Total time for drilling Hours per day evaluable for drilling Say = 4 nours per cycle No night work so 12 hours drilling (assuming one 4 hourly work period available for drilling, per 2 days is lost due to Low Tide occurring during darkness)

Total days required for drilling = 9 days + 25% for

y boys + 25% for drill jamming, breakdowns and adverse weather say = 11.5 days

49. <u>Blasting.</u> Timings used are an assessment based on desired results and a +25% factor for trialing of drilling and blasting patterns, removal of debris etc:

Atafu. а. Prepare explosives = 3 mins/hole Prepare hole/loading charges/ tamping of charge = 10 mins/hole Layout of ring main = .30 mins/ring main say = 2 mins/hole Connecting up of charges = 4 mins/hole Layout shot firing cable/test continuity = 15 mins say = 1 min /hole Final check = 1 min/hole Total time/hole for blasting = 21 mins Total number of holes = 762 Total time required for blasting = 267 hours Work period = 12 hrs/2 daysTotal days required for blasting = 23 days + 25% for adverse weather = 29 days

b. Fakaofo.

(Time calculations as for Atafu)
Total time/hole for blasting = 21 mins
Total number of holes = 1269
Total time required for blasting = 445 hours
Work period = 12 hrs/2 days
Total days required for blasting = 37 days + 25% for
adverse weather

= 37 days

```
A nourit work and a sourie thing (truthing and
par 2 days is loot out to tou fing
accurring during defenses)
fotal days regulard for drilling - 2 days - 22% for
drill jamaing,
advarse wather
any - 17.5 days
```

49. Blasting. Similing used are an actualized and desired results and a +25% factor for trialing of drilling and blasting patterns, removal of debris atc.

```
Prepare explosives

Prepare explosives

Prepare hale/loading charges

Prepare hale/loading charges

Layout of ring main

Connecting on of bharges

Connecting of bharges

Connecting on of bharges

Connecting

Connecting
```

#### Eukaofo.

(Time calculations as for where) Total time/holes for bissting = 21 uine Total number of holes = 1263 Total time required for ulasting = 445 hours work period = 12 hrs/2 days Total days required for pinsting = 37 days + 25% for anwerse usather = 37 days

#### Total Time Required for Task

2 IT MANUE		Addited for lask			
50.	a.	Atafu.			
		Drilling		7	days
		Blasting			days
		1 day per 7 days lost due to Sunday	+		days
		1 day per 3 days spent disposing of debris from task site			days
		Allow 3 days for off loading stores			days
		Allow 3 days for loading stores at		1.6	duyo
		completion	+	3	days
		Total Time for Task	=	59	days
				-	
	ь.	Fakaofo.			
		Drilling		11	.5 days
		Blasting			days
		1 day per 7 days lost due to Sunday	+		
		1 day per 3 days spent disposing of debris from task site			days
		Allow 3 days for off loading stores			days
		Allow 3 days for loading stores at			
		completion	+	3	days
		Total Time for Task	=	93	days
	с.	Additional Contingencies.			
		Allow 7 days for stores prep/ loading ship/Customs at Apia	+	7	days
		Allow 3 days for journey on ship to Tokelau	+	3	days

Allow 2 days for journey between Atafu and Fakaofo + 2 days

Allow 3 days for return journey to Apia

Allow 7 days for unloading ship/ Customs/R & R•at Apia

Total time arrive Apia, undertake tasks and depart Apia for New Zealand

= 174 days

7 days

3 days

(approximately 5 1/2 months)

/51. All

Total Time Required for Tank

#### Additional Contingenoiou

%ilow 7 days for stores prep/ loading chip/Gustems at Spla allow 3 days for journey on ship to Tokelsu Allow 2 days for journey between ateru and faxaufu Apia Apia Allow 7 days for return journey to Apia Allow 7 days for unloading ship/ Cuatoms/R & R-at Apia Cuatoms/R & R-at Apia

Total time affine apin for New Lanks and deport Apin for New Zealand

(annirozimutely)

51. All timings assuming ship schedule is co-ordinated with intended movements of team.

## PRIORITY OF WORK

52. Removal of fines from channel bottom at Atafu and Fakaofo is to be complete prior to task commencing. This will allow easy off loading and loading of drilling equipment at wharfs.

53. It is suggested that work at Atafu be done first because the volume of fines at Atafu is considerably less than that at Fakaofo, this will give locals at Fakaofo more time to complete the removal.

### CONCLUSIONS

54.

The following are conclusions:

## a. <u>General.</u>

- The Atafu reef channel requires widening on both the LHS and RHS at the channel entrance.
- (2) The channel at Nukunonu requires deepening, but this involves the removal of fines only. and is not considered an Army task.
- (3) The Fakaofo reef channel, at Fale, requires widening on LHS.
- (4) Atafu and Fakaofo channels also require the removal of fines from the channel bottom, this is not considered an Army task.
- (5) The channels are being used as rubbish tips.
- (6) No routine maintenance is being conducted on any of the channels.
- (7) Piles of loose rock at the edge of the channels contribute to the infilling of the channel with fines.
- (8) Fines must be cleared from the channels, to allow efficient off loading of stores, prior to task commencing.
- (9) Local people believe all work associated with the maintenance and improvement of reef channels is not their responsibility.

#### b. Reconnaissance.

(1) The reef channel reconnaissance party was grossly undermanned and had very little depth of surveying experience.

52.

intended soverents of torn.

#### SHUR 40 KAISOING

is to be complete prior from chemnel bottom at starty and Anhaoto off loading and loading of drilling couloment at its will allow aday

there are anglested that work at Atefp be done first than their at fekato, this will give totale at fekauf anglests to complete the removal.

#### CONCLUSIONS

, 48

-analaulonup ana phiwolipi ani

- Leisnau
- but the LNG and RNS an the channel requires widening on
- (2) The channel at Muxunonu requires despening. but this involves the removal of fines only.
- (3) The Faxaofo reaf channel, at Fale; , raquires
  - (4) Atefu and Fakapfo channels also require the removal of fines from the channel bottom. this is not considered an from the
  - (2) The channels are being wert ad anter (2)
- (b) No routine maintenance is being conducted an
- (7) Piles of loune rook at the edge of the channels contribute to the infilling of the channel with Fines.
  - (0) Fines suit to blasted from the channels, to allow officiant off loading of stures, prior to task commencing.
  - (2) Lucal propie balines all upic associated with the self-
    - . Hennnaissance.
  - arossiy undermanned reconnelsednee party was grossly undermanned and had very liftle depth of surveying experience.

- (2) Guidance on the design for reef channel improvements, was required from a qualified Civil Engineer.
- (3) A test drill and blast of the coral is required for planning data.
- (4) This reconnaissance established an accurate survey grid for future reference of charges in the channels.
- (5) The Army "Anglo", staff used on the reconnaissance became unserviceable very quickly in the humid environment due to age and difficulty of carriage.
- (6) The allowances were mishandled due to interdepartmental misinterpretation.
- c. Proposed Task.
  - The long task duration will be demanding personally and professionally. This will require carefully selected personnel.
  - (2) There is no resupply readily available, therefore, the team must deploy totally self sufficient.
  - (3) New Zealand personnel will find Tokelau food very monotonous and unsubstantial for the work required. Fresh rationing is required from stocks take to Tokelau, a fridge approximately 2 m<sup>3</sup> is also suggested.
  - (4) An airtrack drill and compressor are required for the execution of the tasks.
  - (5) European style accommodation for the team will foster a good rapport amongst the team members and ensure a degree of privacy.
- d. Shipping.
  - The shipping schedule to Tokelau is very limited.
  - (2) The team will require a large deck area for storage of cargo.
- e. It would be beneficial for personnel selected for the team to be given a pre-deployment lecture of Tokelau way of life, protocol and customs.
- f. The team will require time prior to deploying, for the procurement and packaging of stores necessary for the task.

- Buildance on the dealer for seet distingt indrovements, and required from a qualified Divit Engineer.
  - A test drill and giad of the core is
- ) This reconnelssance established on accurate survey grid for future reference of charges in the channels.
- (3) The Army "Anglo", start used on the Asconnetsaance became uncervicenble wary golokiy to the hundt environment due to age and enretsolty of carriage.
- (b) The alineances were algundled due to interusystemental also interpretation.

#### Proposed Task.

- (1) The long task duration will be description personally and professionally. This will require occurbily selected prependel.
- (2) There is no resumply readily available, the team must deploy totally sail surrigiant.
- (3) New Zealand personnel will find toketa for the very monatonous and unsubstantial for the work required. Freak rationing is required from stocks take to Tokeim. a fridge scorukimately 2 a<sup>2</sup> is who suggested.
- (4) Ad airtrack drill and compressor are rejorned.
  - (5) European style accommonstion to the team will fester a good report amongst the team

#### -ghiggins ...

- (1) The shipping subsdule to toketas (1) Italied.
- (2) The tran will require a large deck will (2)
- a. It would be beneficial for personant lecture of ine team to be given a pre-deployment lecture of Takelau way of life, protocol and costone.
  - F. . Une team will require time print of fur the procurement and packaging af stores necessary for the same.

g.

Timi task	ings.	The following are the timings for each
(1)	Ataf	<u>u.</u> To remove:
	(a)	27 men for 40 days.
	(b)	800 m <sup>3</sup> In loose piles (using local labour) 20 men for 40 days.
	(c)	900 m <sup>3</sup> Of rock:
		(i) drilling of boreholes - 7 days.
		(ii) Blasting - 29 days.
(2)	Nuku	nonu. To remove:
	(a)	1450 m <sup>3</sup> From channel (using local labour) 37 men for 80 days.
(3)	Faka	ofo. To remove:
	(a)	1000 m <sup>3</sup> from channel (using local labour) 25 men for 80 days.
	(b)	240 m <sup>3</sup> In loose piles (using local labour) 24 men for 10 days).
		1500 m <sup>3</sup> Of rock:
		(i) drilling of boreholes - 11.5 days.
		(ii) Blasting - 37 days.
(4)	Tota	l Time for Task at Atafu. 59 Days.
(5)	Tota	l Time for Task at Fakaofo. 93 Days.
(6)	Tota Comp	l Number of Days of Work Required to lete Both Tasks. 152 Days.
(7)		l Time on Deployment. (Arrive Apia, rtake tasks and depart Apia for New

#### RECOMMENDATIONS

Zealand). 174 Days.

55.

- The following points are recommended:
- a. RNZE undertake the task of improving the reef channels at Atafu and Fakaofo.
- b. No work commences on the improvement of channels until the locals have removed the infill of fines and necessary piles of rubble.

- (6) Tetal Number of Days of whix sequilate (d) Ecomplete Both Lasks. 152 Days.
- (7) Total Time on Englayants, Include Aproximation and depart Aproximation for Demarkation (7) 174 Depart Aproximation (7) 174 Depart.

#### STATTAGNEMODITICS

The following points are recommended;

- Raze undertake the task of inproving the real
- . We work connentes on the improvement of fines until the locals have removed the infill of fines and necessary giles of rubble.

- d. The purchase of one x P375 portable compressor, 4 x wheeled, adjustable tow bar, c/w rubber hose, steel piping and spares be initiated as soon as possible.
- e. A programme of routine maintenance be established. This could be overseen and directed by the Public Works organisation.
- Rubbish is no longer allowed to be disposed of in the reef channels.
- g. The schedule of the dates of charter for the cargo ship be organised to coincide with the proposed movements of the team.
- h. The task personnel should concentrate for a period of approximately four weeks prior to departure for Tokelau. This period should be used for:
  - briefings;
  - (2) checking of stores; and
  - (3) familiarisation courses on new equipments and refresher courses on trade related skills.
- A good standard of accommodation be made available for the team whilst in Tokelau.
- j. A cook should be included in the team complete with 'tools of the trade' and European style fresh rations. A commercial style refrigerator approximately 2 m<sup>3</sup> is also recommended.
- k. The suggested stores list at Annex O be considered in more depth because of the requirements for the team to be self sufficient.
- 1. On future reconnaissances of this nature:
  - (1) the survey team should include:
    - (a) one x officer,

m .

- (b) one x surveyor (tradesman),
- (c) two x RNZE personnel, and
- (d) one x Civil Engineer (to assess the locals' requests and offer guidance for the final designs).
- (2) Arrangements are made for the required equipment and stores for test drilling and blasting be made available.
- A modern, light weight staff be introduced to the Army to replace the current stock of outdated items. A suggested replacement is:

/(1) the

- 4 x ubseles, adjustable tou ber, o/b rubber hose, steri piging and sparse be initized so seen as passible.
- A programme of routine aniniarance on verabilitant.
   This could be sverseen and director by the Public Morke organization.
- . Rubbish is no langer slicest to be disposed of in the
- The achedule of the dates of charter for the pergrase antp he organised to coincide with the pergrased movements of the team.
- The test personnel should concentrate for a period of approximately four usexs orier to departure for Takelay. This pariod should be used for:
  - (1) briefings:
  - (2) chacking of storms; and
- (3) familiarisation courses on new equipments and refresher courses on trade related exilia.
- A good standard of accommudation be made available
- A cook should be included in the team complete with 'tools of the trads' and European style fresh rations. & commercial style refrigerator approximately 2 m<sup>2</sup> is also recommended.
- K. The suggested stores list at smith to the in more depth bacause of the requirements for the them as he he half sufficient.
  - no future reconcitances of this netbil.
    - anning erhous mest Askans but (1)
    - seatharrs -----
    - - is . raundered 32NH 2 and (3)
- (d) one a Civil Engineer (to assess locale' requests and offer guidence for the final designs).
- (2) Arrengements are made for the realing and blagting ment and stores for test drilling and blagting as mode available.
- A modern, light weight start no introduced it as Army to replace the current stock of outdoted frees

- (1) the 5 m staff produced by 'MIZOGUCHI MFG' CO LTD, JAPAN. It comes complete with nylon carry bag, is easy to observe and has three telescopic extensions. This is currently used by Ministry of Works and Development.
- n. Survey equipment be purchased for Tokelau and periodically used to monitor the infill of the channels.
- o. The personnel selected for the team are considered with the following in mind:
  - compatibility;
  - (2) leadership;
  - (3) knowledge of explosives; and
  - (4) personal home life.

## ENGINEER RECONNAISSANCE REPORT

## ON ENGINEER WORKS REQUIRED

## TO IMPROVE THREE EXISTING REEF CHANNELS

## ON TOKELAU ISLANDS

## SECTION A - ATAFU

### General

1. The reef channel at Atafu has been developed, using explosives from an existing natural channel entrance. The last work done on the channel was in 1979 when coral heads, causing obstructions in the channel entrance, were blasted. Atafu has an excellent concrete wharf at the end of the channel.

### Statistics

 Atafu reef channel is on the north-western side of the atoll at Vao Island (Atafu Village).

Serial	Subject	Description	Referring Appendix to Annex I
(a)	(b)	(c)	(d)
	Channel		
1	Magnetic Bearing	4340 pi	1
2	Length	140 m	1
	Datum		1. 2. 3
3	Description	Top of LH Mooring Bollard	1, 4
4	RL	100.00	1, 4, 5
5	Distance to SCL	32.6 m	1, 4
6	Magnetic Bearing to SCL	2680 ø	1, 4
	Survey Control Line		1000
7	Magnetic Bearing	4340 m/	1
8	Number of Points * Surveyed	16	1, 4
	Cross-Sections		
9	Magnetic Bearing	5940 ø	1
10	Number of Cross- Sections	15	2, 3

/Improvements



Serial	Subject	Description	Referring Appendix to Annex I
(a)	(b)	(c)	(b)
11	Improvements Requirements	Widen channel on RHS from cross-section E	1, 2, 3
		Widen entrance on RHS	
		Widen entrance on LHS	
12	Magnetic Bearing of Excavation	LHS 3650 ø RHS 4780 ø	1
13	Length of Excavation	LHS 58 m, RHS 45.6 m	1
-	Tide Levels		
14	High Tide	RL 100.257	1, 4, 5
15	Low Tide	RL 99.107	1, 4, 5
16	Spring Low Tide	RL 98.807	1, 4, 5
17	Other structures	Wharf RL 100.157	1,5
18	Distance to closest	56 m (Copra Shed)	1
19	Survey references points	Nil, use magnetic bearing and distance No permanent marks available	
20	Other tasks	Removal of rock rubble piles and excavation of fines	
	Volumes for Removal		
21	Rock	898.15 m <sup>3</sup> say 900 m <sup>3</sup>	1, 2, 3, 7
22	Fines	510.45 m <sup>3</sup> say 550 m <sup>3</sup>	1, 2, 3, 4, 7
23	Total	1408.6 m <sup>3</sup> say 1450 m <sup>3</sup>	1, 2, 3, 7

## Detailed Survey

3. The survey of the Atafu Reef channel was conducted during the period 3 - 11 March 1985.

4. Cross Sections A - L were accurately surved using a level, staff, tape and compass. Sea conditions past Cross-Section L did not allow for any accurate surveying due to swell and surge of waves. Cross-Sections M, N and D were reconnoitred using tape and compass only. To compensate for the lack of accuracy a percentage accuracy ratio must be applied to each of the Cross-Sections depending on the type of method used to gain the Cross-Section data. Cross-Sections A - L must be considered applying

- 2 -



a + 10% factor and Cross-Sections M, N and O applying a factor of + 20%. The removal of all rock at Atafu requires drilling and Diasting. The coral has an extremely hard crust (see Annex E), and in attempting to place permanent survey marks, consisting of plastic discs secured by bridging spikes, the spikes did not penetrate the coral at all but bent very easily. All drilling at Cross-Sections M, N and O will be under water at approximately 0.1/0.2 m plus wave surge.

### Air Tools

5. When determining the type of drilling equipment to be recommended for the task, the distance between the site for the compressor (above high tide level) and the closest point to be drilled, must be considered. Assuming the compressor will operate from wharf, there is a distance of 80 m to the closest point to be drilled. Compressed air piping, rather than rubber, should be considered for this because of the high psi loss due to friction over a large distance in rubber pipes. The depth of infill, or kilikili, in the Atafu channel was not auccurately measured, but it is assumed, using local knowledge and Annex D, to be greater than 1.0 m deep. This means that all excavation required to achieve the LT - 1.2 m minimum depth specification, does not require any drilling or blasting. Deepening of Atafu channel is therefore not considered an Army task. See Appendices 2, 3 and 7 to Annex I.

#### Improvements

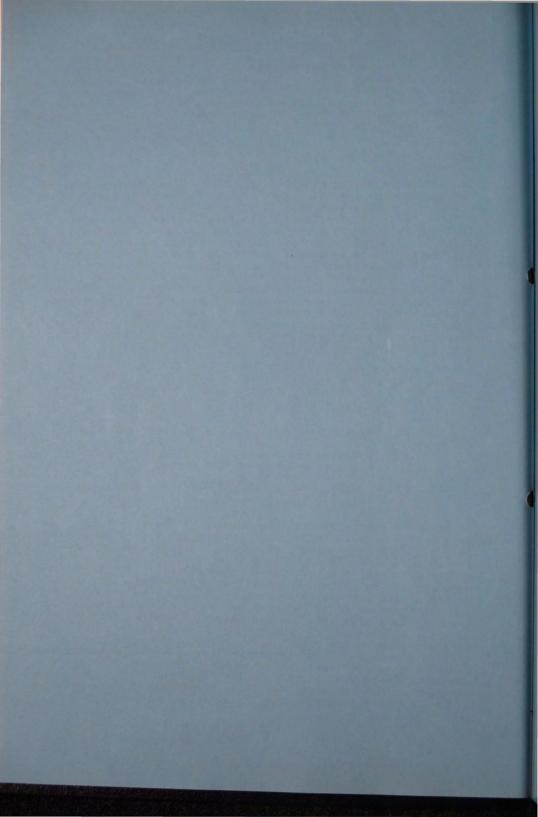
#### 6.

Improvements of the Atafu reef channel are:

- a. widening an RHS by 2.0 m from Cross-Sections E I,
- b. widening the channel at the entrance on LHS at magnetic bearing of 3650 Ø, and
- c. widening the channel at the entrnace on RHS at magentic bearing of 4780 ø.

These improvements necessitate removal of the rock rubble piles on RHS of channel. These piles are debris ex-original construction and were manhandled into piles, therefore no problems to remove (see Annex I, Appendices 1 and 2). The rock piles are currently on the extreme edge of both sides of the channel and consists of approximately 400 m<sup>3</sup> each. When observing the action of the sea as it moves from High Tide to Low Tide, it appears that the receding water drags large quantities of fines from the rock pile into the channel. The fines appear to be the products of erosion upon the rock piles and, therefore, are being constantly produced through wave action. At High Tide, the water totally submerges all of the rock piles. Additional depth would be maintained if dumped rubbish was not discarded into the channel. There was no evidence that any form of routine maintenance was being periodically conducted. If this was done it would ensure continued serviceability of the channel.

/Accommodation



### Accommodation

7. There is a European style guest house on Atafu for use and accommodation of official guests. The Administration Officer and his family are presently occupying it until their house is built. A second guest house, 'Modulok' type, is to be completed construction by the end of June 1985. This will include 2 x bedrooms (4 x beds), lounge, kitchen, bathroom, shower, flush toilet, electric lights and power (when generator is operating), able to sleep up to 10 personnel. This would be made available for use by the Aid team.

### Resources

8. The Aumaga will provide local labour as and when required. The only pieces of machinery on the Island are 2 x small concrete mixers. A quantity of hand tools in various states of repair are available for general use.

### Explosive Storage

9. There are no buildings available for the storage of explosives. The most suitable site for a magazine is on the northern side of Atafu Village approximately 250 m into the bush. Village occupies all available cleared area. Locals keep their pigs nearby, this would mean a standing patrol to be kept on magazine 24 hours a day. The local people are extremely inquisitive.

### Explosives Required

10. See Annex L.

#### Stores Required

11. See Annex O.

### Manning

12. See Annex P.



## ENGINEER RECONNAISSANCE REPORT

## ON ENGINEER WORKS REQUIRED

## TO IMPROVE THREE EXISTING REEF CHANNELS

## ON TOKELAU ISLANDS

## SECTION B - NUKUNONU

#### General

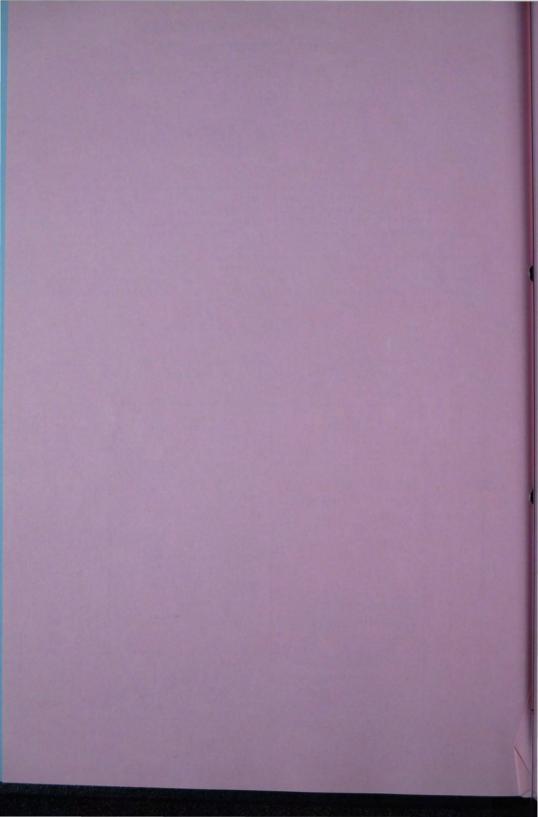
1. The Nukunonu reef channel is in good condition and serves the Village of Nukunonu well. The channel is an area of the reef where the sea conditions are apparently always calm. The channel is relatively wide (average approximately 30 m) and has never caused any problems for access into and out of the channel. Towards the LHS of the channel, the movement of the sea water at high tide has scoured out a deeper channel (see Appendix 1 to Annex J). This deeper area of the channel is used particularly by the boats at low tide (see Appendix 2 to Annex J). The continual silting up of the channel due to sea action is a problem.

### Statistics

2. The Nukunonu channel is situated on the south western side of the atoll at Nukunonu Island (Nukunonu Village).

Serial	Subject	Description	Referring Appendix to Annex J
(a)	(b)	(c)	(d)
	Channel		
1	Magnetic Bearing	3960 Ø	1
2	Length	130 m	1
	Datum		1
3	Description	Bottom RH corner of footpath	1
4	RL	100.00	1
5	Distance to SCL	36 m	1
6	Magnetic Bearing to * SCL	4950 m	1
	Survey Control Line		
7	Magnetic Bearing	3960 ø	1
8	Number of Points Surveyed	4	1

/Cross-



- 2 -

Serial	Subject	Description	Referring Appendix to Annex J
(a)	(b)	(C)	(b)
	Cross-Sections		
9	Magnetic Bearing	2360 m	1
10	Number of Cross- Sections	4	3
	Improvemets		
11	Requirements	Locals mentioned widening at RHS entrance - absolutely no need. Requires deepening particu- larly at shore	1, 2
	Tide Levels		
12	High Tide	RL 99.889	1, 3
13	Low Tide	RL 98.2	1,3
14	Spring Low Tide Spring High Tide	RL 98.00 RL 100.519	1,3
15	Other structures	Nil	
16	Distance to closest building	21 m (Stores Fale)	1
17	Survey references points	Nil, use magnetic bearing and distance no permanent marks available	
18	Other tasks	Prevention of wave action dragging coral beach sand from beach into channel	1
	Volumes for Removal	The second second	
21	Rock	Nil 7	1, 2, 4
22	Fines	1426.8 m <sup>3</sup> say 1450 m <sup>3</sup>	1.
23	Total	1426.8 m <sup>3</sup> say 1450 m <sup>3</sup> - only for area detailed at Appendix 1 to Annex J	1, 2, 4

## Detailed Survey

3. The survey of the Nukunonu reef channel was conducted on 28 February 1985. The survey was conducted using survey equip-ment. A SCL was established on the RHS of the channel but is



submerged at all times. The Cross-Sections shown at Appendix 2 to Annex J and the volume calculations at Appendix 4 to Annex J, must have an accuracy ratio of + 10% applied.

4. The only improvement required at Nukunonu is deepening of the channel, particularly at the shore (see Appendix 2 to Annex J). This inclves the removal of fines only and is therefore not considered an Army task.



## ENGINEER RECONNAISSANCE REPORT

## ON ENGINEER WORKS REQUIRED

## TO IMPROVE THREE EXISTING REEF CHANNELS

## ON TOKELAU ISLANDS

## SECTION C - FAKAOFO

### General

1. The reef channel at Fakaofo was constructed by RNZE during 1963/64. Due to a poor reconnaissance and subsequently, a poor estimation of time, work and explosives requirements was done. The 1963 team, led by Lieutenant D.W.S. Maloney, left Fakaofo having not completed their task. Work was continued on improving the channel by RNZE, during the following 24 months. The cause of the problem at Fakaofo is the incorrect alignment of the channel to the breaking waves, causing difficulty in manoeuvreing boats in the channel entrance. The construction of the channel at this angle was intentional to stop the wave surge up channel. This appears now to have been an incorrect judgement and was made prior to the channel construction commencing.

2. During 1981, a team led by Mr P. Asher, constructed an additional channel on Fakaofo to that existing at Fale. This new channel was constructed to the north west of Fakaofo atoll on the northern side of the reef at a cost of NZ\$75,000. It linked the Island of Fenua Fala to the open sea.

3. Fenua Fala is a large Island approximately 1.5 km north west of Fale. It is a spacious Island and accommodates approximately 100 people of the Fakaofo population. Fale however, is a very small Island and is incredibly over crowded. It is reported to be the most densely populated Island in the Pacific Ocean, being the size of less than 2 x rugby fields, it has a population of over 500 people.

4. The continued inhabitation of Fale stems back to it being the tradition 'capital' of Fakaofo. Over recent years, the Fakaofo population has been encouraged to move to Fenua Fala by the Ministry of Foreign Affairs.

5. Previous aid teams have constructed the only school and hospital there and the recent construction of a new channel makes Fenua Fala a far more desirable place to live. However, the locals will not move and have begun to outlaw those who have begun living in Fenua Fala. They are now not allowed to voice their opinions individually at the weekly meetings of the Taupulaga and the number of their respresentative Elders has been reduced.

6. The new channel has proved to be excellent in all respects, such as:

a. construction;

b. siting; and

A LAND TO A COLORAD AND AND COMPLEX

To the set of the set

2. Oursing 2007, a tosa led op Mo P, Ammar, constructed an additional channel un Fiscolo to thet colating at Falm, This has channel was constructed to the south unit of Famoli stall on One noteners side of one such as a cost of MEET, COR. Th it need inter laight of Famue Fale to the spect of MEET, COR. Th it need inter

3. Penus Fale is a large bitand antroximitely 2 % is not used of fale. It is a position faibled and accomposite a spractmetrix unait initial of the freeship was time and a sprached to be the qual unait is increatibly was time and in the sprached to be the qual unait populated interacts in the sprached acted the also densit here is a supple fields. It has a something of over 500 people.

Line constrant intestitution of fals state the in it and the tradicion to be been should be been to fals and false to securize to he hear should be been to fals and the Ministery of Faraign offerre.

5. Provide and the rector construction at a real restored the neepital there and the rector construction of a real restored the constant will not move and near begun to using the begun tiving in fame fais. They are now not allowed in value there is the near the second of the second of allowed in value restored and the neares of their respresentative fidere has been reduced.

the new common has proved to be eventione to etc manner.

## c. accessibility.

However, it is only permitted to be used in extreme emergencies, such as a life or death situation when the Fale channel is totally inaccessible. The Fenua Fala channel is therefore wasted. This indicates the abrupt and perhaps stubborn manner of the local people. They believe that their points of view and opinions are always correct and this often means it is difficult to get them to accept any outside advice. See para 26 of Part II.

- 2 -

#### Statistics

7. The Fakaofo channel is on the south western side of the atoll at Fale Island (Village).

Serial	Subject	Description	Referring Appendix to Annex K
(a)	(b)	(c)	(b)
14	Channel	7.5 m	
1	Magnetic Bearing	4200 př	1
2	Length	180 m	1
	Datum	The Destaution of the	
3	Description	Front RH corner of copra shed on wharf at ground level	1,4
4	RL	100.00	1, 4, 5
5	Distance to SCL	11.5 m	1, 4
6	Magnetic Bearing to SCL	5030 pi	1, 4
	Survey Control Line		
7	Magnetic Bearing	4320 pí	1
8	Number of Points Surveyed	18	1, 4
	Cross-Sections	and the second second	and the strends
9	Magnetic Bearing	2720 pi	1
10	Number of Cross- Sections	18	2, 3
actor a	Improvements	Widen channel on LHS	1, 2, 3
11	Requirements	from patch of concrete on LH channel side at Cross-Section	

#### AGTTTW/ GRADIE

Housever, it is only densitied to be used in actman chargemeirs. auch as a life or desir situation when the fals channed is upsted. This indicates the scrupt and perman subbirs measure of the local neugla. They solve and this offer points of view and opinions are also a sourcet and this offer many is difficult to get them to accord any suffice advisor, the part is of more trained by a source of a sourcet and the offer source is of more to get them to accord any suffice advisor, the part is of more trained by a source of the source of the source of the source of a source of the source of the source of a source of the source o

#### Statistics

7. The Faxaofe channel is an the south marian aide of the

Olephia of tenant

Serial	Subject	Description	Referring Appendix to Annex K
(a)	(b)	(c)	(b)
12	Magnetic Bearing of Excavation	3950 ø	1
13	Length of Excavation	118 m	1
	Tide Levels	the Constraint of Land	
14	High Tide	RL 99.944	1, 4, 5
15	Low Tide	RL 98.894	1, 4, 5
16	Spring Low Tide	RL 98.694	1, 4, 5
17	Other structures	Channel has concrete area around three x sides up to 21.5 m up channel. Recently constructed sea wall 2.0 m high. Old derrick on wharf.	1
18	Distance to closest building	6.6 m	1
19	Survey reference	Nil, use magnetic bearing and distance, no permanent marks available	
20	Other Tasks	Removal of rock rubble pile and excavation	2, 3, 4, 6
	Volumes for Removal		
21	Rock	1454.75 m <sup>3</sup> say 1500 m <sup>3</sup>	1, 2, 3, 7
22	Fines	969.15 m <sup>3</sup> say 1000 m <sup>3</sup>	1, 2, 3, 4, 7
23	Total	2423.9 m <sup>3</sup> say 2500 m <sup>3</sup>	1, 2, 3, 7

- 3 -

## Detailed Survey

8. The survey was conducted during the period 13 - 15 March 1985. An accurate survey was done using a level, staff, tape and compass for Cross-Sections A - M. Sea conditions past Cross-Section M did not allow for any accurate surveying due to the swell and surge of waves. Cross-Sections N - X were reconnoitred using a tape and compass only. To compensate for the lack of accuracy, a percentage accuracy ratio must be applied to each of the Cross-Section data. Cross-Sections A - M must be considered applying a + 10% factor and Cross-Sections N - X applying a factor of + 20%. Removal of all rock at Fakaofo requires drilling and blasting.

Permanent

#### Vavau8 Dellada0

B. The survey are conducted during the while a terr, case and compare. An accurate adjusted with a survey are conditioned at the compare adjust of the survey of a compare adjust of the look of the survey of a survey of the look of the look of the compare adjust of a sucrease survey of a survey of the look of the look of the compare adjust of a survey of the look of the compare adjust of a survey of the compare adjust of a survey of the look of the compare adjust of a survey of the compare adjust of adjust of adjust of the compare adjust of adjus

 Permanent survey marks were intended to be placed at Fakaofo, but the coral here proved to be too hard.

- 4 -

10. All drilling at Cross-Sections N - X will be under water approximately 0.1 - 0.2 m plus wave surge.

#### Air Tools

11. The minimum distance between compressor (above High Tide) and the closest point to be drilled must be considered when determining loss of psi due to frction of rubber hose. At Fakaofo the compressor can be located near the 'pole' (see Appendix 1 to Annex K) as the coral here is always above High Tide mark. The closest point of drilling is at Cross-Section H, approximately 40 m away. This distance will require alternative piping of compressed air other than rubber to avoid excess loss of psi.

12. Local knowledge and reference to Annex D suggests that the infill of fines in the channel is in excess of 1.5 m deep. No blasting or drilling is required to enable efficient removal of fines. Excavation of channel to achieve minimum required depth of Low Tide - 1.2 m is not considered an Army task (see Appendices 2, 3, and 7 to Annex K).

#### Improvements

13.

- Improvements required at Fakaofo (Fale) channel are:
  - a. widening of channel on LHS at magnetic bearing of 3950 ø from a patch of concrete on the LH side of channel to sea. This bi-sects a relatively small pile of rock rubble of approximately 240 m<sup>3</sup>. This will be required to be removed prior to any work commencing on the task.

14. Regular Routine Maintenance of clearing fines from the channel is not being undertaken by the locals. This is a necessary requirement to keep the channel serviceable.

#### Accommodation

15. There are two large European style guest houses on Fale and three on Fenua Fala. They all consist of one large room with a capacity to sleep 12 pople comfortably, and a flush toilet. There are no cooking or washing facilities. The Taupulaga stated that Guest House accommodation would be made available for an aid team.

#### Resources

16. Local labour, as and when required, will be provided by Aumaga. No other resources can be relied upon.

/Explosive

2. Permanent server early ours interested to be placed at

10. All definiting at CreaseSpatians N - X will be ones

#### ALCONT TIA

11. The striken distance between to must be found with tide) and the closest point to be contribed and be toundered when determining land of one to failed an entry only (and hopendix 1 to homex 5) as the corei ware in allow and a single (and tide mark. The closest point of stilling is at Group-Westion H, approximately 40 a surv This distance will sequire distance piping of compressed air other than summer to such another lose of pat.

12. Local knowledge and relating in anomale of 1.2 w deep. the infill of fines in the chevines in in anomale afficient remainer the blacking at draining is sequired to entable afficient remainer of fines. Excession of the month is considered of area (and months of the 1.3, and 7 to Annax M).

#### Imoroveneots

There is a state of the state o

The sole of the set of the set of the set of the sole of the sole

14. Argular Routine Haintenence of clearing in the to be of the locale. While is a comment is new the channel serviceedia.

#### Accelenadetion

15. There are the large branches of one large rank and three on Femma Fals. They all consist of one large with a capacity to also 12 ough a confortably, and a fluch tollat. There are no consting or maching facilities. The Taugulage are to all that Guest found accommodention would be main and the set and and team.

#### Restdorozes.

### Explosive Storage

17. Due to overcrowding explained in paragraph 3, the explosives must be stored off the inhabited Island. There is an expance of reef that remains above water level to the north west of Fale (see Annex C), the area detailed as 'old hospital' is now the Administration Block. The suggested magazine site is on a isolated area of this expanse of reef.

### Other Considerations

18. The locals at Fakaofo also believe that there is insufficient concreted area at the end of the channel to allow for efficient loading/off loading of boats. They said that they also want about 7.0 m of the channel backfilled then concreted. After some advice and pursuasion, the Elders were discouraged from this course of action and were satisfied with the suggestion of concreting a larger area of the reef on both sides of the channel.

### Explosives Required

19. See Annex L.

Stores Required

20. See Annex O.

#### Manning

21. See Annex P.

#### Shitopive systerics

is any the summaries of realisted in perganete 1, and another with the second of realisted interaction in the most of fair (are formation of the second late of the second in any the second real of this explanated angents site is on a isolated seas of this explanate of your.

#### anolistigoranoi taulu

18. The loads of feleofs allow allow their there is insufficient concreted offs and all the and all the channel to added they elso uses about 7.0 a of the channel to outlind them concreted. After none advice and estauming of the figure with distributed from this course of estauming and ears wellefted with the suggestion of concreted a turger area of the real so bono cides of the channel.

#### Explosives sevieolox3

See Annex L.

Stords Required

See Annax 0.

#### gainnam

See Annex P.

lephone: Wellington 726-499 Extension 8464, 8465

BOULLE



TOKELAU RECON REPORT DATED C MAY 85 Chief Engineers Office, Army General Staff, Defence Headquarters, Private Bag.

15 Feb 55

w B frendequal Sence Construction Engineers Miniety of Works and Development 2.0. Bux 12001 helington

Veca Amian,

TO KELAU TSCANDS RECONNAISSANCE TERMS OF REFERENCE : LT ARSKINNER

References: A. Conference Ministry of Foreign Affire 6th Floor 1500 hours 10 Feb 55 B. Telecon Mr Davied Truylor May Reg Barnett of 15 Feb 85

he recommansame task to the Tokelan 1. involves Referre primaily in two main Islands

ancus

deepening and widening to 20/25 feel, he reef channels at Fakaofo (Fale) and Atafu; and

b. dismantling and remaining to deep water a large wreck on Fakaofo ( The AJ SOKILA) and an older small word on Atrifa (a fishing veasel). 12. I underit

I I understand also that the Tokelan anthenties longh of satisfictory width, may need despening It the storeline. An opinion on that vegenment small also be included in the Defense Report. Attached is a copy of Cabinet Minute 5/2/25, sub paras b(i) and it being of relevance This veconnaissance. A copy is also attached Referre HO (Poling Branch) Whente 23/19/1 dated Teb sis, the contents are self-explanating. The members of the before verannessame and are ht AMSRune, RNZE and CPO John Kearney JZN. Adrian Shune has been adviced to seek per judame and assertance as regards to a final dreign parameters of the feel channel register. In this respect the expect advice of a leter Ushes would be unlined. had in consultation with the Bob Sueddon and " Malidum Faulls of Macuo, he design report is be prepared by Macuo. Needlass to say, Adrian ad yourself togethis with Pater Asher should establish close working velationship to enable Adrian sumes to prepare a priorbility report on Perfunc-indeclaking the work desired, subject to confirmate indeclaking the work desired, subject to confirmate Adrian Stumer has been for the advised that weeks) if he precises the requirement. I have 1 to atma

in the Takelans for sufficient them to conside a shar to report an the ingread of administrative considerate L'med to be addressed when manting a team for conded periode an works projects. The draign promode ud methodology for undertaking the tacks I'm hapeful ud methodology for undertaking the tacks I'm hapeful ut he will establish whilst you are in the Toleclaus I I trust the aforegoing helps to cleinfy any satisfanding 'terms of reference' questions that you my have . Determine Central Phone Lines (RABARRET.) or LE Cabruet Minute 85/2/25 Enclosures 2. Orfenne HO (Polung Branch) Minute 23/19/1 dated 7 Feb 55 loyies to. Munishry of toning Affairs Bruate Bag Wellington Lt AM Skinner, RNZE 25 Engineer Support Squadran Lunton Military Camp

8 2 35



MINUTE

Policy Branch

23/19/1

MIVIVER A

DNOP Col Ops

## DEFENCE ASSISTANCE TO TOKELAU

Reference: Cabinet Minute 85/2/25 (copy attached), sub paras b(i) and (ii)

1. This is to confirm the informal requests you have received already to provide one naval officer and one Army engineer to visit Tokelau between 25 Feb and 3 Mar 1985. The charter vessel "AVONDALE" will leave and return to Apia on those dates and the Ministry of Foreign Affairs has reserved accommodation on it.

2. <u>Objective:</u> to prepare a report for the Minister of Defence on the feasibility - using Defence resources to the maximum extent consistent with budgetary provisions and established Defence commitments - of:

- a. deepening, and widening to 20/25 feet, the reef channels at Fakaofo (Fale) and Atafu; and
- b. dismantling and removing to deep water a large wreck on Fakaofo (the "AI SOKULA") and an older small wreck on Atafu (a fishing vessel).

3. Although it is not mentioned in the Cabinet Minute, the Tokelau authorities are also concerned that the channel on Nukunonu, though of satisfactory width, may need deepening at the shoreline. An opinion on that requirement should be included in the report.

4. A simultaneous reconnaissance is to be carriedout by MWD enrineers, accompanied by a blasting consultant, Mr Peter Asher. Their main interest is in the feasibility of constructing coral airstrips on the atolls. If proceeded with, that too may become - at least in part - a Defence task. In any case, expertise on all three tasks should be freely exchanged by the two elements of the reconnaissance.

/5. The report

370/010

Polsey Branch

010P

## DEFENCE ASSISTANCE TO TOKELAD

# References Cabinat Rinute 85/2/25 (copy strached), aut

 This is to confire the informal requests you have received already to provide one nevel officer and one Arav angineer to visit Tokelau between 25 feb and 3 Mar 1985.
 The charter vessal "AVONDALE" uill leave and return to apia on those dates and the Ministry of Foreign Affairs has received accommodation on it.

 <u>Objective:</u> to prepare a report for the Minister of Oefence on the feasibility - using Defence resources to the maximum extent consistant with budgetary provisions and established Defence commitments - of:

despaning, and videning to 20/25 fuel, the reat

b. dismantling and removing to deep vatat a large wrack on Fakaofo (the "AI SOXULA") and an alder anall wrack on Rhefu (a fishing wassai).

3. Although it is not manifored in the tabinet minute, the Tokelau authorities are also concerned that the channel on Nukumonu, though of satisfactory width, may need deepening ab the shoreline. An opinion on that requirement should be included in the report.

A. A simultaneous reconnelsance is to be carried at by MuD on inders, accompanied by a blasting compultant, mp Peter Asher. Their sain interast is in the fassibility of constructing corei siretrips on the stalls. If proceeded ulth, that too any booses - at least in part - a Defence tast. In any case, separtire on all the reconsistence.

STOCAT BOT .2

5. The report should be forwarded please via Staff channels to this Branch, for preparation of a covering submission to the Minister. It is believed that both Navy and Army have carried out reef-gapping assignments in Tokelau in the past. Reference to relevant reports may assist the recon team.

6. It is desired that the two officers be given a briefing by this Branch and the Ministry of Foreign Affairs before they depart. Could arrangements please be made for them to be in Wellington in the week beginning 18 February at a place and time to be discussed. Phorographs of the two wrecks will be available then.

7. At this stage, financing of these projects has still to be agreed, but MFA has tentatively undertaken to meet the costs of the reconnaissance. Travel to and from Western Samoa, by civil air, will be coordinated by MFA.

HININEX H

(J.A. FISHER) SAO(Pol)I

7 Feb 85

× wow soit for 1 pm

Report plan to

His Granch, Du

632, NT 12+5

on ved vestang 13 7-6 in MFA. b. The report should be forwarden viewen via Ltaff of manuals to this Standy, for promission of a securing authorsay have an via the finister. It is buildened that beth Havy in the part, Affarence to reprogram antiputeries in fossion recom tead.

3. It is desired that the two affibers be given a briafing by this Branch and the Ministry of Foreign Affairs them to be in Wallington in the work beginning 18 "Minung to at a place and time to be discussed. Photographs of the two wracks will be available them.

to be agreed, but MA has tentetively undertaken to area still dests of the reconnelssence. Travel to and from Vesterp Sames, by civil sir, will be contdinated by MFA.

38 de7 1

CABINE RECEIVED CM 85/2/25 CM 85/2 CM 85/2/25 CM 85/2 CM 85/2

> Minister of Defence Minister of State Services

REPORT ON OVERSEAS VISIT : RT HON DAVID LANGE

At the meeting on 28 June 1985 Cabinet:

- a noted the report attached to CS (85) 35 on your visit to Tokelau;
  - invited the Minister of Defence to provide you with a report on the feasibility of the Armed Services:
    - i widening the narrow reef passages at Fakaolo and Atafu;
    - ii removing two wrecks which are causing fish poisoning;
    - iii providing surveillance of the Exclusive Economic Zone and enforcement patrols;

c noted that copies of your report will be referred for appropriate action or consideration to the Ministers of Foreign Affairs, Defence, State Services, Transport and Pacific Island Affairs.

Recell

Secretary of the Cabinet

b

The Advances of any be refused only advance to the total of a state of a s

- 1 widening the narrow reaf passages at Fakaola and Atafut
  - 11 removing two wrecks which are causing fish polsoning;
- 111 providing surveillance of the Exclusive Economic Sone and enforcement patrols;

noted that copies of your report will be referred for appropriate action or consideration to the Ministers of Foreign Affairs, Defence, State Services, Transport and Pacific Teland Affairs.

Sacretary of the Cabinet



ANNEX B TO TOKELAU RECON REPORT DATED 10 MAY 85

118/13/109/1

#### MINISTRY OF FOREIGN AFFAIRS

WELLINGTON

20 February 1985

Lieutenant A Skinner New Zealand Army C/o Officers Mess Linton Military Camp

Dear Lieutenant Skinner

I am authorised by the Minister of Foreign Affairs to offer you an assignment as a short term adviser to report to the Ministry of Defence on the feasibility of deepening and widening the reef channels at Fakaofo (Fale) and Atafu.

Your assignment will be for the period 23 February-22 March 1985 and will be under the auspices of the New Zealand Development Cooperation Programme.

## BACKGROUND AND TERMS OF REFERENCE

The background to this assignment and the terms of reference for it are set out in Major R A Barrett's letter of 15 February to Mr Brian Prendergast, Senior Construction Engineer, Ministry of Works and Development which has been copied by Major Barrett to you. A copy of this letter is attached for your ease of reference at Annex A. In summary the reconnaisance task requires you to report to the Ministry of Defence on the following:

i deepening and widening to 20-25 feet the reef channel at Atafu.

deepening and widening the Nukunonu reef channel. ii

iii removing rubble from the existing channel at Fakaofo (Fale) and (i) realigning, widening (by 20-25 feet) and deepening it. <u>Or</u> (ii) investigating the development of the nearby natural channel.

Stat Alenged 02

Lieutenant A Sminnet New Zealand Army C/o Officers Meds Linton Military Camp

Inning Insucenterst

I am authorized by the Minister of Poteiner to report offer you an assignment as a short term adviser to despaning offer you an assignment as a short term adviser of despaning of the Ministry of Defence on the Fakaoto (Fale) and Atato, and uidening the real channels at Pakaoto (Fale)

Your assignment will be for the period 22 the New March 1985 and will be under the auspides of the New March 1985 and will be under the gramme.

UNALLY TREMS OF REFERENCE

The background to this assignment and interval reference for it are set out in Major B A Bariath's ister of 15 February to Mr Brian Frendercest. Senior Construction Envirest. Ministry of Works and Development which has been copied by Major Barratt to you. A cosy of which has been copied by Major Barratt to you. A cosy of this letter is attached to to transmore the toolowing: Annex A. Is summary the reconstigance on the following: for report to the Ministry of Defence on the following: to report to the Ministry of Defence on the following:

- i despendent of painebly bas painegeeb
- at Atalu-
- 11 despaning and within the sylaring channel at rataoin
- ili removing rubbis and (i) realigning, widening rine (raie) and (i) realigning it. Or (ii) investigating the antitical channel, development of the nearby natural channel.

It has been stressed that in looking at these options, you should consult closely with the appropriate elders. You will understand the importance of this.

The Office for Tokelau Affairs in Apia has advised that they have had a brief discussion on the question of reef passage clearance in the Pacific with Mr Godfred Shuma of the United Nations Centre for Human Settlements. Mr Shuma, a harbour engineer and based in Rarotonga has carried out similar reef passage work in the Cook Islands. He drew attention to the need for a very careful assessment to be undertaken before any decision on widening or deepening work is made. In particular, he emphasised the need to gather extensive comments from the local people on how the sea behaves around channels under various weather conditions. We would wish you to note Mr Shuma's advice.

You are aware that during the first sector of your assignment a Ministry of Works and Development team, accompanied by a Commission for the Environment investigating officer will be undertaking a concurrent exercise. The Ministry of Works team, comprising Mr Brian Prendergast, Construction Engineer and Team Leader, Mr Warwick Hills and Mr Peter Asher, have responsibility for preparing a design and construction proposal together with a firm estimate of cost of the establishment of a land based air service in Tokelau. The Commission for the Environment officer will advise and report on the social and environmental implications of this.

It has been agreed by your Ministry and the Ministry of Works that the Works' team will liaise closely with you on engineering aspects of your assignment, and that the design report will be prepared by the Ministry of Works. You will have opportunity to discuss how this aspect should proceed with the Ministry of Works team prior to your departure and during your journey together to Tokelau.

During the assignment in Apia and Tokelau, you should liaise with the Official Secretary for Tokelau Affairs. Mr A H Macey or whichever senior member of the Tokelau Public Service he may nominate to assist you. The Office for Tokelau Affairs is situated on Savalalo Street, Apia, Phone: 20-822 or 20-823.

#### CONDUCT

You will appreciate that New Zealand's Development Cooperation Programme, besides providing technical assistance to the partner government countries, also serves to promote goodwill and understanding. You should make every effort to reach an understanding of those people with whom you will be working and to develop a It has been stressed that in looking at these options, you atom the appropriate olders. You should consult olders under a this.

The Office for Taxelau Affeirs in Apia name name of they have had a brief discussion on the question of teat of they have had a brief discussion of the number of the defined shume of the United Mariana a marked and the mariana and based is Saratanda, has calrided and rimitar real passage work is Saratanda, bas asserted and to be undertaken before any deviation on a same tead of the converte set of the converted and the same deviation of the draw attention to the mod for a very carrier be asserted the made to a same tead of the converted and the same deviation of the converted and the same deviation of the draw attention to the mod for a very carrier be asserted to be undertaken before any deviation of the same tead the same deviation of the same deviatis devia

You are aware that during the first sector of in assignment a Ministry of Works and Development team, accompanied by a Consisten for the Environment investigating officer will be undertaking a concurrent assoring. The Ministry of Norks team, comprising Wr Brian Prendergest. Construction Engineer and Team teacher, Nr Warwick Hills and Mr Peter Asher, have responsibility for brendergest. Gonstruction proposal together with brender a design and construction proposal together with a firm estimate of cost of the establishment of a land based air service in Toksieu. The Commission for the Environment officer will, advise and respond. on the social Environment officer will, advise and respond.

It has been agreed by your Ministry and the you on Works that the Works ream will liaiss closely with you on engineering aspects of your assignment, and that the design report will be prepared by the Ministry of Works. You will have opportunity to discuss how this aspect You will have opportunity to discuss how this aspect should proceed with the Ministry of Works team priof to enough proceed with the Ministry of Works to Tokelau.

During the assignment in Apia and Tokelou Affairs, Mr lisine with the Official Secretary for Tokelau Public A H Macey or whichaver sonior member of the Tokelau Public Service he may members to assist you. The office for Tokelau Affairs is situated on Savalaio Street, Apia.

#### CONDUCE

You will appreciate that New salars technical Cooperation Programme, besides providing technical assistance to the partnar government countries, also assistance to the partnar goodwill and understanding of those make every effort to reach an understanding of develop a make every effort to reach an understand and to develop a rapport with them. I am confident that you will avoid any course of action which could adversely affect the success of your assignment or which would reflect badly on New Zealand's reputation overseas.

#### REMUNERATION

Details are attached at Annex B

We should appreciate receiving written confirmation of your acceptance of this offer of appointment on the terms and conditions set out above and in the attachment/s to this letter.

We should like to wish you a successful and enjoyable assignment in Tokelau.

Yours sincerely

Miller) (R

Director of External Aid

Encl

н

ANNEX B

- 3 -

rapport with them. I am confident that you will avoid any course of action which could advarsaly affect the success of your assignment or which would reflect hedly on New Zealand's reputation ovartaes.

REMUNESATION

Datally are attached at Annex D

We should appreciate receiving written confirmation of your acceptance of this offer of appointment on the terms and conditions set out above and in the strachmont/s to this letter.

We should like to wish you a successful and enjoyable

Konte Wruceterlà

ANNEX C TO TOKELAU RECON REPORT DATED (0 MAY 85

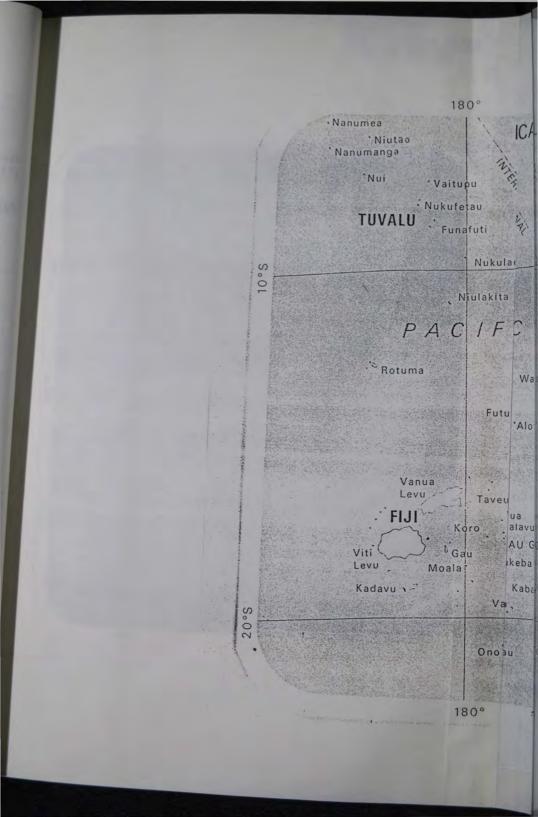
## MAPS

Attached as Appendices are maps of Atafu, Nukunonu and Fakaofo showing the reef channel sites and locations of the ship wrecks.

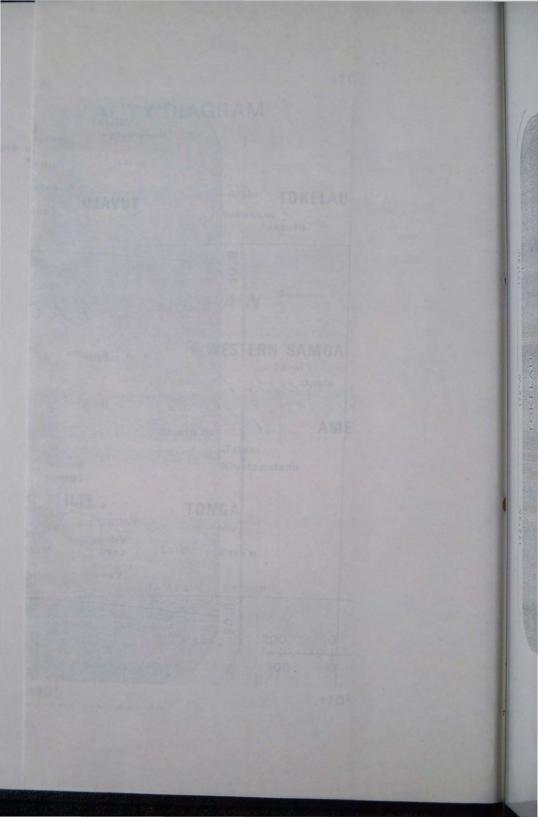
Appendices:	1.	Мар	of	Atafu	
-------------	----	-----	----	-------	--

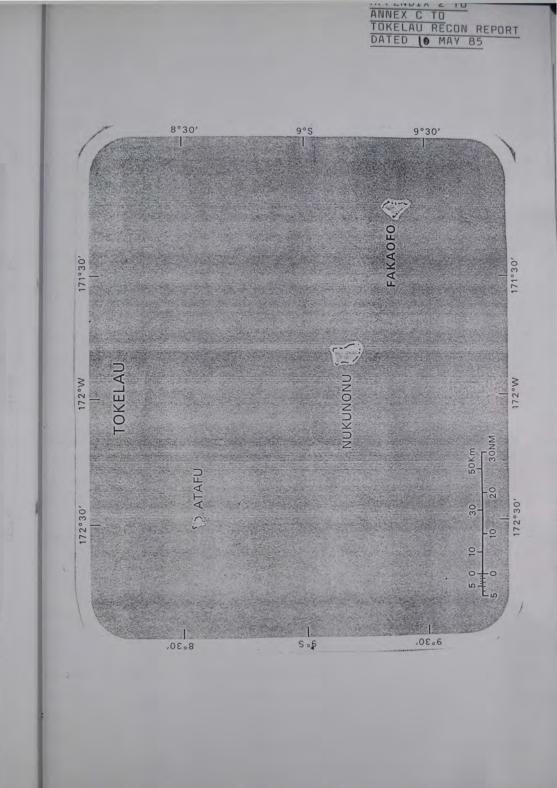
j.

- 2. Map of Nukunonu
- 3. Map of Fakaofo

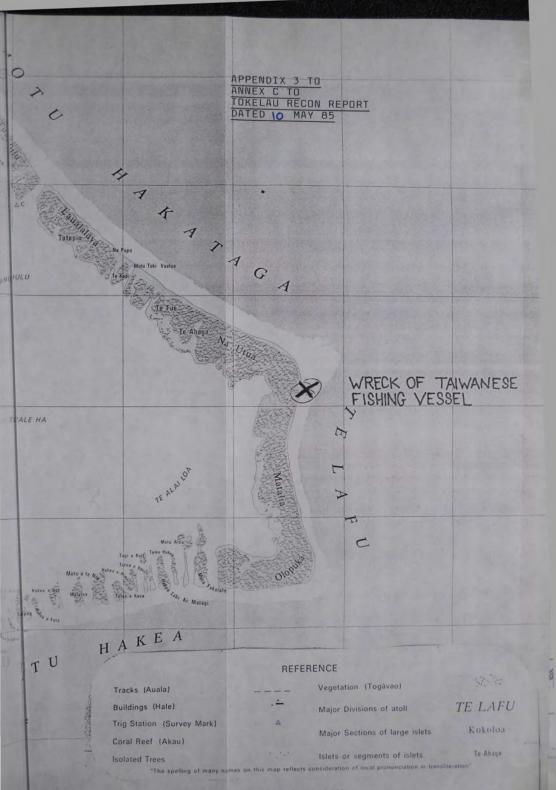








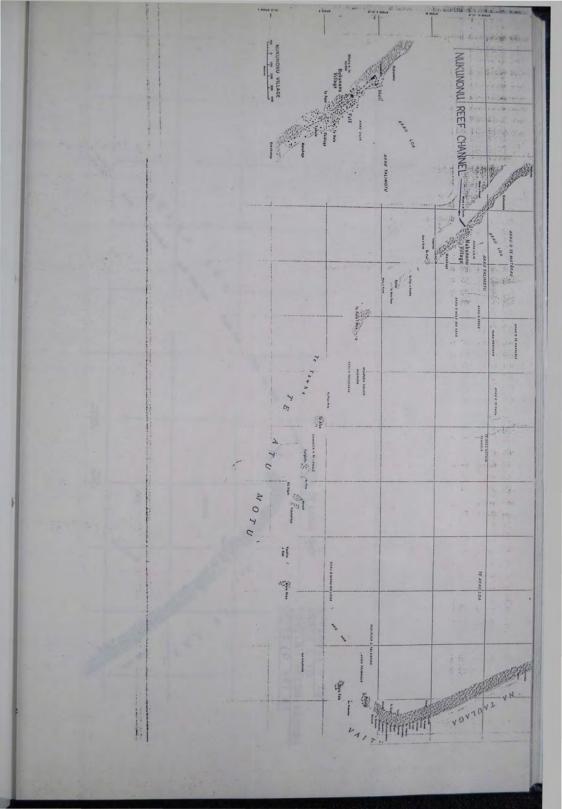


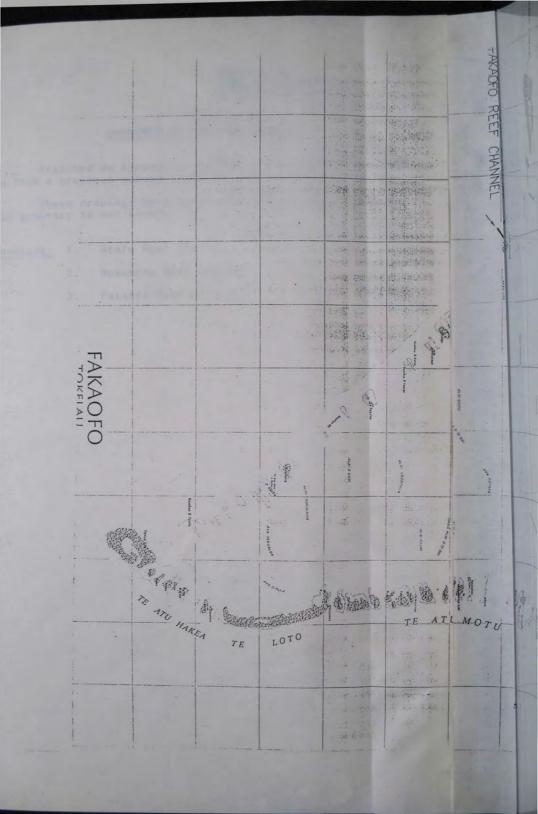


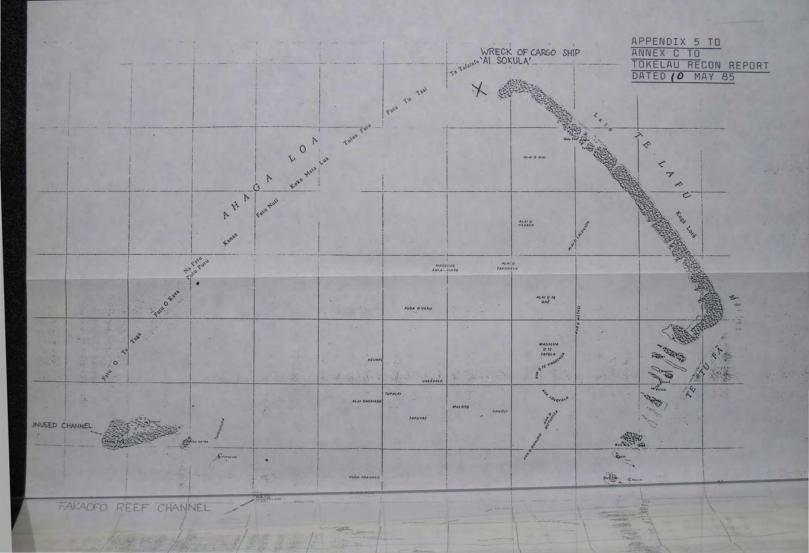
SCALE 1:25 000

Kitometres 3











ANNEX D TO TOKELAU RECON REPORT DATED 10 MAY 85

#### DRAWINGS OF PREVIOUS SURVEY

1. Attached as Appendices to this Annex are the drawings made from a previous survey conducted during Feb and May 76.

2. These drawings have been used as References, although their accuracy is not known.

Appendices: 1. Atafu Reef Channel

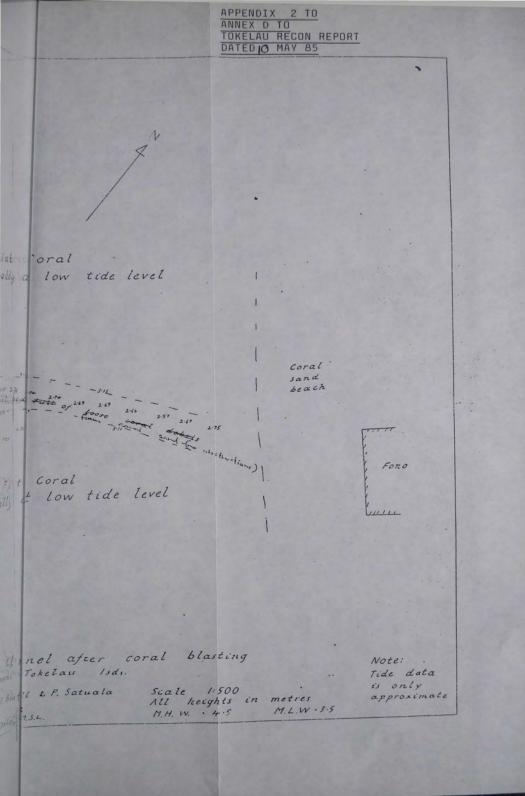
2. Nukumonu Reef Channel

3. Fakaofo Reef Channel

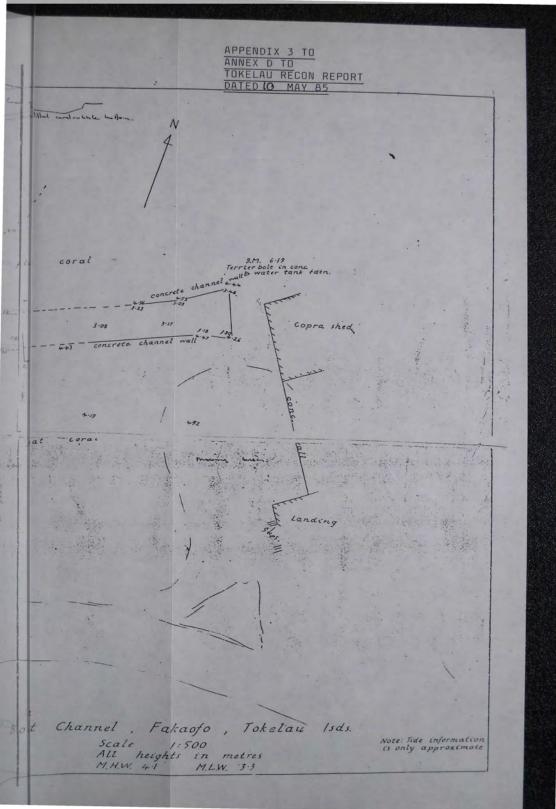
Outer reef area of channeled and Fat Gral crregular coral. cener light in tide les submerged at Low Lide 13 +06 1-21 0-74 1-57 2-18 20036 . 2.0 210 205202 200 - 255 253 area of loose rocks 211-212-270-266 all will below grapather teel all will below grapather teel all will below grapather teel 1.57 1.95 1.94 1.85 2.00 2.05 Channe : 20 C++ 0.73 1422-11 221 2.49 261 248 246 2.50 2.35 11 Il h Lie States and charters of Singer, Loose will als is top if and Loose rocks to Sottom humps at Low tide to within 2m. To be remeral by mere of surface at low tide Flat generally Plan of Boat Channes Ataju, 7 de Surveyed by P.e. May 197 Sc tum 3.6 m below P. in Datum

APPENDIX 1 TO ANNEX D TO TOKELAU RECON REPORT DATED 10 MAY 85 N Fort Coral mercy at low tide level line and --- to the inp of reaf Copra Shed apael bottom consests of 200 2001" coral débris coral sand beach one oral rocks on top of reef E Hat Coral ally at low tide level mana after Coral blasting Frelau Isds. Note : Tedal data is only approximate PB fell & P. Satuala 

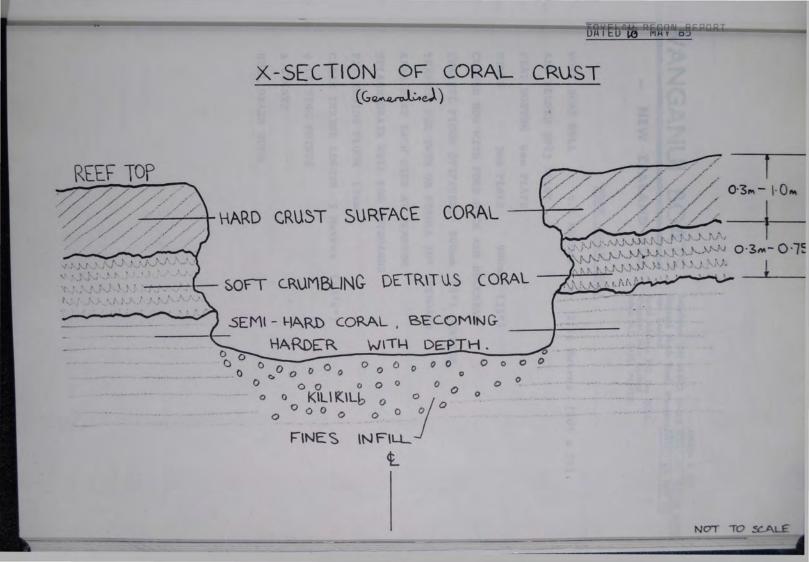
Flat outer reef area generally of irregular. coral X there possible X to the banch X there is a minimum of sm of depth completely elser of alistmetion all the bury along the channel. submerged at Dlow tide - 1.54 2.3/ . 2.75 2.69 2.74 2.57 2.47 2.65 channel be loose coral mi 2.43 2.32 -2.62 256 - - 2.60 - - 2.68 - - 2.86 - - 3.00 - - 2.75 -40.0 at a familie rocks on bottom Ocean Loose coral on top of rer 1.1 all comil tomores towered to give mining Filitard generally trade Plan of Boat Chanela Nukunone Tout Surveyed by P. Ben It Ung May 1976 Datum . 4.0 m below m

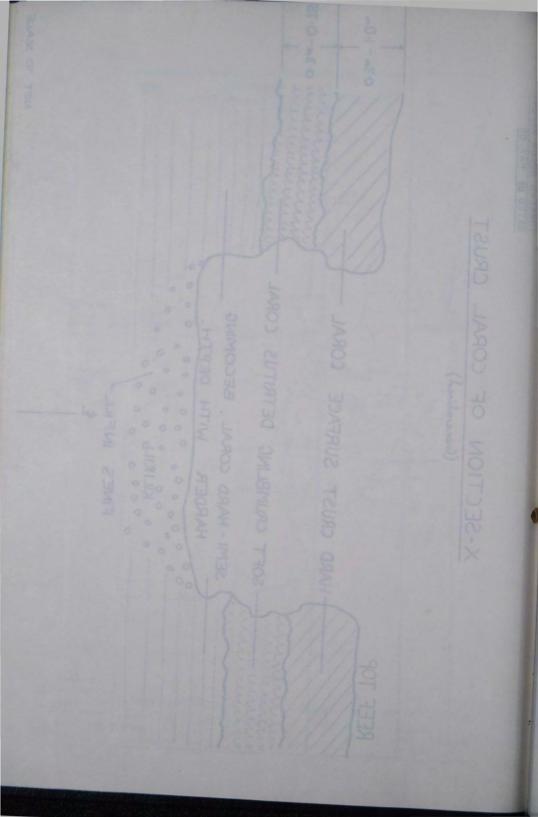












NANGANUI BOATS

NEW ZEALAND LTD.

ANNEX F TO Telephones: (64) 46-002, 46-022 TOKELAU RECON REPO Shipyard: Heads Road, Wanganui, DATED 10 MAY 85 New Zealand. Postal Address: P.O. Box 8032, Wanganui, New Zealand. Telex: N.Z. 3455, 'ALSTEEL'

#### WORK BOAT HULL

WORK BOAT HULL 6.1 Metres x 2.14 Metres (20' x 7') ALL WELDED 5083 ALLOY FLAT BOTTOM 4mm PLATE SIDES 3mm PLATE 900mm (35") CURVED BOW WITH FORE DECK AND BULKHEAD CHANNEL FLOOR STIFFNERS 200mm (8") CENTRES TRANSOM FOR TWIN OR SINGLE 20" OUTBOARD REAR SEAT EACH SIDE AT TRANSOM SPLASH-DRAIN WELL FOR OUTBOARDS PLY INSIDE FLOOR 12mm CLEAR INSIDE LENGTH 5 Metres (16'4") 4 LIFTING POINTS 4 CLEATS

# ANGANUI BOATS

antisyand Stands Road, Wangama 1972 1992 190 1992 199 Antisyand Standard Road, Wangama 1971 19 20 1937 19 Antisyand Standard Poly 2012.

### NEW ZEALAND LTD.

#### MURK BOAT BULL

ALL WELDED 5083 ALLOY ALL WELDED 5083 ALLOY FRAT BOTTOM Ama FLATE SEDES 3ma FLATE 900mm (35") CURVED BOW WITH FORE DECK AND SULFARAD CELEVES NOW WITH FORE DECK AND SULFARAD CELEVES NOW WITH FORE DECK AND SULFARAD REAR SEAT EACH SIDE AT TRANSIC REAR SEAT EACH SIDE AT TRANSOM SPLASH-DRAIM WELL FOR OUTBOARD FLT ISSIDE FLOOR 12mm 4 ELITTING FOINTS 4 CLEATS

	ANNEX G TO TOKELAU RECON REPORT DATEDIOMAY 85
TOKELAU SHIPP:	ING SCHEDNEE RECEIVED
<u>121</u>	
M V AVC	NDALE 7
	Office for Tokelau Allairs
- 28 January	Visit by Prime Minister and Budget Committee meetings
February - 3 March	Fuel*
- 19 March	General Fono at Nukumonu
- 13 May	
June - 2 July	Inter Pone machines

3 - 9 August

12

14 - 23 September General Fono

12 - 18 October

9 - 18 November ) 16 - 25 November )

Inter-Fono meetings

Fuel\* (M V "Sami")

or ) Committee meetings

20 - 27 December Scholarship students' home leave

Deck passengers not carried on fuel sailings

## BOAT FARES

Deck passengers	WS\$25 one way
Deck passengers with saloon meals	WS\$65 one way
Cabin passengers with saloon meals	WS\$95 one way

draught of the wateria (almost a canone for on every almost of

Ministry of Foreign Affairs WELLINGTON

11 February 1985 a he Show a supervision, the exception in TOKELAU SHIPPING SCHEDOOD

STANSON V.K.

2 - 28 January Wiste by Frime Minister and Budget Compittue needing

- 19 March Fuels

Inter-Fono mentione

General Fore

1882" V RD \*Iou'l Fuel\* CM V "Samt

Committee meetings

27 December Scholarship students', home leave

Deck passengers not carried on fuel sailtons

#### BOAT PARES

Deck passengers with saloon meals WS525 one way Cabin passengers with saloon meals WS555 one way

> Ministry of Foreign Affairs WELLINGTON

> > 11 February 1985

14. A. Skinner

ANNEX H TO TOKELAU RECON REPORT DATED 10 MAY 85

NOTES OF A MEETING WITH MR GOTFRED SHUMA (HARBOUR ENGINEER, UNITED NATIONS CENTRE FOR HUMAN SETTLEMENTS)

Place Date Present Office for Tokelau Affairs, Apia 19 March 1985 Mr G Shuma Mr A Macey ) Mr C Perez ) Office for Tokelau Affairs C P O J Kearney NZ Navy Lt A Skinner NZ Army Ms D Almao Foreign Affairs

Mr Shuma is a UNDP consultant currently advising theCook Islands Government on the Avatiu Harbour development scheme and reef blasting projects in the outer islands. During the meeting he offered the following general comments on reef channel construction projects and maintenance.

#### (A) Preliminary Survey Work

Before any construction or maintenance is carried out, it is essential to compile a record of depth soundings throughout the length of the channel. This information provides a base for measuring the rate at which silt accumulates and allows the person(s) responsible for channel maintenance to decide when clearance is necessary. Once the basic dimensions of the channel are known, local Tokelauans can be trained to take soundings at regular intervals, to plot the results on a graph and to request dreding maintenance as required. Sophisticated depth guages are not needed for this type of work. A simple lead line can be used in the deeper water (about  $2\frac{1}{2} - 3$  metres) at the channel entrance.

The optimal depth for a channel should allow for: (a) the draught of the vessel (about 4 inches for an empty aluminium whaleboat plus 12 - 18 inches for the outboard motor); (b) a tolerance (equal to 20% of the draught) for underwater clearance and wave and swell action; (c) a margin for silt accumulation.

In Mr Shuma's experience, the excavation for the channel should on the deep rather than the shallow side; at the same time it should not be too deep as this increases the volume of incoming water leyond desirable limits. ANNEX H TO TORELAU RECON REPOR

> CHARDOUR ENGLISHER, UNITED HATTONS CONTREE FOR MEMOUR ENGLISEER, UNITED HATTONS CONTREE FOR MEMAN CENTREMENTS)

19 March 1985 Mr G Shume Mr A Macay J Office Yor Touclas Mr O Ferres M2 Navy Lb A Stanoar M2 Navy Ma D Almad Standau Milaire

Mr Shuma is a UKEP consultant currently savising theCook Islands Government on the Avatiu Barbour development scheme and reaf blasting projects in the outer falands. During the section he offered the following general comments on reaf channel construction are jects and saintenance.

1) Preliminary Survey Work

before any construction or maintemance is carried out, it the cemential to compile a record of depth soundings throughout the length of the channel. This information provides a base for seasuring the rest at which all scoundings and allows the person(s) responsible for channel maintemants to decide when channel are known, local Tokelanang can be trained to take acountings at regular istarvais, to plot the resulm of a graph depth gunges are treating maintemants as required. A simple is the channel on the used in the despet water (about 27 - 3 matree) are the channel on trades.

The optimal dopth for a channel about allow fort (a) draught of the vessel (about 4 inches for an empty aluminium whaleboat plus 12 - 18 inches for the outboard motor): (b) a tolerance (equal to 20% of the draught) for underwater clearance and unwel action; (c) a recent for well action;

In Mr Shuma's experience, the excevation for the chemner should on the deep rather than the shallow side; at the same true it should not be too deep as this increases the volume of terreline water levered desirable limits. -2-

## (B) Explosives Work

Whether widening or realigning a channel, it is very important to employ an experienced and reliable underwater explosives expert for the job. A "trigger-happy" or untrained specialist who deviates from the engineer's design parameters can create unnecessary hazards.

To establish an appropriate drilling pattern for the explosives, details of the type of coral and required depth should be known. ICI (Explosives Division) can provide information on the suitability of certain explosives for various types of coral. Delay detonators are generally used to remove the fill. During the blasting phase, there are also opportunities for the visiting expert to train Tokelauans in underwater explosives work. If this is thought desirable, the trainees can also attend a course in explosives work offered by ICI.

### (C) Retaining Walls

It is possible to reinforce the side walls of the channels provided the reefs are solid enough. This is done by keying gabian baskets into the reef with spikes. The basket netting should be coated with pvc to reduce rusting. The retaining wall should however not be built right up to the edge of the reef. It has to be realized that as boulders and other material are inevitably washed back into the channel constant maintenance is necessary.

#### (D) Maintenance

Channel maintenance tends to be a problem in remote islands. The clearance of rubble and silt is not regarded as a traditional task by village labour forces and unless some mechanical assistance is provided, channel upkeep tends to be neglected. It is not necessary to supply sophisticated machinery for this sort of work. A simple dragline operation using steel buckets (because the material does not float), a small 2 ton air winch, and a compressor or small engine as a backup, is adequate for the typical situation. The dragline should be designed to suit the capacity of the compressor or engine attached. An hydraulic unit can be substituted for the compressor or engine; but although it is smaller and faster to operate, it has the disadvantage of requiring more frequent servicing.

Mr Shuma recommended the use of reconditioned or secondhand rather than new equipment (which ages within two months of purchase anyway).with replacement regularly scheduled every 2 - 3 years. Any equipment ordered should be tested in simulated working conditions prior to purchase and delivery. Whathar widening of residents and reliable mineria important to explore an explore the set of the set apportants who the lates from the ampiness a design to secto apportants in unarcasery hearths.

To establish as appropriate dilling an readrad day's applicatives details of the type of costal and readrad day's aboutd be known. Tell (Explosives Division can provide televation on the estremitive of carteric are penerally used various types of costal. Delay deterators are generally used to remove the fill. During the blacking press the state of opportunities for the variant appears to train lobal manes in undervater explosives work. If this is chought desirable, the trainees can also attend a course in explorities work offered

# Revalating Maria

It is possible to reinforce the site done by kaying provided the reafs are solid anough. This is done by kaying subian baskers into the real with spikes. The basket netring should be costed with put to reduce rusting. The relaining wall should however not be built right up to the edge of the reaf. It has no be realized that an boulders and other material are inevitably washed back into the channel constant.

#### D) Maintennas

Channel maintenance temms of and sile is not required allocate. The clearance to rubble and sile is not required to tradicional task by village labout forces and whene sease acchanical assiltance is supply appeared to a be neglected. It is not measured to apply applied to acchanical parallelistic is and whene will 2 ton this source of work. A simple dragilias operation as small 2 ton air winch, and a compression or small engine as a backup, is adequate for the typical situation. The dragilias should be designed to such the capacity of the compressor of regime attached. An hydraulic unit as he applied to the compressor of engine: but although it is ambiguite and faster to operate, it has the disadvantage of main and faster to operate, it has the disadvantage of anticipate for the compressor of engine: but although it is anticipated for the compressor of engine: but although it is anticipated for the compressor of engine: but although it is anticipated for the compressor of engine: but although it is anticipated for the compressor of engine: but although it is anticipated for the compressor of engine: but although it is anticipated for the compressor of engine: but although it is anticipated for the compressor of engine: but although it is anticipated for the compressor of engine: but although it is anticipated for the compressor of engine: but although it is anticipated for the compressor of engine: but although it is anticipated for the compressor of engine: but although it is anticipated for the compressor of engine: but although it is anticipated for the compressor of engine is but although it is anticipated for the compressor of engine is but although it is anticipated for the compressor of engine is but although it is anticipated for the compressor of engine is but although it is anticipated for the compressor of the source of t

Mr Shuma recommended the use of recommended the use nonthal hand rather than new equipment (which ages within two monthal of purchase anyway) with replacement regularly scheduled every 2 - 5 years. Any equipment ordered should be cented in simulated conditions prior to purchase and delivery. As reef channels generally require dredging once every six to twenty-four months, it makes sense to rotate the same equipment around all three islands and to employ one permanent team (including at least 2 trained operators) to use it. The appointment of a select operators encourages a sense of responsibility for the machinery and enhances the chances that regularservicing the carried out.

Dredging operations **could** take up to several months depending on the accumulation of silts and kilikili. A very broad estimate of the time required could be calculated once the rate at which the dragline removes fill and the mass of the silt were known. The work should be done in the offhurricane season.

# (E) Shore Facilities

Mr Shuma recommended that every channel have a basin and a large concrete landing platform. The latter should be built just above the high water mark for ease of cargo and passenger handling. Cargo handling equipment, such as derricks, were not a necessary accessory. In his experience, derricks tended to be too slow at loading and unloading petrol drums, etc. and tended therefore not to be ged. It was far more important to build an adequate landing platform for receiving and loading goods.

### (F) Fale Channel

Mr Shuma also asked why the natural channel at Fale had not been developed. The explanation was that the natural channel drains water from other areas and its flow of water is too great and too strong for boat channel conditions. He said this explanation appeared valid.

D J Almao 20.3.85 As real commands generally require dradging once every equipment around all threat allowed and to employ one permanent from (including at last? 2 critical permanent) to use it? The appointment of a select operators are entered to chartes texponability for the machines and a second atte chartes that regular servicing which he cartined out

breaging operations aduld take up to several south depending on the accumulation of miles and bilidit. A very broad estimate of the time required could be calculated once the main ware known. The work should be done in the offburricane season.

DADLE LUCITION

Mr Shuma recommended that every channel have a basin and a large concrete landing platform. The latter should be built just above the high water mark for same of cargo and passenger handling. Cargo handling squipment, such as derricks, were not a necessary escassory. In his experience, derricks tended to be too slow at loading and unloading petrol drume, etc. and tended therefore not to be filed. It was far more important to build an adequate landing platform for recalving and loading goods.

201e Channel

Ar sinum also saked way the natural channel at Fale had not been doweloped. The explanation was that the institual channel drains water from other areas and its flow of water is too great and too strong for best channel conditions. He said this explanation appeared waitd.

ANNEX I TO TOKELAU RECON REPORT DATED 10 MAY 85

# ATAFU REEF CHANNEL

Appendices to this Annex are the technical details of the data obtained during the surveying of the channel.

Appendices:	1.	Plan	View	

1

ANG BUILTANAY

- 2. 3D Plan View
- 3. Detailed Cross-Sections
- 4. Longitudinal Cross-Section
- 5. Survey Sheets
- 6. Centre-Line Levels
- 7. Volume Calculations

Note: Appendices 1, 2, 3 and 4 are not attached, but are separate to this Report.

TOMELAU RECOM REPORT

#### ATAFU REEF CHANNEL

Appendices to this Annax are the technical details of the data obtained during the surveying of the channel.

Appendices: 1, Pian View

30 Plan View

Datailed Grass-Sections.

. Longitudinal Crass-Section

S. Survey Sneets

. Centre-Line Levels

. Volume Calculations .

tote: Appendices 1, 2, 3 and 4 are not attached, but are separate

						~				APPENDIX 5 TO
				_		Please re	turn to nearest	office of Ministr	y of Works and D	Development ANNEX I TO TOKELAU RECON
Job	Atak	Reef Takela		3e		······	Instr Type of staff Conditi	NK 2 Anglo ons Hot 32		nnek Job File
Back sight	Inter- mediate	e Fore sight	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Offset(m)	Remarks
0.562					103.000			32.6 m	434¢m	Em Blm (DATUM) To 'L' 26.80 mag
A	1.470	-		0.908	99.092			10	ø	(L'at start et traverse ie comer = A-10)
B	1.405		0 065		99.157			10	10	A-la='L' conner of traverse ie corner = A-la)
_C	1.440			0.035	99.122			10	20	Section RL=99-1m
D	1.555			0.115	99.007			10	30	Sechian RL = 99.1m and Dev
E	1.655			0.100	98.907			10	40	Dost
Ē	1.602		0.053		98 960			10	_50	eve
G	1.690			0.088	98.872			10	60	elo
H	1.583		0.110		98.982			10	70	Development
I	1.705		2.12	0.125	98.857			10	80	• • • • • • • • • • • • • • • • • • •
J	1. 838			0.133	98.724			10	90	nt s
K	1.878			0.040	98.684			10	100	
L	1.940			0.062	98.622			10	110	
m	1.915		0.025		98.647		-		120	24 133
N	2.150		1	8.235	98.412			10	1303	
0_	2.250	_		0.100	98.312			10	140	Entrance to Natural Channel Pavallel
P	2.30			0.120	98.192			10	150	Edge of Roof Finger at Ltide
Q	3.100			0.730	97.462			10	160	- Alwaus under water.
R	-	3.900		0.800				5	165	- Edge of Reel Finger - Very Deep Nater
-	0.405		0.157		100.157			100.157		- Always under Water. - Edge of Reef / Finger - Very Deep Nater. Height of Nharf Deck
_		Below W	0		99.107					Low Tide Level In Relation to Datum
t	0.1	Abovel	Ubark		100 257					High I h II II II II II
1	72.0	2 2 2 - L	2.22		3.338	Differenc	es			Tigh
			1 mg	1499KI	anak 11	-				ALC: NOT THE REAL PROPERTY OF THE PROPERTY OF
1	100									

b			Passage u. ls.	?			Instr Type of staff Condition	NK2 ANGLO ons Hot 32°C	Observer Ski Booker " Date 5 Mc Checked	21.85	Job File Sheet File Ref	of	
Back	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (.m)	Bearing Offset	-		Remarks	
399	1	1			100.00	-0.908	99.092	Ø	98.53	F.M	LH Side 58	\$\$ the mag B	
	1.55			0.151	99.849		98.941	18		LH	Rock &	11 1 9 0	
	1.523		0.027		99.876		98.968			Just_	before edge	of shelf.	
	1.845		0.178		100.054		99 146	27			, 0	, ,	
	2.445			1.1	98.954		98.046	29					
	2.387		0.058		99.012		98.104	31					
	2.338		0.019		99.061		98.153	33					
	2.232		0.106		99.167	-	98.259	35					
_	2.17		0.062		99.229		98.321	37					
_	2.05		0.12		99.349		98.441	39					
- 1	1.54		0.51		99.859	}	98.961	.41					
	1.532		0.008	-	99.867		98.959	43					
	1.585	-		0.003	99.864		98.956	45					
	1565			0.03.	99.884		98 926	_47			Reek Ł		
		1.248.	0.317		100.157		99 243.	64		Have	, Relatively	Unweather coral,	
_										Cater	ed only at	High tide.	
												0	
-1													
-													
~ 0		010	1:00		00 000						-		
a ca	157	Mintania.	1.2×1		0.151	Different	es			-	-		

							Carl I
				and the second sec			

Job		Reef F Okelal	besage 1 ls			Please r	Instr	NK-2 Anglo ons Hat 3292	Observer Skin Booker Date 5 Mai Checked	nev.	Job File Sheet File Ref	Field Sheet No	
Back	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Bearing Offset			Remarks	1
358					100.00	-0.843	99.157	¢.	98.595	FM	LH Side 59.4	In mag B	
	1.122		0 236		100.236		99.393	18		LHK	ROCK 4	11	6
	1.567			0.454	99.782	-	98.937	25		Just	Before edge	statelf.	
	2.415		-	0-889	98.943		98.100	27			1 0		0
	2.605			0.19	98.753		97.91	29					and Dev
	2.455		0.15		98 903		98.06	31					De
	2.353		0.102		99 005		98.162	33					- eve
	2.247		0.106		99.111		98.268	35					elo
	2018		0.229		99.34		98 497	. 87					pment
	1407		0.611		99.951		99.108	39					nei
	1.302		0.105	-	100.056		99.213	.41					Pt
	1.237		0.065.		100.121		99 278	43			ROCK &		
		1.502		0.265	99.856.		99.013	64		(AB-	for #2)		_
													_
													_
			100	1	1								Lev
													0
			-1.00										Hin
													2
200		500	1.101	-71.0,	20.100								-Sh
Willia ()	3/sh		A-111		A.1/1/1	Differen	es			-	-		er

Job	Atafu	Reef	Passag U 15	je			Instr Type of staff Conditio	ANGLO ns HOT 329	Observer Ski Booker " Date 5 MA Checked	R.85.	Job File Sheet File Ref	Field Sheet No. 4 of 3 sheets Plan Ref C	
Back sight	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Bearing Offset			Remarks	
398					100.00	-0.878	99.122	¢	98.56	FM	LH Side 59.	40 mag C	
	1.068		0.33		100.33		99 452	18		LH	ROCK L		- 8
	1.488			0.42.	99.91		99.032	25		she	If edge		
	2:391			0.903	99.007		98.129	27			0		and
	2.418		-	0.027	98.98		98:102	29					and the second second
	2.38		8.038	300	99.018		98.14	31					De
	2.305		0.075		99.093		98.215	33					Ve
	1.836		0.469		99.562		98 . 684_	35					
	1-406		0.43		99.992		99.114	37					pn
	1.22		0.186		100.178		99.3	39					
_	1.183		0.037	03.6	100.215		99.337	41					11
	1.275.			0.092	100.123		99 245	43			ROCK £		
		1.425.		0.15	99.973.		99 .095.	64.		(As	#2).		
							-						
						4							
	_												ev
													evenin
-													n n
- 1						-				-			0
ag 1	commindo.	1.1.25	1515	1.000	99.122						-		- ne

Iob	Atafu	Reef	Passaa AU IS	ę.			Type of staff	NK-2 ANCILO ons HOT 329	Observer Sk Booker Date SMA Checked	R.85	Job File         Field           Sheet No	
Back sight	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Bearing Offset	-	Remarks	1
368					100.00	-09413	99.007	0	199.10	FM	LH. Side 59.40 mag @	
	1.032		0.336		100.336		99.343	18		LHK	zoek ¢	-
	1.872			0.340	99.996		99.003	25		Shel	fedge.	9
	2.452	-		1.080	98.916		97.923	27				۵
-	2.450		0.002		98 918		97.925	29				and
	2.455		5	0.00.	98.923		97.92	31				and Dev
	1-727		0.728		99.651		98.648	.33				Develo
	1.203		0.524		100:175		99.172	35				elo
4	3.935		0.268		100-443		99.44	37				pment
(	3.887		0.048		103 491		99.488	39			•	ne
0	3.927		0	0.04	100.451		99.448	41				nt
	3.968			0.041	100.41		99 401	43		ROC	RERH	
		1.460		0-492	99.918.		98.915.	64		LAS	#2)	
												_
												- 6
												eve
_												ellin
and a			-									Bu
											-	S
The C.	0.97		10.09		0.092	Differen	-04					he

			- alter	-	ł	r

ъ		, Reel Takelo	Passo au 15	zge			Instr. A Type of staff A Condițio		Observer SKI Booker Matu Date 6 Mar Checked SKIN	lina.	Job File Sheet File Ref	Field Sheet No. 6. of	15
ack ight	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Bearing Offset			Remarks	
543					100.00	-1-093	98.907	¢	59.40 m	mag.			
	1.048		6.495		100.495		99.402			LYK	Rock £		5
	1.569			0.621	99.954		98.881	_25		Edge	e shelf		
	2.533			0.964.			97.917	27					0
	2.382		0.151		99.161		98.068	29					and
	2.237		0.145		99.306		98.213	31		•			U
	1.913		0.324		99.63		98.537	- 33					Develo
	1.194		0.719		100 .349		99.256	35					010
	0.795		0.399		100.748		99.655	37					opment
	3.723	the second s	0.072		100.82		99.727	39					let
	3.675		0.048		100.868		99.715	41					F
	3.635		0.04		100.908		99.815	43			Rook E		
		1.37		0.742	100.166		99.073	64		(As	#2)		
						-							ev
													0
													lling
													0 5
Co.	-166		n non .		0.166.	Differen	l				-		

.

Job		Reef R OKELAU					Condition	ANGLO	Observer Skill Booker Moto Date 6 May 9 Checked Skill	15	Job File Sheet File Ref	Field Sheet No	
Back sight	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Bearing Offset			Remarks	
337					100.00	-1.04	98.96		59.40m	mag			
	0.917		0.42		100.42		99.38	18			zoeic &		5
	1.652			0.735	99.685		98.645	24.3		Eeler	e shelf.		1
	2.276		1	0:624	99.061		98.021			0			0
	2.163		0.113		99.174		98.134	29					and
	2.121		0.042		99.216		98.176	31					De
	1.584		0.537		99.753		98.713						
	0.965		0.619		100 .372	-	99.332	35					0
	0.678		0.287		100.659		99.619	37					velopment
-	0.476		0.202		100.861		99.821			-			nei
1	0.525		1	0.049	100 812		99.772	41					27
	0.568			0.043	100.769		99.729	43			rock £		
		1.320		0.752.	100.017		98.977	64.		(AS )	FOR #2)		
-				-	× .								Level
					-								elling
		1.00											S

ob	Alafo	and the second se	AU IS	zge D			Type of staff	NK-2 'ANGLO' 23 GEND	Observer Ski Booker Mati Date 6.111 Checked Ski	shine 85	Job File Sheet File Ref	of	ts	
Back	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (M)	Bearing Offset			Remarks		
291					100.00	-1-128	98.872	¢	59.40m	mag				/
	0.805		0.486		100.486		99.358	_18	1-1	1	ROCK &			4
	1.344		and the second se	and the second s	99.947		98.819	23.9			e shelf			4
	2.078			0.734	a second s		98.085	27		0	1.			2
	2-088			0.01	99.203		98.075	29		1				and Dev
	1.990		0.098		99.301		98.173	31						De
1	570		0.42		99.721		98.593			-				Develo
1	.054		0.516		100.237		99.189	.35		1				relo
0	3.819		0.235		100.472		99.344							opment
0	3.723		0.096		100.568		99.44	39						nei
- 0	.730			0.007	100.561	-	99.433	41						nt
C	3.685		0.045	-	100.606	-1	99.478	43						
	1	.340	(	3.655	99.951		98.823	64			C.Y. Law			
										1000	her have			
_							1							
										-				
														Le
														vellin
-														111
-														Bu
- sin		211									~			Sh
13	1319		10.04		B.049	Differen	ces.			-				e

Job	Hafu	Reef	Passac In Isla	ze hols		Please	Instr. Type of staff	NK-2 ANCLO	of Works and D Observer. Sk Booker Mate Date 6 Mate Checked Sk	inner slina 85	Job File Sheet	Field Sheet No	
Back sight	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (M)	Bearing Offset			Remarks	1
0.999					100.00	-1.018	98.982	¢	59.40m	mag			
	0919		0.08		101.08	-	99.062	18			ROCK &		4
	1.415			0.496	100.584		98.566	22.8		Eda	e shalf		4
	2025			0.61	99.974		97.956	.25		0	) ]		ω :
	2.134			0.69	99.865		97.847	25					and
	2.083		0.051		99.91b		97.898			-			and Development
	1.879		0.204		100.12		98-102	31					eve
	1.695		0.184		100.304		98.286	33					0
	3.675		1.02		101 .324		99.306	35					-10
	0.941		100	0.266	101.058		99.04	37					Development
	0.815		0.126		101.184		99 166	39					nt
	0.938			0.123	101.061		99.043	-41		2 2			
	3.905		0-033		101.094		99.076	.43		RHF	JOCK E		
		1.320		0.415	100.679		98.661	_64		LAS	for #2).		
											,		_
_				1.14									_
			-		1								Leve
													- e
				-									lling
	ummma.			2 210	00.000					-			-h
Max n.	291	Villin hin	0.32		0.321.	Differen	ces		-	-		**	0

---

1.542       0.403       99.968       98.817       35         1.503       0.039       99.999       98.856       37         1.418       0.035       108.084       98.9141       39         1.368       0.05       100.134       98.991       41         1.368       0.05       100.134       98.991       41         1.470       0.102       100.032       98.889       43       RH & cck. 4         1.440       100.062       98.919       64       (As For #2)       41	1470 0.102 100.032 98.889 43 RH BOCK 4		Ata Inter- mediate 1.184 2.295 2.332 2.341 2.236 1.945 1.542	To Kela Fore	Page U. (skai (D) Rise 0.318 0.318 0.318 0.318 0.285 0.403	Fall Fall 1.111 O.037 0.009	99.272 99.557 99.968	Corr.	Instr. Type of staff Condition Adjusted Level 98.857 98.064 98.027 98.018 98.018 98.129 98.129 98.414 98.817		of Works and D Observer, Skil Booker, Mar Date, E.M.A. Checked, Skil Bearing Offset S9 - 4 (2 m/	mer 85 mer	Job File Sheet File Ref	Field Sheet No	A Ministry of and Develo
1470 0.102 100.032 98.889 43 RH BOCK 4	1470 0.102 100.052 98.889 43 RH & & CAS For #2)	-	1.503		0.039		99.999		98.856	_37					opm:
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	1.440 100.062 98.919 64 (As For #2)	-	1.368		0.05		100.134		98.991	41		DIL	and d		rks
		_	1410	1.440		0.102						CAS	For #2)		-
		-		1925					99.51			110	Rec <sup>44</sup> 9)		_

Јођ			Passac J ISCAN				Instr Type of staff Conditio	NK-2 ANGLO PARWARM	Observer Ski) Booker Mart Date 6 May Checked Ski	(85	Job File Sheet File Ref	of	
Back sight	Inter- mediate	Fore sight	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (M)	Bearing Offset			Remarks	1
.192					100.00	-1.276	98.724	¢	59.40m	mag	10		
	1-505			0.013	99.987		98.711	18			ack £		6
	1.495		0.010		99.997		98.721	21.5					19
	2.241			0.746	99.251		97.975						0
	2.252	_	1.000	0.011	99.24		97.964	25					and
	2-275				99.217		97.94)	27		1			1.1
	2.250		0.025		99.242		97.966	29					and Develo
	2.035		0.215		99.457		98.181_						elo
_	1.933		0.102	-	99.559		98.283	33					Ide
	1.515		8.418		99.977		98.701	35					ne
Concernence of the	1.510		0.005		99.982		98.706						velopment
	1.425		0.085		100.067		98.795	39					
and the second se	1.410		0.015		100.082		98.806	41					
A	1.445		and the second		100.047		98.771	43					
		1.505			99.987		98.711	64		(AA E	or #2)		
	-									SCIO T			
					-								-
													Leve
	-												ellin
					- PCan Mary								ing
													2
-	A12	CTITUTION OF	1 0.012		The Train						-		Shet

applit       mediate       applit       applit	b	Ata		Raesa au Isbi				Type of staff	NK-2 Anglo' HOT	Observer SK Booker Matt Date & Mal Checked Sk	(85	Job File Sheet File Ref	Field Sheet No	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Back ight			Rise	Fall	Reduced Level	Corr.	Adjusted Level					Remarks	1
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	462					100.00	-1.316.	98.684		59.40m	mac	1. No Rock	Piles	
1.344 $0.01$ $100.18$ $98.802$ $9$ $98.814$ $12$ $98.814$ $12$ $98.814$ $12$ $98.832$ $15$ $98.832$ $15$ $98.832$ $15$ $98.832$ $15$ $98.832$ $15$ $98.832$ $16$ $98.832$ $15$ $98.832$ $16$ $1322$ $0.028$ $100.14$ $98.832$ $18$ $12$ $98.832$ $18$ $12$ $98.832$ $18$ <		1.431		0.031		100.031		98-715	3			5		5
1.332 $0.612$ $100.13$ $98.814$ $12$ $12$ $1.344$ $0.016$ $100.148$ $98.852$ $15$ $15$ $1202$ $0.031$ $100.148$ $98.852$ $15$ $1202$ $0.031$ $100.141$ $98.852$ $15$ $1202$ $0.031$ $100.121$ $98.812$ $18$ $12$ $1202$ $0.031$ $100.121$ $98.811$ $21$ $1202$ $0.9851$ $94.34$ $97.924$ $23$ $1202$ $0.9851$ $94.34$ $97.924$ $23$ $1202$ $0.9851$ $94.34$ $97.924$ $23$ $1202$ $0.9851$ $94.34$ $97.924$ $23$ $1202$ $0.9851$ $94.34$ $97.924$ $23$ $1202$ $0.9851$ $94.9251$ $97.924$ $23$ $1202$ $0.9851$ $97.924$ $23$ $1202$ $0.9851$ $97.924$ $23$ $1202$ $0.9851$ $97.924$ $23$ $1202$ $0.9851$ $97.924$ $233$ $1202$ $97.921$ $97.921$ $97.921$ $97.921$ $97.921$ $97.921$ $98.728$ $98.721$		1.445		-	0.014	108-017		98.701	6					C
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		1.344		0.101		100.118		98.802	9					2
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		1.332		0.012		100.13			12					
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		1.314		0018		100-148		98.832	15	-				0
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		1.322			0 008	100-14			18					
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		1.335			0.013	100.127		98.811	21					
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		2.222			0-887	99.24		97.924	23					17
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	4	2.565			0-343	98.897		97.581	25					
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		2.424		0.141		99.038		97.722	27					
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	4	2.405		0.019		99.057		97.741	29					
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	10	2 328		0.077		99.134		97.818	31					_
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	4	2.175		0.153		99.287		97-971	33					
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		1.505		0.67		99.957		98.641	35					
1.425     0.024     103.027     98.721     43       1.395     0.033     100.067     98.781     45       1.382     0.013     100.08     98.764     47       1.440     0.6588     100.022     98.706     64.	10	1.348		0.157		100.114		98.798	38					
1.385         0.03         1.00.067         98.781         45           1.382         0.013         100.08         98.764         47           1.440         0.6558         100.02         98.706         64.		1.385			0.037	100.077		98.761	41					
1·395         0·03         100·067         98·781         45         6           1·382         0·013         100·08         98·764         47         6	1	.425			0.04	100.037		98.721	43					
<u> </u>	1	.395		0.03		100.067		98.751						
<u> </u>		.382		003		100.08		98.764	47					
			1.440.		0.058	100.022								
	Ills a	100		a	7 1221	6.022	Differen	ces		1	2		**	0

ob	A:	tafu R Tak	eef Pa 21au 1sk	seage and s			Instr Type of staff Conditio	NK-2 ANGLO PASE HOF	Observer Ski Booker Mato Date 6 Mai Checked Sk	Ino	Job File Sheet File Ref	Field Sheet No. 13 of	
Back	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (M)	Bearing Offset			Remarks	
485					100.00	-1.378	98.622	Ø	59.40 m	mag			
	+545			0.06	99.94		98.562	5					-
	1.477		0.068		100.08		98.63	16					
	1.532			C .055			98.575	15				1	2 A
	1558			0.026	99.927		98.549	20		-			ini
	2.790			1.232	98.695		97.317	.27.4		-			Ministry of Works and Development
	1535		1.255		99.95		98.572						Y O
	1.497		0.038		99.988		98.61	40					lo
	1.501			6:004	99.984		98.606	45					Non
	1.575			0.074	99.91		98.532	50		-			nei
		1.633		0.058	99.852		98.474	. 64 .					nt
						-							
-													
-													
_													
_													
-													
													Lev
-													evelling
													lin
							() ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )						
		1 632	1 2/1	1 500	98.622								She

APPENDIX 6 TO ANNEX I TO TORELAU RECOA REPORT OATED 40 RAY 85

#### ATAFU REEF CHANNEL

### CENTRE - LINE LEVELS

Serial	Cross Section	Calculation	Fines	Rock (Blasting Req)	Total Volume
(a)	(b)	(c)	(b)	(e)	(f)
1	А – В	$\frac{3.96 \text{ m}^2 + 4.8 \text{ m}^2}{2} \times 10 \text{ m}$	43.8 m <sup>3</sup>	Nil	43.8 m <sup>3</sup>
2	8 - C	$\frac{4.8 \text{ m}^2 + 6.3 \text{ m}^2}{2} \times 10 \text{ m}$	55.5 m <sup>3</sup>	Nil	55.5 m <sup>3</sup>
3	C - D	$\frac{6.3 \text{ m}^2 + 2.63 \text{ m}^2}{2} \times 10 \text{ m}$	44.65 m <sup>3</sup>	Nil	• 44.65 m <sup>3</sup>
4	D – E	$\frac{2.63 \text{ m}^2 + 6.18 \text{ m}^2}{2} \times 10 \text{ m}$	44.05 m <sup>3</sup>	Nil	. 44.05 m <sup>3</sup>
5	E - F	$\frac{6.18 \text{ m}^2 + 9.52 \text{ m}^2}{2} \times 10 \text{ m}$	78.5 m <sup>3</sup>	Nil	78.5 m <sup>3</sup>
6	F - G	$\frac{9.52 \text{ m}^2 + 8.41 \text{ m}^2}{2} \times 10 \text{ m}$	89.65 m <sup>3</sup>	Nil	89.65 m <sup>3</sup>
7	G – H	$\frac{8.41 \text{ m}^2 + 5.97 \text{ m}^2}{2} \times 10 \text{ m}$	71.9 m <sup>3</sup>	Nil	71.9 m <sup>3</sup>
8	H - I	$\frac{5.97 \text{ m}^2 + 6.04 \text{ m}^2}{2} \times 10 \text{ m}$	60.05 m <sup>3</sup>	Nil	60.05 m <sup>3</sup>

APPENDIX 7 10 ANNEX 1 10 TOKELAU RECON REPORT DATED 40 MAY 85 TAFU - WOLUME CALCULATIONS

APPENDIX 7 TO ANNEX I

Serial	Cross Section	Calculation	Fines	Rock (Blasting Req)	Total Volume
(a)	(b)	(с)	(b)	(e)	(f)
9	I - J	$\frac{2.43 \text{ m}^2 + 2.04 \text{ m}^2}{2} \times 10 \text{ m}$	22.35 m <sup>3</sup>		71.0 m <sup>3</sup>
9	1 - J	$\frac{3.61 \text{ m}^2 + 6.12 \text{ m}^2}{2} \times 10 \text{ m}$		48.65 m <sup>3</sup>	/1.0
10	J – K	$\frac{8.16 \text{ m}^2 + 18.27 \text{ m}^2}{2} \times 10 \text{ m}$	Nil	132.15 m <sup>3</sup>	132.15 m <sup>3</sup>
11	K - L	$\frac{18.27 \text{ m}^2 + 20.52 \text{ m}^2}{2} \times 10 \text{ m}$	Nil	193.95 m <sup>3</sup>	193.95 m <sup>3</sup>
12	L – M	$\frac{20.52 \text{ m}^2 + 21.42 \text{ m}^2}{2} \times 10 \text{ m}$	Nil	209.7 m <sup>3</sup>	209.7 m <sup>3</sup>
13	M – N	$\frac{21.42 \text{ m}^2 + 15.42 \text{ m}^2}{2} \times 10 \text{ m}$	Nil	184.2 m <sup>3</sup>	184.2 m <sup>3</sup>
14	N - 0	$\frac{15.42 \text{ m}^2 + 10.48 \text{ m}^2}{2} \times 10 \text{ m}$	Nil	129.5 m <sup>3</sup>	129.5 m <sup>3</sup>
15	TOTAL		510.45 <sup>3</sup>	898.15 m <sup>3</sup>	1408.6 m <sup>3</sup>

-

ANNEX J TO TOKELAU RECON REPORT DATED 10 MAY 85

# NUKUNONU REEF CHANNEL

Appendices to this Annex are the technical details of data obtained during the surveying of the channel.

Appendices: 1. Plan View

Maris Dallavar

- 2. Detailed Cross-Sections
- 3. Survey Sheets
- 4. Volume Calculations

Note: Appendices 1, 2, are not attached, but are separate to this Report.

TOXELAU RECON REPORT

### NUKUNDNU REEF CHANNEL

Appendices to inta Annex are the technical details of data obtained during the surveying of the channel.

Note: Appendices 1, 2, 3 and 4 are not attached, but are separate to this Report.

Job	Nokor	onv k take	leet Pae lau Isl	and		Please	Instr Type of	office of Minist NK - 2 Apala Apala	Observer. Skill Booker Skill Date Ogth F Checked	Innek, lat Field Field REPORT	RECON
Back sight	Inter- mediate	Fore sight	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Bearing Offset	DiBland = 24 m	
A							98.39			DATUM = Corner RHS FOOTPATH.	3
							98.375 97.335	12	Off set 3 m		
							98.075	48		AB, BC, CD = 30 mea	Ministry of and Develop
B							48.335 97.535	\$ 10			evelo
							97.205	25 39			Development
							98.125				ent
			OTP3 -				97.385	9			-
							96.805 97.335	20 30			
2					******		98 435	ø			
					- 1	_	97.835	7 13.5		Low tide 98.2 High tide 99.889	Leve
							97-705.	20			evelling
											She

APPENDIX 4 TO ANNEX J TO TOKELAU RECON REPORT DATED 10 MAY 85

# NUKUNONU - VOLUME CALCULATIONS

Serial	Cross Section	Calculations	Fines	Rock (Blasting Req)	Total Volume
(a)	(b)	(c)	(d)	(8)	(f)
1	A – B	$\frac{18.22 \text{ m}^2 + 18.52 \text{ m}^2}{2} \times 30 \text{ m}$	551.1 m <sup>3</sup>	Nil	551.1 m <sup>3</sup>
2	8 - C	$\frac{18.52 \text{ m}^2 + 10.53 \text{ m}^2}{2} \times 30 \text{ m}$	435.75 m <sup>3</sup>	Nil	435.75 m <sup>3</sup>
3	C - D	$\frac{10.53 \text{ m}^2 + 12.8 \text{ m}^2}{2} \times 30 \text{ m}$	280.95 m <sup>3</sup>	Nil	280.95 m <sup>3</sup>
4	TOTAL		1267.8 m <sup>3</sup>	Nil	1267.8 m <sup>3</sup>

APPENDIX & TO APPENDIX 0 10 APPENDIX 01 APPENDIX 01 APPENDIX APPEN NUKUNDNU - VOLUME CALCULATIONS

ANNEX K TO TOKELAU RECON REPORT DATED (0 MAY 85

# FAKADFD REEF CHANNEL

Appendices to this Annex are the technical details of data obtained during the surveying of the channel.

Appendices: 1. Pl	Lan	View
-------------------	-----	------

- 2. 3D Plan View
- 3. Detailed Cross-Sections
- 4. Longitudinal Cross-Section
- 5. Survey Sheets
- 6. Centre-Line Levels
- 7. Volume Calculations

Note: Appendices 1, 2, 3 and 4 are not attached, but are separate to this Report.

TORELAU RECON REPORT

#### FAKADED REEF. CHANNEL

Appendices to this Annex are the technical details of data obtained during the surveying of the chemnel.

- Appendices: 1. Plan View
- 20 Plan View
- 5. Detailed Cross-Sections
- . Longitudinal Gross-Section
  - 5. Survey Shuets
  - 6. Centra-Line Levals
  - 7. Valuma Calculations

Note: Appendices 1, 2, 3 and 4 are not attached, but are separate to this Report.

2			5	R	P			N	-L	K			H	_G	_F	E	D	C	B	A	1.075	Back sight	Job		
						2.115	2.035	1.885	1.88	1823	1.864	1.752	1.325	1.174	1.072	1.155	1.23	1.27	1.41	1.30		Inter- mediate	Fal		
	Summing																					Fore	kaofo T	0	
01	1								0.045	0.041					0.083	0.075	0.04	0.14				Rise	Reef 1 okelar	2.1.5	
122221	1227	-			- + -	0.08		0.20	0.057		0.112	0.427	0.151	0.102				a	0.11.	0.225		Fall	besoge ) Is		
JE OF		10.14	96.14	98.7		98.96		99.04	99.195	99.252	99.211	99.323	99.75	99.901	100.003	99.92	99.845	99 405	99.665	99.775	100.00	Reduced Level			
-	Differenc								-									-	-			Corr.		Please re	
	es									Ŧ	1.246											Adjusted Level	Type of staff		
-		200	200	170,	150	140	130	120	110	100	90	80	- 70	60	50	40	30	20	10	\$	11.5	Distance (m)	NK-2 Anglo Bay Waren		
																		43.20 m	50.3¢r	to level	FIN DATUM	Bearing Offset	Observer Skill Booker Skill Date 13 Mc Checked	y of Works and De	
12 17	@ He	Low		A11			Lag	F1								+		RH	1	DAT	level		nev av. 85		
1-	eight = 99.80	tide = 1.0		en sheet #2			e of cone bl	a la bi		1								side on RI		rum = Como	to DATUM =		Job File Sheet File Ref		5
	14 @ RH comprof wharf	0 m below @ 98.894	5 m abave @ 99.944	A			oer										·	ts of conc maoring block		Cof Copira sted RH Frant	11.5m	Remarks	Field Sheet No	Field ANNEX K	APPENDI
24	She	(C)	ellin	.ev	-				-		+ S	en	Stry of Works Development	of		De	ini	2 m					MAY 85		

Please return to nearest office of Ministry of Works and Development Observer Skinner Booker Skinner Date 13 May 85 Instr. NK-2 Field Fakado Reef Paceage. Tokebu Is 2 Job File .... Job Sheet No .... Type of Anab. 14. of ..... 10 Sheet ..... ... sheets Conditions boym A Checked .... File Ref ..... Plan Ref .... Distance Bearing Adjusted Reduced Back Inter-Fore Corr. Remarks Fall Rise Level Level Offset sight mediate sight (m) 99.775 Ø 2530 1.19 99.853 2 1.112 0.078 Edge channel RHS 99.894 2.7 0.041 1.071 99.113 0.781 1.852 4 Ministry of Works and Development 99.11 1.855 0.003 6 99 058 8 1.9C. 0.052 98.992 1.973 0.066 10 98.932 12 2.033 0.06 98.681 2.284 0.251 14 . 99.14 1 825 16 0.459 Edgechannel LHS Sea wall o Im away 0.807 99.947 1.018 18 evellin 0 S 5 e

Job			KEEF 1 HV. 1S	PASSACC	5		Type of staff	NK-2 ANGO" NS WARM	Observer SKIN Booker MATU Date 12 MA Checked SKIN	NO 18.85	Job File Sheet File Ref	of	
Back sight	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Bearing Offset			Remarks	1
1.39					100.00	-0.335	99.665	Ø	272 dup				
	1.231		0.159		100.159		99.824	2					
	1.164		0.067		100.226		99.891	4					
	1.195			0.031	100.195		99.86,	5.3		RH	CHANNEL	ERCE	1
	2.557			1.362	98.833		98.498	6		- Ser	and the second		
	2.547		0.01		98.843		98.508	K					
	2.538		0.009		98.852		98.517	10					
	2.565	-1	-	0.027	98.825		98.49	12					
1	2.480		0.085		98.91		98.575	14		-			
	2.453		0.027		98.937		98.602	16					
	2,280		0.17		99.11		98.775	16.3		LH	CHANNEL E	2062	
		1.324	0.95		000 COI		99.731	18					
					+								
	D. 054		· 101	· · · -	20 1.0.	Jifferen							

	1111		1.	1		1	1		1	1	1	1	hall		60Z	. <i>H</i> d
			10		Fal		-	10		1		1	2.002	Back sight		Job
123			2.415	3.185	3.060	2.825	172	2.503	070	390.1	1.090	1-112		Inter- mediate	T	Fakaofe
Ý.		2.435									-			Fore	skelac	
0.43			-							0.022	0.002	0.890		Rise	Takelau Islands	Ref Passage
0.432 00 0.435 0		0.02		0.125	0.235	0.033	0.289	1.433	0.002					Fall	25	sone
a one .		94.164	99.784	99.014	99.139		99.407	99.696	101.129	101.132	101.11	100.89	100.00	Reduced	-	
							-	-		1	1		-0.195	Corr.		
		214.24	98.992	98.222	LAS . 84	98.582	S19-86	98.904	100.437	100.439	100.317	100.295	-0.195 99.405	Adjusted Level	staff	Type of Det of
		l4.	5.11	16	14	12:	10	8	7.4	- 6 -	4	2	Ø	Distance (M)	Conditions V Wayna	NK-2
										-			2720 m	Offset	Date J.B. May 85 Checked Skimmer	Booker MAtelino
			LH channel edge.						RH edge Channal					Remarks	Sheet of	Job File Sheet No
and and and a contract of the second se			tr	10 19U	bu M	10 01€	SAG LA	DO	br	M	0	3	/	-/	Crossing	

Ministry of Works

tevelling

Back	Inter-	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance	Bearing	Remarks	
sight	mediate	sight	Rise	Fair			and the second second	(m)	Offset	Activity of the second s	
1.259					100.00	-0.155	99.845	¢	272 0		
	1.535			0.276			99.569	2			(T)
	1.150	11	0.385		100.109	6	99.954	4			
	1.405			0.255		8	99.699	6			2 2
	1.435	-		0.03	99.824		99.669	7.6			nd
	2,443	2		1.008	98.816		98.661	8		*	D
10	2.614			0.171	98.645	1	98.49	10	C. Land		eve
	2,695			0.081	98.564	2	98.409				elo
	2.639		0.056	0-0	98.62		98.465	14			pr
	2,565		0.074		98.694	4	98.539	16			and Development
	2.230		0.335	1	99.029		98.874				nt
		1.162	1.068	-	100.097		99.942				
					199 71	5.	99.5	6 21			
		1							110.00		
		-			7						-
											Levelling
								-			
	-				-		1				5
		-									
				2 100	and the second	-					She
44711111A -			MA	2- 1111	h.nn-	Varat	2002				R

and Development

Levelling Sh

Job	FA1		s RSER ELAU		SA6E		Instr. N. Type of staff Conditio	K-2 "ANGLO" ns HOT	Observer SKIN Booker MATUL Date Date Checked SKIN	100	Job File Sheet File Ref	11.	
Back sight	Inter- mediate	Fore		Fall	Reduced Level	Corr.	Adjusted Level	Distance	Bearing Offset			Remarks	
1.324				a series	100.00	-0.08	99.92	ø	2720m				
	1.513			0.189	99.811		99.731	2					
	1.520		-	0.007			99.724	4					_
	1.675		-	0.155	99.6149		99.569	6					
	1.745			0.073	99.576		99.496	7.6					
	2.585			0.837	98.736	-	98-659	8		-			
	2.875		-	0:29	98.449		98.369	10					
	2.942			0.067	98.382	-	98.302	12					
_	2.975			0.033	98.349	-	98.269	14					_
	2.950		0.025		98.374		98.294	16					
	2.875	_	0.055		98.429		98.349	18	-				
	2,855	-	0.04		98.469	-	98.389	19					
-	_	1.618	1.237.		99.706		99.626	21					
-													-
		-	-										-
-	_								-				-
	-		-										-
	n . 721.		00000	· /-	10.001C	Diffe			-	-	-		

and the second

WHITE DOCTOR OF THE PARTY

priash m

Job	Fakad		el Pae au Is	Boge E	3		Instr Type of staff Condition	Analo	Observer SIA Booker Mate Date 13 Mc Checked SIAW	alina 21.85	Job File Sheet File Ref	Field Sheet No. 7 of	4
Back sight	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Bearing Offset			Remarks	
315						+0.003	108.003	¢	2720m				-
	1.304		0.011		100.01		100.014	2					- 5
	1.325			0.021	99.99		99.993	4					1
	1:278		0.047		100-037		100.04	6					
	1.403			0.125	99.912		99.915	8					- 0
	1.762			0.359	99.553		99.556	8.8					- 0
	2.938			0.097	98.3TT 98.28		98.285	10					CVCI
	3.035			0.041	98.168		98.171						ciopinent
	3.147			9-112	98.18		98.183	14				,	
	3-135		0.012		98.24		98.243	18					
	1.775		1.30	-	99 54		99.543	19.5					-1
	<u></u>	1.705	0.07		99.61		99.613	2]					
													_
					· · · · · · · · · · · · · · · · · · ·				-				
			- * *										
													Venn
				-		-							9
	2 20		15 1	im	100 00)	Dulleren	202	-		-		and the second second	

						Please r	eturn to nearest	office of Ministr	y of Works and Deve	elopment	t		
Job	Faka	ola R Estela	o Islan	zoge d			Instr Type of staff Condition	NK-2 Angle Baseffot	Observer Slown Booker Motoli Date 3 Mov Checked Skinn	iner ivoa 85 -	Job File Sheet File Ref	Field Sheet No. 8. of	~
Back sight	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Bearing Offset		177 + 1941	Remarks	
.316		17 64	-			-0.099	99.901		2720m				
0.0	1324			0.008			99.893	\$ 2					5
	1.582.			0.258		-	99.635	4					9
	1.507	-	0.075	1 1 1 1 1 1 1 1		-	99.71	6					0
	1.623	1		0.116			99.594	8					br
	1.688			0 065			99.529	8.9					and Development
_	2.947	-		1.259			98.27	_10					- Ve
	2.907		0.04			-	98.31						010
	3.108			0.201			98.109	14					nd
_	3.095		0.013				98.122	16				•	lei
	3.110		T. Strate	0.05			98.107						7
	2.512.		0.598				98.705	18.9					
		1.540	0.972				99.671	_ 21_					
							1						
_						· · · · ·							
_						· ······							
			1.24			-							Le
_													evelling
			8										
		1											
-		1510	NM	10121									55
	01.227	Sillinin.	a.2.		0.224	Differen	ces	_		-			

A and Development

Levelling St

Job				Paesa S	<u>6</u>		Type of staff	ANG-0"	ObserverSKINA Booker MATUL Date 13 MAK Checked SKINA	011 85	Job File Sheet File Ref	of	
Back sight	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Bearing Offset			Remarks	1
1.302	2				100.00	-0.25	99.75.	ø	272 \$m				
	1.331		0.1	0.029	99.971		99.721	2					
	1.495		0-05	0.164	99.807		99.557	4					
	1.667			0-172	99.635		99.385	6					1
	1.713		1017	0.046	99.589		99.339	8					
	2.085			0.372	99.217		98.967	10		-			
	2.887		0.00	0.802	98.415		98.165	12					
	2,825		0.062	0.00	98.477		98.227	14					
	2.918			0-093	48.384		98.134	16					
	2.062			0.144	98.24		97.99	18					
	2.665		0.397		98.637		98.387	20					
		1.520	1.145		99.782		99.532	22				•	
			puß		6.23		11 55						
			0 3 1				10.007						
	10.000		A				211115						
	10000		000		CTAR CO.		17.247	-					
		1.0.00	10-10		100-574		1 10 6 12	121					
					ŧ								
													_
						0					-		
	5 3.0				0.218	fleret				-	-		

and Developmen

Levelling 5

Job	FA		O REA		SAGE		Type of staff	NK-2 "ANGLO" 35 WARIA	Observer SKU Booker MATUL Date 14 MA Checked SKU	INO	Job File Sheet File Ref	Field Sheet No. 10 of	sheets Row I
Back sight	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Bearing Offset			Remarks	
1.409		1		1	100-00	-0.677	99.323	i es	2720 yr				
	1,285		0.124	1- 2-5	100-124		99-447	2					
	1.248		0.037	-	100.161		99-484	K					
	1.486	2		0.238	99.923		99.246	6					
	1.233		0-253	10-004	100-176		99.499	8					
	1.518			0.235	99.891		99.214	10		-			
	1.515		0.003	10000	99.894		99.217	12					
	1.654			0.139	99.755		99.078	13					
	2.129		1	0.475	99.28		98.603	14		-			
	2,375			0.244	99.036		98.359	16					
	2,395			0.022	99.014		98.337	18					-
	2.362		0.033		99.047		98.37	20					
	2,204		0.158		99.205		98.528	27					
	1.645	-	0.559		99.764		99.087	23.6					
	1.537		0.108	6.000	99.872		99.195	25					
	1,485		0.052		99.924		99.247	27					
-		1.320	0.165	E	100.089		99.412	30					
				-	1								
						1							
-													
	0-089	Vilinin	0.0	49	0.089	Differen	ces			-			
					-	-				-			

There are a strength and the same

THE ARE THE

Job	FACA			PABSI 15			Type of,	NK-2 "ANGLO"	Observer SKI Booker MATU Date 14 MA Checked SKI	4NO.	Job File Sheet File Ref	of	
Back sight	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance	Bearing Offset			Remarks	
1.467	7				100.00	0.749	:19.211 .	B	272 Øm				
	1.515		1000	0.048	99.952		99.163	2	/		-		
	1.369		0.146		100.098		99.309	4					
	1.419			0.05	100.048		99.259	6					
	1.423		A CH	0.004	100.044		99.255	8		-			1
	1.467			0.044	100.00		99.211	10		-			-
	1.618			0.151	99.849		99.06	12		-			
	1.714			0.096	99.753	-	98.964	14					
	2.262			0.548	99.205		98.416	16	1				
	2.374			0.112	99.093		98.304	18					
	2.395			0-021	99.072		98.283	20					
	2,347		0.048	5103	99.12		98.331	22					1
	1.637		0.71		99.83		99.041	24					
	1.535		0.102		99.932		99.43	26					
	1.540			0.005	99.927		99.138	28					
	1.515		0-025		99.952		99.163	30					_
	1	1.456	0.059		100.011		99.222	32	1				
_		0-13			0.00		10-16						
										-			
	GINI	Viiliin	11 0-1	On T	0.011	Differe	nces		_	-			

		Survey Sh	5	1	1	-	-	1	-	-	MK	18/1	L/spe	d0.09	-99	6047	_		_	
			1.248	1.560	1.624	1.724	2,487	2.498	2.395	2.535	2.137	1.842	1.530	1.034	0.968	1.014	1.007	1.104	1.167	
		0.453 0.295.	0.312	0.064	1.0	0.763	110.0								0.046		0.097	0.063		
								0.103	0.06	0.198	591.0	0.412	0.496	0.066		0.007	10 - 4			-
HI WE		100:214	99.919	99.607	99.543	99.443	98.68	98.669	98.772	98.832	99.03	99.225	99-637		100.199	100.153	100.16	100.003	100.00 -0:745	
_Differences																				
es.		09.466	99.171	98.359	98.795	08.695	97.932	97.921	48.024	98.084	98.282	98.477	08.859	99.385	99.451	SOH.bb	99.412	99.315	99.252	
		34	32	30	28	26	24	22	20	18	16	14	12	10	æ	6	4	29	Ø	11)
																			272 Din	
L																				
Tovalling H			1 :7	-		a				əu					-				*	

Јор	Ŧ		FO R: KELAN		KSJAEE		Type of	MK-2 "ANGLO"	Checked SKI	NUES Job File	of	
Back sight	Inter- mediate	Fore sight	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Bearing Offset		Remarks	1
1.416					100.00	-0.805	99.195.	ø	272 Øm			-
	1.362		0.054		100.054		99.249	2				1
	1.454			0.092	99.962		99.157	4				
	1.436		0.018		99-98		99.175	6				2
	1.046		0.39	1	100.37		99.565	8				
	1.617			0.571	99.799	-	98.994	10		-		
	1.838			0.221	99.578		98.773	12				
	2.048			0.21	99.368		98.563	14.4	1.			
	2.496			0.448	98.92	1	98.115	16				
	2.288		1	0.092	98.828		98.023	18				
100	2.641			0.053	98.775		97.97	20				
	2.733			0.092	98.683	1	97.578	22				
-	2-826			0.093	98.59		97.785	24				
	2.282	- Mel	0.544		99.134		98.329	26				
	2.209		0.073		99.207		98.402	28				
	1.548		0.661		99.868		99.063	30				
	1.264		0.2.84		100.152		99.347	32				
	1.149	1-149	0.115		100.267		99.462	34				131
												S TH SA
			2									- El
-												0
416			0 12	1000	20.05	_		1				
10	0-26	1.149	2.151	61/2 B	99.195	LAHEror	ices			3		

in the

0920-2000millis riburis

WALST DESCRIPTION OF THE OWNER

ob	Fak	aofo 1 Toki	Roel Po elau le	esaqe ilands	M		Instr. Type of staff Condițio		Observer Skil Booker Mute Date 13 Ma Checked SAD	ilino 185	Job File Sheet File Ref		
Back sight	Inter- mediate	Fore	Rise	Fall	Reduced Level	Corr.	Adjusted Level	Distance (m)	Bearing Offset			Remarks	_
1.281					100.00	-0.76	99.24	_¢	2720m				
	1.253			0.002	99.998		99.238	2					
	1322			0.069	99.929		99.169	4					
	1.369			0.047	99.882		99.122	6					2
	1.444		-	0.075	99.807		99.047	8				and the second second	
	1.431		0.013		99.82		99.06	10					
	1.302		0.129		99.949		99.189	12					
	1.703			0.401	99.548		98.788	14					
	1.935			0 232	99.316		98.556	18					
	2379			0 444	98.872		98.112	18					
	2.555	a () ()		0.176	98.696	-	97.936	20					
	2.662			0.107	98.589		97.829	22					
	2.780			0.118	98.171		97.711	24					
	2.65		0.13				97.841	28.6					
	1.948		and the second se	0.702			98.543	31					
		1.920.	0.28				98.823	49.9					
					3 8 4								9
				-									
CI D		1.970	1-704	9.373	99.21					-			

							APPENDIX ANNEX K TOKELAU DATED LC
					FAKADE	O REE	F CHANNEL
					CENTRE	- LI	NE LEVELS
	Seria	1	Cros	14	ction	C	entre Line RL
1	(a)	-		(b)	1	-	(c)
-	1	14.2		А		-	98.992
1	2	15	E	В		2	98.49
1	3	10	1 15	C		19	98.582
1112	4	12	1%	D		1	98.437
1	5		1.2	E		-	98.294
	6		1	F			98.171
	7			G			98.109
1.3	8		100	Н		-	98.134
	9		5	I			98.337
1	10		1 24	J			98.294
	11			К			98.054
	12			L			97.97
1	13		LTN	М		-	97.883
	14			N			97.75
	15			0			97.52
	16			P			97.3
-			1	Q			97.0
1	17		1.55				96.76
	18		1 2.8	Х			50.70

ANNERSIX & TO ANNEY M TO TONILAU RECON REPORT DATED TO MAY 43

PAKADFO RECF CHANNEL

CENTRE - LINE LEVELS

		and a second of the		TOKELAU RE DATED 10 M	ECON REPORT
				SHARALING Reg.	Total Success
		FAKAOFO - VOLUME	CALCULATIONS	167	
Serial	Cross Section	Calculation	Fines	Rock (Blasting Req)	Total Volume
(a)	(占)	(c)	(d)	(8)	(f)
1	А – В	$\frac{18.15 \text{ m}^2 + 9.4 \text{ m}^2}{2} \times 10 \text{ m}$	140.75 m <sup>3</sup>	Nil	140.75 m <sup>3</sup>
2	8 <b>-</b> C	$\frac{9.4 \text{ m}^2 + 6.33 \text{ m}^2}{2} \times 10 \text{ m}$	78.65 m <sup>3</sup>	Nil	78.65 m <sup>3</sup>
3	C - D	$\frac{6.33 \text{ m}^2 + 8.93 \text{ m}^2}{2} \times 10 \text{ m}$	76.3 m <sup>3</sup>	Nil	76.3 m <sup>3</sup>
4	D - E	$\frac{8.93 \text{ m}^2 + 8.36 \text{ m}^2}{2} \times 10 \text{ m}$	86.45 m <sup>3</sup>	Nil	86.45 m <sup>3</sup>
5	E – F	$\frac{8.36 \text{ m}^2 + 4.55 \text{ m}^2}{2} \times 10 \text{ m}$	64.55 m <sup>3</sup>	Nil	64.55 m <sup>3</sup>
6	F - G	$\frac{4.55 \text{ m}^2 + 4.28 \text{ m}^2}{2} \times 10 \text{ m}$	44.15 m <sup>3</sup>	Nil	44.15 m <sup>3</sup>
7	G – H	$\frac{4.28 \text{ m}^2 + 6.2 \text{ m}^2}{2} \times 10 \text{ m}$	52.4 m <sup>3</sup>	Nil	52.4 m <sup>3</sup>
8	H - I	$\frac{6.2 \text{ m}^2 + 12.44 \text{ m}^2}{2} \times 10 \text{ m}$	93.1 m <sup>3</sup>	Nil	93.1 m <sup>3</sup>
	4-0	14.70 W + 22.00 al + 10 a		186.2 2	128.2 8

A B-W WARDS BEAMS WAD - SETE W2 WAS - SETE W2 B H - 2 B-B W2 - SETE W2 - 10 B - SETE W2 - 1112 - 3112 - 32,3 W3

APPENDIX 7 10 APPENDIX 7 10 APPENDIX 7 10 TUXELAL AFROM APPED 10 MAY 85

# AKADFO - VOLUME CALCULATIONS

APPENDIX 7 TO ANNEX K

Serial	Cross Section	Calculation	Fines	Rock (Blasting Req)	Total Volume
(a)	(b)	(c)	(d)	(e)	(f)
	2 - 2	$\frac{8.84 \text{ m}^2 + 8.24 \text{ m}^2}{2} \times 10 \text{ m}$	85.3 m <sup>3</sup>		126,2" "
9	I - J	$\frac{3.6 \text{ m}^2 + 7.86 \text{ m}^2}{2} \times 10 \text{ m}$		57.3 m <sup>3</sup>	142.6 m <sup>3</sup>
	2 - " =	$\frac{8.24 \text{ m}^2 + 6.89 \text{ m}^2}{2} \times 10 \text{ m}$	75.65 m <sup>3</sup>		525 . R . # R
10	J – K	$\frac{7.86 \text{ m}^2 + 10.28 \text{ m}^2}{2} \times 10 \text{ m}$		90.7 m <sup>3</sup>	166.35 m <sup>3</sup>
		$\frac{6.89 \text{ m}^2 + 7.61 \text{ m}^2}{2} \times 10 \text{ m}$	72.5 m <sup>3</sup>		
11	K – L	$\frac{10.28 \text{ m}^2 + 11.19 \text{ m}^2}{2} \times 10 \text{ m}$		107.35 m <sup>3</sup>	179.85 m <sup>3</sup>
12	L – M	$\frac{7.61 \text{ m}^2 + 5.54 \text{ m}^2}{2} \times 10 \text{ m}$	65.75 m <sup>3</sup>		. 179.35 m <sup>3</sup>
12	L - 11	$\frac{11.19 \text{ m}^2 + 11.53 \text{ m}^2}{2} \times 10 \text{ m}$		113.6 m <sup>3</sup>	179.99 m-
13	M – N	$\frac{5.54 \text{ m}^2 + 1.18 \text{ m}^2}{2} \times 10 \text{ m}$	33.6 m <sup>3</sup>		
	M - N	$\frac{11.53 \text{ m}^2 + 13.58 \text{ m}^2}{2} \times 10 \text{ m}$		125.55 m <sup>3</sup>	159.15 m <sup>3</sup>
14	N - 0	$\frac{14.76 \text{ m}^2 + 22.88 \text{ m}^2}{2} \times 10 \text{ m}$	Nil	188.2 m <sup>3</sup>	188.2 m <sup>3</sup>
35	10 - 10 - 1	19:75 m2 + 22 UB m2 8 10 m	NIT	-188;2 m <sup>2</sup>	188.2 43

- 3 -

APPENDIX 7 TO ANNEX K

-

Serial	Cross Section	Calculation	Fines	Rock (Blasting Req)	Total Volume
(a)	(占)	(C)	(d)	(8)	(f)
15	0 – P	$\frac{22.88 \text{ m}^2 + 18.37 \text{ m}^2}{2} \times 10 \text{ m}$	Nil	206.25 m <sup>3</sup>	206.25 m <sup>3</sup>
16	P - Q	$\frac{18.37 \text{ m}^2 + 20.64 \text{ m}^2}{2} \times 20 \text{ m}$	Nil	390.1 m <sup>3</sup>	390.1 m <sup>3</sup>
17	Q - X	$\frac{20.64 \text{ m}^2 + 14.5 \text{ m}^2}{2} \times 10 \text{ m}$	Nil	175.7 m <sup>3</sup>	175.7 m <sup>3</sup>
18	TOTAL		969.15 m <sup>3</sup>	1454.75 m <sup>3</sup>	2423.9 m <sup>3</sup>

10

N. 122F



ANNEX L TO TOKELAU RECON REPORT DATED 10 MAY 85

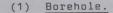
1.4 10

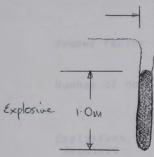
#### EXPLOSIVE CALCULATIONS

 The following is an assessment of type and quantity of explosives and associated equipment required for the task at Atafu and Fakaofo:

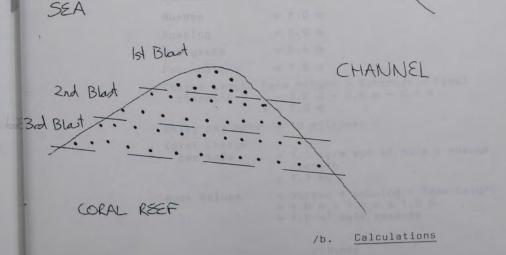
50mm

a. <u>Drilling Pattern</u>. This can only be effectively determined once test drills and blasts have been completed insitu at Atafu and Fakaofo respectively. However, a suggested borehole depth and drilling pattern is as follows:





(2) Drilling Pattern.

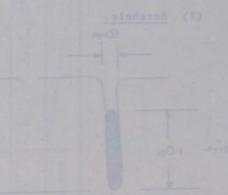


TOMECAU RECON REPORT

#### EXPLOSIVE CALCULATIONS

1. The following is an assessment of type and quantity of explosives and associated equipment required for the task at Atafu and Fakoufo:

Drilling Pattern. This can only be effectively determined anos test drills and blasts have been completed insitu at Atafu and Fakado respectively However, a suggested borehole depth and drilling pattern is as follows:



(2) Orilling Pattern.

- 2 -

ANNEX L

ь.

с.

Calculations to Remove 900 m<sup>3</sup> at Atafu.

Burden = 1.0 m Spacing = 1.0 m Sub grade = 0.4 m Final stemming = 0.4 m Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m = 1.0 m Delay per hole = 10 mili/sec Total charge per hole = 1.3 kg/m run of hole x charge length = 1.3 kg Rock Volume = burden x spacing x face height = 1.0 m × 1.0 m × 1.0 m = bulk measure = 1.0 m <sup>3</sup> Powder factor = charge per hold + bulk measure = 1.3 kg + 1.0 m <sup>3</sup> = 1.3 Number of holes = Rock required + charge per hold = 900 m <sup>3</sup> + 1.3 kg Explosives Required = 762 holes x 1.3 kg = 990.6 kg = 990.6 kg = 990.6 kg = 990.6 kg = 990.6 kg = 1.613 carts Calculations to Remove 1500m <sup>3</sup> at Fakaofo. Burden = 1.0 m Sub grade = 0.4 m Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m = 1.0 m		Remove you me at Atafu.
Sub grade = 0.4 m Final stemming = 0.4 m Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m = 1.0 m Delay per hole = 10 mili/sec Total charge per hole = 1.3 kg/m run of hole x charge length = 1.3 kg Rock Volume = burden x spacing x face height = 1.0 m x 1.0 m x 1.0 m = bulk measure = 1.0 m <sup>3</sup> Powder factor = charge per hold + bulk measure = 1.3 kg + 1.0 m <sup>3</sup> = 1.3 Number of holes = Rock required + charge per hold = 900 m <sup>3</sup> + 1.3 kg = 693 holes + 10% = 762 holes Explosives Required = 762 holes x 1.3 kg = 990.6 kg = 990.6 kg = 990.6 kg = 990.6 + 0.676 gms = 1466 carts + 10% = 1613 carts Calculations to Remove 1500m <sup>3</sup> at Fakaofo. Burden = 1.0 m Spacing = 1.0 m Sub grade = 0.4 m Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m • = 1.0 m Delay per hole = 10 mili/sec	Burden	the second second second second second
<pre>Final stemming = 0.4 m Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m = 1.0 m Delay per hole = 10 mili/sec Total charge per hole = 1.3 kg/m run of hole x charge length = 1.3 kg Rock Volume = burden x spacing x face height = 1.0 m × 1.0 m × 1.0 m = bulk measure = 1.0 m<sup>3</sup> Powder factor = charge per hold + bulk measure = 1.3 kg + 1.0 m<sup>3</sup> = 1.3 Number of holes = Rock required + charge per hole = 900 m<sup>3</sup> * 1.3 kg = 693 holes + 10% = 762 holes Explosives Required = 762 holes x 1.3 kg = 990.6 kg = 990.6 kg = 990.6 kg = 990.6 kg = 1613 carts Calculations to Remove 1500m<sup>3</sup> at Fakaofo. Burden = 1.0 m Spacing = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m Delay per hole = 10 mili/sec</pre>	Spacing	= 1.0 m
<pre>Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m = 1.0 m Delay per hole = 10 mili/sec Total charge per hole = 1.3 kg/m run of hole x charge length = 1.3 kg Rock Volume = burden x spacing x face height = 1.0 m × 1.0 m × 1.0 m = bulk measure = 1.0 m<sup>3</sup></pre> Powder factor = charge per hold + bulk measure = 1.3 kg + 1.0 m <sup>3</sup> = 1.3 Number of holes = Rock required + charge per hole = 900 m <sup>3</sup> + 1.3 kg = 693 holes + 10% = 762 holes Explosives Required = 762 holes x 1.3 kg = 990.6 kg = 990.6 kg = 990.6 kg = 1466 carts + 10% = 1613 carts Calculations to Remove 1500m <sup>3</sup> at Fakaofo. Burden = 1.0 m Sub grade = 0.4 m Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m Delay per hole = 10 mili/sec	Sub grade	= 0.4 m
Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m = 1.0 m Delay per hole = 10 mili/sec Total charge per hole = 1.3 kg/m run of hole x charge length = 1.3 kg Rock Volume = burden x spacing x face height = 1.0 m x 1.0 m x 1.0 m = bulk measure = 1.0 m <sup>3</sup> Powder factor = charge per hold + bulk measure = 1.3 kg + 1.0 m <sup>3</sup> = 1.3 Number of holes = Rock required + charge per hold = 900 m <sup>3</sup> + 1.3 kg = 693 holes + 10% = 762 holes Explosives Required = 762 holes x 1.3 kg = 990.6 kg = 990.6 kg = 990.6 kg = 990.6 kg = 990.6 carts + 10% = 1613 carts Calculations to Remove 1500m <sup>3</sup> at Fakaofo. Burden = 1.0 m Sub grade = 0.4 m Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m • 1.0 m Delay per hole = 10 mili/sec	Final stemming	= 0.4 m
<pre>stemming = 1.0 m + 0.4 m - 0.4 m = 1.0 m Delay per hole = 10 mili/sec Total charge per hole = 1.3 kg/m run of hole x charge length = 1.3 kg Rock Volume = burden x spacing x face height = 1.0 m × 1.0 m × 1.0 m = bulk measure = 1.0 m<sup>3</sup></pre> Powder factor = charge per hold + bulk measure = 1.3 kg + 1.0 m <sup>3</sup> = 1.3 Number of holes = Rock required + charge per hold = 900 m <sup>3</sup> + 1.3 kg = 693 holes + 10% = 762 holes Explosives Required = 762 holes x 1.3 kg = 990.6 kg = 990.6 kg = 990.6 kg = 990.6 + 0.676 gms = 1466 carts + 10% = 1613 carts Calculations to Remove 1500m <sup>3</sup> at Fakaofo. Burden = 1.0 m Spacing = 1.0 m Sub grade = 0.4 m Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m · · = 1.0 m Delay per hole = 10 mili/sec	Face height	= 1.0 m
Total charge per hole = 1.3 kg/m run of hole x charge length = 1.3 kg Rock Volume = burden x spacing x face height = 1.0 m × 1.0 m × 1.0 m = bulk measure = 1.0 m <sup>3</sup> Powder factor = charge per hold + bulk measure = 1.3 kg + 1.0 m <sup>3</sup> = 1.3 Number of holes = Rock required + charge per hold = 900 m <sup>3</sup> + 1.3 kg = 693 holes + 10% = 762 holes Explosives Required = 762 holes x 1.3 kg = 990.6 kg = 990.6 kg = 990.6 carts + 10% = 1613 carts Calculations to Remove 1500m <sup>3</sup> at Fakaofo. Burden = 1.0 m Spacing = 1.0 m Sub grade = 0.4 m Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m . = 1.0 m Delay per hole = 10 mili/sec	Charge Length Fa Stemming	= 1.0 m + 0.4 m - 0.4 m
<pre>per hole = 1.3 kg/m run of hole x charge length = 1.3 kg Rock Volume = burden x spacing x face height = 1.0 m x 1.0 m x 1.0 m = bulk measure = 1.0 m<sup>3</sup> Powder factor = charge per hold + bulk measure = 1.3 kg + 1.0 m<sup>3</sup> = 1.3 Number of holes = Rock required + charge per hold = 900 m<sup>3</sup> + 1.3 kg = 693 holes + 10% = 762 holes Explosives Required = 762 holes x 1.3 kg = 990.6 kg = 990.6 kg = 990.6 + 0.676 gms = 1466 carts + 10% = 1613 carts Calculations to Remove 1500m<sup>3</sup> at Fakaofo. Burden = 1.0 m Spacing = 1.0 m Sub grade = 0.4 m Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m  = 1.0 m Delay per hole = 10 mili/sec</pre>	Delay per hole	= 10 mili/sec
$= 1.0 \text{ m} \times 1.0 \text{ m} \times 1.0 \text{ m}$ $= bulk measure$ $= 1.0 \text{ m}^{3}$ Powder factor $= charge \text{ per hold} + bulk measure$ $= 1.3 \text{ kg} + 1.0 \text{ m}^{3}$ $= 1.3$ Number of holes = Rock required + charge per hold $= 900 \text{ m}^{3} \times 1.3 \text{ kg}$ $= 693 \text{ holes} + 10\%$ $= 762 \text{ holes} \times 1.3 \text{ kg}$ $= 990.6 \text{ kg}$ $= 990.6 \text{ kg}$ $= 990.6 \pm 0.676 \text{ gms}$ $= 1466 \text{ carts} \pm 10\%$ $= 1613 \text{ carts}$ Calculations to Remove 1500m <sup>3</sup> at Fakaofo. Burden $= 1.0 \text{ m}$ Spacing $= 1.0 \text{ m}$ Sub grade $= 0.4 \text{ m}$ Face height $= 1.0 \text{ m}$ Charge Length Face height + Subgrade - Final Stemming $= 1.0 \text{ m}$ Delay per hole $= 10 \text{ mili/sec}$		length
$= 1.3 \text{ kg} \pm 1.0 \text{ m}^3$ $= 1.3$ Number of holes = Rock required $\pm$ charge per hole $= 900 \text{ m}^3 \pm 1.3 \text{ kg}$ $= 693 \text{ holes} \pm 10\%$ $= 762 \text{ holes}$ Explosives Required = 762 holes $\times 1.3 \text{ kg}$ $= 990.6 \text{ kg}$ $= 990.6 \pm 0.676 \text{ gms}$ $= 1466 \text{ carts} \pm 10\%$ $= 1613 \text{ carts}$ Calculations to Remove $1500\text{m}^3$ at Fakaofo. Burden = 1.0 m Spacing = 1.0 m Sub grade = 0.4 m Face height = 1.0 m Charge Length Face height $\pm$ Subgrade $-$ Final Stemming = 1.0 m Delay per hole = 10 mili/sec	Rock Volume	= 1.0 m × 1.0 m × 1.0 m
$= 900 \text{ m}^{3} \pm 1.3 \text{ kg}$ $= 693 \text{ holes} \pm 10\%$ $= 762 \text{ holes}$ Explosives Required $= 762 \text{ holes} \times 1.3 \text{ kg}$ $= 990.6 \text{ kg}$ $= 990.6 \pm 0.676 \text{ gms}$ $= 1466 \text{ carts} \pm 10\%$ $= 1613 \text{ carts}$ Calculations to Remove 1500m <sup>3</sup> at Fakaofo. Burden $= 1.0 \text{ m}$ Spacing $= 1.0 \text{ m}$ Sub grade $= 0.4 \text{ m}$ Face height $= 1.0 \text{ m}$ Charge Length Face height + Subgrade - Final Stemming $= 1.0 \text{ m}$ Delay per hole $= 10 \text{ mili/sec}$	Powder factor	$= 1.3 \text{ kg} \div 1.0 \text{ m}^3$
Required = 762 holes x 1.3 kg = 990.6 kg = 990.6 $\div$ 0.676 gms = 1466 carts $\div$ 10% = 1613 carts Calculations to Remove 1500m <sup>3</sup> at Fakaofo. Burden = 1.0 m Spacing = 1.0 m Sub grade = 0.4 m Face height = 1.0 m Charge Length Face height $\div$ Subgrade $-$ Final Stemming = 1.0 m $+$ 0.4 m $-$ 0.4 m $\cdot$ $\cdot$ = 1.0 m Delay per hole = 10 mili/sec	Number of holes	= 693 holes + 10%
Burden = 1.0 m Spacing = 1.0 m Sub grade = 0.4 m Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m · · · = 1.0 m Delay per hole = 10 mili/sec		= 990.6 kg = 990.6 ÷ 0.676 gms = 1466 carts + 10%
Spacing = 1.0 m Sub grade = 0.4 m Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m 	Calculations to	Remove 1500m <sup>3</sup> at Fakaofo.
Sub grade = 0.4 m Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m • = 1.0 m Delay per hole = 10 mili/sec	Burden	= 1.0 m
Face height = 1.0 m Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m 	Spacing	= 1.0 m
Charge Length Face height + Subgrade - Final Stemming = 1.0 m + 0.4 m - 0.4 m • = 1.0 m Delay per hole = 10 mili/sec	Sub grade	= 0.4 m
Stemming = 1.0 m + 0.4 m - 0.4 m • = 1.0 m Delay per hole = 10 mili/sec	Face height	= 1.0 m
		= 1.0 m + 0.4 m - 0.4 m
Tatal Chappe	Delay per hole	= 10 mili/sec
per hole = 1.3 kg/m run of hole x charge length	Total Charge per hole	length
= 1.3 kg	T THE REAL	
Rock Volume = burden x spacing x face height = 1.0 m x 1.0 m x 1.0 m = 1.0 m <sup>3</sup> bulk measure	Rock Volume	<ul> <li>burden x spacing x face height</li> <li>1.0 m x 1.0 m x 1.0 m</li> <li>1.0 m<sup>3</sup> bulk measure</li> </ul>

- Z - DRNEX L

(P Didder

and the second se	
Powder Factor	<pre>= charge per hole + bulk measure = 1.3 kg + 1.0 m<sup>3</sup> = 1.3</pre>
Number of holes	= Rock required + charge per hole = 1500 m <sup>3</sup> + 1.3 kg = 1154 holes + 1-% = 1269 holes
Explosives Required	= 1269 holes x 1.3 kg = 1649.7 kg = 1500.2 kg + 0.676 gms = 2441 carts + 10% = 2685 carts

ANNEX L

- 3 -

Total explosives required = 4298 carts in boxes of 37 carts, Molanite.

d. Flexicord Required. For ring main to charge:

Hole depth = 1.4 m Length of Card = 2 x 1.4 m + tying off = 0.4 m + securing of explosives = 0.2 m = 3.4 m, say 3.5 m per hole

.. Atafu (762 holes) = 2667 m Fakaofo (1269 holes) = 4441.5 m

For ring mains: @ 1.5 m/hole

∴ Atafu (762 holes) = 1143 m Fakaofo (1269 holes) = 1903.5 m

Totals: Atafu = 3810 m Fakaofo = 6345 m Total = 10155 m

e. Detonators Required.

f. Detonating Relay Connectors Required.
@ a x DRC/5 holes = 407

g. It must be remembered that there is no readily available resupply available on Tokelau.

h. Shot firing cable = 600 m.



## FEATURES

ICI has been manufacturing slurry explosives in New Zealand since 1968, and has shown a steady advance in technology and performance. 'Molanite' is a high strength detonator-sensitive slurry formulated from non-explosive ingredients and is designed to replace conventional gelatinous explosives in many blasting applications. The latest advance, automatic cartridging of the slurries, provides superior packaging, and accuracy of diameters and lengths.

The 'Molanite' range of products is designed to provide good storage qualities, ease of loading, and packaging to meet your needs.

#### **OPERATOR COMFORT**

The 'Molanite' range does not produce the headaches symptomatic of the nitro-glycerine explosives, and there are no fumes in storage.



#### 'Molanite' loads easily

#### LOW FUME TOXICITY

On detonation 'Molanite' produces less toxic fumes and smoke compared with conventional explosives. This very attractive property makes 'Molanite' a good choice when blasting in confined spa

the scal

Sec.

#### SAFETY

Whilst sensitive to a detonator 'Molanite' has a sensitivity to mechanical impact than conventio explosives. Tests have also shown that when engulfed in a hot fire 'Molanite' will burn but it is unlikely to detonate.



Specialist packs

# watergels

#### WATER RESISTANCE

R

The firm gel structure of 'Molanite' has inherent water resistant properties which permit it to be loaded into water filled holes without detracting from its explosive properties. The new packaging material enhances this feature.

#### **TECHNICAL ADVICE**

The 'Molanite' range of products is backed by ICI's team of experienced and qualified field staff for consulation on-site to ensure the most efficient use of the products in all blasting conditions.

#### RMING

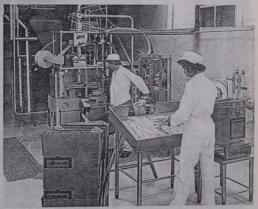
hare' in all grades and diameters can be reliably no by a No. 8 detonator or a 10 gram per treateonating cord e.g. 'Flexicord' or 'Redcord'. where, where the ambient temperature is below the primer such as an 'Anzomex Booster' or ste' is strongly recommended.

Made in New Zealand



ding with 'Flexicord'

Priming with detonator



**Cartridging Machine** 



Factory

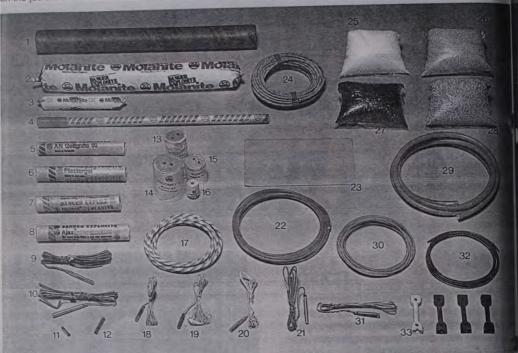
# Cl powermasters at your command

ICI research and development is your guarantee of a dependable, powerful product range to optimise your blasting.

In keeping with the high standard of reliability of all ICI explosives, "Molanite" is subject to stringent quality control and testing. This extends from laboratory to on-the-job situations.

Service with safety is the guiding principle of ICI, world leaders in research and development of explosives and techniques for their application.

ICI "Molanite" is manufactured in New Zealand to satisfy a broad spectrum of specifically local requirements. It is always readily available; and it is backed up by a full technical advisory service which is freely available for blasting consultation.



#### Everything for blasting . . . anywhere in N.Z.

In addition to manufacture, sales and technical service, ICI supplies a full range of back-up accessories

DETONATORS . DETONATING FUSE IGNITER CORD • EXPLODERS • VIBRATION DETECTING EQUIPMENT All products are available in continuous supply throughout New Zealand.

- 1. AN Gelatine Dynamite '95'
- 2. 'Molanite' large diameter 'Molanite' SX
- 3.
- 4.\_'Exactex
- 5. AN gelignite '60'
- 6. 'Plastergel'
- 'Morcol' 7.
- 8. 'Ajax'
- 9. 'L' series millisecond delay detonator
- 10. Half second delay detonator
- 11. Igniter cord connector
- 12. No 8 plain detonator
- 13. 'Anzomex' Booster M 250g
- 14. 'Anzomex' Booster Q 416g
- 15. 'Anzomex' Booster D 139g

- 16. 'Anzomex' Booster A 25g
- 17. 'Flexicord' detonating cord
- 18. No 8/1.8m aluminium electric detonator
- 19. No 6/1.8m copper electric detonator
- 20. No 8/1.8m submarine detonator
- 21. No 8 star/1.8m seismic detonator
- 22. 'Redcord' detonating cord
- 23. 'Metabel'
- 24. 'Selected Buff' safety fuse
- 25. 'Nitropril' ammonium nitrate 26. 'Amex'
- 27. Blasting powder
- 28. 'Aluminex'
- 29. 'Shearcord' 30. 'Trunkcord'
- 31. Electric lighter
- 32. Igniter cord fast
- Detonating relay connector gold 35 m/s green 45 m/s
  - blue 25 m/s
  - black 15 m/s

ICI New Zealand Limited, Box 900, Auckland New Zealand.

POWERMASTERS YOUR COMMANN Explosives



# advantages

EXPLOSIV

## ICI Molanite: a big advance "MOLANITE" high strength

detonator-sensitive slurry is formulated entirely from non-explosive ingredients and is designed to replace conventional gelatinous explosives in blasting applications

"MOLANITE" is designed to slump into down holes to provide good coupling with the walls of the blast hole and to achieve a high loading density . important features in optimising the economics of a blasting operation!

#### Safety: high standards

Whilst sensitive to initiation by a detonator, "MOLANITE" unlike conventional nitro-glycerine explosives is not detonated by mechanical impact.

Tests have also shown, that when engulfed by a hot fire "MOLANITE" will burn with a strong intense flame but will not detonate.

#### Fume: less toxicity

On detonation "MOLANITE" produces less toxic fumes and smoke when compared with conventional explosive. This excellent property makes



"MOLANITE" a good choice when blasting in a confined space as in shaft sinking or tunnelling.

Priming: simple and reliable "MOLANITE" can be reliably primed by a No. 8 detonator or by "CORDTEX" detonating fuse as an alternative to the use of high explosive primers. Below 10° C, an HE primer is recommended.

Strength: accurately controlled "MOLANITE" has an energy yield similar to AN Gelignite 60 and is designed for the diverse conditions encountered in New Zealand.

#### Operator comfort: no headaches

"MOLANITE" does not produce the headaches symptomatic of nitro-glycerine explosives and there are no fumes in storage.

#### Water resistant: for all conditions

The firm gel structure of "MOLANITE" has inherent water resistant properties which permit it to be loaded into water filled blast-holes without detracting from its explosive properties.



Electric Detona

D/ATMCTE



Pierce one end



Insert detonator and a half hitch around li cartridge



Cartridge ready for charging

# technical data

#### "Cordtex"

Eatter 2



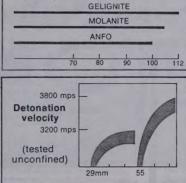
ma ave hitch around loavidge

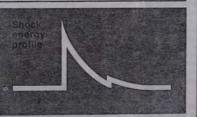


Intringe ready for Mang into hole.

#### Weight strength

The "MOLANITE" grade number represents weight strength relative to that of ANFO (100) as measured underwater by seismic evaluation. The chart shows these relationships.





		Cartridge Length (mm)	Cartridge Weight	Number per Case
MOLANITE	25	300	208g	120
	29	300	238g	105
	40	500	676g	37
	55	500	1.5kg	17
	65	500	2.1kg	12
	80	500	3.1kg	8
	90	500	4.2kg	6
	100	500	5.0kg	5

#### Density

The packaged density of "MOLANITE" is 1.18 gram/cc.

Packaging "MOLANITE" cartridges are packed into fibre board cases containing 25 kg of explosives. Each individual cartridge is packed in polythene layflat tubing.

R





"Molanite" is available in these stock sizes - ICI can make any diameter or length cartridge on request.

# **ICI**-powermasters at your command

ICI research and development is your guarantee of a dependable, powerful product range to optimise your blasting.

In keeping with the high standard of reliability of all ICI Explosive, "MOLANITE" is subject to stringent quality control and testing. This extends from laboratory to on-the-job situation.

Service with safety is the guiding principle of ICI, world leaders in the research and development of

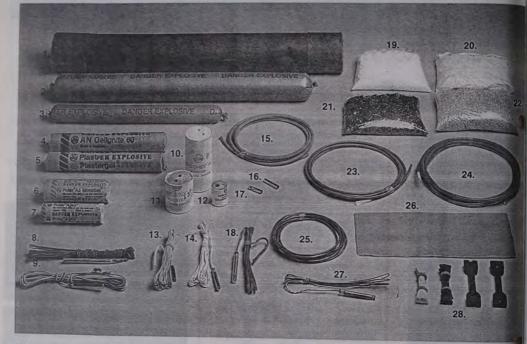
explosives and techniques for their application. ICI "Molanite" is manufactured in New Zealand to satisfy a broad spectrum of specifically local requirements. It is always readily available; and it is backed up by a full technical advisory service which is freely available for blasting consultation.

Included is a Quarry Design Service and Blasting Courses. ICI offer you the complete explosives service.

POWFRMASTERS

ICI New Zealand Limited

Explosives Division



#### Everything for blasting ... anywhere in N.Z.

In addition to manufacture, sales and technical service, ICI supply a full range of back-up accessories: DETONATORS . DETONATING FUSE . IGNITER CORD • EXPLODERS • VIBRATION DETECTING EQUIPMENT All products are available in continuous supply throughout New Zealand.

- AN Gelatine Dynamite 95
   "Molanite" large diameter
   "Molanite" small diameter 4. AN Gelignite 60
- 5. Plastergel
- 6. A3 Monobel
- 7. Ajax
- 8.
- "L" Series Millisecond Delay Detonator
- 9. Half Second Delay Detonator

"Anzomex" Booster 'M'
 "Anzomex" Booster 'D'
 "Anzomex" Booster 'A'

- 13. Electric Detonator
- 14. Submarine Detonator
- 15. Safety Fuse
- 16. Plain Detonator
- 17. Igniter Cord Connector
- 18. Seismic Detonator
- 19. Ammonium Nitrate 20. "Amex"
- 21. Blasting Powder
- 22. "Aluminex'
- 23. Blue Cordtex
- 24. Premium Cordtex
- 25. Igniter Cord Fast 26. "Metabel"
- 27. Electric lighter
- 28. DRC's, L. to R: 35, 45, 25, 15 m/s

ICI New Zealand Limited, Box 900, Auckland, New Zealand.

ANNEX L TO TOKELAU RECON REPORT DATED IO MAY 85



Volume 1 Number 4 March 1980

ICI New Zealand Limited Explosives Division has marketed the packaged slurry explosive "Molanite" for some years now. However, its mechanics of detonation are not generally fully understood by blasters. This edition of "EXPLOSIVES IN ACTION" will explain its nature, and examine factors which can influence its performance.

## Slurry Explosives—a review of their characteristics and initiation requirements

#### HISTORY

In the mid 1950's the development of fuel oil sensitised prilled ammonium nitrate (ANFO), revolutionized the explosives industry. However, this new source of cheap explosive energy had two significant limitations. ANFO is readily desensitised by relatively small quantities of water while its low density and detonation pressures restrict its effectiveness on the hardest rocks, particularly in the "toe" of the burdens of blastholes.

Although the addition of aluminium powders to ANFO gives improved energy characteristics, the water desensitisation problem still remains. This disadvantage led to further extensive research and a basic knowledge of the mechanics of detonation provides the key to understanding the resulting development of slurry explosives such as "Molanite".

#### MECHANICS OF DETONATION

An explosive consists of solids, gases and liquids which rely upon the introduction of a specific energy input for reaction. The detonation thus creates an intense supersonic shock wave which travels through the explosive compressing it to a high density. Then chemical reaction occurs with the conversion of the explosive ingredients behind the primary reaction zone into mainly gaseous products at high temperature. This in turn sustains the shock wave at a constant velocity throughout the explosive.

It is therefore most important that the initiators of high explosives produce the proper pressure and temperature conditions to efficiently promote the optimum reaction from a particular explosive's ingredients.

An additional means of sustaining the detonation

#### MAJOR EXPANSION SCHEME ANNOUNCEMENT

In a major development programme, details of which are just released, ICI New Zealand will invest about \$1 million in the building of new facilities to produce water gel or slurry explosives.

The manager of ICI New Zealand Explosives Division, Dr.J.A. Kernohan, said the present factory, built twelve years ago at Kawakawa Bay in the Firth of Thames, has been operating at near full capacity to meet market demands for its "Molanite" explosive.

"The new extension will add to capacity and incorporates new concepts and the latest overseas technology in terms of plant design, formulation and packaging design.

"Increased manufacturing capacity will enable further replacement of imported products by local manufacture, together with expanded customer servicing." Work on the new expansion is expected to be completed by the end of the year.

process of an explosive is to increase the pressure or the initiating shock (i.e. priming), or by the introduction of "hot spots" into an explosive. These materials to form friction abatic compression of thin the explosive. With s the "hot spots" are ession of tiny air or gas

"Molanite" retains the lel (metallic) and inium and ammonium ches and water are r cohesive strength and e entrapped air bubbles ation. "The quantity and pubbles is critical for lurry explosives." Any r size of these bubbles slurry explosives will Il explosives are ation of pressure, while ost commonly used , relative to volume and ult. It is these two areas standing as to their of all slurry explosives.

d and recommended for ould be clearly ED exposure will result

ensity and reduction in permeates the gel. ther salts as well as the

ely to occur when lit prior to loading (to coupling) and the full losive may not be

apping of "Molanite" lowing water such as g and some agricultural eaching of the itiser. In such extreme ngly recommends the .g. slotted cartridge explosive as soon after

pling to increase the porehole (particularly in desirable function of eadily achieved by planite" prior to loading ever, borehole loading cartridges bridge at the partly filled deep venting this problem in artridges down the c. Once the water level is line frees the hook and . The pressure of contribute to the

Molanite" can be istinct areas as follows:

e exerted by water or underwater blasting

sites. In these circumstances the density of 'Molanite" is increased as the tiny air bubbles within the explosive are compressed. The resulting reduction in sensitivity (i.e. available "hot spots" for compression), causes lowered explosive efficiency and often erratic blast results despite a higher volume of explosives per metre of borehole. In general terms, "Molanite" in its normal packaging should not be used in underwater blasts more than 20m deep. ICI makes special rigid packaged charges for underwater blasting tasks where "Molanite" is required. We can provide specialist advice on specific explosive problems associated with this area of blasting.

#### "Temperature"

Although normally sensitive to a Number 8 strength detonator for initiation, slurry explosives are less sensitive when the size of air bubbles is reduced by low temperature. When the temperature drops below 10°C, it is recommended that a booster from our "Anzomex" range be employed as a primer.

#### "Tamping"

Excessive tamping of "Molanite" can cause physical destruction of the air bubble and fuel relationship. This is particularly applicable in the small diameter cartridge range. Firm tamping of stemming material is suggested to provide maximum charge confinement.

#### **DIVISIONAL PROFILE**



#### ALAN CHRISTENSEN

Alan has recently been appointed South Island representative for Explosives Division. He is based in Alexandra to keep close contact with our customers in Otago, Southland, and Canterbury. Alan has been involved with the distribution of explosives at our Waitawa magazine area for the last two years. Before joining ICI he was involved with the fishing and transport industries.

# And Street Lines

Oranic Pressure Cesensitist Normann could construct and a subsection of the Strang Holms of Song Party And Starting of Contract of T and territory or much and prison Gardward by Inte Mail along to the large prop And the second s

and the second second

and the second of

Section Section

and the second second

And Hells of the Instant of Anothing whether of these to And be even by the first start of through the this preserves in the test

State of a state IN Ensure Multime charge approximate Avenie danale, where protices

(A) Office a delay period of at least 50 millerends between the byreindes

All Una a wedge cut in hut nië roumie. S C leaning the book a revised to design to said the conditions.

These dynamic pressure effects increar 1 version and the explorate can be defort. With the Batter of Stream

#### "Detonation Cord

Low order Selection has been select in Watery coefficies where some sharry a representative term has on the prime ( and the second second and the set of the second formation whether the And Antice (Malester) and "one of the second Kong Barana and and a survey of And Belleville

#### "Channel Effect"

1016

MARCH AND

Title

Shock waves move through different mediums such as air, water and rocks at different speeds. Therefore, if there is a significant gap between a "Molanite" charge and a borehole wall, the shock from a detonation will be moving at two speeds. The air shock always has a higher velocity than the detonation velocity and as it proceeds, the detonation front causes a progressive

compression of the explosive until the "Molanite" density is so high, the explosive can fail.

(N.B. Although this phenomenon occurs with N.G. sensitised explosives, it does not have the same result).

#### Dynamic Pressure Desensitisation \*

This phenomenon should be considered when using closely spaced boreholes such as "Burn cuts" in tunnelling, pole holes and some trench blasting situations. Bedding planes, or blast induced cracks intersecting an unfired borehole from a preceding millisecond delay shothole, can provide a path for gas pressure. Gas streaming into this closely adjoining borehole can therefore pressurise the explosive and effectively desensitise it at its time of detonation.

Porous, weak sandstones, limestones, coal, plastic clays or material with a density of less than 2.3g/cm<sup>3</sup> could be expected to give difficulties. It should be stressed, that this phenomenon can be controlled in the following ways:

- Ensure that the charge approximates the borehole diameter, where practicable:
- (ii) Utilize a delay period of at least 50 milliseconds between the boreholes concerned:
- (iii) Use a wedge cut in tunnel rounds, or consult ICI technical staff about a revised "burn cut" design to suit the conditions.

These dynamic pressure effects appear to be transitory and the explosive can be detonated later with a Number 8 strength detonator.

#### "Detonating Cord"

Low order detonation has been seen in secondary blasting operations where some slurry explosive ingredients have been left on the sides of post blast borehole walls and the rock breakage has been poor. While temperature, tamping effort, degree of confinement, borehole/explosive diameters and length need careful reviewing, the influence of detonating cord should not be ignored. Transfer of the shock energy of detonating cord to small diameter/lengths of cartridges does not automatically "Molanite" ensure that the explosive attains its optimum performance. This is particularly critical when using 5-8g/m (explosive core) detonating cord as the initiator may not be in positive contact with the explosive, or, some of the above factors also apply. In such cases a Number 8 strength detonator may be a more preferable initiator.

STORAGE

Our experience has shown that age affects slurry explosives' sensitivity, and cartridge rigidity also suffers. Although we have fired (using a Number 6 strength detonator), "Molanite" cartridges four years old, we recommend a storage life of twelve months in New Zealand temperatures. Regular explosive stock rotation is most important in geographical areas where pronounced temperature variations prevail.

#### PRIMING

#### Priming "Malanite'

Under most circumstances "Molanite" is successfully initiated by detonating cord or Number 8 strength detonators. Proper priming will overcome many of the extraneous pressure and temperature effects mentioned earlier. The primer must have the following properties:

- (i) A higher rate of velocity of detonation,
- (ii) Produce high shock pressure,
- (iii) Be as close as possible to the borehole diameter.

ICI's range of cast P.E.T.N./T.N.T. "Anzomex" boosters are ideal for this purpose.

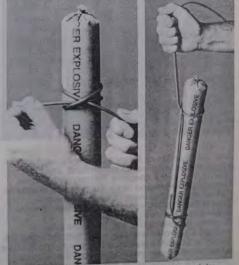
#### "Molanite" primers

Conversely, "Molanite" itself can be used as a primer of dry blasting agents (D.B.A.'s) such as ANFO, "Amex" and "Aluminex". The minimum length of these primers should equal twice the borehole diameter of the common range of blastholes drilled in New Zealand for two reasons:

- (i) To prevent bridging when loading into the borehole,
- (ii) To ensure that adequate detonation velocity and pressure is reached within the primer.

The diameter of a "Molanite" primer should be as close as possible to the borehole diameter when using detonating cord as the initiator, to ensure intimate contact. This can be best achieved by slitting the primer prior to loading, to facilitate slumping and full cross sectional filling of the borehole. Although special short primers of "Molanite" can be made at our factory at short notice, the gel consistency of "Molanite" allows a blaster to cut primers from the standard cartridges to suit his own requirements. This method is the most commonly adopted practice in New Zealand and has an economic advantage over cast boosters for priming dry blasting agents. The pictures below illustrate the various methods of priming "Molanite" and using this explosive as a primer in its own right.

#### DETONATING CORD



. Tie a clove hitch around the cartridge.

 Cartridge ready for lowering into hole.

#### ELECTRIC DETONATOR

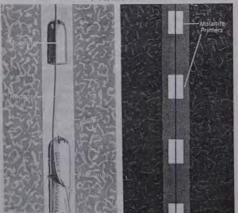


 Insert detonator and take two half hitches round the cartridge (as shown in Fig. 2)



4. Cartridge ready for charging

#### PRIMING



#### "Molanite" Dimer

The introduction of metrics in New Zealand and its implications for product dimensions and blast design, led to ICI adopting 200mm and 500mm lengths for small and large diameter cartridges of "Molanite" respectively. These dimensions coupled with packaging in 25 kg cases, greatly simplifies blast design calculations. Another consideration has been the effect of ragged boreholes and worn drill bits reducing the nominal borehole size thus preventing the loading of 65mm diameter cartridges into 75mm blastholes. Recognizing this problem, ICI has introduced a 60mm diameter cartridge into its "Molanite" range of explosives. This size allows for ease of borehole loading in such conditions while retaining the necessary degree of borehole coupling for optimum density per metre of borehole. This function is most important where stubborn "toe" conditions apply, as well as allowing optimisation of the drilling pattern for total "work" and cost efficiency from the explosives.

The table below lists our current standard range of cartridged "Molanite".

Cartridged	Cartridged
Diameter	Length
25 mm 29 mm 32 mm 40 mm 55 mm 60 mm 65 mm 80 mm 90 mm 100 mm 115 mm	200 mm 200 mm 200 mm 500 mm 500 mm 500 mm 500 mm 500 mm 500 mm 500 mm

#### General

Slurry explosives such as "Molanite" can be produced in various strengths and degrees of rigidity. Our experience has shown that a balancing of these factors (i.e. rigidity versus slump), is necessary to meet the general blasting requirements of cartridged slurry explosives in New Zealand.

With reasonable forward notice, it is possible for ICI to vary the diameter or length of a cartridge of "Molanite", and as for the Bluff Harbour deepening project, introduce specially packaged rigid unit charges to meet the unusually demanding factors applying there. It should be appreciated however, that slurry explosives are but one of a broad range of ICI explosive products. Slurry explosives DO NOT fulfil every requirement for blasting tasks and must therefore be considered on a "suitability for the job in hand" basis. Blast designers should not hesitate to seek our technical assistance on such matters, or for general or specialized advice on all facets of blasting.

#### Summary

Several thousand tonnes of "Molanite" have been used in the last few years and ICI's "Molanite" now ranks as the second most commonly used explosive in New Zealand — only slightly behind ANFO. Provided blasters realise that "Molanite" has different properties and characteristics from nitroglycerine explosives and recognise the factors which influence its performance, they will enjoy the user comfort and economic advantages to be gained from this explosive.

#### ICI EXPLOSIVES BINDERS

A specially printed 2-ring binder is now available to file all ICI Technical and Sales Literature.

For a post-free copy, please send \$5.00 cheque/money order to ICI New Zealand Ltd, Explosives Division, PO Box 900, Auckland.



"Explosives in Action" is published by the Explosives Division of ICI New Zealand Ltd, P.O. Box 900, Auckland, New Zealand.

APPENDIX 4 TO ANNEX L TO TOKELAU RECON REPORT DATED IO MAY 85

'Flexicord' is a strong, reliable detonating cord especially developed to possess properties which meet the requirements of all detonating cord users.

Fexico

'Flexicord' has a core of high explosive (PETN) treated with a water-repellent agent. The core is encased in a tube of polyester tape bound by polypropylene yarns which are covered in a flexible PVC sheathing. Outer yarns are firmly attached to the plastic sheathing with an adhesive.

The combination of treated explosive core, polypropylene yarns, plastic covering and outer covering has produced a cord which has excellent water-repelling properties, high tensile strength, good flexibility, knottability and abrasion resistance. The cord has high visibility, provided by the white outer covering with red and blue stripes, and has excellent storage handling and firing characteristics in all conditions likely to be encountered in the field. 'Flexicord' has the ability to withstand suddenly applied loads and to stretch and detonate reliably under severe conditions of rock movement encountered in delay firing.

#### Field of application

'Flexicord' may be used in conditions of severe abrasion. Its superior handling, flexibility and knot-holding properties are beneficial where water or oil (from ANFO) is present.

#### Packaging

'Flexicord' is packed 1000 metres to a case (4 x 250 metre reels).

This product is not waxy to touch or grasp in warm weather. Also 'Flexicord' doesn't "spring" the knots one ties as for our plastic-sheathed Premium and Blue "Cordtex". A special additive to the PETN explosive core has been used to further improve water resistance.



#### Properties Colour

Colour

VOD Tensile strength External diameter Coreload (PETN) Weight White, red/blue stripes 7140-7500 metres/sec 125-130 kg 4.5 mm approx 10.0 g/m (nominal) 23.5 kg/1000 m approx

#### Safety

'Flexicord' is insensitive to initiation by ordinary impact, friction or shock, and to static electricity and stray currents. 'Shearcord' is similar to Premium 'Cordtex' with a core of the high explosive PETN encased in a high strength carcase which is covered by a flexible jacket of polythene. The difference between the two is that 'Shearcord' is much heavier in construction, and the charge weight of PETN is seven times that of Premium 'Cordtex'. The heavy charge weight makes 'Shearcord' suitable for smooth-wall blasting techniques.



#### Properties

Colour VOD Tensile strength External diameter Coreload (PETN) Weight Orange 6400 metres/sec 120 kg 10.5 mm 70 gram/metre 100 kg/1000 m

#### Safety

'Shearcord' is insensitive to initiation by ordinary impact, friction, or shock, and very insensitive to static electricity and stray currents.

#### Use

'Shearcord' is cut to length as required using a sharp knife or approved cutter. All cut ends should be secured by using special end caps to prevent loss of explosive powder core.

Initiation may be achieved by attaching longitudinally either a detonator or Premium 'Cordtex' to the 'Shearcord'.

#### Packing

'Shearcord' is packed on 50 metre reels, with 4 reels (i.e. 200 metres) per case. 'Shearcord' End Caps are packed in plastic bags of 50, with 4 bags (i.e. 200 end caps) per carton, and 5 cartons (i.e. 1000 end caps) per case.

#### POWERMASTERS AT YOUR COMMAND COMMAND

Explosives Division Box 900 Auckland

ANNEX M TO TOKELAU RECON REPORT DATED 10 MAY 85

#### DRILLING EQUIPMENT

1. Attached as Appendices to this Annex are copies of brochures produced by Ingersol-Rand Ltd (drilling equipment). The Appendices contain information about the recommended air-track drill and compressor required for the tasks in Tokelau.

2. Enclosure 2 contains detailed information.

3. The recommended airtrack drill is the "LM-100 Crawlair Drill". It appears to be a most suitable piece of equipment for employment in Tokelau and has the following advantages; it is:

- a. light weight;
- b. easily operated by one man;
- able to be transported by local aluminium boats with relative ease;
- capable of approximately 500% more production during the same time as hand operated tools;
- suitable for other Army tasks associated with quarrying and blasting;
- f. cost effective; and
- g. fitted with an independant rotation drifter, the YD 90.

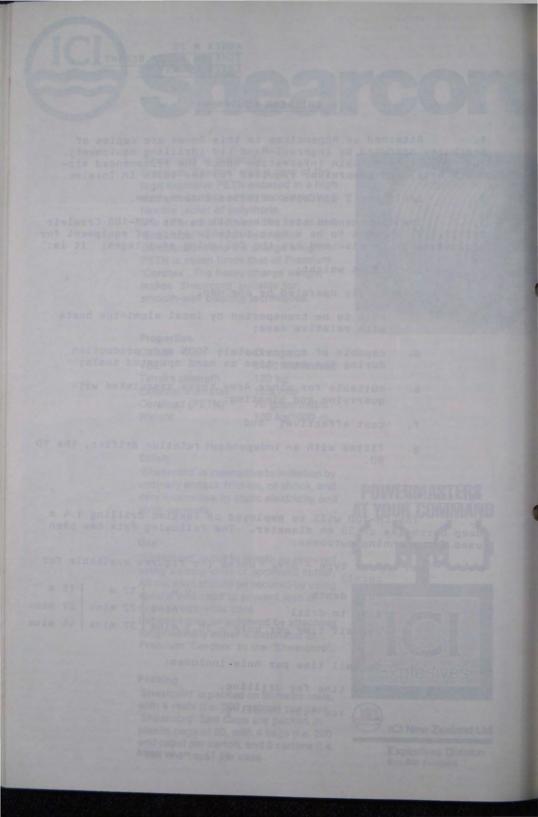
#### Performance

4. The LM-100 will be employed on Tokelau drilling 1.4 m deep boreholes of 50 mm diameter. The following data has been used for planning purposes:

a. Rock type - Grey Wacke (no figures available for coral)
 hole depth - 9 m | 12 m | 15 m
 time to drill - 18 mins | 22 mins | 27 mins
 overall time per hole - 30.5 mins | 37 mins | 44 mins

b. Overall time per hole includes:

- (1) time for drilling,
- (2) rod tube handling,



- (3) movement to next hole,
- (4) line-up and colaring, and
- (5) total time per hole plus 5% contingency factor.

5. The LM-100 requires a minimum of 375 CFM supply of air. It also recommended that the P375 Portable Compressor be purchased for the task. The P375 is a diesel compressor and has the following advantages; it:

- 2 -

- a. its wheel mounted;
- b. has a low centre of gravity;
- c. has a hand brake;
- d. has a tow bar that can be adjusted for height; and
  - e. has four wheels.

6. Detailed costs of LM-100 and P375 compresor are included in Enclosure 2.

APPENDIX 1 TO ANNEX M TO TOKELAU RECON REPORT DATED OMAY 85





APPENDIX 1 TO ANNEX M TO

## ne versatile LM-100 Crawlair drill. Small in size

a lightweight elergy-saving difter rig for 4-64 mm 1/4-21/2") holes.

> In't let the small size of this my little drilling rig fool you. It's a ull-mechanized, self-propelled malair drill that does all the heavy on for you. It trams easily from noto hole at the touch of a throttle, owig a portable air compressor. Indrill tower is quickly positioned meffortless hydraulic cylinder pontion.

> lith the YD-90 drifter, it handles 1 518 mm (10') rod change, with 32 Tul(1.25") rods, threaded bits and olings, to depths 12 m (40') at namum efficiency.

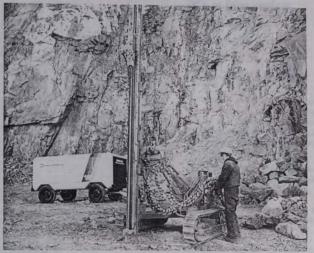
> Suple, safe one-man operation. Allramming and positioning conru are located at the rear of the natine for easy operation. Drilling orols, can be mounted on the ovr or at the side of the machine, convenience in either deep-hole ngle-pass drilling.

uged crawler construction. Wh two independently-controlled 7 d tramming-air motors, it can clip a 35° grade.

k oscillation. Heavy steel ran frame has walking-beam track oslation that permits each track to inp or down to match ground mularities.

me powerful hydraulics. A 3-hp hyaulic pump motor assures fastabsitioning.

Annd oil gages. Continuous indiunin of air pressure and lubricator nivel take the guesswork out of dipperation.



ks well in close quarters



Independent rotation drifter. The YD-90 air drifter has ample power for drilling holes to 64 mm (21/2") in diameter. Integral air motor drive provides independent rotation with infinitely variable speed control

Uses little air. With a P425 Spiro-Flo\* compressor, there's plenty of air to operate the drill, rig and optional dry dust collector.





DA V YJON GAN

### versatile LM-100 Crawlair drill. Small in size

File

And species designed as a straight straight days

Tradepoint and a set along a series Trie (15.00 are defined by an angle games for which globals are retried on a demonstrat. Integral are trotried which in a series and point areas from and in tradinately seemble quark areas

Using HUBs als, Wesh a P423 Speed Was compression theory's planty of an its operate the doll, eig and op themal dry dust collector

anima West of views of a



Standard and a strend liquid.

a lightwaight way-saving the rig for 84 mm -84 mm

(c) of the second size of bigs brins the lines, and going out these means the lines, and going field with the does all the heavy the rate. It transmouth of a theory of the control of a theory of theory experiments in the second size of the second of the second size of the second of the second size of the second of the second size o

is the Y theory builton, it has also been (40) and changes with W Variate threaded bits and any is depine [3 as (40) at any ambiency.

a setta tata-man operatian per se ante portocolare cota sectada et the rear of the et setta setta operation. Defining to the actor of the machine, are the actor of the machine, the setta defining.

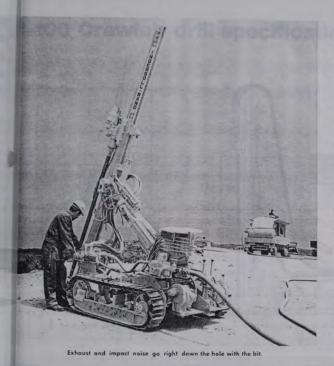
d crewter construction, tro independently controlled unming-air motors, it can bit grade.

e manifestions, Hanny stead forme from walking beams trach them their generation search tracked to ever deserve to matcale grouped writing.

provint al injeferantices, A. 2-Inj. Ma party mater similar lastristing.

ed all grages. Communications for an pressure and take mater relation the grantwork out of scientism

## gin performance.





The AT-480 dust collector, available with YD-90 drifter or DHD-09 Down-hole drill, uses only 2 m<sup>3</sup>/min (70 cfm) of 7 kg/cm<sup>3</sup> (100 psi) air.

## It's a low-noise deep-drilling downhole rig for 85-90 mm (3<sup>3</sup>/<sub>8</sub>-3<sup>1</sup>/<sub>2</sub>'') holes.

Equipped with a rotary head and larger centralizer, the LM-100 gives you all the Crawlair benefits, plus the basic advantages of Downhole drilling-with the Ingersoll-Rand DHD-09 Downhole drill.

**Drills faster** on deep holes because penetration rate doesn't fall off with each rod added to the string.

**Uses less air** because the same air does double duty, powering the drill and then cleaning the hole.

**Drills straighter** because the Downhole drill is less easily deflected off-course by varying strata.

**Extends rod life** because no impact forces are transmitted through the drill rod.

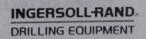
The DHD-09 Downhole drill is engineered and built to provide top performance at rock-bottom cost. Penetration is proportional to the air pressure across the drill. Check these other I-R features:

**Stop-action plunger** automatically stops the hammer action whenever the drill is raised.

Wear sleeve surrounding the drill cylinder can be reversed to extend sleeve life. It's easy and economical to replace.

**Piston** delivers full impact force directly on the bit at any depth of hole.

Bit retaining key prevents accidental dropout yet permits easy removal for grinding or replacement.



APPENDIX 1 TO

## performance.

## II's a low-noise deep-dhilling 65-90 mm (3%-3%") holes

Equipped with a transport hand and larger testimation, that LM-(40) given the basis of Cravelar benefits, pirm definitor - wath - diventional definitor - wath - basis for Ingersad-Rond E1010-06 Department.chr3

Defilie basker on derp lands berg an participation rure dasars's lab of write and year and added to the strong.

Basic Reas all broaten the party of these desires fairs, powering the well and phere classically the focus

Division advantations for more the Downhole and is formers of well-sense off-counter by varying struct.

Extends and the beauty on impact for our new to enumers the ough the drill and

The Diffuent loss of the provide top performanced and their or provide top performances of management to the att provide astrong star strands when att provide astrong the provident to the start of the performance

blog-action plantan attendents ango the partners attend whenever sing and a mixed.

Wear aloare contration of the and systems and by recentered of antend aloreve the fitnessty and economical to replace.

pieton delivers full impact (area to

Bit retaining toy provide and

INGERSOLL-RAND.

Independent impact while we start his have been been been

The Advance have subscripts, and takes with 10-46 dollars as a second of the second state of the second s

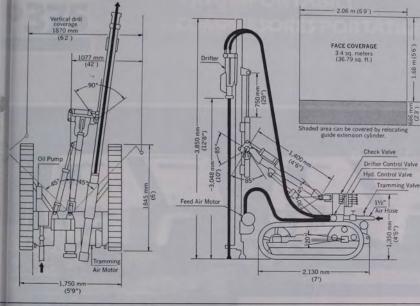
APPENDIX 1 TO ANNEX M TO

1.68 m (5'6')

INGERSOLL-RAND.

DRILLING EQUIPMENT

## I-100 Crawlair drill specifications

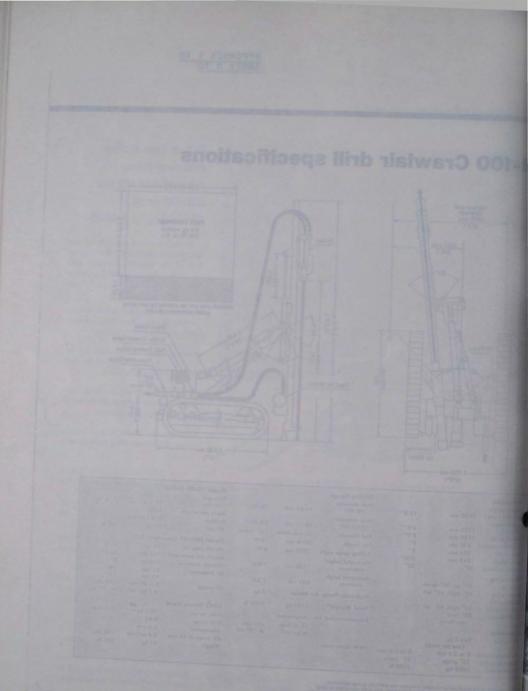


Inensions erall length tower horiz.) Hight (tower tooriz.) erall width bund clearance	3850 mm 1350 mm 1750 mm 230 mm	12'8" 4'5" 5'9" 9"	Drilling Range Hole diameter (YD-90) Hole diameter (DHD-09) Rod diameter	44-64 mm 85-90 mm 32 mm round	1¾-2½" 3¾-3½" 1¼" round	Model YD-90 Drifter Bore and stroke Blows per minute Rotation Weight	90 × 85 mm 1600 0 to 150 rpm 85 kg	3½ × 3¾″ 187 Њ
ck width ck length ck oscillation	204 mm 1845 mm 20°	8'' 6'%'' 20°	Rod length Drilling range width Horizontal height,	3048 mm 2050 mm	10'0'' 6'9''	Model DHD-09 Down Weight (less bit)	hole Drill 24 kg 965 mm	53 lb 35.6''
sitioning om lift	45° up, 30° down	20	Horizontal height, minimum	2350 mm 680 mm	7'8½" 2'2¾"	Length (bit extended) Outside diameter Bit diameters	76 mm 85 mm 90 mm	33.0 3%'' 3%''
ide swing horizontal)	45° right, 45° left 45° right, 45° left		Hydraulic Pump Air		3 hp		3.5 m <sup>3</sup> /min at 7 kg/cm <sup>2</sup>	125 cfm at 100 psi
ide dump	85° (two positions)		Total Weight* Recommended Air	Construction of the local data and the	5400 lb		79.5 kg-m	575 ft-lb
motors	Two 7-hp (one per track)			12 m <sup>3</sup> /min at kg/cm <sup>2</sup>	425 cfm at 100 psi	Horsepower	0-65 4.0 max 3.4 m <sup>3</sup> /min	120 cfm
mming speed mbing ability awbar pull	0 to 2.6 kph 35° grade 1400 kg	0 to 1.6 mph 35° grade 3100 lb	*With YD-90 drifter.			tur erege er er itri	91 kg	200 lb

This brochure is intended to extend any warrantly or representation, regarding the products described herein. Any such warranties or other of sale of products shall be in accordance with Ingersol-Rand's standard of sale for such products, which are available upon represent.

Igsoll-Rand Company Drill Division Inosburg, New Jersey 08865

166-A <1977 1981 Ingersoll-Rand Co Printed in U.S.A.



INGERSOLL-RAND

An Company

CODES VIEW AND VIEW

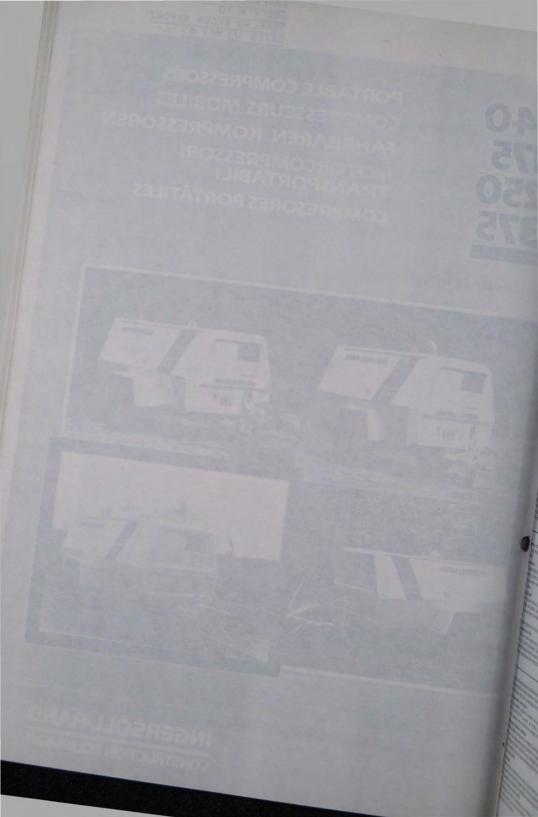
the state of the second st

APPENDIX 2 TO ANNEX M TO TOKELAU RECON REPORT DATED 10 MAY 85

# 140 175 250 375

PORTA BLE COMPRESSORS COMPRESSEURS MOBILES FAHRBAREN KOMPRESSOREN MOTORCOMPRESSORI TRANSPORTABILI COMPRESORES PORTÁTILES





## P 40/P175/P250/P375 WHISPERISED®

A lat of precision engineered portable compressors, designed for tox infernance, maximum efficiency, economic operation and mixum operational Me.

On Operation As dets meet to surpass CAGI-PNEUROP notae emission and da, and can therefore be used in areas where strict noise art on standards are in force.

an ten services and the service of the service of the services of the services of the service of

Linds 15 seasor rotors are precision-machined to the ideal design other components are precision dis-cast. The result greater (cy) and lower hele consumption.
E was and air-end assemblies are mounted on heavy gauge at-ter and air-end assemblies are mounted on heavy gauge at-

unumme de compresseurs mobiles fabriquée avec précision et san pour un entretien réduit, un rendement maximum, un re ninement économique et une durée de vie opérationnelle

monnement silencieux a se modèles sansion ou dépassent les normes d'émission de u'AGI-PNEUROP, et peuvent donc être utilisés dans les a s où des normes strictes d'émission de bruit sont en vigueur.

ars grande puissance or modeles sont equips de moteurs desel industriets qui, la machine choise, sont reflorids par air ou par eau une puissance de 38 kW (51 ch) a 83.5 kW (112 ch) 1 frmn. Tous les modèles offrent une excellente économie de ant.

resseurs ors du compresseur sont usinés avec précision selon le profit Les autres composants sont a par moulage mécanique de précision. Le résultat un ment plus élevé et une consommation de carburant plus

nteurs et les compresseurs sont montés sur des châssis en

wihe tahrbarer Schraubenkompressoren mit geringem Kongsaufwand, langer Lebensdauer und wirtschaftlichem

Suschpegel ul Modelle unterschreiten die AVV-Normen. Sie können setzt werden, wo Geräusche auf ein Mindestmaß legesetzt werden müssen.

cleistungsmotoren Indellie besitzen Dieselmotoren, die je nach Modeli entweder befor wassergehüht sind. Die Leistung dieser Motoren liegt wen 38 und 83,5 kW bei 2500 Umm. Sie zeichnen sich alle höhe Wirtschaftlichkeit aus.

Laulerpooli zu erreichen. Andere Komponenten sind laulerpooli zu erreichen. Andere Komponenten sind laulerpooli zu erreichen. Andere Komponenten sind lansregossen. Das Resultat größere Elizienz und nach exeleten Gurmidampferm in einem Chassis aus hochwertigem montiert. um eine größere Laufube zu erzelen.

## steel chassis by means of special rubber mounts, thereby isolat vibration the lowing vehicle and meets European specifications. The other is a rigid lowing bar running gear which meets EEC specifications Wide wheel base, hing ground clearance and a low center of pravity make all models very stable on even the roughest ground. The over the base system provides for excellent orhaling characteristics. A hand parking brake which allows for sale parking is a standard time.

Names Air Regulation The Slepiess system, from site to buil engine speed, allows for continuous, smooth flow of compressed air output in response to all pontinuous.

Aremand Ar OII Separation Less Itima 10 p.p.m. due to a two-stage separation system: Unique Cooling All models are designed to operate with adors closed. The unique cooling system allows the units to operate in an ambient conditions, depending on the machine model, of up to 125' (SZC). The singline and air-end are protected by separate air intake filters explored with the element restriction indicators. **Remining Gear Remining Gear** Inter single area as uspended running gear are available. The first incorporates a two-bar that can be adjusted to suit the height of Irst incorporates a two-bar that can be adjusted to suit the height of

tôle d'acier de torte épaisseur par l'interméd-laire de plots spéciaux en caoutchouc, isolant ainsi

Régulation d'air debit d'air comprime uniforme répondant totalement à la debit d'air comprime uniforme répondant totalement à la demande d'air.

Séparation air-huite Inférieure à 10 p.p.m. grâce au système de séparation à deux

etages. Refroidissement unique Tous les modèles sont conçus pour pouvoir tonctionner avec les portes termées. Le système de retroidissement unique permet aux unités de tonchonner dans des conditions ambiantes allanti jusqua 32°C, en fonction du modèle de machine. Fittres à air accs bi-tages Le moteur et l'ensemble compresseur sont protégés par des filtres d'admission séparés, quupés d'indicateurs de colmatage de l'étement filtret.

Châssia

Deux types de châssis à suspension par barres de torsion sont

die EG-Bestimmungen gerecht wird. Die breite Spurweite, der hohe Bodenabstand und der niedrige Schwerpunkt sorgen für eine sehr schere Straßenlage des Kompressors bein Schleppen sowoh auf der Straße als auch im Gelände. Die Auflauf- und Feststellbremse wirken sehr zusverlässig.

Leichte Zugänglichkeit Die großen verschließbaren Klappen, die sich leicht durch Gasdruckledem anheben lassen, machen alle Wankurgsbereiche leicht zugänglich. Außerdem ist eine großzugige Werkzeugablage vortlanden.

Regler und instrumente Das Schrecheslagischen sogt für eine automatische Statesung der Kompresons bei zu hohen Lutterngestieren zu rückigen Didukst, zu hohen Motorengeraturen. Signatieuchen weisen auf die Ursachte einer vorbeugenden Ausschaftung hin. Zu den instrumerten gehören ein Betriebsstruk-Mannester und een Betriebsstruckfrauzhter. Start- und Betriebsregier kannen durch einer verschliebare Klappe vor underligten Zugrift gesichter

na di motocompressori trasportabili, progettati per ridurre al la manutenzione, con la massima efficienza ed economia di

## prosita

modelli sono disponibili sia in versione standard che silenziata. Inte secondo caso sono conformi alle norme europee vigenti e ito possono venire. Impiegati in zone con rigorosi regolamenti

Immere er Diesel I motocompressori sono rafiredasi ad ania o ad acqua ed Indi dal imodelo, sono rafiredasi ad ania o ad acqua ed Ino una potenza variabile da 51 HP (38 kW) a 83.5 HP (83.5

### alare attenzione è stata posta nella riduzione dei consu

calare attenzione a tratargonan-pressore a Vita el sono stali lavorati con linitira di altissima precisione così el tito gia alli comprenti. Come multato si sono ottenute una el tito gia alli comprenti. Come multato si sono ottenute una le el compressione sono montati su di un robusto telalo in acciaio

per mezzo di adaguati supporti in gomma che isolano dalle vibrazioni.

Viblazioni. Regolazione della portata La regolazione di lipo continuo e progressivo, dai regime di minimo al massimo numerio di giu dei motore, consente di soddistare la richiesta d'aria con una erogazione uniforme.

Indiresta d ana con una erogazione uniforme. Separazione aria allo Meno di 10 ppm grazie di olio al sistema di separazione a due stadi. **Patrieddamento** Tutti i modelli sono stati progettati per operare a portelloni chusi. Il sistema di rattifuedamento consente di operare, a seconda del modelle, fino a una temperatura ambiente di 52°. Fitti aria a due stadi di tipo a secco Motore e compressore sono dotati di filori di apirazione completi di micatori di misamento defl'emento littante.

Timone Timone Sono disponibili due differenti timone di traino. Un tipo incorpora una barra regolabile in tunzione dell'altezza del veligito tranante a risponde alle vigenti norme europee. Un secondo veligito tranante a risponde alle vigenti norme europee. 4

modello e equipaggiato di barra fissa. L'ampia carreggiata, l'afezza da terra ed il basso barreentro garantiscono la massema stabilita achte sui terrei più accidentali. L'impianto tenante di spo a repulsione è sinonimo di eccellenti caratteristische di tenatura un freci meccanto di stazionamento manuale equipaggia di serie lutti i

ama de compresores portáliles de precisión, concebidos para incionas una duración operativa maxima con economía, máx-ricencia y reducidas moestadade de mantenimento. Itoramiento allenciaso las modeles complen o exceden las normas de emisión de CAGI-MREUROP y pueden, por lo tanto, utilizarse en acoas una aplicar. Incorperan los monitores dassel lipo industrial, de do mosta subrectoresas, pueden fernínados por aguar o do mosta subrectoresas, pueden fernínados por aguar o dos modeles subreccionados pueden fernínados por aguar o dos modeles os excepcionalmente económicos en el com-de compusitor.

presorea presorea Intres de los compresores se hacen mecanozados con preci-fe acuerdo con el pertil de diseño ideal. Otros componentes se Intropuelados a precisión. El rejultado es una mayor eficiencia

untos de militor y compresor van montados sobre un loero grueso por medio de monturas de goma especial, sini de la vibración.

The large lockable doors, the itting of which is added by gas struts, open wide allowing full accessibility to all maintenance areas and two large lock storage space. One result and instrumentation pressure, on rationamentation are respectively for automatic shuddown by high discharge ar temperature. Signal use, low engine on pressure, on rate nonjne temperature. Signal use, low engine on of protective shuddown, tratuments include discharge allow esues of protective shuddown. Instruments include discharge and gauge and engine hour meters. Starting and operating occords are located in a look-able enclosure for prefection against vandalism.

disponibles. La premier comporte un linno ragidable en tonction de la hasteur du vehicule de nenonjuage et est posicione aux applicitations competense. Le seu posicial de la cele. Des mais timon nicida contorne aux specifications de la CEE. Des mais timon nicida espacies. Les agrie au soi importante et un centre de grande bus rendent tous les modèles this stables, même sur les terrans les plus accentres. Le systemia de trois d'industriante et un centre de grande bus rendent tous les modèles this stables, même sur les terrans les plus accentres. Le systemia de trois d'industriante et un centre de grande bus rendent tous les modèles d'in d'industriante et au suisté par équipement danctair. Les grandes portes varrouitables, dont fotovenure est assisté par des équitoreus à gaz. souvent sur une grand etingeur et donnes applice de trangement des outils. Commandes et instrumentation. Catinua de commande sons entrentente d'au de service, de labble pression d'huile ou de haute temp stable d'ar de service, de labble pression d'huile ou de haute temp stable d'ar de service, de labble pression d'huile ou de haute temp stable d'ar de service, de labble pression d'huile ou de haute temp stable de la d'a de pression d'huile ou de haute termé comprenent et d'autoritation d'autoritation comprenent un manontéte d'ai de service et d'autoritations do mêter. Les commandes de la de service et d'autoritations autor regroupéles dans un boîter anti-raudalisme.

APPENDIX 2 TO ANNEX M

Llefermengenregelung Die stutentose Liefermengenregelung von Leerlauf bis Vollast sorgt für eine gleichmäßigen, kontinuierliche Liefermenge je nach Luftbedarf.

Lünebeam. Lutt-Ol-Abscheidung Aufgrund eines äußerst wirksamen Zweistufen – Abscheid syste beträgt der Rest-Olgehalt der Druckluit weniger als 10 p.p.m.

Köhlung Alle Modelle werden mit geschlossenen Türen und Klappen betreber. Das werksame Kuhlsystem ermöglicht es, die Kompressoren, seibst bei Umgebungstemperaturen bis zu 52°C,

Zwei-Stuten-Trockeneinlaßluttfilter Motor und Kompressor werden durch separate Lutteinlaßliter geschützt, Filterkontrolle durch verschmutzungsanzeiger.

Processiti, trainformation data training and training and training and training and training and training and the training and training an

modeli. Accessibilità' Due grandi sportellori con seratura a chiave il ciu sollevamento el facittato da pisononi a gas, permettono il massimo accesso a tuti componenti che possono richiedere un intervento manutentivo e ad un capiente viso per lo struggio di attrezzi. Pannello strumenti e comandi Un circuito che non richiede manufenzione, comanda l'arresto del motocompressore in seguito ad alte (esperatura aria allo sconico. bestas pressione dio del motor e alta temperatura motore. Distas pressione dio del motor e alta temperatura motore. Gli strumenti comprendoro, urmanometro asti di scanico o publicitati in un vano dotato di sportello a chiave contro atti vandato.

Regulación neumática El sistema progresivo, desde la marcha lenta a la velocidad máxima del motor, permite una produccion continua de flujo constante de aire comprimido en respuesta a las necesidades de aire. Separación de aire y acette Menos de 10ppm debido al sistema de negración bietápico. Enfriamiento excepcional Todos los módelos se han diseñado para que functionen con las puertas cerradas. El excepcional sistema de influenciento parmite functionar a las unidades en condiciones ambientales que, de alsundo con el morelos de máguina, pueden alcanzar SPCC. Filtros necesidos de la tipo seco El motor y el compreso estan protegidos por línitos individuales de admismon de lamo.

elemento de fisto. Stetema de rodadura Se disporte de dos lipos de sistemas de rodadura con suspensión por baliestas. El primero incorpora una barra de remolque que se pueda austar para adaptarás a la altura del vehiculo remolcador y cumple las especificaciones e uno pasa. El con os un sistema de reclácivar con barra de remolque ripida que cumple las especifi-

caciones de la CEE. La amplia base entre ruedas, elevada separa-ción del suelo y bajo centro de gravedad. Accen que todos los mod-elos sean muy estables incluso en los terrenos más escubrosos. El sistema de freno de sobrevelocidad proporciona unas caracterís-ticas excelentes de trenaja. El terno manal de expanzamento que permite un spancamiento seguro es un dispositivo normal. permeto de acceso Las grandes puertas con cerraduras, cuyo levantamiento se facilita por medic de cilíndos de gas, se abren ampliamente permiterado una accesibilidad completa a todas las zonas de mantenimiento y el amplio espació de almacomamiento de herramientas.

ampos espaceo de astracemantemo de manimentas. Controles el instrumentos El salema de control exercito de manimente de populación una lin-peraturas de las de decargos hajo presión de acade del moitor e el cavada temperatura de la decargos hajo presión de acade del moitor e al cavada temperaturas del motor. Las fues indicadoras señalhan la causa de la interrupción profectora del funcionamienta. Los in-strumentos incluyen un manomimor de anie de decarga y un com-tador de horas de funcionamiento del motor. Los controles de puesta an manche y funcionamiento del motor aco controles de puesta en manche y funcionamiento del motor aco controles de puesta en manche y funcionamiento del motor aco controles de

## OP175/P250/P375 WHISPERISED

the residence descent directly where the party

And the other start and a long of solar and the

And the second s

option into all of contrast contrast. No. of the second of

distant and the second strange and the second

a mainten over anappent interes and the first the second s

Print Print Print Print

the same state and same barried in the same

tere and the second sec

a Pala al la sine particular de la sine de

sugar as an and the second states

would be associated as relationship

a surface of the second s

A new party of the set of factors when the

A DE DE LE A LES DE LE D

And in the Party of Street Str

on shares a state of the state

and a second sec

And the second s

All works of the second second

A strategy of the strategy of

And the second desired where the property of the second desired with the second desired at the second desired

An plane and the second state of the second st

APRIL OF A DESCRIPTION OF A DESCRIPTIONO

A restored control for the total restore again the second seco

there are \$1.0 in a rate of the states are set of the states of the stat

All of the second second

Thereby is and it will be account in meaning in terms in specific and the product manipulation of the last framework line.

a strength of the particular of the and all the strength of the

the first and a start of and a

A particular property in terms of the same state of the second se

the sublex is and a

bi met od pometa ostanova mit poleta ile technik statovne stoke, žippi zracijeva ile utratov te technika

This has a start of second and the second is should be able and

### investigation of a local division of

and a spectrum and an end of the second seco

And the set of the set

The statement of the location

Many loss in the second second second in the second s

A start of the second s

and states in proper spinor is price in allow the

Contract of the second second

the set of the set of

I wonte montepo el metale del sur sur este entre biscon citad un present i acompte di accasso constatuation in accasso con present i accasso di accasso constatuation in accasso

And other spinster stars to the start of the first start a strength of the start of

Target

sectors for sector sector program and the sector sector sector

And the second s

Management of the same state o

Anne dell'an provinsi presidente anno 1995 e la constitución de la con

which the second second

### Annual Servers

And the second s

Stand of Long

And the second s

er and the

and the second second

The state of the second discovery of the second sec

A solid trend to college clock theorem, while trends, into research the second term of term of

No superior diversion of the second s

montal participation of the second se





# Standard Portable Compressors from 85cfm to 375cfm (2.4-10.5m<sup>3</sup>/min)

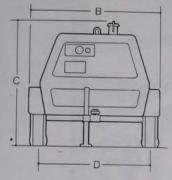


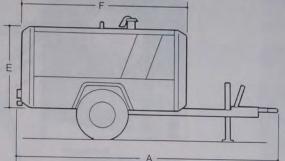
Standard Portable Compressors from 85cfm to 375cfm (2.4-10.5m<sup>3</sup>/min)

ANNEX M

# Standard Spiro-Flo® Portable Compressors. P85-SD to P375-SD

85cfm to 375cfm at 102 psig (2.4m<sup>3</sup>min to 10.5m<sup>3</sup>min at 7.0 bar)

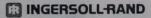




## **General Data**

Model P855		P100ASD	P140SP	P175SD	P250SD	*P375SD
Measurements & Weights	Call of the second	2.000				
A – Overall Length mm	2460	2460	3150	3150	3560	4200
B – Overall Width mm	1285	1285	1530	1530	1910	1580
C - Overall Height mm	1250	1250	1610	1610	1630	1680
D - Track Width mm	1120	1120	1321	1321	1625	1420
E - Canopy Height mm	895	895	1066	1066	1066	1070
F - Canopy Length mm	1578	1578	1930	1930	2340	2875
Net Weight					2010	2010
(incl. lube oil) Kg	625	625	1130	1050	1300	1787
Gross Weight						
(incl. fuel) Kg	660	660	1180	1120	1400	1920
Tyre Size	5.60 x 13	5.60 x 13	6.70 x 13	6.70 x 15	6.70 x 15	6.70 x 13
	4PR	4PR	6PR	6PR	6PR	6PR
Compressor & Performance				and a state of the		-
Compressor Type			-SINGLE STA	GE SCREW-		
Free air delivery						
cfm/m <sup>3</sup> min	85/2.4	100/2.8	140/3.9	175/4.9	250/7.1	375/10.5
Normal Operating Pressure						
psig/bar	102/7.0	102/7.0	102/7.0	102/7.0	102/7.0	102/7.0
Max Pressure psig/bar	120/8.3	120/8.3	120/8.3	120/8.3	120/8.3	120/8.3
Air Outlets	2 x R3/4"	2 x R3/4"	3 x R3/4"	3 x R3/4"	3 x R3/4"	3 x R3/4"
					1 x R11/4"	1 x R11/4"
Operating ambient temperature	- 23° to	- 23° to	- 23° to	- 23° to	- 23° to	- 23° to
range at sea level	52°C	52°C	52°C	52°C	52°C	52°C
Engine Data	and and a second	and and				D
Туре	Deutz	Deutz	Perkins	Deutz F3L912	Deutz F4L912	Deutz F6L912
Model	F2L511D	F2L511D	3.1522	F3L912		
No. of Cylinders	2	2	3	3	4	6
Bore x Stroke mm	100 x 105	100 x 105	91.4 x 127	100 x 120	100 x 120	100 x 120
Rated Speed rpm	2200	2500	2500	2500	2500	2500
No Load Speed rpm	1600	1600	1400	1400	1400	1400
kW/bhp at Rated Speed	20.9/28	23/31	33.2/44.5	40.3/54	55.2/74	83/112
Fuel Tank Capacity (ltr)	36	36	64	80	118	163

\*P375SD with 4-wheel running gear



Efcie Dependable

Ingersoll-Rand's range of small portable compressors covers all major applications for general construction. All units have the latest technology in screw compressor, regulation and diesel engine design.

The advantages are: Increased Productivity – for more Workpower

 Compact Design – so lighter in weight

• Fuel Efficient - so more air per gallon/Ltr fuel

• High Ambient Capability - up to 52°C (125°F)

**OTHER FEATURES include:** 

Torsion Bar Suspension

High Ground Clearance

Brakes – both Overrun and Parking

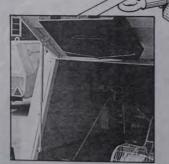
 External Lifting Bail – Easier Handling

 Toolbox – For Breakers and Accessories etc. (Optional for P85/P100)

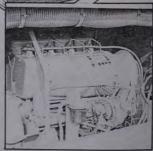
\*P-375 SD with 4-wheel running gear and has no overrun brakes. \*\*P85/P100 not equipped with solid-state monitoring system or high-temperature switch for engine



Instrument and controel for ease of operation and s Instruments include disce gauge, hourmeter and a solice monitoring system which pro-automatic shutdown in the evf high discharge air temperatu low engine oil pressure and h engine temperature

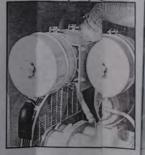


Gas spring door lifts Both side doors open wide with minimum effort for easy access by means of gas-filled door lifts.

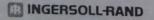


Reliable and fuel efficient diesel engines

All units are powered by reliable Deutz and Perkins engines.



Two stage air filtrati Engine and air end, "type" replaceable filter elementith restriction indicators are fill as standard



# cient

Compact



APPENDIX 3 TO ANNEX M

### Regulation

The rolling diaphragm regulation system automatically matches engine speed to air demand to ensure smooth operation, giving longer engine life and less fuel consumption.



Efficient two stage oil separation. Compressor oil filter with replaceable spin-on type filter element.



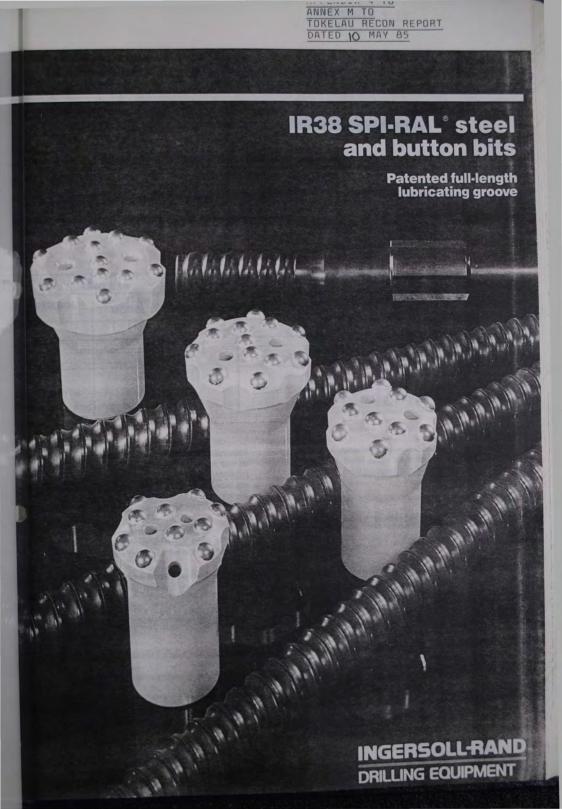
Cooling fan Direct driven by air end. • Less Power Required • Lower Operating Costs • High Ambient Operating Capability

Asymetrical profile, precision matched rotors: The rotors are machine finished to assure closer tolerances. • Optimum Seal Strip Efficiency • Minimum Slip Losses • High Fuel Efficiency • Reduced Operating Costs



Date optimis associate on allow a site of the test function and based based and the second as a second

INGERSOLL RAND





## Ingersoll-Rand IR38 Spi-Ral<sup>®</sup> Steel System: Up to 4<sup>"</sup> (102-mm) holes

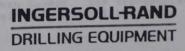
	STRIKI	NG BAR		38 mm DR	ILL STE	BUTTON BITS			
	SYMBOL	DRIFTER	COUPLING	SYMBOL	LENGTH		SYMBOL	BIT SIZE	
	UTILIZE I	MODEL	SYMBOL	and the second second	FT.	M		IN.	MM
	SB38S3B	VL-120/140	AT ALCONG	E38SB10	10	3.1	21/2B38S	21/2	63
		VL-120/140	0000000	2303010		0.1	3 B38S	3	76
	SB38F17A		- C38SBB		10	0.7	3½B38S	31/2	89
		F-170	and the second	E38SB12	12	3.7	4 B38S	4	102

- Full length reconditionability The steel is threaded over its full length. When an end wears, it can be simply cut off and the remaining length chamfered and put back into service. This can extend steel life as much as six times compared with ordinary steel, reducing inventory and overall drilling costs.
- Rolled thread reforms the grain structure of the steel, giving greater shear strength than with cut threads. Rolling also improves tensile strength.
- Case hardening provides extra toughness for wear resistance, minimizes fatigue and retards corrosion.
- Lubrication groove in the crest of each thread (an I-R patent) retains lubricant and assures easy detachability.
- Ingersoll-Rand Company Rock Drill Division Phillipsburg, NJ 08865

• Easier detachability— IR38 thread form has a steeper helix angle that requires less torque to break thread connections, saving time and extending steel life.

APPENDIX 4 TO ANNEX M

- Longer thread life— The thread also has more flank area and greater contact area between mating threads. This reduces thread deformation and wear, contributing to longer thread life between reconditionings.
- Carset® button bits— Advanced metallurgy provides the best combination of carbide wear and bit erosion, to maintain proper button exposure. Precision manufacture prevents stress concentrations.



## Ingersoli-Rand IR38 Spi-Ral' Steel System: Up to 4" (102-mm) holes

If all langth responsible multi-lag — The all of instanded space the fail langth. When all and available it can be plotting out and and the resonanting longth allowed was the last rescale as an intervence of with a stilling value contacts invertingly and available infiling value.

Melled thread reforms the grain structure of the viset, grains grains show shortish than whith real threads, Rolling and improves tensile strength.

Case hardening provides extra toughness for west eventuries, minimizes for provide correction

- holestant growte in the creat of each fivered into his polient) retaines laborated and assures easy astachability.

ten Dru Division

- Basser derarchability— IR28 formad form form to storyner beiez angle that equares has invoz to breas thread concertaines, sivilar that and a web ang area hits.
- Langes thread life. The invest size true more faces area and presize contact and interest justand threads. This reduces hereat deformation and areas, contributing to barges thread life between execution true.
- Garart's botton bits Arturated considery and added the best management of sample was worded automoust to management behing experiment bracks according and added to a sample brack and according to a sample brack and a sample bracks.

INGERSOLL RAND

## ANNEX N TO TOKELAU RECON REPORT DATED 10 MAY 85

## TRANSPORTATION OF DRILLING EQUIPMENT CALCULATIONS

 Annex M shows details of the airtrack drill and compressor that are recommended for use in Tokelau for proposed channel improvements.

2. The criteria is:

- a. width of machinery, (airtrack = 1.75 m, compressor = 1.33 m);
- b. length of machinery, (airtrack = 2.13 m, compressor = 2.88 m); and
- c. weight of machinery, (airtrack = 2000 kg approximately, compressor = 1920 kg).

3. The 'MV AVONDALE' has four forward derricks, each with a lift capacity of 5 tons. The ship can therefore load and off load airtrack and compressor.

4. Annex F details the design of the boats employed by the locals for transporting stores from the cargo ship to the Island. The internal capacity of these work boats for cargo storage is:

- a. bow to stern 6.1 m; and
- b. side to side 2.14 m.

Therefore, there is sufficient floor space in the boats for the airtrack drill and the compressor on separate trips. The boat's internal floor is plywood and will require additional reinforcing. It is suggested that a quantity, say 25 x 3 mlengths, 250 mm x 75 mm timber is taken to Tokelau. This can be used as dunnage for protection on the bottom of the boat.

5. The local outboard motors employed on the boats will not be sufficiently powerful to transport these loads and will require the use of the 40 hp outboard motors recommended in the Stores List at Annex O.

6. A requirement made of the manufacturers when the boats were purchased for Tokelau, was that they must be capable of carrying a 2 tonne load. This requirement was apparently achieved. It must be realised however, that the two items of equipment weigh about 2 tonnes each. It is suggested that six 44 gallon drums be available for securing to the sides of the boat, should it prove to be unsafe when loaded. The transportation of the drill will require the main boom and drifter to be removed to reduce its weight. TONELAU RECON REPORT

### TRANSPORTATION OF DELLING EQUIPMENT CALCULATIONS

 Annex M shows details of the airtrack drill and compressed that are recommended for use in fakelou for proposed channel improvements.

The driteria is:

width of machinery, (mintench = 1.75 m. compression - 1.33 m);

... langth of machinery. (sirtrack = 2.13 m.

weight of machinery. (airtrack = 2000 kg operate

3. The 'WV AVDEDALE' has four forward services, such and off a life sapacity of 5 tons. The ship can therefore load and off

A. Annex F details the design of the boats employed by the Incals for transporting stores from the carge with to the laisnd.

and in f.a - f.i ma and

side to side - ani alle .

Interators, there is sufficient floor space in the total to act's airteact drill and the compressor on separate trips. The toat's internal floor is plywood and will require additional reinforcing. It is supported that a quantity, say 25% 3 misneths. 250 cm x 75 mm timber is taken to fokalow. This can be used as durnege and the base of the base of the base.

5. The local authoard motors employed on the sold will not be sufficiently powerful to transport these loads and will require the use of the 40 hp authoard solars recommended in the returns list of Annex 0.

6. A requirement made of the manufacturits and a capable of mare purchased for Tokelau, was that they must be capable of carrying a 2 tenne load. This requirement was apparently achieved. It must be realised however, insi the two items of the capible of the tenne of the second and the sides of the tenne of the second action at the second ac

7. Consideration was given to constructing a raft using Tokelau boats, but was disregarded due to:

 the possible problems associated with supporting relatively heavy loads above the height of the sides of the boats; and

- 2 -

b. the difficulty that would be encountered in safely entering the channel (two boat widths).

8. The off loading of the drill and compressor at each of the wharfs will have to be co-ordinated with mid-tide levels to allow the side of the boat to be level with the top of the wharf. An expedient ramp will be required from the wharf to the bottom of the boat to allow off loading and loading. It is suggested that the expedient ramp be constructed from the quantity of timber suggested in paragraph 4. If necessary, the ramp can be supported at mid-point by timber and if a lack of traction occurs, cleats can be cut into the timber.

9. The airtrack drill will be required to be off loaded so that it can tow the compressor off the boat.

that fitting caula fill Tant Sat Grispers Demolitizer Pennist Gular 170

Personal Support

Tent' 2 der Tent' 2 der Marest Light weisst Harest Light weisst Henn'sslapminte 'asteri' Dels saleine Teale Folging (erge conting aff and Alleban) Teale Folging (erge conting aff and Alleban) Teale Tolaine ment Form G: Hetin Meak Jetry von Weisek 24 litte Platre wei esting upgnalle. Jatopulant 6 x 2 mm Danks prar incluming conter, puts, utersile siz Mefsigereter teammerstet mettern 2 m<sup>2</sup> contailer A. Bailar drugs togs Busgeney, and rete miler  Consideration was given to constructing a rare value Tokelau boats, but was disregarded dum to:

the possible problems associated with supporting relatively heavy loads above the height of the sides of the posts; and

B. The off leading of the drill and compressor at each of the wharfs will have to be co-ordinated with mid-tide levels to allow the side of the boat to be level with the top of the wharf. An expedient ramp will be required from the whorf to suggested that the expedient ramp be constructed from the quantity of thober suggested in paragraph 4. If necessary, the ramp can be supported at mid-point by timber and if a lack of traction occurs, diests can be out into the timber.

9. The sirtrack drill will be required to be off loaded to that it can tow the compressor off the boat.

ANNEX D TO TOKELAU RECON REPORT DATED ( MAY 85

## SUGGESTED STORES REQUIRED

DASE MARDO

Ear Protection	100
Gloves Industrial Leather	Qty
	10 prs
Explosives	
Explosive signs	2
Gloves rubber	2 10 prs
Red Flags	2
Barbed Wire	qtv
Short pickets	10
Fire Extinguishers (explosive and kitchen)	3
Exploder	1
D10 c/w reef	qtv
Shot firing cable (100 m coil)	6 coils
Test Set	1
Crimpers	
Demolitions Pamphlet	2 prs 1
Ruler 1 m	1
Personal Support	
14' x 14' tent	3
Tent 2 Man	1
Mosquito net	9
Blanket Light weight	9
Beds collapsible 'safari'	9
Chair folding	4
Stool folding	2
Table Folding large (eating off and kitchen)	1
Table folding small	1
Form GS	1
Basins Wash	2
Jerry can water 22 litre	2
Plates and eating utensils	4 sets
Tarpaulins 6 x 5 mm	1
Cooks gear including cooker, pots, utensils etc	qty
Refrigerator commercial pattern 2 m <sup>3</sup> capacity	1
44 Gallon drums (for buoyancy and rain water	6
collection)	U

collection)

TORELAU RECON REPORT

## SUCRESTED STORES REQUIRED

- 2 -

Generator 6.5 KVA	
Dart Board	1
Cards	1
Projector	1
Films	1
Screen	Qty 1
Expendables	
Fly spray	qty

Sandbags	
	qty
Bags multiwall	qty
Soap powder	qty
Bags plastic	qty
Swarfega	qty
Toilet paper	qty
Tape Insulation	qty
Tape Masking	qty
Twine	qty
Cordage	qty
Dazzle paint	qty

## First Aid

Solar screen	qty
Sunburn lotion	qty
Foot powder	qty
Antiseptic Cream	qty
Coral cut cream	qty
Insect Repellant	qty
Elastoplast	qty
Chapstick	qty
Painkillers	qty

## Drilling Equipment

Rockdrill (airtrack) (see Appendix 1 to Annex M)	1
Drill steels (see Appendix 3 to Annex M)	6
Drill bits (see Appendix 3 to Annex M)	6
Compressor 375 CFM (see Appendix 2 to Annex M)	1
Hand drifter c/w steels, bits and hoses with under water connections	2

•

## Expendables

## Plrst Ald

### Orilling Equipment

Rockdrill (sirtrack) (see Appendix 1 to Annex H) Drill steels (see Appendix 3 to Annex H) Drill bits (see Appendix 3 to Annex H) Compressor 375 CFM (see Appendix 2 to Annex M) Hand drifter of steels, bits and noses with under water connections

- 5 -	ANNEX O
Survey Equipment	
Tape 30 m	
Tape 100 m	1
Level c/w tripod	1
Staff	1
Compass Prismatic	1
GS Tools	
Shovel IS	2
Shovel LHRM	3
Sledge Hammer 10 lb	2
Wire cutters	1 pr
Grease Guns	2
Jumping bars	3
Crow bars	2
Chainsaw	1

	Div	ing	Equi	pment
--	-----	-----	------	-------

Diving set incl:	Mask	3 sets
	Fins	
	Snorkel	
	Knife	
	Hard soled booties	
	Cylinders c/w back pack	
	Spares	
	Protective Heavy weight wet suit	
	Regulator and mouth piece	
	Weight belt	
	Bouyancy compensators	
Compressor		1
Zodiac boat		1
Paddles		2
Outboard motor 40	hp	2
Fuel tank		1
POL		

## Petrol - marine - compressors Diesel - compressors - generator

### D\_X34MA - C -

Survey Equipment

## 65 10018

shovel LHRM Shovel LHRM Mire cutters Mire cutters Greate Bune Jumping bars Creat bars Creat bars

> Diving set incl: Mes file file file file

Knife Hard soled bootles Cylinders c/w back pack Spares Protective Heavy weight wet sult Regulater and south piece Walght belt

> Compressor Zodiac boat Paddies Duthoard motor 40 h Fuel tank POL Pol - compress Diesel - compress

2 Stroke Oil - outboard motor Engine oil - all non-2 stroke motors Protective - grease - CRC qty

ANNEX D

## Rationing

Own resources from New Zealand Supplementation of fresh rations from Apia Repayment to locals for purchase of local food Timber, 250 mm x 75 mm x 3 m 25 lengths 2 Strake Oil - authoars mater Engine oil - ail non-2 strake matere Protective - grease

### euluolites

Dun resources from New Lasland Supplementation of Fresh rations from Apia Repayment to locals for purchase of local food

25 lengths

ANNEX P TO TOKELAU RECON REPORT DATED 10 MAY 85

### SUGGESTED MANNING

 The following is a suggested manning for an Army team tasked to widen channels at Atafu and Fakaofo:

- a. one x officer;
- b. one x Senior Non Commissioned Officer (SNCO);
- c. one x Junior NCO';
- d. five x Field Engineers (to include three x divers for reef edge inspections and one x person qualfied in First Aid);
- e. one x cook;
- f. one x vehicle mechanic.

15, 25, 33 and 45 stillawrouds = 437 (31 Day 84) \$ \$2.63 mach 102 of each DRC so hay 400 - \$1154.5-

Shat Firing Cable 600 \*

Devirable Purchases. Atlas Enivormeter - 5243.89 (15 Feb 54) Missin 30 shat - 3481.47 (15 Feb 54) Total cost for explosions - \$12549.92

(Including sub-pare ... single ...

### ANNEX P TO TOKELAU RECON REPORT DATED 10 MAY 85

### SUBGESTED MANNING

 The following is a suggested manning for an Army tesm tasked to widen channels at Atafu and Faksofs:

- a. one x officer;
- : One x Swnior Non Commissioned Officer (SNCO):
  - c. one x Junior NCB's -
- 1. Five x Field Engineers (to include three x divers for reaf edge inspections and one x person qualified in First Aid):
  - e. one x cock;
  - . one x vehicle machanic.

ANNEX Q TO TOKELAU RECON REPORT DATED (O MAY 85

## EXPLOSIVE COSTING

 The costing for explosives required is as follows and is costed at Government Stores Board prices:

- a. <u>Molanite Explosive</u> (4298 carts) = 2905 kg 40 mm dia, (31 Dec 84) @ \$79.22 per 25 kg = \$9205.36
  - b. Flexicord = 10155 m

LOSEZOL HT

(31 Dec 84) @ \$161.99 per 334 m coil = \$4925.18

## c. Detonators.

Electric No 8/1.8 metre aluminum = 82 (31 Dec 84) @ \$97.14 per 100 say 100 = \$97.14

d. DCR.

15, 25, 35 and 45 milliseconds = 407 (31 Dec 84) @ \$2.83 each 102 of each DRC so say 408 = \$1154.64

e. <u>Shot Firing Cable</u> 600 m (16 Feb 84) @ \$27.20 per 100 m coil = \$163.20

f. <u>Desirable Purchases.</u>
Atlas Galvonmeter = \$243.99
(16 Feb 84)
Nissan 30 shot = \$421.47
(16 Feb 84)
Total cost for\*explosives = \$15545.52
(including sub-para f., = \$16210.98)

TOMEX Q TO TOMELAU RECON REPORT DATED LO MAY 85

### EXPLOSIVE CHITING

1. The coating for explanives required is as follows and is coated at Government Stores Board pricast

- al <u>Molanite Expinaise</u> (4298 carts) = 2905 kg 40 mm dis. (31 Dec 84) 8 879.22 per 25 kg - 39205.3
  - Flexicord = 10153 m
     (31 Dec 84) # \$151.99 per 33% m coll = \$1925.1
    - c. <u>Detometors.</u> Electric No 8/1.8 metre eluminum = 82 (31 Dec 84) 8 \$97.14 per 100 eav 100 = \$97.14
      - 004. .15, 25, 35 and 45 milliseconda = 407 (31 Dec 84) 8 \$2.83 each 102 of each ORC so say 408 = \$1154.54
  - Shot Firing Cable 600 m (16 Feb 84) # \$27.20 per 100 m coll = \$163.20
    - Desirable Purcheses. Atlas Galvonagter = \$243.99 (16 Feb 86) (16 Feb 84) Total cost For\*explosives = \$15545.52 Total cost For\*explosives = \$15245.52

ANNEX R TO TOKELAU RECON REPORT DATED 10 MAY 85

## ROL REQUIRED AND COSTING

1. The following is an approximate POL expenditure calculation using the hourly rates shown:

a.	375 CFM compressor ₪ 15 1/hr (diesel ₪ \$0.5304/1)		
	usage	=	222 hours
		=	3330 1
			\$ 1766.23
 ь.	6.5 KVA generator @ 3.5 l/hr (petrol) (petrol @ \$0.8559/l)	)	
	assume usage of 14 hrs/day x 152		
	days		2128 hours 7448 l
			\$ 6374.74

c. Outboard motor 40 hp @ 18 l/hr (Petrol 2-stroke) (petrol @ \$0.8559/l) mixture 1:50 (oil 2-stroke @ \$1.3654/l) assume usage of 6 hrs/week for 22 weeks = 23761 = \$ 6

= 132 hrs weeks = 23761 = \$ 64.86 oil = \$ 1986.11 petrol = \$ 2050.97

Total POL expenditure = \$10191.94

across the read to the rig, then alleviating the read to drag the compression through the surf. For this, as support using a privative plan he have the the surf for written 101 or so from the suil reg, by three the the the private for this pipe in our offer.

The volume machiness sectors of sig, arginessing data and pricing; potential, mean-station of sig, arginessing data and pricing; hop-fully, these will making you an Tutly mentionis the project.

He would welcome the represents to further summan this project

Yours faithfully SCHEADE (NZ) LING DID

IC. J. BONNY ) TR SALTS MANNALLE TORELAU RECOR REPORT

### ROL REQUIRED AND COSTING



ENCLOSURE 2 TO TOKELAN RECON REPORT DATED 10 MAY 85

Schlage (N.Z.) Limited

Head Office: 437 Rosebank Road, P.O. Box 19:347 Avondale, Auckland New Zealand. Telephone 885:096 Telex NZ 21491

SCHLAGE Part of worldwide Ingersoll-Band

10 May 1985

Ministry of Defence Army Department 25 Engineer Support Squadron Linton Camp PALMERSTON NORTH

ATTENTION : LIEUTENANT A.M. SKINNER

Dear Sir

#### TOKELAU ISLAND PROJECT OUR REFERENCE : NZ8348/85

In reply to your letter of 17 April 1985 and our meeting recently, I have enclosed herewith details of the equipment we discussed.

It would be impossible in my mind to use hand-held jack hammers, as used on the previous project, under the conditions you will experience; due mainly to the tidal situations and the terrain you will encounter. For this reason, we suggest the use of a light mounted crawlair rig. This will give you flexibility to traverse the unit across the coral reef and will speed up the operation to enable you to meet the project deadline. It will also enable a much cleaner drilling technique with little or no plaining of the finished channel walls.

The portable compressor can be installed on the shore and air piped across the reef to the rig, thus alleviating the need to drag the compressor through the surf. For this, we suggest using a galvanised pipe to take the air supply to within 50' or so from the drill rig. We have included pricing for this pipe in our offer.

The various sections enclosed deal with performance and output potential, description of rig, engineering data and pricing. Hopefully, these will enable you to fully evaluate the project.

We would welcome the opportunity to further discuss this project and our offer with you.

Yours faithfully SCHLAGE (NZ) LIMITED

(C.J. Benny) IR SALES MANAGER TREELAN RECON PETER

SCHLAGE

shart of worldwide inglessi-faunc

10 May 1985

riper Office RV Recebers Policy PD Bio 1536 Res Listens Tension Michigan Tension Michigan

> Ministry of Defence Army Department 23 Engineer Support Squ Linton Camp ParkErston World

ATTENTION : LIEUTENANT A.M. SKINER

Dear Sir

TOXELAU ISLAND PROJECT OUR REFERENCE : M28348/85

In reply to your latter of 17 April 1965 and our meating recently.

It would be impossible in my mind to use hand-held jeck howeves, as used on the previous project, under the conditions you will experience; due wainly to the tidal aituations and the terrain you will encounter. For this reason, we suggest the use of a light mounted crawlair rig. This will give you flaxibility to traverse the unit across the ceral reaf and will apped up the operation to anoble you to nest the project deadline. It will also enable a much cleaner drilling termique with little or no plaining of the finished chemes wails.

The portable compression can be installed on the shore and the piped across the reaf to the rig, thus allevisting the need to drug the compressor through the suif. For this, we suggest using a galvaniesd gipe to take the air supply to within 30' or so from the drill rig. We have included pricing for this pipe in our offer.

Whe various sections enclosed deal with performance and output, potential, description of rig, engineering data and pricing. Hopefully, these will enable you to fully evaluate the project.

We would welcome the opportunity to further discuss this project

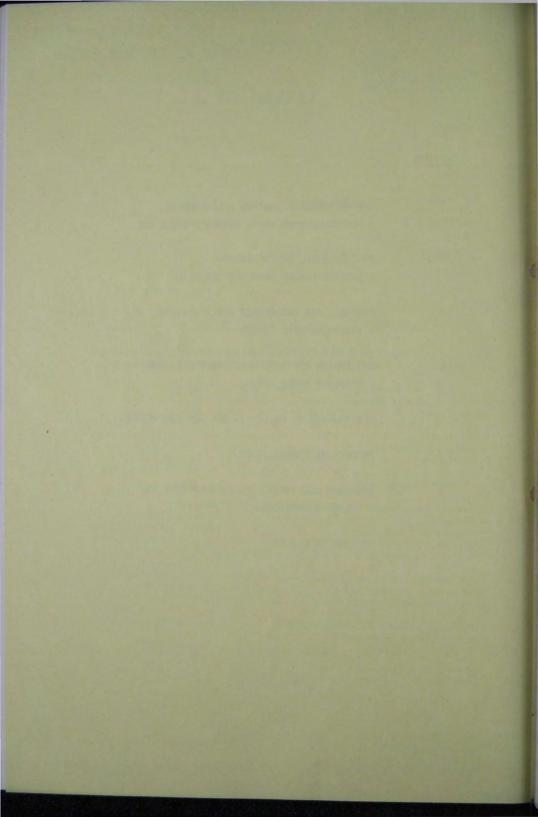
Yours faithfully SCHLAEE (N2) LIMITED

(C.J. Berny) IR SALES MANAGER

### TITLE

### SECTION

1	GENERAL DESCRIPTION AND SPECIFICATION - INGERSOLL-RAND LM100 CRAWLAIR DRILL RIG
2-	DRIFTER DRILL SPECIFICATION - INGERSOLL-RAND YD90 DRIFTER DRILL
3	PORTABLE AIR COMPRESSOR SPECIFICATION - INGERSOLL-RAND P375SD
4	UNDERWATER OPERATIONS OF INGERSOLL-RAND CRAWLAIR DRILL RIGS
5	PORTABILITY OF DRILL RIG AND AIR COMPRESSOR
6	PRODUCTION CAPABILITIES
7	DRILLING ACCESSORY LIFE CALCULATIONS AND USEAGE QUANTITIES
8	PRICING SCHEDULE



#### SECTION 1

:

### GENERAL DESCRIPTION AND SPECIFICATION

#### INGERSOLL-RAND LM100 CRAWLAIR DRILL RIG

The LM100 drilling rig is a track mounted, air powered, self-propelled, rock drilling unit. The tracks are driven by powerful air propelling motors, also incorporating a 1300 psig hydraulic system, heavy duty boom, and a drill guide for 10 feet drill steel changes, that supports the Ingersoll-Rand drifter drill.

It is designed to tow its own compressor by means of a tow hitch mounted to the rear centre of the main frame.

Attached is a more detailed set of specifications for the drill rig.

AL MINIST

#### SECTION 1 : DEMERAL DESCRIPTION AND SPECIFICATION

INTERSOLL-RAND LMICO CRAW, AIS DRILL SIC

The LMT00 stilling rig is a track mounted, air powered, malf-propelled, rock drilling unit. The tracks are driven by powerful air propelling mators, miss incorporating a 1300 paig hydraulic system, heavy duty boom, and a drill guide for 10 feet drill steel changes, that supports the Ingersoli-Rand drifter drill.

It is designed to the its even compressor by means of a tow hitch sounted to the rear centre of the wain frame.

Attached is a more detailed set of specifications for the drill rig.

#### GENERAL DESCRIPTION & SPECIFICATIONS OF LM100 CRAWLAIR DRILLING RIG

#### DESRIPTION

The LM100 Crawlair Drilling Rig is a track mounted, air operated, self-propelled, roc drilling unit with powerful, air driven propelling motors; a 1300 psi hydraulic sysem; a heavy duty boom; and a drill guide for 10 ft. steel change, which will sucort a drifter or a downhole drill to meet various drilling conditions.

The LM100 is a compact, powerful unit designed to drill 1-3/4 in. (44mm) through 2-12 in. (64mm) holes with the YD90 Drifter, and 3-3/8 in. (85mm) through 3-1/2 in. (9(m) holes with a rotary head and the DHD09 Downhole Drill. It is capable of driling vertical to horizontal blastholes, and is recommended for shaft sinking, resplitting, trench work, sewer construction and bridge demolition.

The LM100 is a pioneering drill rig, capable of climbing steep grades over rough terain. Its low stance and compact design enables it to work well in tight quarters.

The lifting eye located on the boom allows balanced hoisting for positioning the namine on the job or on your trailer.

SETTRAL SPECIFICATIONS		ENGLISH	(METRIC)
Ma Weight (with Drifter)		5,400 16.	(2,450 kg)
Owmall Length (guide horizontal)		12'8"	(3,850mm)
Dvrall Width		5'9"	(1,750mm)
Ovrall Height (boom vertical) (less boom)		15'8" 3'11"	(4,770mm) (1,200mm)
with of Grouser		8"	(204mm)
Grund Clearance	•	9"	(230mm)
Trick Oscillation		20 <sup>0</sup>	(20 <sup>0</sup> )
Bon Movement: Above Centerline Below Centerline Swing Range		45 <sup>0</sup> 30 <sup>0</sup> 90 <sup>0</sup>	(45 <sup>0</sup> ) (30 <sup>0</sup> ) (90 <sup>0</sup> )
Gude Movement: Swing Dump	•	90 <sup>0</sup> 75 <sup>0</sup>	(90 <sup>0</sup> ) (75 <sup>0</sup> )
Traming Speed		1.8 MPH	3 km/hr
Clmbing Ability		35 <sup>0</sup> grade	(35°)
Prpelling Air Motor		7 HP	AND IS A DOME
Drwbar Pull .		3,100 <sup>1</sup> b.	(1,400 kg)
Tarvel Speed		0-1.8 MPH	

#### GENERAL DESCRIPTION & SPECIFICATIONS OF LNTOD CRAM.AIR ORILLING RIG

drilling unit with powerful, air driven propelling motors; a 1300 psi hydraulic mi a heavy duty boom: and a drill guide for 10 ft. steel change, which will not a drifter or a downhole drill to meet various drilling conditions

The UNIOD 13 a compact, powerful unit designed to drill 1-3/4 (n. (44mm) through and in. (64mm) holes with the Y090 Drifter, and 3-3/8 (n. (65mm) through 3-1/2 (n. arm) holes with a rotary head and the OHOOS Downhole Drill. It is capable of ing vertical to harizontal blastholes, and is recommended for shaft sinking. resplitting, trench work, sewer construction and bridge demolition.

the LAIDO 15 a proneering drill rig. capable of climbing steep grades over rough

the intting eye located on the boom allows balanced hofsting for positioning the

TAL SPECIFICATIONS	

#### OFIONAL EQUIPMENT

Vaposol Dust Control System - The Vaposol system is an improved method of damp drilling, developed for use on track-mounted rock drilling rigs to reduce the health hazards caused by inhalation of rock drill dust particles during drilling operations.

Dust Collector System - The dust collector system is a dry, fan-induced draft, pulse jet, self-cleaning unit designed to draw dust and rock cuttings away from the hole and deposit them on the ground away from the operator. The air consumption required to drive the suction fan is 90-100 psi.

Downhole Drill Package - The YD90 Drifter can be removed in favor of the ZD45 rotary head. This light-weight rotary head is powered by a 4 HP reversible air motor, designed to provide independent rotation for the DHD09 downhole drill. The DHD09 is a hammer drill which is capable of drilling 3-3/8" - 3-1/2" holes using less air.

#### MIN FRAME

The main frame is a rugged steel fabrication, which is the mounting base for vrious assemblies of the LM100. A hydraulic reservoir is mounted on the rear center the main frame, with the air line lubricator mounted directly to the left.

A tow hitch is mounted to the rear center of the main frame which enables the cill to pull along a portable compressor. It can also be used to pull the drill with a primary mover over very rough terrain.

All controls for boom movement are located directly behind the machine near the.

A 1.5 HP vane type air motor drives a hydraulic pump which supplies power for the irious drilling functions. The motor and pump are mounted on the left hand strut, tween the two track assemblies. The system operates at 1300 PSI. This low pressure estem ensures long component life, and cuts down costs on hoses and fittings.

Drill controls can be mounted on the drill guide or on the hydraulic boom ontrol console at the side of the drill. The rear mount is used when two men are andatory on the job site.

#### NDERCARRIAGE

The undercarriage consists of a right and left hand track assembly. Each track s driven by an independently controlled, reversible air motor. These are piston ir motors with 7 HP each to supply power for towing a compressor and climbing steep rades.

The LM100 has a maximum of 20<sup>0</sup> oscillation. This is accomplished through heavy duty struts welded to the track assembly and hinged under the main frame.

The braking system is mechanical with positive engagement, which is a safety eature. A declutching device allows the brake to be disengaged when the crawlair s being towed. Each assembly has 5 rollers for even wear on the chains which support grousers. The track tension is easily adjusted by tightening the adjusting spring

#### THEMALUDE UNIT

Yaposol Oust Control System - the Yaposol System is an improved method of damp crititing, developed for use on track-mounted rock drilling rigs to reduce the health hazards caused by inhalation of rock drill dust particles during drilling contractions.

bask Collector System - The dust collector system is a cry, fan-induced draft, colse jet, self-cleaning unit designed to draw dust and rock cuttings away from the hole and deposit them on the ground away from the operator. The air consemption required to drive the suction fan is 90-100 psi.

downmole Drill Package - The Y090 Drifter can be removed in favor of the 2045 rotary Head. This light-weight rotary head is powered by a 4 HP reversible air restor, designed to provide independent rotation for the DH009 downhole drill. The DH009 is a harmer drill which is couchie of drilling 3-3/8" - 3-3/2" holes designed less air.

## The main frame is a rugged steel fabrication, whi

tious assemblies of the UM100. A hydraulic reservoir is mounted on the rear center the main frame, with the air line lubricator mounted directly to the left.

A tow hitch is mounted to the rear center of the main frame which endoles the iii to puil along a portable compressor. It can also be used to pull the drill a grimary mover over very rough terrain.

All controls for boom movement are located directly behind the machine near the

A 1.5 HP vane type air motor drives a hydraulic pump which supplies power for Yous drilling functions. The motor and pump are mounted on the left hand strut, been the two track assemblies. The system operates at 1300 PSI. This low pressurtem ensures long component life, and cuts down costs on hoses and fittings.

prill controls can be mounted on the drill guide or on the hydraufic boom the console at the side of the drill. The rear mount is used when two man are console at the lob site.

#### BALARRIAGE

The undercarriage consists of a right and left hand track assault, driven by an independently controlled, reversible air motor. These are piston r notors with 7 HP each to supply power for towing a compressor and climbing steep

The LMIGO has a maximum of 20<sup>o</sup> oscillation. This is accomplished on ough wears

The braking system is mechanical with positive engloment, which the crawlair river. A declutching device allows the brake to be disangaged when the chains which support being towed. Each assembly has 5 rollers for even wear on the chains which support memory. The track tension is easily adjusted by tightening the adjusting spring The boom assembly consists of a round tube with a forked clevis welded to each ter; a lift cylinder; a swing cylinder; and the attaching components.

The rear clevis of the boom is attached by a pedestal to the boom base clevis of the main frame. This attachment produces a universal joint which permits a crerage of  $45^{\circ}$  right or left of centerline and  $45^{\circ}$  above  $30^{\circ}$  below the horizontal creterline. The clevis at the front end of the boom supports the dump and swing arembly.

The swing cylinder is attached at its piston end, to the side of the boom, by a wing clevis, pin, and a welded clevis on the boom. The blind end of the cylinder attached to a pedestal which is pinned to the boom base clevis on the main frame.

The lift cylinder is located underneath the boom. Its piston end is attached tward the front of the boom through a swing clevis pinned to a clevis welded on the bttomside of the boom. The blind end of the cylinder is pinned to a clevis welded t the center of the main frame cross member.

A lifting bail is welded on the top side of the boom, which allows machine to positioned in confined areas.

#### DILL GUIDE & MOUNTING

The drill guide is constructed of 4" steel channel. The guide is equipped with alatch type centralizer which is bolted to the drill guide, and a heavy duty footnece is welded to the base of the guide below the centralizer. Feed pressure for the difter is supplied by a 3 HP, five cylinder piston air motor, mounted on the bottom tck side of the guide.

The drill guide is supported by guide extension mounting which in turn is spported by the dump and swing assembly. The extension mounting is designed to stend the drill guide for additional coverage and to plant the footpiece firmly sainst the drilling surface for added stability.

The dump and swing assembly is a hydraulically powered drill guide positioning evice, supported at the front end of the boom. The assembly permits a full 180° rill guide dump (end over end rotation) and 85° drill guide swing (50° left, 3° right).

BOM

The noom assembly consists of a round tube with a forked clevis weided to each, a whift cylinder; a swing cylinder; and the attaching components.

The rear clevis of the boom is attached by a pedestal to the boom base clevis are coin frame. This attachment produces a universal joint which permits a erage of 45° right or left of centerline and 45° above 30° below the horizontal. staring. The clevis at the fromt end of the boom supports the dump and swing

The swing cylinder is attached at its piston end, to the side of the boom, by aging clevis, pin, and a welded clevis on the boom. The blind end of the cylinder actioned to a pedestal which is pinned to the boom base clevis on the main frame.

The lift cylinder is located underneach the boom. Its piston and is attached and the front of the boom through a swing clevis pinned to a clevis welded on the investide of the boom. The blind and of the cylinder is pinned to a clevis welded the center of the wain frame cross member.

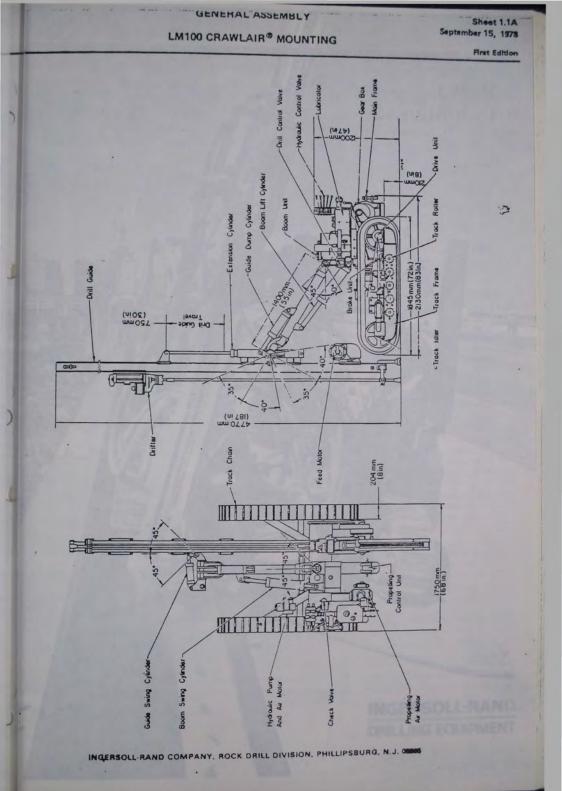
A lifting bail is welded on the top side of the boom, which allows machine to

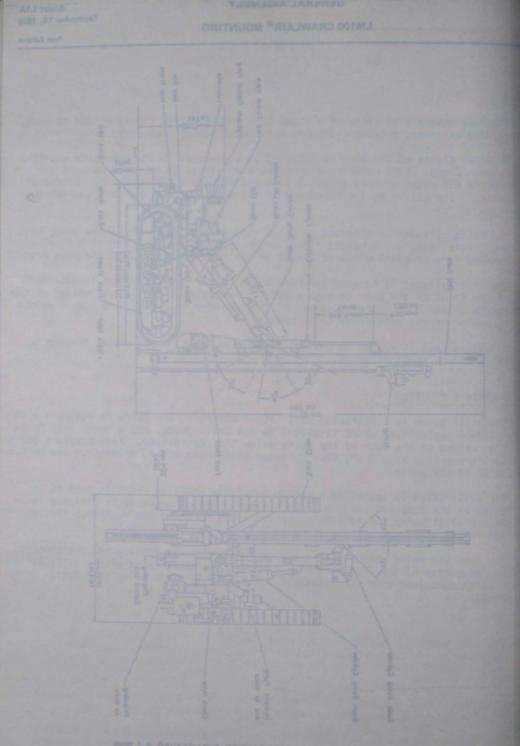
#### L GUIDE & MOUNTING

The artill guide is constructed of 4" steel channely the guide and a heavy duty footthen type centralizer which is bolted to the drill guide, and a heavy duty footthese is welded to the base of the guide below the centralizer. Feed pressure for the refter is supplied by a 3 MP, five cylinder piston air motor, mounted on the bottom or side of the guide.

The drill guide is supported by guide extension mounting which in turn is apported by the dump and swing assembly. The extension mounting is designed to extend the drill guide for additional coverage and to plant the footplece firmly

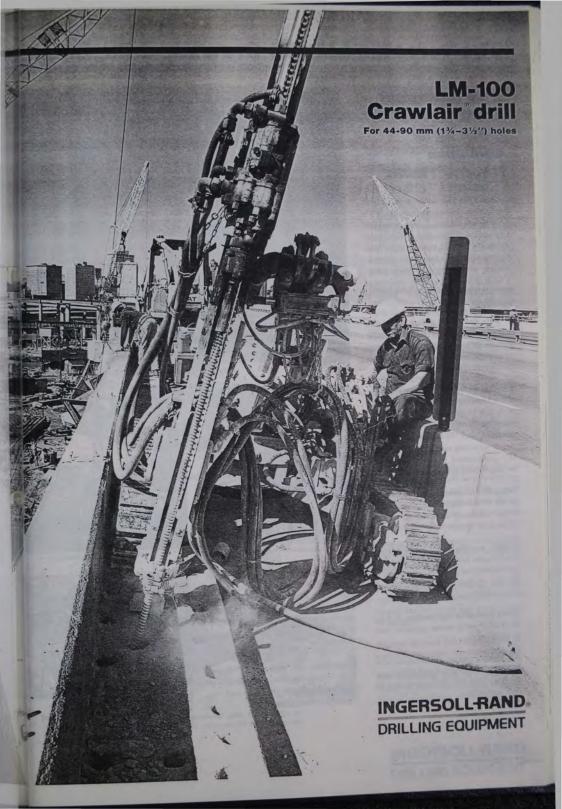
The dump and swing assembly is a hydraulically powered drift durine built is a swite, supported at the front and of the boom. The assembly nermits a full 180° iii guide dump (and over end rotation) and 85° drift guide swing (50° laft,





NUMBER OF STREET

NUCLERSOLL RA



# The versatile LM-100 Crawlair drill. Small in

## It's a lightweight energy-saving drifter rig for 44-64 mm (1<sup>3</sup>/<sub>4</sub>-2<sup>1</sup>/<sub>2</sub>'') holes.

Don't let the small size of this husky little drilling rig fool you. It's a fully-mechanized, self-propelled Crawlair drill that does all the heavy work for you. It trams easily from hole to hole at the touch of a throttle, towing a portable air compressor. The drill tower is quickly positioned by effortless hydraulic cylinder operation.

With the YD-90 drifter, it handles a 3048 mm (10') rod change, with 32 mm (1.25") rods, threaded bits and couplings, to depths 12 m (40') at maximum efficiency.

Simple, safe one-man operation. All tramming and positioning controls are located at the rear of the machine for easy operation. Drilling controls, can be mounted on the tower or at the side of the machine, for convenience in either deep-hole or single-pass drilling.

**Rugged crawler construction.** With two independently-controlled 7-hp tramming-air motors, it can climb a 35° grade.

Track oscillation. Heavy steel main frame has walking-beam track oscillation that permits each track to tilt up or down to match ground irregularities.

More powerful hydraulics. A 3-hp hydraulic pump motor assures faster positioning.

Air and oil gages. Continuous indication of air pressure and lubricator oil level take the guesswork out of drill operation.



Works well in close quarters.



Independent-rotation drifter.

Independent rotation drifter. The YD-90 air drifter has ample power for drilling holes to 64 mm  $(2^{1/2''})$  in diameter. Integral air motor drive provides independent rotation with infinitely variable speed control.

Uses little air. With a P425 Spiro-Flo<sup>®</sup> compressor, there's plenty of air to operate the drill, rig and optional dry dust collector.



Lifts easily for shaft sinking.



## n performance.



Exhaust and impact noise go right down the hole with the bit.



stion driffer.

ter tes ange

Ingral in 120

Mar let mar

774 57

The AT-480 dust collector, available with YD-90 drifter or DHD-09 Down-hole drill, uses only 2 m<sup>3</sup>/min (70 cfm) of 7 kg/cm<sup>2</sup> (100 psi) air.

## It's a low-noi deep-drilling downhole rig 85-90 mm (3<sup>3</sup>/<sub>8</sub>-3<sup>1</sup>/<sub>2</sub>'') ho

Equipped with a rota larger centralizer, the I you all the Crawlair to the basic advantages of drilling—with the In DHD-09 Downhole dri

Drills faster on deep h penetration rate doesn' each rod added to the s

**Uses less air** because does double duty, powe and then cleaning the h

Drills straighter h Downhole drill is less ea off-course by varying s

**Extends rod life** becau forces are transmitted drill rod.

The DHD-09 Dow engineered and built t performance at rock-Penetration is proporti pressure across the these other I-R feature

Stop-action plunger stops the hammer action the drill is raised.

Wear sleeve surroun cylinder can be revers sleeve life. It's easy an to replace.

Piston delivers full im rectly on the bit at any o

Bit retaining key p dental dropout yet per moval for grinding or r



# LM-100 Crawlair drill specifications

Hole diameter (YD-90)

Hole diameter (DHD-09)

Rod diameter

Drilling range width

Horizontal height,

Horizontal height,

Hydraulic Pump Air Motor

Recommended Air Compressor 12 m³/min at kg/cm²

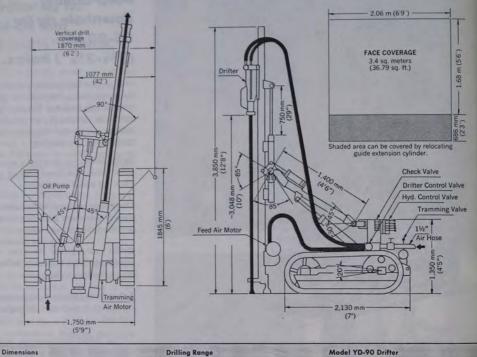
maximum

minimum

**Total Weight\*** 

\*With YD-90 drifter

Rod length



44-64 mm

85-90 mm

3048 mm

2050 mm

2350 mm

680 mm

2450 kg

32 mm round

13/4-21/2"

3%-31/2"

10'0"

7'81/2"

2'23/4"

5400 lb

425 cfm

at 100 psi

3 hp

6'9"

11/4" round

Model	YD-90	Drifter
-------	-------	---------

3½×3¾″	90 × 85 mm	Bore and stroke
	1600	Blows per minute
	0 to 150 rpm	Rotation
187 lb	85 kg	Weight
	nhole Drill	Model DHD-09 Dow
53 lb	24 kg	Weight (less bit)
35.6"	965 mm	Length (bit extended)
3"	76 mm	Outside diameter
3%"	85 mm	Bit diameters
31/2"	90 mm	
125 cfm	3.5 m <sup>3</sup> /min	Air usage
at 100 psi	at 7 kg/cm <sup>2</sup>	
		ZD45 Rotary Head
575 ft-lb	79.5 kg-m	Max. torque
	0-65	RPM range
	4.0 max	Horsepower
120 cfm	3.4 m <sup>3</sup> /min	Air usage at 25 rpm
200 lb	91 kg	Weight

this brochure is intended to extend any warranty or representation, regarding the products described heren. Any such warranties or other of sale of products shall be in accordance with ingersoli-Rand's standard of sale for such products, which are available upon request.

Ingersoll-Rand Company Rock Drill Division Phillipsburg, New Jersey 08865

Overall length

Height (tower horiz.)

Overall width

Track width

Trock length

Positioning

Boom lift

Boom swing

Guide swing

Guide dump

Tramming

Air motors

Tramming speed

Climbing ability

Drawbar pull

(horizontal)

(tower horiz.)

Ground clearance 230 mm

Track oscillation 20°

3850 mm

1350 mm

1750 mm

204 mm

1845 mm

Two 7-hp

0 to 2.6 kph

35° grade

1400 kg

45° up, 30° down

45° right, 45° left

45° right, 45° left 85° (two positions)

(one per track)

12'8"

4'5"

5'9"

9"

8"

6' 3%"

0 to 1.6 mph

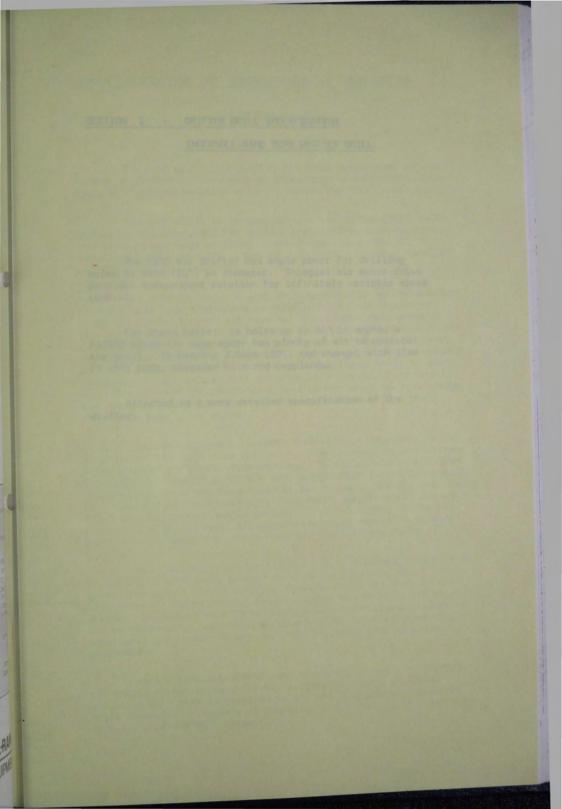
35° grade

3100 lb

20

Form 4466-A <1977, 1981 Ingersoll-Rand Co. Printed in U.S.A.

INGERSOLL-RAND. DRILLING EQUIPMENT





#### SECTION 2 : DRIFTER DRILL SPECIFICATION

#### INGERSOLL-RAND YD90 DRIFTER DRILL

The YD90 air drifter has ample power for drilling holes to 64mm ( $2\frac{1}{2}$ ") in diameter. Integral air motor drive provides independant rotation for infinitely variable speed control.

For short holes; ie holes up to 30' in depth, a P375SD Spiro-flo compressor has plenty of air to operate the drill. It handles 3.048m (10') rod change, with 32mm (1.25") rods, threaded bits and couplings.

Attached is a more detailed specification of the drifter.

presentative and the drill main air inter, The cylinder mains in front walves pirton, and piston ates bearing. It includes main air front about ports, around port, and vent ports which direct herrested air costs the drill mounting fast drain. Forks on the air distribute body (and the bronze liner) direct the main opisating air through th front and reat piston account of reservoirs which deposit a file of late hand, and ar scall all reservoirs which deposit a file of later the brance between the piston head and the cylinder wait.

The firmi air requirements for the two parameters of the built of this string and is used to slow the cuttings out of the built. The second of air conduced deposeds on the processing at the blow least in the backtonic, and the reacher of stately in the drill along lands in the backtonic, and the reacher of stately in the drill string. In uniform such formal land, improved deall performance the estimated by throughout the drill raws at a big additioned air to the backer, be that the drill raws at a big

Are all true into restar soul the used with the nil-taken all moving parts of the still are infrared by the nil-taken aperating all doubt in directed to all critical points. More the specialing all doubt in directed to all critical points of reservoir still is possion on a "transfer" scooking, a lubricating oil reservoir is built taken the more drame.

#### SECTION S : DRIFTLR ORILL SPECIFICATION

#### IMLERSOLL-RAND VISO ORIFTER ORILL

The YD90 air drifter has emple power for drilling holes to blass (2%) in diameter. Integral eir sotor drive provides independent rotation for infinitely variable apend quotrol.

For short buies; is holes up to 30 in depth, a P3755D Spiro-fie compressor has plonty of air to operate the deili. It hendles 5.000s (10") cod change, with 32ee (1,25") rods, threaded bats and couplings.

Attached in a more detailed specification of the defifier.

### GENERAL DESCRIPTION AND SPECIFICATIONS OF YD90 DRIFTER

#### DESCRIPTION

The YD90 drill is a 3.5" (90mm) bore, valveless, pneumatic hammer drill that incorporates an independently controlled, gear type, air powered rotation motor to rotate the drill steel and bit.

The YD90 drill is recommended for use on the LM100 selfpropelled mountings, and for surface applications with feed chain mountings on any type of fixed or mobile drilling rig. It is capable of drilling 1.75" (45mm) to 2.5" (62mm) diameter holes in all types of rock formations.

The YD90 is designed with an independently controlled, air powered, gear type rotation motor that provides continuous drill steel rotation - forward and reverse. This heavy duty motor is mounted on the top of the drive gear cover at the lower end of the drill. The motor drive gear and idler gear convert the force of the operating air to rotation power. The rotation power developed by these gears is transmitted through a drive gear shaft to the chuck drive intermittent gear and then into the drill steel and bit. The drive shaft serves as a torsion bar which absorbs energy and prevents damage to the motor drive gear teeth if the drill steel gets hung up or stuck.

The air required to operate the drill is dependent on the pressure at the drill main air inlet. The cylinder houses the air valve piston, and piston stem bearing. It includes main air front supply ports, exhaust port, and vent ports which direct lubricated air onto the drill mounting feed chain. Ports in the air distributor body (and the bronze liner) direct the main operating air through the front and rear piston supply ports. Three oil rings, cut in the piston head, act as small oil reservoirs which deposit a film of lubrication between the piston head and the cylinder wall.

The final air requirements for the YD90 passes through the hollow drill string and is used to blow the cuttings out of the hole. The amount of air consumed depends on the pressure at the blow inlet in the backhead, and the number of steels in the drill string. In uniform rock formations, improved drill performance can be obtained by throttling back excess blow air and diverting additional air to the hammer, so that the drill runs at a high pressure.

An air line lubricator must be used with the YD90 drifter, all moving parts of the drill are lubricated by the oil-laden operating air which is directed to all critical points. When the drill is used on a "Crawlair" mounting, a lubricating oil reservoir is built into the main frame.

#### GENERAL DESCRIPTION AND SPECIFICATIONS OF YORO ORDERDA

00114183630

The YOSO drill is a 3.5" ("Durn) bore, valueinan, programmic hummer drill that incorporates an independently controlled, gear type, air powered rotation solar to rotate the drill steel and bit.

The YDMO drill is recommended for use on the Leron Seinpropelled mountings, and for surface applications with feed chain mountings on any type of fixed or schile drilling rig. It is capable of drilling 1.75° (Sime) to 2.5° (62 mm) dismater hules in mil types of rock formations.

The YD90 is designed with an independencip continuous drill powered, gear type rotation solar that provides continuous drill atent rotation - foreard and reverse. This heavy dity solar is mounted on the top of the drive gear cover at the leave and if the drill. The solar drive gear and idler gear covert she force of by these operating air to rotation power. The rotation power developed drill. The drive intermitted through a drive gear shuft to the druck drive intermittent gear and then into the drill steel and drill. The drive shuft earwas as a torsion har which aborts energy and prevents damage to the mater drive gear texth if the drill and prevents damage to the mater drive gear texth if the drill

The air required to operate the drill is subject houses the sir pressure at the drill sain air inlet. The sylinder houses the sir valve platon, and platon atem bearing. It includes main air from anoply ports, exhaust part, and vents ports which direct lubricated air onto the drill sounting feed whin. Forts in the air distributor body (and the branz liner) direct the main operating air through the front and their platen supply parts. Three oil rings, cut in the platon head, act as small oil reservairs which deposit a file of lubrication between the platen head and the cylinder wall.

The final air requirements for the thut upturing out of the boliow druil string and is used to blow the cuttings out of the hole. The amount of air consumed depends on the pressure at the blow inlet in the backhead, and the number of steels in the druil string. In uniform rock formations, improved drill performance can be obtained by throttling back excess blow air and diverting additional air to the hammer, to that the drill runs at a high

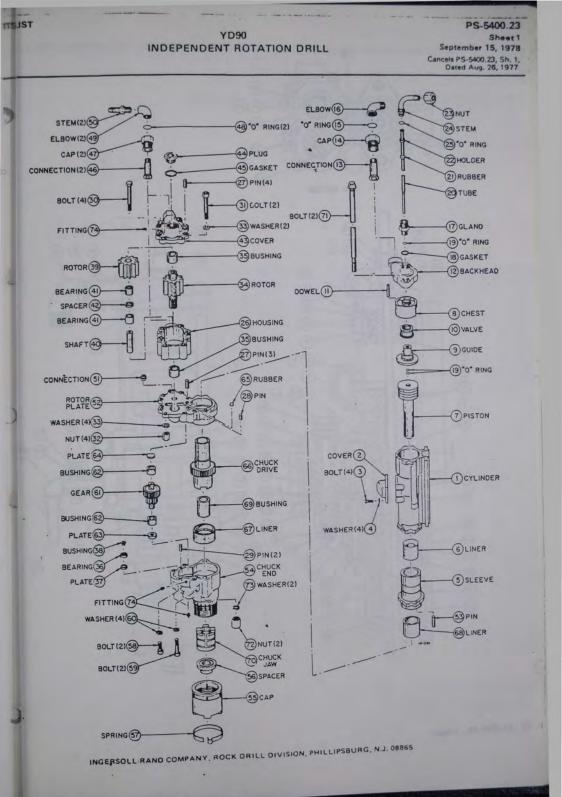
An air line lubricator must be used with the lots ail soving parts of the drill are lubricated by the ail-laden operating air which is directed to all critical points. When the drill is used on a "Crawlair" mounting, a lubricating ail reservoir in buffit into the main frame.

#### SPECIFICATIONS

-----

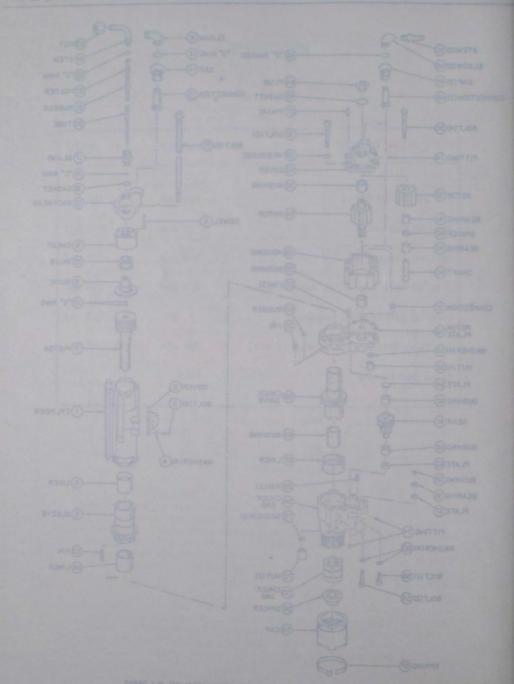
DRILL SPECIFICATIONS	ENGLISH	METRIC
A A A A A A A A A A A A A A A A A A A		Contraction of the second
Net Weight of Drill	187 lbs	(85 kg)
Bore of Cylinder	3.5 ins	(90 mm)
Working Stroke	3.5 ins	(90 mm)
Size of Main Air Inlet Hose Required	1.5 ins	(38 mm)
Size of Blower Hose Required	1 in	(25 mm)
Air Consumption at 100 psig (7 bar)	368 cfm	(10.3 m3/min)
Blows per Minute	1600	On I

AND A REAL PROPERTY AND A DECK OFFICE DR. PROPERTY AND A

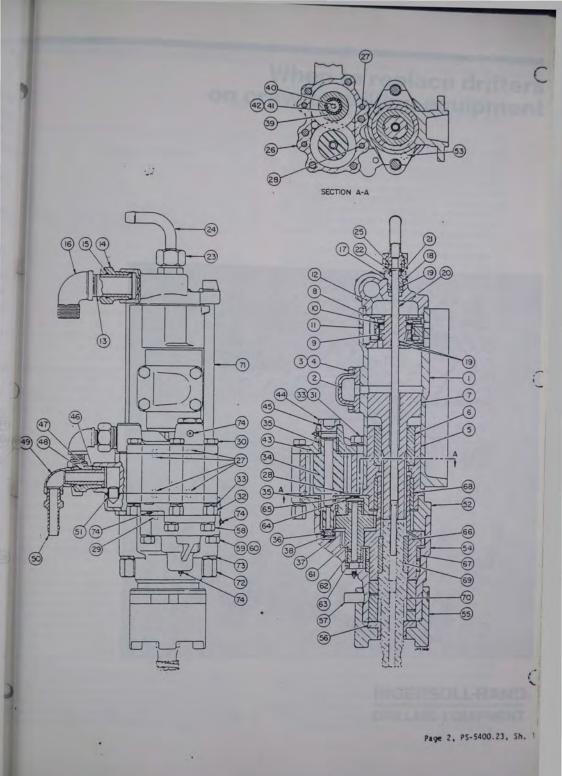


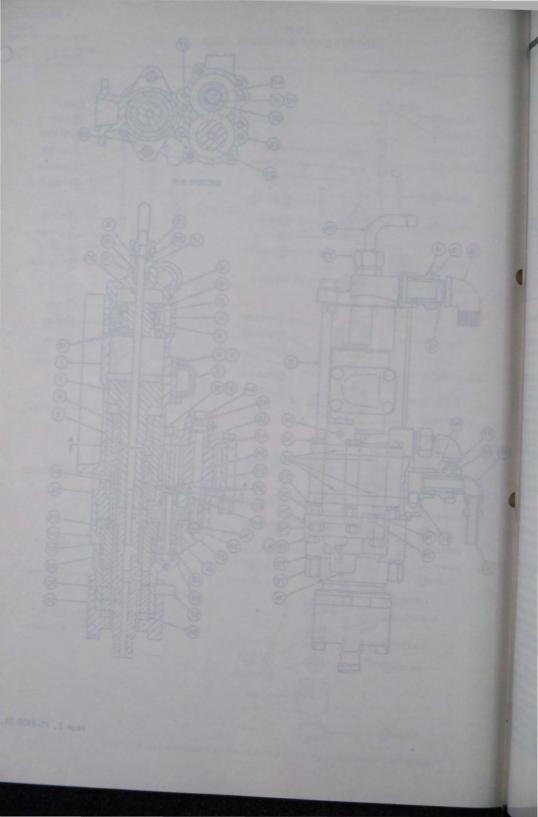
# YON HUDEPENDENT ROTATION DRILL

Barranter 15, 1979



THE REAL PROPERTY ROCK DRILL DIVISION, PROFESSION, PRO





# When to replace drifters on crawler drilling equipment

and the particular

INGERSOLL-RAND

## When to replace drifters on crawler drilling equipment

The question of whether to rebuild or replace equipment as it wears in service has always been complicated by an almost infinite variety of qualifications. Most decisions are made on the basis of costs—to repair equipment at an early stage in its working life; or to keep the equipment working, although at lower efficiency, until it can operate no longer. In the latter case, a prolonged period of operation at low productivity may be more costly than initial rebuilding.

With the drifter units mounted on crawler drilling equipment, there are some very definite indications when rebuilding is needed, and some very potent reasons to replace some types of drifters rather than to rebuild them.

#### Two Types of Drifters

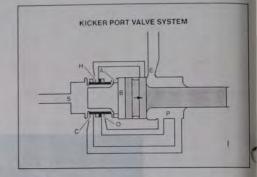
Pneumatic drifters are available in either valveoperated or valveless designs. Valve-operated drifters had, until recently, been more popular. The valveless designs were developed first, but were large and heavy. Around the turn of the century, and through the 1920's, moving drills from one hole to another was done manually. Therefore, the lighter valve-operated drills won greater acceptance when they became available. Today, with drifters of every kind mounted on hydraulic booms or arms of crawler equipment, moving from one location to another requires little or no manual labor so drifter weight or size is of little concern. The complexity of drifter design, sensitivity to wear and ease of reconditioning, however, can be vital to performance and operating costs of crawler drills.

#### Valve-Operated Drifters

The spool valves of valve-operated drifters tend to reveal the wear of pistons and cylinders at a fairly early stage.

Illustration (I) demonstrates the operation of a typical "kicker-port" valved rock drill or drifter. The kicker-port valves are spool valves activated by air pressure applied through the passages or kicker-ports in the cylinder, opened by the piston as it reciprocates. The valve operates by directing pressure to the front or rear side of a flange on the valve.

In the illustration, the piston is shown moving forward, on a power stroke with compressed air (S) passing through ports (A) to the back chamber (B). Just before the piston reaches exhaust port (E), it uncovers a kicker port that directs air through another passage to the back side of valve flange (H). This snaps the valve forward to shut off air flow to the back chamber (B). Immediately afterwards,



exhaust port (E) opens and the back chamber (B) drops to nearly atmospheric pressure.

The piston now strikes the striking bar and drill steel and begins its return stroke driven by air pressure still flowing through port (C), into the front chamber (P). On the return stroke the piston opens the kicker-port on the forward side of exhaust port (E). This admits air to the front side of the valve flange at (O) causing the valve to shift back, cutting the air supply to the front chamber (P). The air pressure is now redirected to the back chamber (B) through ports (A). This air cushions the piston at the top of its stroke and the cycle repeats.

Although details may vary, this is the principle of operation for all spool-valve-operated drifters.

#### Valveless Drifters

With valveless drifters, the piston acts as its own valve. The sequence of operation following, is typical of the valveless drifters produced by Ingersoll-Rand and other manufacturers although details may differ.

In illustration II, the piston is driven forward by air passing the "tail" diameter at (A) from the air supply (S). When the piston tail closes the ports at (A), air is shut off and the piston continues to be driven forward by the expansion of air in back chamber (B). Further forward the piston head uncovers exhaust port (E) and the piston tail uncovers the front chamber ports at (C).

The piston delivers its blow to the striking bar and begins its return stroke, driven by air flowing to front chamber (P) through (C). When the returning piston tail covers ports (C), air flow to (P) is discontinued but the piston is still driven back by the expansion of the air in chamber (P). A little further back the piston head uncovers the front edge of VALVELESS SYSTEM

\*xhaust port (E) and the piston tail opens the backthamber air supply at ports (A). This air cushions he piston at the end of its return stroke and starts i new cycle.

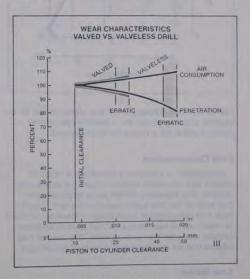
#### Symptoms of Wear

The use of a good rock-drill oil injected into the compressed air that drives the drifter, delivered at a constant rate, will minimize wear and lengthen working life. However, all mechanical things wear out eventually. With drifters, the bushings or bearings that support the piston will be one of the areas most subject to wear. The piston and the cylinder will wear where they are in running contact. The part of the piston which strikes the striking bar delivering percussive force to the drill steel will show wear. The mating surface of the striking bar and the threads that join the drill steel are designed to withstand the impacts necessary to drill three to five thousand feet of hole in hardrock before being replaced. And of course, the valve in valve-operated drifters will manifest symptoms of wear. With valveoperated drifters, as the clearance between the piston and cylinder increases, air can escape past the piston and trip the spool valve prematurely, causing erratic performance. Before that happens, there will be a noticeable reduction in penetration rate. If an air pressure gauge is placed at the inlet for the drifter, it will show a substantial drop in pressure, compared to a new unit. By the time the wear or clearance between piston and cylinder reaches .25mm (.0097 in.) the drifter will be virtually inoperable.

With valveless drifters, as wear progresses, there will be a drop in pressure as air escapes past the piston, and a noticeable reduction in penetration rate will occur. However, since there is no spool valve involved, the valveless drifter can continue to operate much longer-until clearance between piston and cylinder approaches .45mm (.0175 in.).

#### **Replacement is More Economical**

With both types of drifter, at this point a decision must be made whether to rebuild or replace. As can be seen, the valveless drifter is a simple design and, therefore, easier to rebuild. In addition to its greater tolerance to wear between piston and cylinder, it has another advantage. The piston is supported by two widely spaced bearings or bushings. This minimizes contact wear between the cylinder and piston, and helps reduce bearing wear as well. For all practical purposes, this means that this type of valveless drifter will operate significantly longer than valve-operated drifters in the same service. It can be more economical to replace valved drifters with valveless designs, rather than rebuild them.

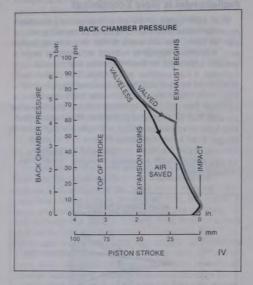


#### Ingersoll-Rand Valveless Drifters

One supplier produces valveless drifters suitable for operation on virtually any crawler drilling rig. The Ingersoll-Rand VL-120, designed to drill holes from 2½ to 3½ inches in diameter (64-89mm) and the VL-140 valveless drifter for holes from 2½ to 4 inches (64-102mm), both provide penetration rates at least equal to original equipment, and at reduced air consumption.

#### **Operating Advantages**

Valveless drifters have several operating advantages. First, they require less compressed air. Illustration IV compares the pressure in the back chamber of valved and valveless drifters. Pressure in a valved drifter is supplied continually, until just before the valve is tripped or just before the exhaust port is opened. Pressure in the back chamber of a valveless drifter is cut off long before the exhaust



port is opened. Expansion of the compressed air is used to provide power for a greater part of the piston stroke. As a result air is conserved.

#### **Fuel Conservation**

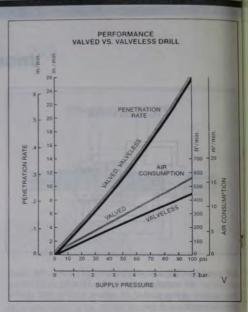
Illustration V compares penetration rates of valved and valveless drifters under the same conditions. The valveless drifter uses approximately 3m<sup>3</sup> less air for the same penetration rate. Therefore, the compressor plant doesn't have to produce as much air. It can conserve fuel, and in addition, reduce wear on that unit as well. The cost of fuel makes this an increasingly important advantage.

#### Low Noise

Further advantages resulting from the use of air expansion during piston travel are that there is less noise, and less tendency to "diesel" when the

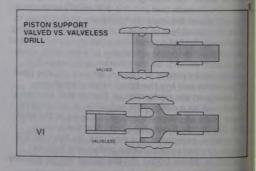
Ingersoll-Rand Co. Rock Drill Division Phillipsburg, N.J. 08865

Form 4524-A © 1981, 1982 Ingersoll-Rand Co. Printed in U.S.A.

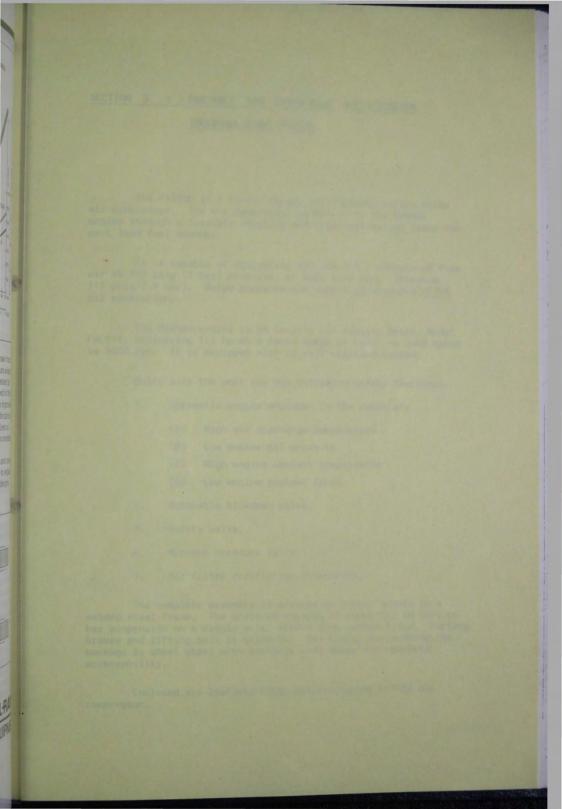


drifter is run as the drill steel is withdrawn from the hole. The dieseling phenomenon occurs when the lubricating oil entrained in the compressed air ignites due to high pressures developed in the front chamber of the drifter. Because of the improved piston support in valveless drifters, lubrication is less critical and less oil can be used. Less oil produces less oil fog in the exhaust; a consideration for operator comfort and health.

From the viewpoint of maintenance and operating costs, it is apparent that it will pay to replace valve-operated drifters with valveless designs rather than rebuild the former.



INGERSOLL-RAND



#### **Doersting Advantages**

Advantages of the phase service and an average of the second set in the second set of the second set is the second set of the second set o

om na nacional. Escuencien el cina sur spatializad su l'hi colonidas portar ko o genesia clari el ma promoto de casa ve su recelto an anco comman

#### Ford Conservation

Relation of the second second because added range of individual and values and defines under the second second them. The mathematic entries used to prove the second and second second second particular to the second test second second second second to the second second second second second second to the second second

#### LON Notse.

- Lotther advartages (anothing train phe can be available to the second terms extended to the second terms and the second terms of the "compared to the second terms" when the second terms of te

Port Drie Lieferen Ports Drie Lieferen Philipperung, N.J. Beard

NAME AND A DOOR OF A DOOR

spritten den in From onseptiete, dez deuter sein chonnen und eine seinen dieten auf der deuter wird deuter auf der einen die deuter verbin die seine deuter auf bestienen die her verbin seine deuter auf bestienen die her verbin internet die deuter het eine deuter seine Recht die deuter eine bestienen mit verbing und deuter mit het in wir pass bestie eine verbing deuter die deuter bestienen deuter seine het eine deuter seine deuter in deuter seine seine mit verbing eine deuter mit het in wirh pass bestienen.

## PRINTER ALPONIAT

DRILLING EQUIPM

### SECTION 3 : PORTABLE AIR COMPRESSOR SPECIFICATION

### INGERSOLL-RAND P375SD

The P375SD is a single stage, oil flooded, rotary screw air compressor. The air compressor is driven by the diesel engine through a flexible coupling and rotor optimizing gears for part load fuel economy.

It is capable of delivering 375 cfm (10.5 m3/min) of free air at 102 psig (7 bar) pressure, at full load rpm. (Maximum 115 psig/7.9 bar). Rated pressure and output is measured <u>AFTER</u> oil separation.

The diesel engine is an in-line air cooled, Deutz, Model F6L912, delivering 112 hp at a rated speed of rpm; no load speed is 1000 rpm. It is equipped with 24 volt starting system.

Built into the unit are the following safety features:-

- 1. Automatic engine shutdown in the event of:
  - (A) High air discharge temperature
  - (B) Low engine oil pressure
  - (C) High engine coolant temperature
  - (D) Low engine coolant level
- 2. Automatic blowdown valve.
- 3. Safety valve.
- 4. Minimum pressure valve.
- 5. Air filter restriction indicators.

The complete assembly is mounted on rubber mounts on a welded steel frame. The unitized chassis is supported on torsion bar suspension on a single axle; fitted with rubber tyres. Parking brakes and lifting bail is standard. The canopy surrounding the package is sheet steel with lockable side doors for complete accessability.

Enclosed are leaflets fully describing the P375SD air compressor.

## RECTION 3 1 PORTABLE AIR COMPRESSION SPECIFICATION

### INDERSOLL-RAND P375SD

The P3753D is a single stage, oil flooded, rotary berew air compressor. The air compressor is driven by the diseal engine through a firstble coupling and rotar optimizing gears for part load tual economy.

All is expetile of delivering 375 and (10.5 m3/min) of free air at 102 perig (3 bar) pressure, at full lead rpm. (Hoximum 115 perg.7.9 bar). Refed pressure and butput is measured AFIER oil separation.

The discol engine is an 16-11co air booled, Doutr, Model fALS12, delivering 112 hp at a rated speed of rpm; no load speed is 1000 rpm. It is equipped with 20 volt starting system.

Built Into the unit are the following safety features:-

- Automatic engine shutdown in the event of:
  - (A) Migh air discharge temperature
    - (B) low engine oil pressure
  - (C) High engine coolant temperatur
    - (D) Low angune coolant lave
      - 2. Automatic biowdown walve
        - 3. Safety valve.
        - A. Minimum pressure valve.
    - Air filter restriction indicators,

The complete assembly is bounded on rubber mounts on a welded steel frame. The unitized charais is supported on torsion bar suppersion on a single sole; fitted with rubber lyces. Parking brakkes and iffing bail is standard. The canopy surrounding the accessebility.

Enclosed are teaflets fully describing the Philod are compression.

# PERFORMANCE DATA

FUEL CONSUMPTION

P375SD

Engine Manufacturing	:	Deutz
Model	:	F6L912
Available BHP	:	112
RPM	:	2500
Rated Operating Pressure	:	100 psig

# % RATED CAPACITY

50%	ACFM	:	187
	Cub. ft. / lb Fuel Litres/hour	:	507
75%	ACFM	:	281
	Cub. ft. / lb Fuel	:	596
	Litres/hour	: /	15.2

100%	ACFM	:	375
	Cub. ft. / 1b Fuel	:	608
	Litres/hour	:	20

### PERFORMANCE DATA

### FUEL CONSUMPTION

### P37550

Litres/hour

Dub. 11. 3 10 100



# Introduction

In 1902 Ingersoll-Rand introduced the world's first truly Portable Air Compressor, and has pioneered every major advance in the field since then. We introduced the two-stage air-cooled unit, followed it with the first sliding-vane rotary Portable, and then with the first screw-type Portable. Today we are acknowledged leaders in Portable Compressor technology.

Wherever in the world compressed air is used — on construction sites, in quarries or open cast mines, for road maintenance or water well drilling — the chances are an Ingersoll-Rand compressor will be at work, providing efficient, cost effective performance.

Ingersoll-Rand is a world-wide organisation with a manufacturing, service and distribution network covering virtually every corner of the globe. We maintain our leadership in the Portable Compressor industry because we employ precision manufacturing methods and the most exacting quality control standards.

This brochure is designed to give you an insight into the unmatched development, manufacturing, quality control and back-up service facilities we provide with every Premium Portable, from the smallest 65 cfm (30 lt/sec) unit to the largest, which is capable of delivering 5000 cfm (2350 lt/sec) of air.



# **Research and Development**

# permittent/ noisisered



Our track record in Portable Air Compressor technology from the beginning of this century illustrates the importance Ingersoll-Rand places on Research and Development. The work goes on today to help us ensure that we can supply the right machine for any and all customer requirements.

As well as producing many product 'firsts', the continuous research and engineering development programmes help to create new materials and new manufacturing methods and skills, which can be applied to the design of new machines and can also contribute to the improvement of existing products. Every new idea is thoroughly tested by our compressor technology professionals and discussed with end-users. Our Research and Development test cells provide the environment for theoretical ideas to be put to practical examination. Only when they have passed all the tests will they be incorporated into new product designs.

Creative engineering has kept Ingersoll-Rand Portables ahead of the field by bringing new ideas into action to produce premium products which combine the highest levels of efficiency with outstanding performance and economy of operation.

# **Quality Control and Testing**

At every stage of manufacture Ingersoll-Rand Portable Compressors are subjected to a rigourous regime of quality control testing, in order to ensure that our standards are met, and that the customer receives the premier portable he expects.

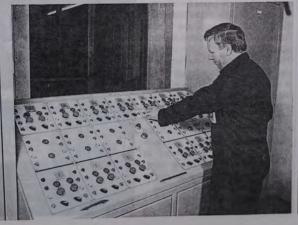
For example, all the critical dimensions on rotor housings are examined on computer-assisted inspection machines. Permanent records are produced of every inspection.

Once total assembly is complete when the air end, engine, chassis, auxilliaries and controls have been brought together — each unit is acceptance tested.

Every new Ingersoll-Rand Portable undergoes many hours of operation to provide the break-in, regulation and performance test data required. Only those that pass this final examination get our coveted seal of approval — an Ingersoll-Rand nameplate.

Whisperised<sup>®</sup> versions of the compressors are tested on the most advanced sound-testing facilities

in the industry, which enable our engineers to monitor and analyse the noise levels around a compressor with a high degree of accuracy and make sure they meet noise-control regulations where necessary.



# Precision Manufacturing

to considered incohires



Creative engineering counts for nothing if it is not matched with the highest manufacturing standards.

Ingersoll-Rand has the ability to match its engineering standards with manufacturing excellence. Wherever in the world Ingersoll-Rand Portable Compressors are produced only the most advanced metal-working equipment is used, so the same level of accuracy is achieved globally.

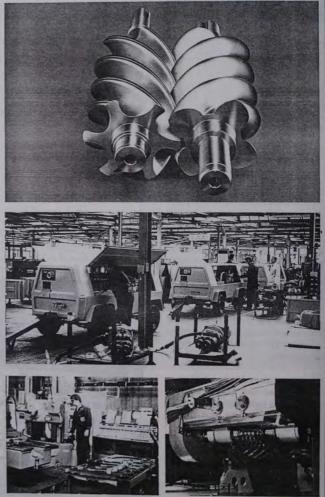
Rotor housings are precision-bored with great accuracy. Close rotor clearance is an important factor in improving efficiency — rotors must turn freely within the housings, but the clearances must be close enough to minimise air slippage. The right machine tools, operated by well-trained staff, provide the assurance that Ingersoll-Rand rotor housings are manufactured to the highest standards possible.

The manufacture of the rotors is the most critical operation of all. It involves the precision-machining of extremely complex rotor shapes from cylindrical blanks of high-grade solid steel. Highly specialised contour milling machines — a part of the Ingersoll-Rand worldwide investment in producing only the finest compressors — are used to generate the rotors from bar stock.

All rotors for compressors of 175 cfm capacity and over are precision ground to a glistening mirror-like finish in order to approach the theoretical ideal of a rotor profile and also to reduce fluid friction on all rotor surfaces — another important factor in improving efficiency.

Rotors for the smaller 100 and 175 cfm compressors are produced in a two-stage operation called Rotor Hobbing. In these small sizes where the compressors run intermittently and engine horsepower is small, hobbed rotors provide the level of efficiency required.

The mating of rotors is the final, critical step. Male and female rotors are precision matched and then each pair is inspected for back-lash and interlobe clearance. The attention paid to this critical operation produces the nearest to screw compressor perfection attainable today.



# Parts and Service Worldwide

Ingersoll-Rand compressors are built to stay the course. They will provide long hours of trouble-free operation - but at some stage they panies and Distributors located in will need servicing.

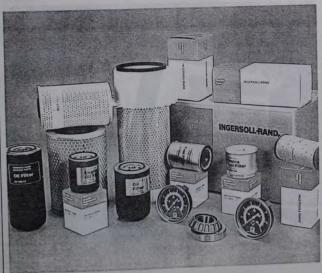
With our own automated 24 hoursa-day parts service, and a network of our own autonomous Comevery part of the world, we are

geared to provide our customers with the fast, efficient back-up required to keep the machines operational.

Distributors and the autonomous Companies hold inventories of spare parts. If, by chance, the part you require is not in stock a call to one of our strategically-located computer-controlled parts stores will have the missing item on its way in a hurry.

Parts availability and worldwide back-up service are additional reasons for selecting an Ingersoll-Rand Portable Compressor.

# Ingersoll-Rand Genuine Parts



To keep your Portable Compressor at peak performance, you should insist on only genuine Ingersoll-Rand replacement parts.

Substitutes may cost less at the time of purchase, but their useful life will be shorter, and the risks of failure and consequential damage to your Portable Compressor are much higher.

Don't take the risk - insist on precision-Ingersoll-Rand's manufactured and tested spare parts.



Nothing contained in this brochure is intended to extend any warranty or representation, expressed or implied, regarding the products described herein. Any such warranties or other terms and conditions of sale of products shall be in accordance with ingersoll-Rand's standard terms and conditions of sale for such products, which are available upon request. Specifications and machinery may be altered without notice at any time.

# INGERSOLL-RAND WORLDWIDE DISTRIBUTION





# Ingersoll-Rand Product Lines

Air hoists and winches Air and gas compressors Air and electric tools Aircraft support equipment Anti-friction bearings Automated production systems Centrifugal and reciprocating pumps Coal mining machinery Construction equipment Door hardware Electronic access systems Engine starting systems Fluid jet cutting systems Gas turbines Gears and couplings

Industrial process machinery Mobile drilling and well service rigs Pavement milling equipment Pellet mills Portable air compressors Power recovery systems Pulp processing machinery Reciprocating gas engines Rock drills Separation equipment Specialty steel products Steam turbines Vibratory compactors Water well drills

INGERSOLL-RAND.

Ingersoll-Rand 1984 Form No LN8069 Printed in UK

# P140 P175 P250 P375

COMPRESSEURS MOBILES FAHRBAREN KOMPRESSOREN MOTORCOMPRESSORI TRANSPORTABILI COMPRESORES PORTÁTILES



# CONSTRUCTION EQUIPMENT

# P140/P175/P250/P375 WHISPERISED®

A range of precision engineerist portable compressure, designed for two maintenance, maximum efficiency, economic operation and maximum operational life.

Outer Operation As models meet to surpass, CAGI-PNEUROP noise emission astroducts, and can therefore be used in areas where shot noise emission stantards are in loce.

Heavy Duty Engines All models incorporate industrial type deset engines which. All models incorporate industrial type deset of and deliver from dependent on unit selected, an air or white received at deliver from S1 bhp (38 ks) to 112 bhp (38 S ks) at a speed of 2,500 r p m. All mode pender centrandreg fluer economy.

### Alr-Ends

Air-Ends Compressor rotors are precision-machined to the ideal design profile. Other components are precision de-cast. The result greater efficiency and lower fuel consumption. Engines and ar-end assembles are mounted on heavy gauge all-

Une gamme de compresseurs mobiles fabriquée avec précision en conque pour un antiretien réduit, un rendement maximum, un tonchannement économique et une durée de via opérationnelle

Fonctionnement sitencieux Tous les modèles satistori ou dépassent les normes d'émission de bruit CAGI-PNEUROP, et peuvent donc être utilisés dans les endroits où ées normes situites d'émission de bruit sont en vigueur.

Moteurs grandle pulssance Tous les modèles son équipés de moteurs diesel industriels qui, selon la matinie chosie, son retroités par au eu el set une puissance de 38 kW (51 ch ) a 83,5 kW (112 ch 2500 tims. Teus les modèles offrent une exelliste à concerne de

Compresseurs Les rations du compresseur sont usinés avec précision selon le protifi losal. Les autres composants sont realisés par moulage mécanique de précision. Le résultat un rendemente plus élevé et une consommation de caburant plus

moteurs et les comprésseurs sont montés sur des châssis en

a of special rubber mounts, thereby iso

Air Regulation The Steplets system, from idle to full engine speed, allows for a continuous, smooth flow of compressed air output in response to air

Air Oil Separation Less than 10 p.p.m. due to a two-stage separation system

Leas than 10 p.p.m. due to a two-stage separation system. Unique Cooling All models are designed in operate with doors closed. The unique cooling system allows the units to operate in ambient conditions, depending on the machine model of up to 125' 152°C). Two Stage DV Type AIP Filter The engine and air end are protected by separate air intake filters applied with three demonst retiniction indicators.

Running Gear Two types of torsion bar suspended running gear are available. The first incorporates a tow-bar that can be adjusted to suit the height of

tôle d'acier de forte épaisseur par l'interméd-laire de plots spéciaux en caoutchouc, isolant ainsi des vibrations.

Régulation d'air Le système progressit, du ralenti à la pleine vitesse, pernet un débit d'air comprimé uniforme répondant totaloment à la demande d'air

Séparation air-huile Intérieure à 10 p.p.m. grâce au système de séparation à deux

Retroldissement unique Tous les modèles sont conçus pour pouvoir fonctionner avec les portes termétes. Le systeme de retroidissement unique permet aux unida de lonctionner dans des conditions ambiantes alant jusqua 32°C, en fonction du modèle de machine.

Filtres à la rescuie de médicar de médicar de machine. Els moteur et l'ensemble compresseur sont protégés par des filtres d'admission séparés, équipés d'indicateurs de colmatage de l'idement litrant.

Deux types de châssis à suspension par barres de torsion sont

the lowing vehicle and mechs European specifications. The other is a right traving bar running gear which meths EEC specifications. Welds wheel basis, high grund clearance and a low centre of payaity make at models very stable on even the roughest ground. The num bruke system provides for excellent floking characteristi hand parking brake which allows for safe parking is a state

Immu: Ease of Access The large lockable doors, the lifting of which is aided by gas sinuls, poper wide allowing full accessibility to all maintenance areas and the large too's toorage space Controls and Instrumentation The maintenance-tree control system provides for automatic shutdown by high discharge and temperatures, low engine ou pressure, or high engine temperature. Signal lights show the cause gauge and engine hour meter. Starting and openating all pressure gauge and engine hour meter. Starting and openating a pressure bactand an allochable enclosure for protection against vandation.

disponibles. La presinier comporte un limon réglabile en fonction data hauteur du véhicule de remorquiage et est contornes aux specifications exopennes. Les accord est un chasisé bitmon régla-contorne aux specifications de la C.E.E. Des roues largement espacées, une garde au soil inportante et un centré de gravite base rendent tous les modèles très stabiles, même sur les terrains les plus accolerais. Le système de rien d'unitabiliterne d'accolerate espicement standard **Pacilité d'accol Euler** de stabilisment des terrains les plus accolerates. Le système de rien sur les roues largeures de seguipement standard **Pacilité d'accol Euler** des stabilisment des tabilisment est la système de la sous les organes à entreferir et au grand espace de rangement des outils. **Commandes et instrumentation Commandes et instrumentation** comprennent du contra de la souries de la stabiliste pression d'huile ou de haute formprature du moteur. Des langees contranon et la commandes sur de grand baserier, de la lange pression d'huile ou de haute formprature du moteur. Des langees comprennent un manométre d'air de service et un compteur Uneater comprennent un manométre d'air de service et un compteur Uneater service da stabilister service da stabilister service d'accolerations and metter. Esse sommandes es de mise en marche et d'accolerations organement dus outils estabilister and moteur. Les commandes est emise en marche et d'accolerations organement du sobilier anti-vaudalisme.

Baumhe fährbärer Schraubenkompressoren mit geningen Warungsaufwand, langer Lebensdauer und wirtschaftlichen Bernite.

Geräuschpegel Alle Modelle unterschreiten die AVV-Normen. Sie können eingesetzt werden, wo Geräusche auf ein Mindestmaß herabgesetzt werden müssen.

Hochleistungsmotoren Alle Modelle besitzen Dieselmotoren, die je nach Modell entweder kun- oder wassengekühlt sind. Die Leistung dieser Mötoren liegt zwischen 38 und 83.5 kW bei 2500 Ulmin. Sie zeichnen sich alle

Kampressor Das Schnackropaat eind mit engsten Toleranzen gelertigt, um das schlassingegesen. Das Fleiteren Andere Komponenten and schlassingegesen. Das Fleiteren Mitter und Kompressor werden mit spezellen Gommälampfern in einem Chasais aus hochwerigem Staft montiert, um eine größere Laufurbe zu erzeien.

Liefermengenregelung Die stutenlose Liefermengenregelung von Leerlauf bis Vollast sorgt für eine gleichmäßigen, kontinulierliche Liefermenge je nach Luhbedaft.

Luft-Ol-Abscheidung Aufgrund eines außerst wirksamen Zweistuten -Abscheid systems betragt der Rest-Olgehalt der Drücklutt weniger als 10 p.p.m.

Kühlung Alle Modelle werden mit geschlassenen Türen und Klappen betrieben. Das werksame Kuhlsystem ermöglicht es, die Kompressoren, selbst bei Umgebungstemperaturen bis zu 52°C,

Zwel-Stufen-Trockeneinlaßluttfilter Motor und Kompressor werden durch separate Lufteinlaßlitter geschützt, Fiterkontrolle durch verschmutzungsanzeiger.

Personal reinschneten auch reinschnitzungentzeiger. Fahrgestell: Straßenlage Es sind zwei Varianten mit Drehstablederung lieferbar. Ein Fahrgestell har eine höherweistellibarz zugverrichtung, die den Spezifikationen europäischer Länder entspricht. Die andere Variante bestätzt eine in der Höhen cihtkreistellibarz Zugverrichtung.

per mezzo di adaguati supporti in gomma che isolano dalle vibrazioni.

vitritizione. Regolazione della portata La regolazione di tipo continuo e progressivo, dal regime di minimo al massimo numero di giù del motore, consente di soddisfare la richiesta d'aria con una erogazione uniforme.

Separazione aria cilo Meno di 10 ppm grazie di olio al sistema di separazione a due stadi

Raffreddamento Tuffi i modelli sono stati progettali per operare a portelloni chiusi. Il sistema di raffreddamento consunte di operare, a seconda def modelle, lino a una temperatura ambiente di 52" Filtri aria a due stadi di tipo a secco Motore e compressore sono dotati di filtri di aspirazione completi di indicatori di intasamento dell'elemento tittrante.

Timone Sono disponibili due differenti timone di traino. Un tipo incorpora una barra regolabile in funzione dell'allezza del veicolo trainante e risponde alle vigenti norme europee. Un secondo

die EG-Bestimmungen gerecht wird. Die breite Spurweite, der hohe Bodenabstand und der niedrige Schwerpunkt sorgen für eine sehr sichere Straßenlage des Kompressors bein Schleppen suwohl auf der Straße als auch im Gelände. Die Auflauf- und Feststellbreimse wirken sehr zuverlässig.

Leichte Zugänglichkeit Die großen verschließbaren Klappen, die sich leicht dim Gasdrucktedern anheben lassen, machen alle Wartungsber leicht zugänglich. Außerdem ist eine großzügige Werkzeuga,

Regier und Instrumente Das Sicherheitssystem sorgt für eine automatische Sillegung des Kompressors bei zu hohen Luftermperaturen, zunledigem Öktruck, zu hohen Motortemperaturen. Signatieuchien weisen auf die Ursache einer vorbeugenden Ausschäftung hin. Zu den Instrumenten gehören ein Betriebsdruck-Manometer und ein Betriebsschuderzähler. Stan-eine verschließbare Klappe vor unbefugtem Zugrift gesichert

modello e equipaggiato di barra fissa. L'ampia carreggiata, raflezza da terra ed il basso baricentro garantiscono la massima stabilita anche sui terro invi accidenta. L'impianto frenante di tipo a repulsione è sinonimo di eccellenti caratteristische di trenatura un reno meccancio di stazionamento manuale equipaggia di serie Iufii

modeli. Accessibilità' Due grand'sportetion con seratura a chave il ciu sollevamento è faciliato da pisonin a gas, permettora il massimo accesso a fuiti componenti che possono nchiedere un intervento manufentivo e ad un capiente vano per lo stivaggio di attrezzi. Panello strumenti e comandi Un circuito te non nchiede manufenzione, comanda l'arresto del molocompressore in seguito ad alta temperatura ana allo scarico, bassa pressione do del motore o dala temperatura motore. Dis strumenti comprendoso unmanomitero. Gli strumenti comprendoso unmanomitero di scarico o pationati en un vano dotato di sportelio a chieve contro atti vandaleji.

Gamma di motocompressori trasportabili, progettati per ridurre al minimo la manulenzione, con la massima efficienza ed economia di

Rumorosita' Tutti i modelli sono disponibili sia in versione standard che silenziata. In questo ascondo caso sono conformi alle norme europee vigente e perfanto possono venire impiegati in zone con rigorosi regolamenti arti-rumore.

ante-functive Motori Diesel Tutti: molocompressori sono equipaggiati con motori diesel che, a secondri del modello, sono rattreddati ad ana, o ad acqua ed erogano una potenza vanabile da S1 HP (38 KW) a 83.5 HP (83.5

inicolare attenzione e stata posta nella riduzione dei consumi

sifeccate attinucione e stata posas trea statistima precisione così refori sono stati lavorali con finitura di alfassima precisione così pre l'utili gi altri componenti. Coma risultato si sono ottenute una rande efficierze e dosti consumi di carburate. Adore e compressore sono montali su di un robusto tetalo in accisio

Regulación neumática El sistema progresivo, desde la marcha tenta a la velocidad máxima del motor, permite una producción continua de flujo constante de aire comprimido en respuesta a las necesidades de aire.

a de separación bielápico.

Merios de toppin debido al instema de separación betagico. Entriamiento excepcional Todos los modelos se han diseñado para que functionen con las puertas cernadas. El excepcional sistema de entriamiento permite funcionar a las unidades en condiciones ambientales que, de accerdo con el modelo de maguina, pueden alcanzar 52°C. El fintos nervensitos bietaplicos de tipo seco El motor y el compreser estan protegidos por fintos individuales de elemento de targo equipados con indicadores de restricción del elemento de targo.

elemento de exilo. Sistema de rendadura Se dispone de dos lipos de sistemas de rodadura con suspensión por balestas E privero incorpora una barra de remolque que se pueda ajustar para adaptaría a la altura del vehiculo remolque que se cumple las especificaciones europase. El otor es un sistema de rodadura con barra de remolque rigida que cumple las especi-

caciones de la CEE. La amplia base entre ruedas, elevada separa-ción del suelo y bajo centro de gravedad, hacen que todos los mod-elos sean my estables incluso en los terrenos más escabatosa. El satema de treno de sobrevelocidad proporciona unas caracterís-ticas excelentes de trenaja. El teno manual de aparcamiento que permite un aparcamiento seguro es un dispositivo normal. Facilidad de acceso Las grandes puentas con cerraduras, cuyo levantamiento se facilitar una accesibilidad completa a nota las ma naplamente permitento una accesibilidad completa a nota en esta de las paramentos per facilitar amplio espacio de almacenamiento de herramientos. Entretos e a las transmismos

amplo espació de almademantento de nervernemas Controlse e la netrumentos. El sistema de control exento de mantenimiento proporciona un terrupción automática del funcionamiento debido e devadas peraturas del ainte de descarga, baja presión del aceite del motil e elevida temperatura del motor. Los luces indicadoras sentilaría la causa de la interrupción protectora del functionamiento. Los in-tador de horas de funcionamiento de la motor. Los controles de punda ven aprecisiva un mandmento de an dongenza y un com-tador de horas de funcionamiento de indos. Los controles de punda en macrica y funcionamiento se halan dentro de un compat-temento con candiado para protegerlos contra el vandatismo.

Form No. LN8104 Ported at LN8104

Una gama de compresores portalités de precisión, concubción para proporcionar una duración operativa máxima con economis máx-ma ficiencia y reducidas necesidades de mantenimiento. Functionamiento silencioso Todes los modeios cumplen o exceden las normas de emisión de nado CADI-PNEUROP y pueden, por lo tanto, utilizarse en zonas donde as aplaciman normas estrictas de emisión de ruido cabal-PNEUROP y pueden, por lo tanto, utilizarse en caba donde as aplacimantes estrictas de emisión de ruido cabal precisión a excuendo com las incorporan fos molores diesel tipo industrial, de asier y entregan de 3BWA as 33.5% pueden i enfrados por apued e asiera de asiera estrictas de 25.00 / pu-narma de computable.

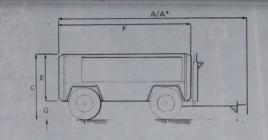
Junio de senses Los notores de las compresores se hacen mecanotados con preci-sión de acuelos con el partil de disuño ideal. Otros componentes se hacen inquetados a presisión. El resultado es una mayor eficiencias y raíls baja borano de combuzible Los conjuntos de indur y compresor van montados sobre un Los conjuntos de indur y compresor van montados sobre un los de lacentes questo por montados de montaras de goma especial astanostica est de la vitración

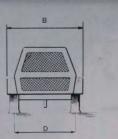
Separación de aire y aceite Menos de 10ppm debido al siste

# VHP 260

VEREESE SEE STEEL STEELE

DEC MANY





# MEASUREMEN AND WEIGHTS MASSE ONS SELFORS DIMENSIONE PESI DIMENSIONES Y PESOS

Measurements and Weig	hts	Dimensions et poids		Masse und Gewichte		Dimensioni e Pesi		Dimensiones y pesos		P375SD	VHP 260
Overall Length Fixed Towbar	A m	Longueur hors tout Timon fixe	A m	Gesamtlaenge Feststehende Zugvorrichtung	A m	Lunghezza totale con barra di traino fissa	Am	Largo Total Lanza fija	A m	4.23	4.23
Overall Length Max. Adjustable Towbar	A*m	Longueur hors tout Timon reglable	A*m	Gesamtlaenge verstellbare Zugvorrichtung	A*m	Lunghezza totale con barra di traino regolabile	A*m	Largo Total max. Lanza graduable	A*m	3.36	3.36
Overall Width	Bm	Largeur hors tout	Bm	Gesamtbreite	B m	Larghezza Totale	Bm	Ancho Total	Bm	1.56	1.56
Overall Height	Cm	Hauteur hors tout	Cm	Gesamthoehe	C m	Altezza Totale	C m	Altura Total	Cm	1.70	1.73
Track Width	Dm	Voie	Dm	Spurweite	Dm	Passo	Dm	Ancho de via	Dm	1.33	1.33
Canopy Height	E m	Hauteur capot	Em	Hoehe Geshaeuse	Em	Altezza cella carrozzeria	Em	Altura de la carena	Em	1.07	1.07
Canopy Length	Fm	Longeur capot	Fm	Laenge Gehaeuse	Fm	Lunghezza della carrozzeria	Fm	Largo de la carena	Fm	2.88	2.88
Ground Clearance	Gm	Garde	Gm	Bodenfreiheit	Gm	Altezza minima da terra	Gm	Luz libre	Gm	0.23	0.23
Gross Weight	kg	Poids brut	kg	Bruttogewicht	kg	Peso Lordo	kg	Peso bruto	kg	1920	2025
Tyre Size		Dimensions Pneus		Reifengroesse		Dimensione dei Pneumatici		Tamaño neumáticos		670 x 13	6PR

10000

Ingersoll-Rand reserve the right to change specifications without notice. Errors and omissions excepted. LN 8117 4/85

# INGERSOLL-RAND

# P375 SL VHP 260

Rated Pressure

Model

Compressor and Performance

Compressor Type

Free Air Delivery cfm, (m<sup>3</sup>min), (1/s)

Rated Operating Pressure psig, (bar), [KPa]

> Maximum Pressure psig, (bar), [KPa]

> > Air Outlets

Operating Ambient Temp. Range @ Sea Level

Engine Data

Туре

Model

Number of Cylinders

Rated Speed R.P.M.

BHP/KW Available at Rated Speed

No Load (Idle) Speed R.P.M.

Fuel Tank Capacity Imp Gal/(Litre) Gamme pression

Modèle

e Compresseur et performance

Type compresseur

Débit effectif en air libre cfm, (m<sup>3</sup>/min), [l/s]

Pression de service psig, (bar), [KPa]

Pression maximum psig, (bar), [KPa]

Sorties d'air

Temp. ambiante d'utilisation au niveau de la mer

Détails moteur

Type Modèle

Nombre de cylindres

Vitesse t/mm

Ch/KW regime nominal (DIN 8 6270)

Vitesse au ralenti t/mn

Capacité réservoir combustible Gallon impérial/litre Nenndruck

Kompressor und Leistung

Kompressor Typ

Liefermenge cfm, (m<sup>3</sup>min), [I/s]

Betriebsdruk psig, (bar), [KPa]

Hoechstdruck psig, (bar), [KPa]

Luftablasshaehne

Umgebungstemperatur Bereich ueber Meeresspiegel

Motor-Daten

Туре

Modell

Zylinderanzahl

Nenndrehzahl U/min

Leistung bei Nenndrehzahl U/min

Leerlaufdrehzahl U/min

Kraftstofftankinhalt Gallonen/Liter Pressione di esercizio

Modello

Caratteristiche tecniche

Tipo di Compressore

Portata d'Aria Effectiva cfm, (m<sup>3</sup>min), [l/s]

Pressione Normale d'esercizio psig, (bar), [KPa]

> Pressione Massima psig, (bar), [KPa]

> > Prese d'aria

Temp. d'Ambiente per Funzionemento Norm. al Livello del Mare

Caratteristiche del Motore Tipo

Modello

Numero di Cilindri

Velocità a pieno carico

Potenza (BHP/KW) Disponibile a pieno carico

Giri a Regime Minimo (Giri/min.)

Velo

Capacitá serbatio carburante Gallon: Imp/(Litri)

# COMPRESSED A ET MOTEUR KOMPRESSOR UND MOTOR COMPRESSOR A MOTOR COMPRESSOR Y MOTOR

and the state of t		
Presión normal	102(7.0) 700	200(13.6) 1360
Modelo	P375SD	VHP 260
Compresor y Actuacion		
Tipo de compresor	Single Sta Avis Mono étage Einstufige Shraube	ge Screw Monostadio a Ve Tornillo una Eta
Caudal de aire libre cfm, ( $m^3$ min), [ $1/s$ ]	375(10.5) [177]	260(7.38) [123]
Presión de trabajo psig, (bar), [KPa]	102(7.0) [700]	200(13.6) [1360
Presión máxima psig, (bar), [KPa]	114(7.9) [790]	210(14.4) [1440]
Salidas de aire	3 x R ¾"	1 x R1%"
emp. ambiente para operación al nivel del mar	- 23°C to 52°C	-23°C to 46°C
Datos del Motor		
Tipo	Deutz	Deutz
Modelo	F6L912	BF6L913
Número de cilindros	6	6
Velocidad normal R.P.M.	2500	2400
BHP/KW disponible a velocidad normal	112/83	143/107
ocidad sin carga (en vacio) RPM	1400	1400
apacidad tanque combustible Gal. Imp./(Litro)	36(163)	36(163)

# INGERSOLL-RAND



Reprinted from Compressed Air Copyright # 1981.

Higher pressure air provides significant boost in rock drill rates.

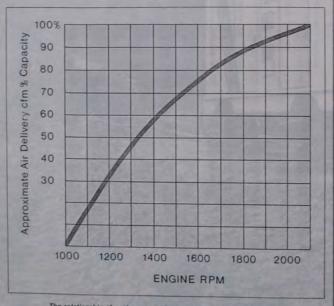
Problem: You have been producing rock for years with the same drill and compressor, which have given few problems and have been very reliable. You might have forgotten them except for the weekly paychecks to the driller and the monthly charges from your powder company.

You have a problem and probably don't realize it.

How would you like to reduce overtime paid to the driller, reduce the number of days of drilling, possibly decrease the cost of bits and steel per toot of hole drilled, and generally increase the overall productivity of your quarry?

Solution: The answer is "pressure." First, you must establish what production you have now and under what conditions. Observe on your drill and compressor while the driller is putting in a typical hole:

- A. Engine rpm while drilling.
- B. Pressure at the compressor.
- C. Time required for one hole: i.e., from the time the bit first touches rock to the time the bit is no longer going down. Add to this the times required to remove the bit



The relationship of engine rpm to the air delivered by the compressor.

from the hole and for the driller to set up on the next hole. With these three items of data, the following parameters can be established.

- 1. Engine rpm is a direct relationship to the compressed air delivered by the compressor. The graph may be used to determine the approximate percent of full-load cfm output for rotary (screw or vane) units. Most applications are probably 100 percent. However, if the engine is running at less than full-load rpm, then the com pressor is not putting out its rated capacity. (Note that the compressor will only deliver the air [cfm] used by the drill plus air leakage, etc.) Determine the approximate cfm output. This is the cfm consumed by the air system or drill.
- Pressure at the compressor. Sounds easy, but look out for broken gauges. It would not hurt to check the accuracy of the gauge because pressure is critical to your productivity. Also, determine where pressure is measured by the gauge on your compressor.

Take the pressure reading you get and deduct 5 ps/ if pressure is measured prior to the separator element on rotary units. This can easily be determined because, if pressure gauge connection is on the large separator tank, it measures before oil separation. If the connection is on the discharge line that goes directly to the air hose, it is after oil separation and do not deduct 5 psi.

Deduct 15 psi for an approximation of the pressure loss through the rock drill—lubrication, hoses, valves, etc. prior to the hammer or drifter. (Note: If you have a needle gauge and can get

mentading at the inlet (gooseat undrifter, you can more accunetenine this pressure loss.) al assure number you have is regilation of the air pressure on men ammer).

takene time required to drill one tota s described) and divide the Hap of the hole (feet) by this Imeninutes). This number repuses actual penetration for averminute of operation using menlume (Step 1) and pressure (Ste 2) available. Then take the the for period of the second ditions plus bit removal second diting diting diting diting ditions plus bit removal second ditin tota me (bit penetration plus the page the pa The same base of the cole and the same base of the same b the appeal is the ope tion.

CNU4 YM

0.00

TOTAT

stehter te

W free boot es

+ 57 15 00 kmg

di lo nu he

enove fre bit.

Ame

a company of the second And States and Street and state P. Start Street with sweeting for With the second

12 Quiterand

The any and the set of the may clarify this method. The property had a 600-cfm comportageziduarson dling a 40-foot-deep hole with with a property of sels. The compressor enthe plants is ming at 2100 rpm. The com-The Month for pauge reads 100 psi Iterotetranges a ge connection is to the large tableting better atorank. Time required to drill that addition of a 40 minutes, including 1 mintest Materia ran steel change. This is minutes of actual drilling the driller takes 5 minutes ward liberate loust the hole and 2 minutes to

the concerned by the stratem ut If you have a drifter with 80 psig A Reservice of 200 feet hour Senter Malalin Massiminute and you want to know imate actual penetration to expect le and tradition anti-pressure is raised to 110 psig. Go setterminut, cur at 110 psig and read plus 55 perhas point incase in penetration. Multiply 200 all nes 1.55, or 310 feet per hour. air nes 1.55, or 310 feet per hour. not see the overall penetration. (For drifters with pressures dif-100 psig). If you have a drifter with to be petrating the rest Settating the rock at a rate of 200 dur 3.3 inches/minute and you want at 3.3 inches/ minute and you want at approximate actual penetration to Ga to the curve at 90 psig and read plus the curve at 90 psig and read plus Go to the curve at 90 psig and read plus Control of the curve at 90 psig at 100 psig Control of the curve at 90 psig at 100 psig Control of the curve at 90 psig at 100 psig Control of the curve at 90 psig at 100 psig Control of the curve at 90 psig at 100 psig Control of the curve at 90 psig at 100 psig Control of the curve at 90 psig at 100 psig Control of the curve at 90 psig at 100 psig at 100 psig Control of the curve at 90 psig at 100 All 10 psig. Multiply 200 feet hour and divide by 1.17. 200 X and divide by 1. = 265 feet/hour. = 265 feet/hour. Adjust this existence of the state of th reposition the drill for the next hole. 1. Assume the compressor is putting

- out 600 cfm. 2. Estimate the pressure at the
  - hammer: Compressor gauge pressure:

hammer =

100 psig Deduct pressure drop: Separator element -5 psig Hoses and fittings -15 Pressure at the

80 psig 3. Estimate actual drill rate.

Feet drilled: 40 feet Time: 37 minutes

# Therefore, actual drill rate

= 1.08 feet/min or 65 feet/hour Now, you want to estimate your actual drill rate with higher pressure air. Consider a portable compressor that would hold 125 psig (measured after the separator) at the compressor and estimate the actual drill rate.

- 1. Compressor gauge pressure (measured after the separator element); 125 psig Deduct pressure drop through hoses and fittings -15 Pressure at the 110 psig hammer = 2. Estimate actual drill rate:
- Percent increase in penetration at 110 psig = 55 percent

(Fre Increa 55 ; 65 1 101 or 1 3. Time r

hole 40 fe 1.68 feet.

= Therefore would occur

drilled. Tat would have With the

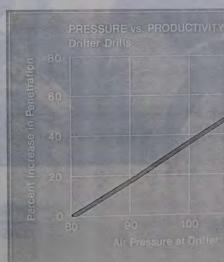
(51 and 71 the advanta two ways: creased op

Increase pattern and per foot of I creased roo in your mar

Pattern 7 X

(63 ft<sup>3</sup> per f X 20° fe /27 ft3/y

Difference betwe This is a rock for ev



drill 10 hours a day for 5 days a week, you will get 5250 tons more with 125psig air than with 100-psig air. If the rock is sold for \$2 per ton, you will increase your revenues by \$10,500 a week (\$42,000 per month or \$504,000 per year and so on.)

Decrease operating cost. Assume that you only want to produce a certain tonnage of rock per year—4,000,000 tons.

Actual: 4,000,000 tons.

## (4,000,000 tons × 27 ft3/yd3)

/(2.25 tons/yd<sup>3</sup> × 51 feet/hour × 63 ft<sup>3</sup> per foot of hole drilled) = 1494 hours drilling

Projected: 4,000,000 tons.

4,000,000 × 27

2.25 × 71 × 63

= 1073 hours of drilling Difference: 1494 - 1073 = 421 hours

Time-saving using 125 psig is 421 hours of drilling. If 1 hour of the operator is valued at \$20/hour, the savings

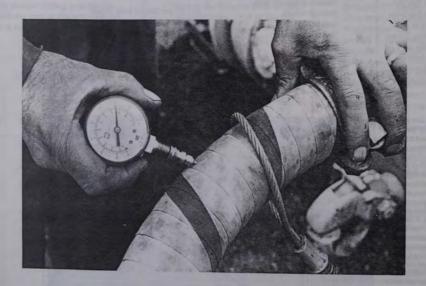
# TABLE 1. EFFECT OF HIGHER PRESSURE AIR ON PRODUCTIVITY

	Actual at 100 psig	Projected at 125 psig
Drill rate	65 feet/hour	101 feet/hour
	Or 1.08 feet/ minute	1.68 feet/minute
Time to drill 40-foot hole	37 minutes	24 minutes
Add time for steel change	3 minutes	3 minutes
Add time for steel removal from hole	5 minutes	5 minutes
Add time to reposition drill	2 minutes	2 minutes
Total time to drill hole	47 minutes	34 minutes
Overall drill rate	= 0.85	40 feet = 1,18
	47 minutes feet/minute	34 minutes feet/minute
Or	51 feet/hour	71 feet/hour
The second and the second		20 feet/hour increase overall

per year would be \$8420 or for 10 years, \$84,200. The money involved is considerable, especially in the long term. You should get the numbers for your rock-drilling operation, crank out the results, and you will believe that "pressure is productivity." □

-William L. Bishop

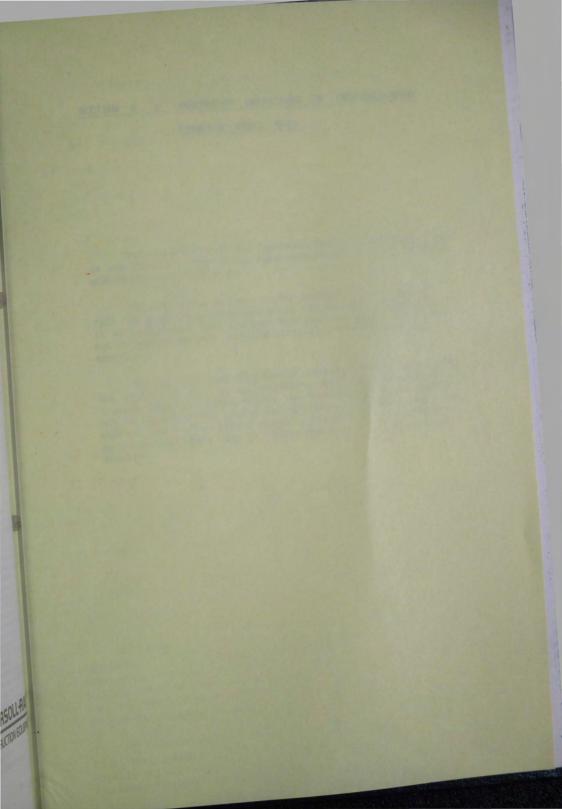
WILLIAM L. BISHOP is manager of sales support, Portable Compressor Division, Ingersoll-Rand Company, Mocksville, North Carolina.



Ingersoll-Rand Company Portable Compressor Division Mocksville, North Carolina 27028

Form 2047 Printed in U.S.A.







# SECTION 4 : UNDERWATER OPERATIONS OF INGERSOLL-RAND

# CRAWLAIR DRILL RIGS

The versatility of the Ingersoll-Rand Crawlair drill rigs is unsurpassed. One of the many uses of the rigs has been for underwater blasthole work.

The particular project in the Tokelau Islands does not call for completely submerged drill rig operation. However, it is recommended that the modifications mentioned be carried out to ensure maximum drilling efficiency and trouble free operation.

Attached are reproductions of several articles describing the ability of our rigs on underwater drilling. The lesson learned from these applications has been that drillers should not be deterred from trying the different or unusual when a job, such as the Tokelan Island project, requires a novel approach. As invariably these lead to faster and more efficient project results.

In order to avoid monthly individual bales to resurfaces for each schemat or over a snuction, it is yeememonded that all these house is connected to a monitolic with a single hase of at these is dimension which is then tun to the surface. At the sources, the single house run to the surface, by some type of finate.

then be brought invalidity to the sortions when had set then be brought invalidity to the sortions when had be tuelly drilling. All lubrication faringer around he well

# SECTION A & UNDERWATER DECRATIONS OF TREEPENTLE-TEAM

### CRAMALE ORILL RILL

The versatility of the Ingermall-Need (remains define tige is unsurpassed. One of the many uses of the rige has been for endermaler blacthole work.

The particular project in the feesial interest and call for completely submarged drill rig operation. However, it is recommended that has modifications mentioned be carried out to onsure meximum drilling efficiency and trankle from

Attached are reproductions of semininal at the leason the ability of our sigs on undername emiliary, the leason learned from these applications has been thild; the issued not be deterned from trying the different or unusual shen a job not be deterned from trying the different or unusual shen a job not be deterned from trying the different or unusual shen a job set at the foldular lease of different or unusual specific terms is a novel approach. As it would be the folder of a faster and sore efficient project and the

# RECOMMENDED CRAWLAIR MODIFICATIONS FOR UNDERWATER OPERATIONS

- 1) Air supply pressure to be 125 psig
- 2) Drifter
  - a) Exhaust to be piped to surface.
  - b) Drifter to be cycling at part throttle before submerging. Do not shut off under water.
  - c) After underwater operation, the main air hose should be disconnected at the drifter, rock drill oil poured in, and the piston cycled for a brief time to ensure oil coating on all internal surfaces.
- 3) Remote Manifold exhaust elbows to be piped to surface
- 4) Feed Motor air bleed exhaust elbows to be piped to surface
- 5) Hydraulic Pump Air Motor pipe both exhaust elbows to surface
- 6) .Hydraulic Tank vent cap to be piped to surface
- 7) Propelling Motors
  - a) Vent caps to be piped to surface.b) Exhausts to be piped to surface.
- Propelling Control Valves exhaust elbows to be piped to surface
- 9) Lubricator nozzles to be adjusted for greater oil flow than normal

In order to avoid running individual holes to the surfaces for each exhaust or vent connection, it is recommended that all these hoses be connected to a manifold with a single hose of at least 3" diameter which is then run to the surface. At the surface, the single hose could be supported by some type of float.

The Crawlair would be submerged for drilling, but then be brought immediately to the surface when not actually drilling. All lubrication fittings should be well greased between drilling shifts.

# RECOMMENDED CRAMEATR MODIFICATIONS FOR UNDERNATER OFTRATIONS

# () Air supply - pressure to be 125 paig

- 2) Drifter -
- i) Exhaust to be piped to surface.
- brifter to be cycling at part unrottle balons submarging. Do not shut off under water.
- c) After underwater open at the differ, rock should be disconnected at the differ, rock drill oil poured in, and the piston cycled for a brief time to ensure oil costing on all internal surfaces.
  - 1) Remote Manifold exhaust albows to be piped to surface
  - 4) Feed Motor air bleed exhaust albows to be piped
- 5) Hydraulic Pump Air Notor pipe both exhaust ero
  - indramite Tank vent cap to be piped to suitas
    - 7) Propelling Motors -
    - a) Vent caps to be piped to surface.
  - B) Propelling Control Valves schaust elbows to be piped to surface
- 9) Labrigator nozzles to be adjusted for greater 312

In order to avoid running individual hores to day surfaces for each exhaust or vent connection, it is recnommended that all these hoses be connected to a manifold with a single hose of at least 3" diameter which is then run to the surface. At the surface, the single hose could be supported by some type of float.

The Crawlair would be submerged for di di not acthen be brought immadiately to the surface when not actually drilling. All lubrication fittings should be well tually drilling shifts.

Land crawler drill plunges into the briney waters of Amlwch Harbor for another underwater drilling shift. The Ingersoll-Rand land drill required only minor initial modifications and a few changes in maintenance procedures to handle this task of subaqueous drilling. Shown in picture at bottom right, partially submerged crawler is steered by diver into operating position. Below, diver-driller goes underwater with his rig.





Portable compressor, an Ingersoll-Rand 600-cfm Gyro-Flo, supplied air for submerged rig. The top of the drill tower can be seen protruding from the water at the left.

# LAND DRILL RIG GOES UNDERWATER

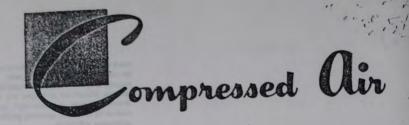
An unusual approach to harbor deepening has proved to be fast and efficient

Crawler drills, like most land construction equipment, have rarely been used in marine environments; it may never have occurred to most drillers to take a standard rock drill into water for submerged blasthole work, particularly in corrosive salt water. However, with the year-long success of a land crawler drill working in sea water off the coast of North Wales, a new dimension in equipment versatility has been demonstrated.

Working in the rough shallows of Amlwch Harbor on the Welsh island of Anglesey, a pneumatic crawler rig has drilled the shot holes for blasting more than 12,000 cubic yards of harbor bottom for North Sea oil shipping facilities in its first 5 months. Apart from minor modifications and a few special maintenance steps, no special preparations were necessary, and no major problems were encountered in drilling.

It is difficult and generally inefficient to drill underwater blastholes in waters too shallow and rough for pontoon vessels to negotiate. Hand drills operated by divers can handle enough shot-hole work for blasting 40 to 50 cubic yards per day of harbor bottom, according to Precision Blasting, Ltd., the British contractor on the Anglesey job. However, by minor adaptions to a conventional self-propelled crawler drill—in this case, an Ingersoll-Rand CM150A Crawlair unit—plus certain special maintenance precautions, the firm averaged five times as much drilling as possible manually, to permit blasting 250 cubic yards daily. On the best days, Precision Blasting managed as much as eight times more blasting volume than manual drilling, for 400 cubic yards per day removal of silt and rocky scafloor.

Amlwch Harbor is little more than a cove in Anglesey's windy north coast, only 650 feet wide at its mouth and poking 1200 feet into the cliff-studded shoreline. In the eighteenth century, it was a bustling shipping center for small vessels loading ore from nearby copper mines. More recently, with mines exhausted, the only traffic in the harbor has been fishing smacks and, once in a while, launches boarding pilots for ships inward-bound for Liverpool.



## **MARCH 1976**



Underwater drilling to deepen Wales' Amlwch Harbor involved a special, yet simple, adaptation to a standard land rig, enabling it to effectively bore shot holes in water depths less than 15 feet. A diver sets up the business end of the air-powered rig prior to actual drilling. The novel approach to shallow-water drilling proved better than pontoon vessels or manual methods. See page 6.

- Land Drill Rig Goes Underwater Minor modifications convert crawler for submerged blastholes
- 10 Metrics—A Voluntary Conversion—Malcolm E. O'Hagan "We must convert in a way that makes sense for the future"
- 13 Air Power For The Hospital—H. L. Miller Air and vacuum wali "outlets" serve 446-bed complex
- 14 Controlling The Apes England's Bristol Zoo uses pneumatic door operators in its ape house

### DEPARTMENTS

6

- 15 This & That
- 17 Editorial--On Compressor Noise
- 18 Technotes
- 32 Index To Advertisers

### A REVIEW OF THE CAPABILITIES AND ECONOMIES OF AIR AND GASES

C. J. Rockwell, Publisher

- S. M. Parkhill, Editor
- T. M. Jones, Assistant Editor
- C. H. Vivian, Contributing Editor
- J. G. Wilcox, Art Director
- G. D. Meixel,

Product and And Made and - and

- Washington Correspondent F. J. Bellamy, Great Britain
  - Bowater House 114 Knightsbridge London SW1X 7LU
- J. Leman, France Techniques de l'Air Comprime Avenue Albert Einstein Zone Industrielle 78190 Trappes
- Andrea Lenotti, Italy Tecnica dell'Aria Compressa Strada Provinciale Cassanese Vignate-Milano
- M. T. Lane, Canada 620 Cathcart Street Montreal 111, Quebec

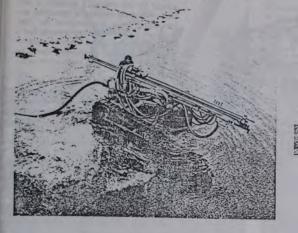
### Volume 81 Number 3

In the United States-Call 201-859-2770



Editorial, advertising, and publication offices: 253 East Washington Avenue, Washington, New Jersey 07882. Copyright © 1976 by Com-

persol-Rand Company. Al rights reserved. Annual substription United States and possessions. Set: treeing, 150. Single cogies, domestic 50.75, toreign 50.95. Compressed Ak is indexed in Applied Science and Technology Index, Engineering Index, and Science Otation Index. Microfilm volumes (1940 to date) are available from University Microfilms, Inc. Compressed Ak's bajoutation dimotify by Compressed Ak Magazine Company (a division of Ingersol-Rand). Dritting rig enters water in different ways, depending on the conditions. Close to shore, it moves into position as it would on land. Farther out, barge-mounted derrick was used to place Ingersoll-Rand Grawlair machine on harbor bottom. Mounted on this 400-ton barge was 600-cfm portable Gyro-Flo compressor to supply air tor dritting.



View from shoals is of diver moving the Crawlai: drill into position.



# LAND DRILL

it is operating. At Amlwch, the divers needed a bull hose of 180 feet, three times the usual length. Air power to the drill was further tapped by water pressure. "You have about 20-psi water pressure at a 40-foot depth underwater," explains Duff. "Having lost 20 psi to friction, you lose another 20 psi to the water pressure. A pressure of 120 psig coming from the compressor ends up at about 80 psig."

To compensate, Duff attached a 40-foot hose to the harmer exhaust. As soon as the harmer started, air pressure drove the hose to the surface. Exhausting the harmmer at the surface equalized surface and underwater pressures, cancelling the depth's influence.

Since the hose also eliminated one source of bubbles that annoyed the divers, Duff proceeded to eliminate the others, attaching hoses to the two air motors powering the tracks, the motor driving the hydraulics powering the bottom system, and to the exhaust from the main dritter feed. Finally, one more hose led from the hydraulics breather—a necessity. This one had to stay clear of the water altogether. It was tied to a free-floating buoy, which in turn followed the rig around as it drove back and forth on the seabed.

Work in earnest started in June 1974. The drillers grew so accustomed to their submarine working habitat that, visibility regardless, they routinely changed drill steels and performed other minor operating adjustments underwater. One suggestion by fascinated government industrial safety inspectors on the site produced a further 3-foot modification of the controls at the back of the rig. The inspectors were worried that, in the close underwater visibility, a diver tracking the rig might turn it upside down on an unseen obstruction, trapping himself underneath. The extension meant the divers had to walk behind the rig instead of riding on the platform provided, theoretically with more time to get out of the way. (In practice, say the divers, it is safer to stand on the rig because any "untoward movement" of the machine can then be felt at once. If the rig is about to topple, the diver can easily float out of the way. Everything underwater happens in slow motion.)

The salt water itself forced a last modification. The divers found they were habitually having to tighten bolts on the rig when it came out of the water. It turned out that the sea was acting as a penetrating oil, loosening everything. All bolts were then either wired tight or secured with a nonsetting gasket cement.

Five months after it started work in 8hour shifts on the bottom of the harbor, the Crawlair had enabled 12,000 cubic meters of seabed to be blasted, 50 percent of it rock. Weather seldom inhibited the rig, which performed routinely in 30-mph winds and, as expected, tides had no effect. High winds and heavy swells did, however, hinder support to the drill from the surface, occasionally forcing a halt.

The working procedure goes thusly. To submerge the rig, a diver either drives it down a beach and walks underwater with it or hoists it overboard from an NCK 605 crane on a 400-ton steel pontoon stationed in the harbor. One diver at a time works underwater, wearing a standard dry suit and full face mask, with a single hose, two-stage regulator, and 30 pounds of belt lead. He is linked by 300 feet of air hose to two 180-cubic-foot air bottles on the pontoon, where a second diver is standing



Starting this year, however, Shell supertankers will unload oil at a single-buoy mooring 2 miles offshore. The site was chosen both as port for a fleet of tenders needed to service the tankers and as the point at which the oil pipeline will come ashore before running overland 80 miles to a Shell refinery at Stanlow in Cheshire, Wales. Precision Blasting, a subsidiary of England's Northern Rockdrillers, Ltd., was hired for the challenging drilling assignment to prepare for extensive harbor deepening required by the tanker mooring. Breakwater, piers, and spending beaches were required along with moorings for tunker tenders.

The deepening called for drilling 4inch-diameter blastholes 20 feet deep along a 10-foot grid interval over 3500 square yards of harbor bottom to permit blasting to 30-foot depths in schist, Along with the saltwater environment, drilling was complicated by water depths under 15 feet, too shallow for pontoons to negotiate. The shoreline at points rises 50 feet, further complicating pontoon maneuvering. Then too, the harbor is subjected to stiff Irish Sea winds from the northeast and heavy tides, known to rise 25 feet, and as rapidly as 5 feet in an hour.

Accepting the unusually challenging drilling subcontract from general contractor John Howard (Northern) Ltd., Precision Blasting's first decision was to train four drillers to operate underwater with the skills of a diver, on the theory that no

diver could be trained as quickly to duplicate an experienced driller's skills. Next, Precision Blasting's Jack Duff- looked around for the concept's linchpin, a sufface drilling rig capable of operating underwater. None are designed for that purpose. However, the firm already had a stock of Ingersoll-Rand Crawlair mountings. When Duff's divers were ready, he gave them one and sent them underwater to try it out.

The Crawlair rig drills vertical and angular primary blastholes in hard and abrasive rock. It travels on two five-roller tracks, each governed by an independent 7-hp motor, and is equipped with 10-inchwide stability grousers.

The rig carries a hydraulically powered boom and drill guide to support and position a 4¼-inch URD475 hammer drill. The rig requires a portable compressor to supply operating air for the track motors, the hydraulics, the universal drill rotation, and the hammer itself. The compressor used is a portable DR600 Gyro-Flo. It is a two-stage machine, manufactured by Ingersoll-Rand Company and rated for 100-psig operating pressure at 600 cfm.

There was never much question of a hydraulically operated rig being used. Duff says that "with a hydraulic rig, you need a tube for every operation: one hydraulic pipe and a return for each hydraulic metor----up to four for each track, about 25 in the end; and then, you have air lock problems. You only need one tube with compressed air."

A hydraulic rig could have been used, he says, if the power pack were powered from the surface by compressed air, but standard compressed air equipment simply required far fewer modifications. Even water seeping into a compressed air motor presented no difficulties. It is blasted out when the motor starts.

Duff favored the rig he used because it is easy to set up and move around. No pins had to be removed, for example, nor do the cylinders have to be disconnected and reconnected when the guide is swung from horizontal to vertical.

The Crawlair drill also offered a 14-mm flush tube inducting air through the hammer into the drill steel, twice as large as offered by some similar equipment. Duff considered this a key benefit. He also liked the penetration rate. Once the rig was modified, Duff worked it continuously at 120-psig pressure.

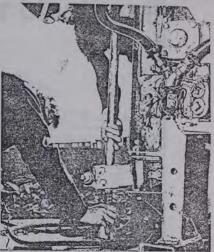
With first trials underwater, the divers found their problems lay with visibility and pressure loss. Much of the bottom of Amlwch Harbor is silt (Amlwch, in the Welsh language, means dust) and visibility ranged from difficult to none at all, forcing the men to work by touch. Every air-operated function in the crawler rig has to exhaust; the air bubble emission rendered even good visibility hopeless.

A certain amount of air pressure is always lost to friction as compressed air travels through a bull-hose link to the tool



Diver on ocean floor (left and on cover) gets set to sink first of daily series of blastholes. Rubber hose to lead drift's compressed air exhaust bubbles out of diver's way was one modification required to adapt I-R drill rig for submarine work.

Drillers (below) fit 4%-inch bit to URD475 hammer drill prior to starting day's work.



. They are in constant telephone cont. If there is any chance of air hoses oming entangled with the rig in the see working quarters, the divers put on uba air bottles.

The first diver drives the rig along the affoor to the approximate drilling site. It is second diver watches the location of is air bubbles from the pontoon. Since shot holes have to be sunk at a strict -foot grid interval across 3500 square rds of harbor bottom, white stripes inted on cliffs flanking the harbor were ed to locate the grid. To line up the ill precisely on shot-hole target, the ill precisely on shot-hole target, the wer on the pontoon sights the surfacing bbles against the painted markers and ues maneuvering directions over the iephone.

Shot holes are drilled up to 20 feet deep. aving drilled one, the diver moves the rig feet in a straight line and sinks the st. Air flush combines with the water pssure for highly efficient scouring, oles are either cased or charged immediely after drilling to keep them from reling. The diameter of the average bore 1 this job is 4 inches.

Blast danger to a fragile eighteenthcentury pier and some stretches of ancient wall on the harbor perimeter, both regarded as historic relics, has required charges to be fired with electric millisecond-delay detonators. Early tests with Vibrograph readings showed maximum risk tolerance by the relics of 120 pounds of explosive. To accommodate this limitation, only ten holes or so are detonated at a time, each with an average 15-pound charge. The diver uses salmon floats to keep detonator leads in sight while he is setting the charges, fastening them 2 or 3 feet above the hole.

If the pontoon were used for any of the drilling, it would have to be withdrawn 200 yards from a blast to avoid damage. This maneuver means casing and winching four steel cables, probably in unfavorable weather. It means a tug standing by to help. In toto, it would be a tedious, timeconsuming operation. The Crawlair rig on the bottom is not subject to any risks, there being no flotation seams, as on the pontoon, to spring. When a diver has prepared a detonation, he simply backs the rig 10 feet from the nearest shot hole and goes back to the pontoon, leaving the rig on the bottom.

At the end of an 8-hour day, the Crawlair rig is driven or hoisted out of the water. Fitters then operate all motors at full-cock, discharging sea water instantaneously. It has been found advisable to change the hydraulic oil and strip the pneumatic hammer more frequently than would be required in surface work, however this is done as "an ounce of prevention." Otherwise, the only special maintenance found necessary has been a daily, thorough wiping down of the whole rig with oil to protect it against corrosion. So far, a spot of rust on the chrome of the rig's hydraulic boom chamber marks its only concession to its 9 months in salt water. (The rig was 8 years old when it went to work on this assignment.)

Perhaps the ultimate lesson learned from the Amlwch Harbor drilling experience is that drillers should not be deterred from trying the different or the unusual when a job requires a novel approach. Precision Blasting did, and the results made the harbor deepening job far faster and more efficient as a result.

conversation has trained as sensitive data and outer and competitioned encourses adding to the production Brancing's Juris Disjon has been assured for the competitive discontainers on large drilling rig complete and conversion for the sensitive discontainers of the competitive discontainers of the

compressed and."

A hydrodic rig order have been present he man, if the annue park were present from Do. coffeet to compressed and the standard tooppensed out symposed doors a manual the fewer modulizations. But

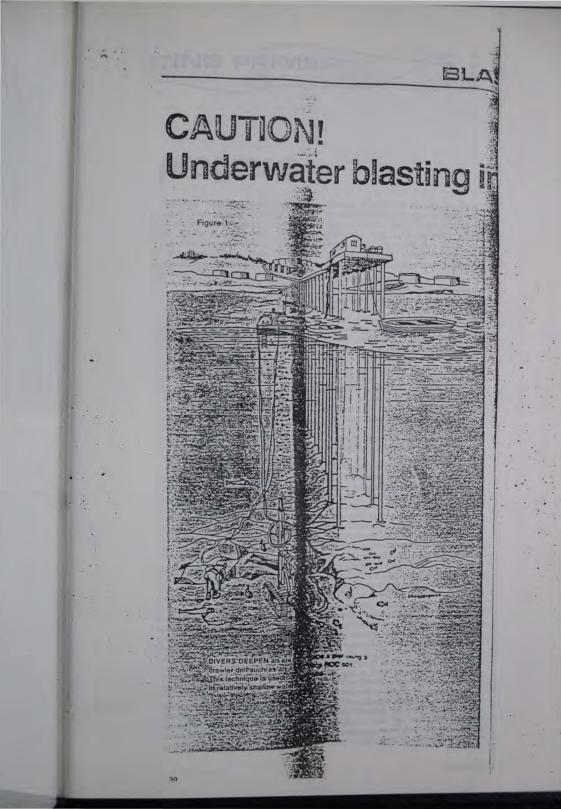
An internal de sectores a construir en la construir de la construir de sectores de sectores de sectores de sectores de la construir de sectores de

of doubter of a deep, and the flowing time and threads through a half have live to the

press tatch in the problem, forward the sign and

And the root at no scheme day, the foundation of the form of behavior and the measure. Forces there are behavior and the fails core, distribution preserve all motions are measure. Its form former streams are measure expensive for any scheme for any the measure the large root of a surface share would be required in an surface work, how others." Otherwise, the any special main-

The Property called for defining &



# CAUTION! Underwater blasting

progress

TING

Blasting requires considerable caution and expertise under the best of conditions. But when the work is to be conducted underwater, there is an additional hazard to life and limb. Nevertheless, methods and procedures have been developed to handle such operations in a safe and cfficient manner.

### by Björn Kihlström

THE TREND toward larger ships, particularly in tankers and bulk carriers, has increased the demand for deeper harbors and ship channels all over the world. And because channel and harbor floors often consist of hard rock, the deepening has to be performed by blasting.

Oil and gas pipelines from offshore terminals need protection from the elements, and underwater trenches offer one way of protecting them. And here again underwater blasting may be necessary.

Often, blasting has to be carried out close to sensitive structures and installations so that blasting operations must be carefully controlled. The vibration hazard is more severe underwater and shock waves more readily transmitted. In short, careful calculation is required to determine the size of the round and the most appropriate blasting method to use.

There are three principal methods for performing underwater blasting: (1) By having divers do the drilling with hand-held rock drills or with crawler drill equipment on the seabed. The divers would also do the charging. (2) By drilling and charging operations carried out from the surface, either from a floating raft, or from a platform on legs or spuds. The latter eliminates the effects of the tides, waves, and currents. (3) By placing suitable amounts of explosives in a quadratic pattern on the

Björn Kihlström is chief consultant with Nitro Consult AB of Stockholm and has an international reputation for solving delicate underwater blasting problems. surface of the rock on the sca floor. Concentrated chargings without any specific form, but in good contact with the rock, may be used. However, when the rock has to be removed to a depth of several meters a special type of charge must be used.

# When to use divers

The first method is economically practicable only in small-scale operations and at modest depths. However, divers have worked at depths exceeding 200 m for short periods, when saturated diving equipment and a pressure chamber were available.

The comparatively small diameter of the drill holes put down in this fashion result in correspondingly small amounts of explosive being placed. The small cooperating charge reduces ground vibrations and water shock waves and is suitable for cautious blasting close to sensitive construction. (See Figure 1.)

### Rafts and platforms

The second method is probably the most commonly used in underwater blasting for harbor deepening, channel clearance, and pipeline trenching. The drilling is performed from a raft or platform on the surface. The type of platform used depends on the conditions at the site. In narrow canals and those having considerable boating traffic, it may be difficult to use a floating raft or an elevated platform with all its wires and anchors.

The drilling is carried out with equipment adapted to the overburden. Guide tubes are used for the overburden part to steer the drill steel during collaring and to keep the hole open for charging. Prefabricated cardboard pipe charges having a diameter of more than 50 mm and a length of more than 600 mm are used.

The Overburden Drilling Method developed in Sweden for underwater drilling from a platform, is a further development of the guide tube method. (See Figure 2.) The drilling equipment consists of an outer casing tube with a ring bit of cemented car-

# progress

Binning requires consideration resultion and expertise under the heart of conditions, But when the works is to be foundarted underthe life and instabilizonal based on the data and presentation has been been developed to handle and afficient attions in a surfa and afficient

### Included miles yo

The relative barrand target along and ciclarity in targets and built converting, that increased the threased its despertion of the threased the threased its threased. And because statutes and the protack, the despering has to be partored by blasting.

Oil and gas superiors from others the architecture and protection from the elements, and underweiger trendus offer ans only of protecting from And here agains and may be measurer.

out close to availage has a be corried out close to available attractions and localizations so this biosticity queations must be carcefully controlled underwater and alack serves arows calculation is required to determine calculation is required to determine transmitted for avoid the must

There are three priorigal methods for performing underwater blacking (1) By having divers do the drilling with hand-hald track drills or with termine, the drilling and charging termines. (2) By drilling and charging president derrived out from the unthese, either from a floating roll, or factor a partierra on logge as agonds. The latter eliminates the affords of the fides, waves, and currents (3) By placing particular an the start on the place principal and partners on the

Bistern Kinhelteben is chief consultered with her environment AR of Stockholme ber antering datasette underworder Mande for antering datasette underworder Mande

Amountyrated chargenets with the most preside from, but in good contact, which she reak, may be quest linear moves when the nock has to be removers the stephe of several moving a protect to a stephe of charge search be used.

### stanp con or usual

The Birth Artis Antonia In accessmentally predicted and a firm and branch approxlations and at meshan deputts. Howwere, divers have proximal at deputs article 200 in fire short perfects when animated diving equipment and a pression diving equipment.

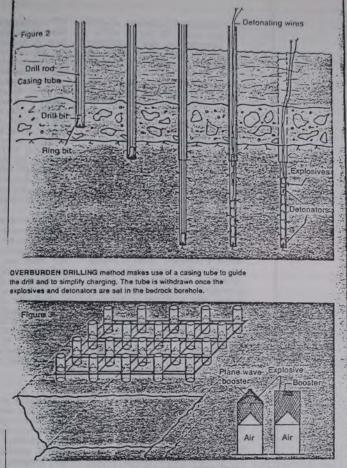
The comparatively sensit discounter of the diffit halos per down in this institute result in correspondingly relative result in correspondingly placed. The small singer sting change which waves and is suitable for ease these blacking clean to placelible senthraction. (Sime Figure 3.)

### granolicity and platforms

The neerest outcould is probably the must commonly used in tunderworker bilasting for barbor descouring, attantion defines and plophing transmission or platform as the turburs. The appedifferent we the turburs of the owndifferent with dispendix in the comdifferent with the state would append and them having consistential lowleing and the user and statement.

The dolling is survived out with equipment adapted to the overburnism. Cache subse are used for the overborders part to stear the drill ball open for strarging and to beep the another of more than 50 mm and a light of theme then 50 mm and a light of theme then 90 mm and a

developed in because for undersumer defiling from a platform, is a further development of the guide tube method. (See Sigure 2.) The drilling caption into a ring bit of constant and results with a ring bit of constant,



SPECIAL CHARGES are set in a pattern stop the bedrock to blast out a trench. Note cone configuration which serves to force the energy of the explosion downward in each charge.

bide at the lower end, and an inner drill steel with a cross bit. In most cases the drilling is performed with only the casing tube equipped with a ring bit through the overburden and 30 to 50 cm down into the rock. The drilling through the rock down to the disired depth is performed with the inner drill steel with the cross bit. The casing tube remains in the hole and serves as a channel for charging. User charging operations are finished the use is removed.

Because of the hazard of drilling into a charged hole, a new hole should both drilled nearer than 2 m from an already charged one. When the hole Pacing is less than 2 m the whole ready-tilled round is loaded at the table time through plastic tubes with the same outside diameter as the drill bders. Gelatine explosives of the dynamite-type are used, either as prefabricated cardboard pipe charges or cartridges. By using pneumatic cartridge chargers it is possible to obtain the theoretical degree of packing. The charging procedure generally calls for two detonators with the same delay number—one at the bottom and one in the column charge. In deeper drill holes, three to four detonators may be necessary to prevent undetonated explosives from remaining in the round, thereby reducing the result of the blasting.

# Surface rock blasting

The third method is used when drilling is inconvenient or impossible. Usually, a thin layer of rock covers a very soft rock or sand or clay. In such cases, concentrated explosive charges are placed on the sea floor,

Orli nos

and the state of t

Children C

vezinarinteare prestava method molece une el a canteg tabe ta para a not and to security charging. The table is elibétasen anna line referènces and conventors aire net la fine bedrade bombrate.

Hertzell, 20 Merziel and aus in a period and in bodiest to find her a transfer test spins and generative works where to be beau the merzy of the anglishes formulated in a spin strategie.

> beite at the lower and, and an inner bird of the lower and, and an inner deal also withing its performed with only the anning table equipped with the same the anning table equipped with the second second and the second with the second second second second second bits and second second second second bits.

Berrares of the honored of different and a charged hole, a new hole should should be be being a series that a first should be been and the series of the bole been and the series of the should the series in the theory plantic tables with a set the strength plantic tables with a set the strength plantic tables with a set to a strength size of the state. Cale the strength size of the

dynamite-type are used, either as prelabilitiested continent dyn drocyn or cartridges the particular outridge theoretical dynamite hig. The drarging providers partiing. The drarging providers partibartes ally calls for two detenators with the areas delay number—case at the detenators and one in the column attarge the dependent and one in the column attarge the second particles and one in the column attarge the dependent and one in the column attarge the dependent and one in the column attarge the dependent of the solution attarge the dependent of the dependent particles and undefined applications have the descing the result of the Masting.

# Surface rock biasting

defailing three nections for importants, defailing a three severe of book nevers a very colt resce is send or also book to such sugget, contacturing explosive in a quadratic pattern. The months are seistant to water nsiderable period; it must sigh detonation velocity, and be in good contact with the erounds are usually initiated mneously by detonating fuse.

a deep trench is to be n homogenous rock, special ter explosive units should be achieve the desired deepnd fragmentation. These are usually metal or plastic d divided in two parts by a one with the tip pointing are the explosive is packed on the explosive is packed on the neath the cone is enclosed to water from entering the cylriee Figure 3.)

the explosive detonates, the al me is hurled toward the lon-I axis of the cylinder, therericting the explosive energy mrd into the sea floor. The ne charge explosive energy is so ar I that the rock can be crushed id th of approximately 5 m. The in epends on the magnitude of strges. These charges are genby sed for producing underwater all trenches or for clearing the for. Blasting by this method m, owever, cause serious ground r ins and water shock waves in s. roundings.

#### utus blasting

Pupint blasting is very common hun built-up areas and close to itg power stations and tunnels, erblasting can be carried out in y and where visibility is unneted. In underwater blasting weer, there are pressure probd visibility is generally lackis therefore important to find rerything possible about the ck:hrough preliminary investi-Lica, such as test drillings and isrc exploration. It is particularly incant to follow the drilling work varefully and to record all the aus in the rock, whether they are me, open, filled with clay, and so

F sured rock can result in flashrebetween adjacent drill holes indifferent delays. Because the cast of explosives being simulmusly initiated exceeds the calcuis, greater ground vibrations anock waves than anticipated will ful Flash-over often leads to the ribrations, inferior fragmen-, and a breakage of the rock the the calculated contour.

Chsequently, pinpoint blasting s blasting to keep the ground totions, the water shock waves, the breakage within permissible limits as determined by the site.

 The ground vibrations from an underwater blast can generally be calculated in the same way as for blasting elsewhere. The risk of flash-over in case of clay or water fissured rock stresses the importance of recording the observations made during drill work and taken into consideration during charging.

The only way to reduce the ground vibrations from underwater blastings is to reduce the cooperating charge. In the case of large rounds, the time needed for the vibrations to reach the vibration sensitive structures can cause interference and result in a lower vibration level than the cooperating charge alone should have caused. This can be effected through the performance of careful ground investigation and calculation.

• The underwater shock waves arise from the detonation of an explosive in water. The most powerful shock waves occur when the explosive is suspended free or lying uncovered on the sea floor. Explosives enclosed in drill holes give rise to considerably smaller shock waves than charges which are not enclosed. The enclosure and the breakage of the rock by the detonating explosive reduces the maximum pressure of the shock wave only 10 to 14% of the maximal pressure of a shock wave resulting from the detonation of an explosive hanging free in the water.

The maximum pressure of a shock wave can be reduced to a considerable extent by using an "air bubble curtain" in the water. The magnitude of the weakening effect depends upon the quantity of air released per second and per meter. However, the impulse of the shock wave is not moderated. The protective influence of the "air bubble curtain" system is therefore questionable, because even though the maximum pressure is reduced, the protection of the shock wave is longer. A transitory shock wave with a high pressure can cause less damage on a structure than a shock wave with low pressure but a long-term effect. The influence of the impulse on the construction can only be stopped by using a shield.

• To prevent breakage of rock beyond the limits prescribed is another important aspect of underwater blasting that calls for control as, for example, when deepening of waters close by a quay.

Smooth blasting can be carried out about the same way as by surface blasting, and even presplitting is possible.

Presplitting requires that certain precautions be observed. There is no burden to be blasted away, but the explosive gases are enclosed drill holes and the pres fissure. If the rock is fissure shock waves from the blastir through these fissures and ca ground vibrations differin those calculated. In most cas ever, the influence of the blas the surroundings can be kep control by careful obser during drilling and chargin ations, and by monitoring the vibrations and shock waves.

a quantizatic partners from an equilation of the second of a second of the second of the second of the second of the second area usually initiated

and by determining one. A data triving is to be a solution on the solution of the solution of the solution. These is a solution of the solution and the solution is contained to the solution is a solution and the solution is contained to the solution is a solution in the solution of the solution is contained to the solution of the solution is a solution of the solution is a solution and the solution is a solution of the solution of the solution is a solution of the solution of the solution is a solution of the solution of the solution is a solution of the solution of the solution is a solution of the solution of the solution is a solution of the solution

a sublative determines, the standard toward the lonext is surfact to explicitor, thereare the explicitor many and the explicitor many and the real of the toward to a all approximating in a The state producting under the there producting underweated being the real of the toward the producting underweated being by this control of the sector of the toward being the toward and toward and the sector of the toward being the toward and toward and the sector of the toward being the toward and toward and the sector of the toward being the toward and toward and the sector of the toward and toward toward about ways as in a sublage.

#### miteold-r

at bioming is very nonnon binit-up areas and close to arrow cashons and the duncain, and what weighting is upthe underwater biasting is bioming to generally lackestablicity is generally lackestablicity is generally lackmath a test defining and another preliminary investtors follow the duffing much is too follow the duffing much is too second aft to periodency in the second aft to periodency in the second aft to periodency in the second with the duffing much is too period with the duffing much

and tasks can result in finiteresearce adjustent dafit balantherent dataya. Bacanas the statistical exceeds the colouies of the state of the coloutransfer and exceeds the coloutransfer attack with the state of the state to be balance informations to be balance of the rock

New subsubited quartons: successfy, pinpaint blasting blasting to long the ground res. The water shock waves, basedong within permissible

finite as tapentions by the site. • The primal vibrations from an underwater blast on gamma way as for blasting absorbars. The risk of blasting absorbars. The risk of tash-over is can of they or water for coording the absorbariants made during drill work and calors into anondistriction driles drively.

The only way to reduce the ground with a loss from to descentary consider in a reduce the cooperating charge in the reduce the cooperating charge method for the vibrations to reach the the the characteristic and reach the second distribution and reach the obcention distribution and the second the obcention the three should be a operating charge along bland the obterior participation of arceled forced the participation and carely denoted provide the participation and carely denoted the section participation and carely denoted the second the second testication and carely denoted the second testication and carely denoted the second testication and the second testication and carely denoted the second testication and the second testication and the second testication and the second testication and tes

• The university shock waves think been the determined on the second distribution of a second distribution of the second distrebution of the second distrebution of the second distrebution of

The number preserve of a sheet ratio can be reduced by a country arbitrary in the reduced by a country in the statistic particle and "all bubble in quarks in the water. The manufacture account and per meters. The measure of anyone of the abbit meters is not account to the protection of the sheet therefore quastionable, because are based the maximum present of the sheet water of the protection of the account of the protection of the sheet wave with a bager. A transition protection the transition of the sheet wave with a bager. A transition probased wave with law pressure too back anyone and the same and back wave such a sheet result of the back anyone such a size of the back and the back anyone such a sis of the back and the bac

 To prevent breakage of rock beyond the limits preserviced is an other impartant separt of underwave blasting that calls for control as, for example, when despandog of matern despandog of

Broath Masting tus be carried out about the same way as by surface blashing, and even presplicing is manufile.

Presentations inquires that certain presentations be observed. There is no burdeen in by blanted away, but the

support and the provident of the property in drill holes and in dramod, the hardest the series in the model, the shocks waves from the bitaning is led through these factors and can save be a series of the influence of the bitaning is led the interaction of the bitaning is led the interaction of the bitaning is of the influence of the bitaning agent during and by carried observations during and by carried observations at a series of the bitaning agent agents and by a series of the bitaning agent at a series of the bitaning





di Journal

# FACTORS IN SUBSEA BLASTING

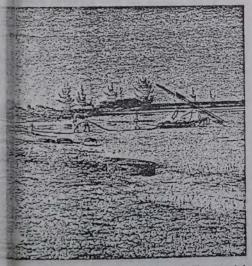
by Albert Teller

eller is president of the International Society of three Specialists. He is vice president of Explothereational, a blasting contracting and consulting socializing in underwater and demolition projects. In delivered technical papers on explosives at the id Engineering Conference, Trondheim, Norway, Society for Building and Construction in Hungary. Is society for Building and Construction in Hungary. Is and contracting work, he is a resident of Issatash. Teller is a member of the American Society Suty Engineers and holds a masters degree from University.

 J years of blasting, much of it underwater, it is ession that most blasters know little about diving
 st divers know little about blasting. There are dy few men who have specialized in underwater

is most axiomatic in the construction and dredging usies; when all else fails, use explosives. Never saless there simply is no other way out. When one users that there is more energy in one small stick of ste than in several dozen rippers or cuttherhead s, one wonders why this attitude is so prevalent.

ason is not too difficult to discover. Which ever theirst, the chicken or the egg - there is little use of trives because there are so few men really qualified, heally, to do the work.



Take site at Homestead, Fla., Navy demonstration presented problems, including a very steep shoreline. The drill operated freet of water without adaptors or changes.

Yet the technically sound application of explosives is not only economical but efficient.

First apparent costs may seem high, but on most projects, the overall cost of properly-applied use of explosives is much less than without their use - referring now not only to those projects where explosives must be used, but on projects where explosives could be used.

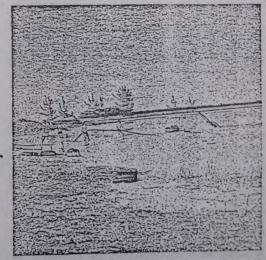
## **USED OR MISUSED?**

It is well to remember that on those projects where explosives must be used, too often they are misused or misapplied.

In 1961 on an island in the Pacific, hundreds of metal beams and dock supports were being eaten away by undersea growth and erosion due to weathering at the splash zone. The problem: devise a method of cleaning the pilings, place concrete at the splash zone and save the cost of replacing pilings and docks.

First, divers using wire brushes proved futile. Sand blasting, entailing the use of divers and compressors, attempting to get the blown sand on the piling whileholding fast against currents and waves - difficult and dangerous - proved unsuccessful. The next try was with explosives.

Ten pilings later, all blown over, damaged, with parts of the dock thrown in the air and other michaps, the project was abandoned.



Even with no equipment to lower the drill into the water the project proved successful and later was used in the Atlantic Ocean off the Azores to drill and blast a cable trench.

Continued on Page 7

# ACTORS IN SUBSEA BLASTING

by Albert Tollar

Inter la president of the leterantient Society of exceptionality, the is view possiblent of Exploterational, a biasting contracting and consulting automage, a biasting contracting and consulting automage automage and densitiated polecies between exception polecies and the consety for Building and Coostruction is therapy, and contracting and Coostruction is therapy, and contracting and Coostruction of Isseand contracting work, is is a resident of Issete Reflex is a member of the American Society of Patience and holds a master dense has been applied.

years of bisating, much of it anderwater, it in solve that most bisaters know little about diving b diverse beaw little about bisating. There are b few man who have apochalized in anderwater

real axiomatic in the construction and deviging real when all size infin, was exploring. Masses have there simply is no other way out. When are in first there is notes every in one small shiel of a first its average of provide the set of the set when its average why this attitude is an provider.

tion in not too difficult to discover, Which ever are the chicken or the east - there is hitle use of the binary there are no few men really evaluated, this, to do the work.

Sile at Horsested, Par, Herr demonstration presented tests, including any any strap stranger, for shift operated for units without abusing or observat.

Tel the technically scend signification of explosives in and only secondonical hot efficients

Prior apparent conta trace access high, but to cash protects, the aveilable could be priority-stepheness case and protectives in second least these without their second second second second to three pairs these without their second leve mean. Into the profective system contactives could be mark.

TORRUSIN SIG DESUSED?

It is well in remember that as these preteries where any station was a mark to mark, the effect they are minuted at

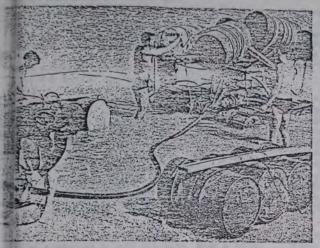
In 1991 on an inhered in the Partitle, hundrade of antal human and dock anyonits were being outer away by metamon provide and economics due to variabeling of the relative provident devices a second of should be pilling, plane concrete at the relative met and the desting of separation pillage and docts.

Privat, diverse unlarg when herabes, proved fully, thank formiting establishing one of diverse and compressions, whiempland to private the blower award to the stillar diverholding field excellent currents and versus - difficult and displayers, proved unnecessable. The agent by sear table explosives,

The pillage faller, all blown over, deringed, with parts of the dock thrown in the site and either minhage, the parject was abackined,

bene with no approach to to an the drill just the autor the propert movied transmitter and tatue wars word. In the Atlantic Dirage of the benew is with north that a match breach.

# A BLASTING - Cont. from Page 3



in iderwater drilling demonstration for the U.S. Navy, a three-ton Worthington drill line floated out and idwered gently into the water. The feat was accomplished with out of 55-gallon tanks tastened to the underwater tractor drill, then flooded.

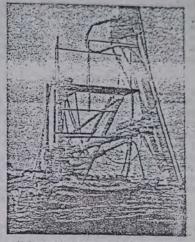
wippint, a research project was started at Honolulu. whites - Hawaii (now Explosives International, a h, Wash.) took on the study to see if the use of plives could sately remove the incrustation from as surfaces underwater. Results were "perfect rere complete safety."

#### SHOCK EFFECT

the rocess developed used the shock effect of detotion cord, carefully placed inside the web of the set. Every effort was made to avoid direct contact the tal, and to allow pressure and shock waves to do in the technique will clean hulls of ships and the incrustation from sea walls, metal caissons and tepipes. That the process could be developed is not telf astounding. What is astounding is that no one done it before, and even more is that no one does it of Our company has used the technique only on rare to ions. We have had little call for its application, is particular technique.

while basting river crossings, reefs, channels, and the ke is pretty much a cut and dried process. Once the the state of the state of the state of the state of the state field, and powder loaded through the drill stems or the casings. It is a tedious, laborious job, haphazard the standard method of drilling ablasting for any type of underwater project. It is

the most economical nor the safest. To the contrict is fairly dangerous, particularly if movement of marge is required from time to time. A drill which is and then wrongly repositioned can, and has, ned detonation of the explosives already loaded, with stant damage and loss of life.



Underwater Ingersoll-Rand C-2 tractor with a drill, rigged to be driven into the Mississippi River, in spite of near-freezing temperatures, drill worked efficiently.

A portion of the Mississippi River was drilled and blasted from the top of an Ingersoll-Rand C-2, rigged with a platform. Controls were moved with the use of hydraulic hoses and the entire operation was performed by a driller from the platform. The weather was unbearably cold and ice floes posed a constant problem. The drill worked very efficiently and, though a diver was required to local the holes, even this was accomplished with a minimum of delay and effort.

Assembling a barge and floating it down-river would have cost almost as much as the whole drilling and blasting operation with a "swimming" drill. Although efforts to keep the drill from freezing consumed a great deal of time, as many as 50 10-foot holes were drilled in a sixhour day, and 600 yards of rock per day was realized.

#### ONE DRILL

This method entailed one drill, a 600 cfm compressor, one driller, one helper and one diver. Explosives were kept on the platform with detonating cord payed out and the correct distance maintained by measuring the amount of cord. The operation saved the prime contractor many thousands of dollars. Rigging platforms and attendant problems are not always required.

Early in 1962 Explosives International used a fully submerged drill to blast a reef in Hawaiian waters. Since that time it has become a more frequently used technique. Air track drills, the kind normally used on rock projects on the surface, are modified to function below the surface, of the water. Air vents are manifolded to the surface by air hose. Hydraulic systems are also vented to the surface, and the exhaust ports from the drifter and the air *Continued on Page 12* 

#### E apert mont . from Page 3





this section presentation for the U.S. Bary, a thread in investigate dull base not and location gentry this water that the first and any second listed with printing large tangent in the state rate of the state with the state floatest.

> 3. A manaryh project was started at the older a . Hawaii (now Electronivas International Work), Hook on Storeshop in see If the ase of a could nearly represent the internation from theory and reachy represents wave "patient retractive states."

#### ELECT EFFECT

As anymitpiped massi the shock affect of detuit, constally placed inside me web of the were affect was made to avoid direct contact and in allow pressure and alreck waves to de the addingue will cause holls of ables and the addingue will cause holls of ables and the process could be developed in colstanding, what is astomediar is that no one foces is ablesting and wen more to that no one foces is the performing as well the trouble only on mass the hard be astomediar in the most one mass the hard be the interval on the most the hard be the interval only on mass the hard be the beautiful for the application, the adding astrong that the interval one one to be the the sector one interval the sector of the interval one one interval the hard beautiful to the sector one one interval the sector of the interval one one one the sector of the interval one one interval the sector of the interval one one interval the sector of the interval one one one the sector of the interval one of the interval the sector of the interval one one of the interval the sector of the interval one of the interval one of the sector of the interval one of the interval one of the sector of the interval one of the interval one of the interval the sector of the interval one of the interval one of the interval the sector of the interval one of the int

and/res river crossinges, needs, channels, and or sing much a can and dynad process. One this and proving loaded dracage the dark planes of the ray, daits are mounted on harges, holars on govern loaded dracage the dark planes of the angle of an abarent restant of holes of the angle of anderwaler poject. It is next accessical not the anders, To the costering damagenes, part estant is duith with the second of the angle of anderwaler data and the induct damagenes, part estant is duith and a second the angle repositioned can, and has, the and the angle repositioned can, and has, and has a set the angle of the second the second the angle of the second and the angle repositioned can, and has,

Construction Improved Prevent C-2 Interfam Vellain diffic, Hagerd Io an private listic true to talenciefford Private, in spite all most strategies in mathematical and provided with preventing to the previous strategies of the previou

A portion of the Mindatered Electr was diffied and the ted from the top of an Ingeneral-finant C-2, tiqued with a post-term. Controls were nerved with the use of hydrawite them the platform. The weather was unharmality only and from the platform. The weather was unharmality only and the plates posed a constant problem. The defit worked the balan, area this was accomplicated with a minimum of datar and effort.

Amanufating a harpe and floating is down-clear would have that alarent as much as for whole willing and bischood opposition wills a "valuation's drift. Although allorer us to be the dulk from frameling consumed a grant dust uf float, as many as 50 10-fout hilts were drifted in a pabeut may, and sitt yands of noth net duy was rankingd

#### ONE DRUL

This method setailed one drift, a 000 che desensari, one driftler, one belger and one diver, Explosives were there on the platform with designating cost any drug and the convest distance maintained by elecandrag the amount of cost. The operation aered the pline contractor many through the distance aered the pline contractor many problems are not always, required.

Startly in 1952 Explosives international area a faily submaniput attit to blash a visit in its waitan mators. Since that uses it has become a work frequentity used tertainpatals thank define, for sind normally used on most products on the surface, are mobilized to fuscifican failow the surface by all breast Egitually systems are annifolded to the surface by all breast Egitually systems are also vanish to the surlar at a surface systems from the different in the surtain the surface systems from the different in the surtain the surface spatiant parts from the different in the surtain the surface spatiant parts from the different in the sur-

## CEA SLASTING - Cont. from Page 7

ors are vented similarly. Other than these changes, ich can be accomplished in a few hours, no others I be made. Holes are loaded by a diver or the operator ne drill, if he is qualified to do so.

970 a demonstration of underwater drilling was made the U.S. Navy at Homestead, Fla. Explosives Interonal was awarded a "sole source" contract to prove feasibility of the technique for future Navy use. The ilems presented were many. First, there was no pment available to lower the drill into the water. The line of the lake, in which the demonstration had be conducted, was very steep, thereby demanding ethod of floating the three-ton drill into the water, vly lowering it to the bottom. The feat was accomped by strapping 55-gallon tanks around the drill, nming it into deep water, and floating the tanks. The re process was later used in the Atlantic Ocean, off Azores, in the drilling and blasting of a cable trench.

## CALCULATIONS

ling underwater is very expensive. From a barge, ts in excess of \$2 per cubic foot are not uncommon. 1 a drill in the water, this cost can be cut by some percent. When calculations are made, drill spacings depth of hole, water involved, pay line and quantity powder able to be placed in a single hole must be sidered.

with drilling holes on the surface, burdens and spacs must be calculated. Certain rules of thumb may be d. Burden and spacing should be nearly equal but in case, the spacing always should be equal to, or ger than the burden. Spacing between holes should 'er be more than the depth of the hole. In underwater sting, more explosives have to be placed in the hole the depth of the water increases.

calculating removal of six feet of rock under 25 feet water, the depth of the water should be assumed to be : half the weight of the rock. For a surface trench 20 t wide, six-feet deep and 100-feet long, holes can be used on six-foot centers with each accommodating a al of 16 pounds of dynamite.

## CALENDAR OF EVENTS

## bruary 8 - 10

Sth National Western Mining Conference and Exhibition, enver Hilton Hotel, Denver, Colorado. Exhibits and apers on: Mining, Milling, Public Lands, Geology, Coat, ealth & Safety, and General Session (discussion) on invironment.

oonsored by the Colorado Mining Association, 402 Majstic Building, Denver, Colorado 80202. (303) 222-0889.

#### :bruary 12 - 16

exhibition space is still available for the Second Annual Conference on Drilling and Blasting sponsored by ISES.

Contact Marvin Pope, Convention Chairman, Del Webb Fowne House, Phoenix, Arizona. Underwater, instead of basing calculations on six feet of rock, 18.5 feet is calculated with 23.4 cubic yards of rock assumed, and 17.5 pounds of explosives used in each hole. By adding two feet of sub-drill, or a total of 11 feet of hole, allows more than enough explosives to break the rock and move it sufficiently for excavation.

#### DRILLING SAVES

It is in the drilling where the savings can be found. If, as is normal with six feet of rock, drilling is on four-foot centers, holes are drilled eight feet into rock. (double spacing for depth of hole). A 20-feet wide trench, 100 feet long, would require 1000 feet of drilling on six-foot centers, 11-feet deep drilling three holes wide and 16 long. Eleven feet depth, or a total of 528 feet is required. With costs of \$2 per foot there is a considerable saving. The drilling cost is just about one half. This is a small trench. Consider excavation of a harbor 500-feet wide, by 1000-feet long.

The calculation of the water into the problem is a relatively simple process, but in most cases this calculation is rarely made. Whether or not drilling is done from a barge, or with a drill submerged is not at issue. There are certainly circumstances where a drill underwater is not feasible.

#### NEW EXPLOSIVES

New explosives called "slurries" lend themselves especially well to underwater work. They are, first of all waterproof, and will withstand great pressures withou deterioration. They are safe to handle, and easy to use They have densities in excess of 1.3, and therefore will sink in water. They will not "float" out of holes, and will remain fixed into place.

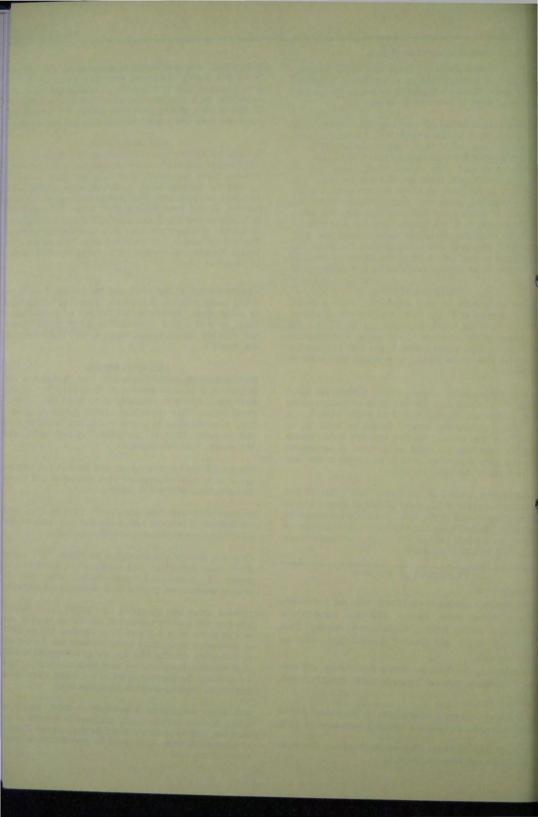
Slurries fill the entire borehole, and there is not annula space loss. Most slurries are less expensive per pounthan standard cartridged dynamite.

Slurries rarely are "cap sensitive". That is, they wil not detonate if initiated with a blasting cap only. In thi regard there are advantages and disadvantages.

They are usually not classified as Class "A" explc sives (cap detonable), and require less sophisticate means of storage and transportation. High velocity primers are required to bring them to their peak velocity

Primers which are classified as "HDP" (high densit primers) are always waterproof, simple to handle, an will detonate when initiated by a blasting cap or piec of detonating cord. Often times slurnes can be brough to detonating velocity with the use of a large detonatin cord, thereby eliminating the need for a cap primer. The are probably the blasting agent of the future where larg underwater blasting projects are encountered.

Underwater blasting is a specialized field, which requires those in it to be highly qualified in the use of e: plosives, and thoroughly trained in the special physic of underwater work. They must be specialists in eve sense of the word.



# SECTION 5 : PORTABILITY OF RIG AND COMPRESSOR

The total operational weight of the LM100 rig, fitted with the YD90 drill, is 5400 lbs (2450 kgs) and occupies a volume of 260 cub.ft. (7.3 cub.m.). Likewise, the P375SD compressor has a weight of 4232 lbs (1920 kgs) and occupies 396 cub.ft. (11.2 cub.m.).

Consequently, lighterage from ship to shore would need to be conducted using a combination of the one tonne capacity barges connected together to form a pontoon capable of handling 2.5 tonnes. This will accommodate the rig initially and secondly the compressor and other ancillary items on a separate voyage.

Also for your information are details of the Hercules C-13OA aircraft compartment loading limits, should you be in a position to airlift the units.

Once on shore, the rig can be driven under its own air supply to a suitable storage area and consequently to your drilling site.

## SECTION 5 1 PORTABILITY OF RIG AND COMPRESSOR

The total operational weight of the LMIDD rig, Fitted with the YD90 drill, is 5400 lbs (2450 kgs) and docupies a volume of 260 cub.ft. (7.5 cub.m.). Likewise, the P37520 compressor has a weight of 4232 lbs (1920 kgs) and occupies 396 cub.ft. (11.2 cub.m.).

Consequently, lighterage from anth to shoke would read to be conducted using a combination of the one tonno capacity barges connected together to form a pontoom capable of and secondly the compressor and ather annihisry items on a seconds voyage.

Also for your information are details of the hereules C-190A sirprefit compartment loading limits, should you be in a mostblen to sirlift the units.

Once on shore, the rig can be driven under its own air supply to a suitable storage area and consequently to your drilling site

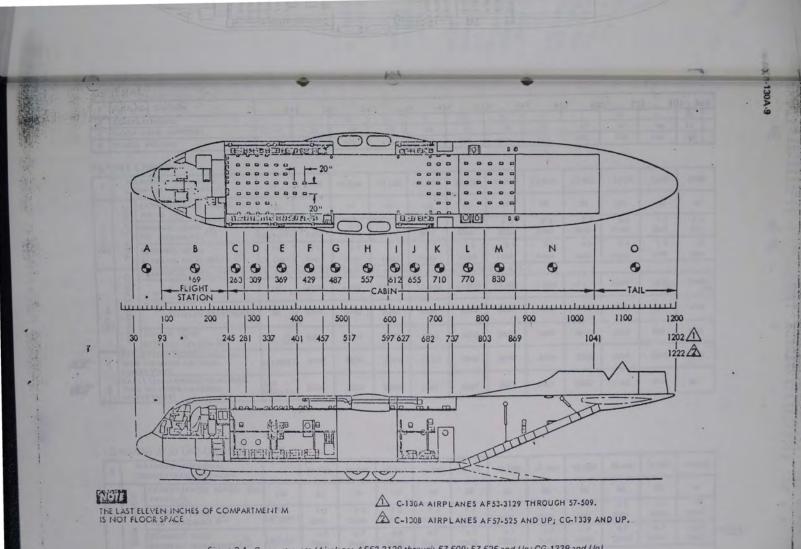
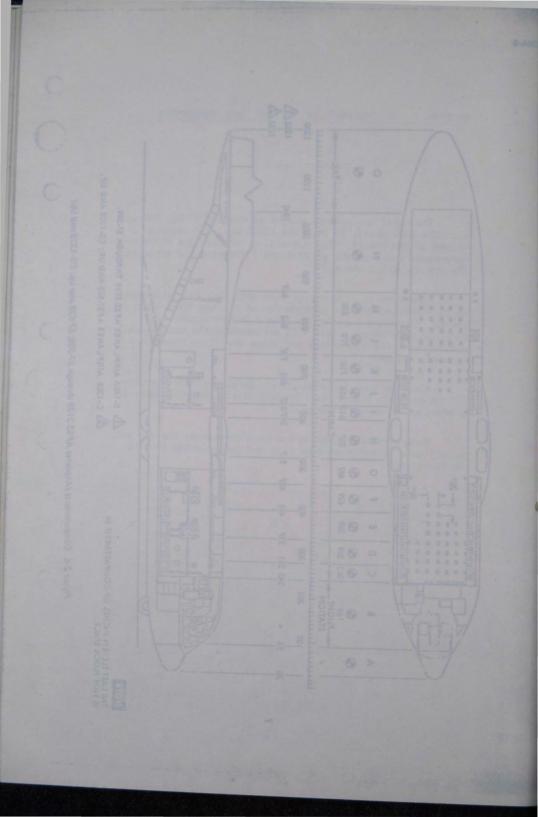


Figure 2-4. Compartments (Airplanes AF53-3129 through 57-509; 57-525 and Up; CG-1339 and Up)



T TOTAL CONTROL

-1 7 2 1 5 F

GENERAL

1	FUSELAGE STATION	24	15 21	81 33	37 4	01 4	57 5	517	597	627 6	82 7	37 8	203 80	69
2	COMPARIMENTS		C	D	E	F	G	H	1	1	K	L	M	
3	FLOOR AREA (APPROX)	SQ FT	31	48	55	-18	51	68	26	47	47	50	56	
4	USABLE VOLUME	CU FT	280	430 .	495	430	460	610	235	420	420	450	280	

13

100

TRE. HICK CENE LOAX LIMIT LATE SLOC BEDIS

A LIST

LOAD SIZAL SIZE FACK

4. THIS ENDER ADDE AREA IS ALL DEAL (FLIG OF CA DF CA SING NEIO) CALCH FOR A REVEL ELAST

PER LI CHART ACTOL

A

FLIGHT LIMITS

107

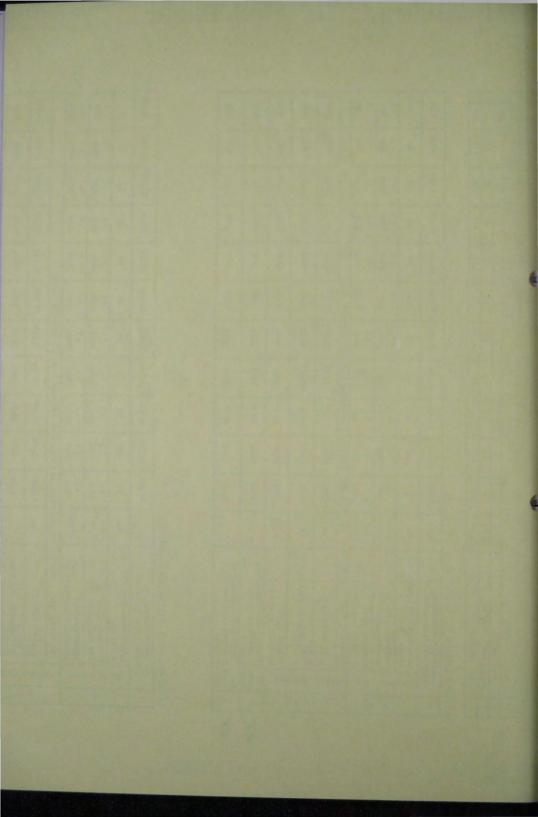
- - - too

1			M INDIVIDUAL	LB	8400	12,900	19,500	28.000	30,000	30.000	15.000	24.400	12,700	2500	2500
	00		ENTRATED LOADS - ALL	PSI	50	50	50	50	50	50	50	50	50	50	50
BULK CAR	1000	RUNNING LOAD		PSI LB/LINF1	3 4 1400	3 4 1400	7 2 3000	7 2 3000	7.2 3060	7.2 3000	7 2 3000	7.2 3000	3.4 1400	1 2 500	1 2 500
	5		ING LOAD	PSI LB/LINFI	3 1 1400	3 1 1400	3 1 1000	3.1	3 I 1000	3 I 1600	3 I 1000	31 1000	3.1 1400	- 13 - 500	13 500
	0	PNEU	MATIC TIRES - 100 PSI M	AX. TIRE P	RESSURE	- FOUR FL	ET MINIM	UM DISTA	NCE BETW	EEN AXLE	s				
	CARG	w O	IREADWAYS	LB	0003	0003	13 000	13,000	13.000	13.000	13 000	13.0 "	0000	2500/2	2500
C	ELED	AXU	BETWEEN TREADWAYS	LB	5000	5000	5000	5000	5000	5000	5000	5000	5000	1200	1200 1
4	WHE		UE LQAD TEN TREADWAYS	18 A	2000	2000	2000	2000	2000	2000	2000	2000	2000	450	450
4	IONI		D CARGO-DUAL-RAIL ORE LATERAL (S)	LB/LINFT	2800	2800	3200	3200	3200	3200	3200	3200	2500	1000	1000
x	PALLETIZED CARGO-DUAL-RAIL IONE OR MOHE LATERAL CONVEYORS)		LE/	2333	2333	2667	2667	2667	2667	2667	2667	25333	833	833	

# LOADING AND UNLOADING LIMITS

1			IM INDIVIDUAL		20.000	30,000	40.000	40.000	40.000	40.000	37.000	40.000	30.000	26,000	26 000	]
	RGO	CON	CENTRATED LOADS - ALL	PSI	50	50	50	50	50	50	50	50	50	50	50	
2	K CAR	10000	TREADWAY	PSI LB/LINFT	7.2 3000	7.2 3000	7.2	7.2	7 2 3000	7.2 3000	7 2 3000	7.2	7.2 3000	7.2 3000	7.2 3000	
	BULH	0.000	NING LOAD	LB/LINFT	6.7 2800	67 2800	6.7 2800	6.7 2800	6.7 2800		6.7 2800	67 2800	6.7 2800	6.7 2800	6.7 2000	- The
	0	PNEL	MATIC TIRES - 100 PSI A	MAX TIRE	PRESSURE	- FOUR FE	ET MINIM	UM DISTA	NCE BET	VEEN AXL	ES					\$
3	CARGO	1201	TREADWAYS	LB	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13.000	13,000	13 000	
	0		BETWEEN TREADWAYS		5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	

ъ.



TOX CONDITIONS

successive division in Advances

#### TWENTSPACE

# SECTION 6 : PRODUCTION CAPABILITIES

INCH HEIGHT

ADLA ANGAL

WAY HIDLE DEPTIT

ACCESUS

-----

Enclosed in this section is a summary performance and output potential chart for the LM100 drill rig, fitted with a YD90 drifter drill and powered by a P375SD portable air compressor.

The chart is based on assumptions, since actual ground conditions are not available.

We have based our calculations on biostromal limestone, which is an organic limestone derived from sedentary organisms such as occur in coral limestones. It is understood the rock is competent and good to drill, leaving a clean "shiny" hole.

We have suggested 2.5" (62 mm) diameters since it will be difficult to contain any blast in holes bigger than this with the shallow depths you intend to drill. Using this size hole, a drill pattern of 6' x 6' will achieve a fragmentation size easily transportable by hand.

However, depending on conditions actually encountered, will depend on actual patterns used. Nevertheless, it is believed our suggestions will be a good bench mark.

## SECTION 6 : PROMICION CAPABILITICS

contput potential chart for the 19100 drill rig. fitted with a VO90 drifter drill and powered by a P3755D portable air compressor.

Ine chart is based on assumptions, since solual ground conditions are not available.

We have based our calculations on biostronal limestons, which is shortgonic limestone derived (row sedentary organisms such as occur in coral limestones. It is understood the rock is competent and good to drill, leaving a clean "shiny" hole.

We have suggetted 2.5" (52 mm) dimeters since it will be difficult to contain any blast in holes bigger than this with the shallow depths you intend to drill. Using this size hole, a drill pattern of 5' x 6' will achieve a fragmentation size semily transportable by hand.

However, depending on conditions actually encountered, will depend on actual patterns used. Mevertheless, it is balieved our suggestions will be a good bench wark.

# SUMMARY PERFORMANCE & OUTPUT POTENTIAL

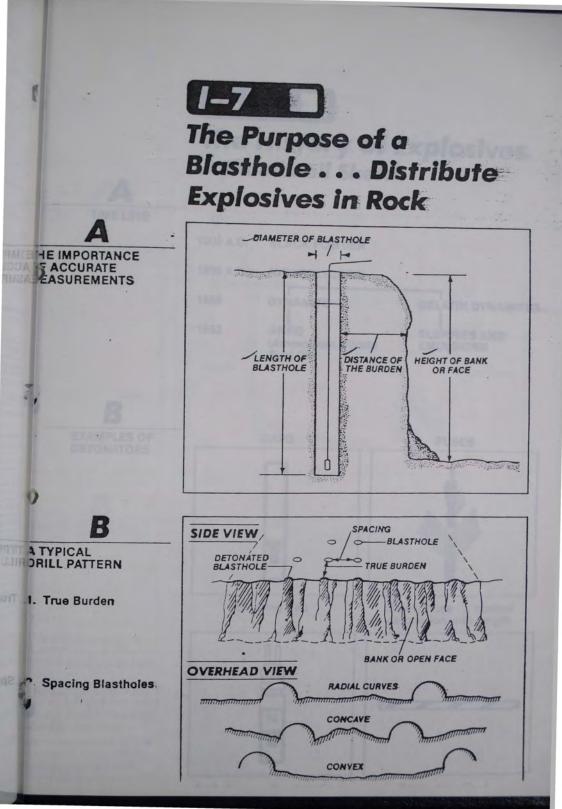
TOKELAU ISLANDS

ROCK CONDITIONS		BIOSTROMAL LIMESTONE 15-20,000 PSI							
PRODUCTION TARGET		INGERSOLL-RAND LM100/YD90 RIG, P375 COMPRESSOR							
EQUIPMENT									
BIT DIAMETER		2.25"	2.25" (57 MM)						
BENCH HEIGHT	ft	3.5	100000	1000	1	1	1		
	m	1					-		
HOLE ANGLE	0	-			1000	-	-		
PAY HOLE DEPTH	ft						-		
	m	and m	C. Lane	a Same	Committee of	-			
BURDEN	ft	6		10.000			-		
	m	1.75					-		
SPACING	ft	6		and a state of the					
CHURCHER CONTRACT	m	1.75					-		
SUB GRADE	ft	5.0							
RASONLUENTS.	m	1.5							
TOTAL DEPTH	ft	5.0							
	m	1.5							
YIELD PER HOLE	yd3	4.66							
(SOLID)	m <sup>3</sup>	3			PL I				
YIELD PER HOLE/FT	yd3	1.33			Luca cal	Paranet DE	1000		
YIELD PER HOLE/METRE	m <sup>3</sup>	3				La Cartera			
AVERAGE PENETRATION	in min								
SPEED OVER HOLE	cm min	-							
PENETRATION RATE	ft hr	100							
	m/hr	_							
TIME ACTUALLY DRILLING	mins	5							
ROD/TUBE HANDLING 3	mins each	N/A		The second					
MOVEMENT HOLE-TO-HOLE	mins	3							
LINE UP AND COLLAR	mins	3							
TOTAL TIME PER HOLE	mins	11							
CONTINGENCY FACTOR	10%	1.1							
OVERALL TIME PER HOLE	mins	12.1							
OVERALL DRILLING RATE	ft hr	42							
INCLE PATTE AN	m hr '	14 A 57 10	12						
INDUSTRIAL 'B' FACTOR	10 %	5	100-10-1		1000	10000	-		
EFFECTIVE HOURS PER	OUR SHIFT	9			-				
INDUSTRIAL DRILLING RATE	ft. hr	37.8		-			-		
	m hr	_				100	-		
HOLES PER HOUR PER RIG		7.5				-	-		
YIELD PER HOUR PER RIG	yd3	35							
	m3	ENEAL	1				_		
YIELD PER SHIFT	yd3	315	-	-		-			
	-		1				-		
							-		
				1		1	-		
	-						-		
						-	-		
EXCESS OVER TARGET	4			-					

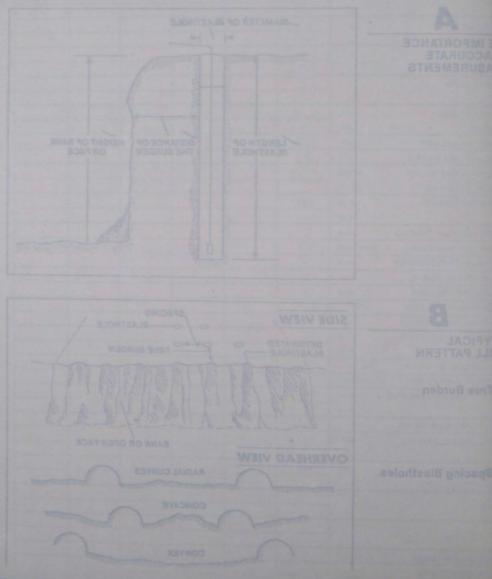
# SUMMARY ROTHING

HET TOKELAU ISLANDS

TROUGS OVER TARGET



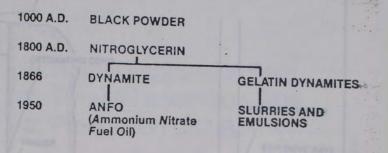
The Purpose of a Blasthole . . . Distribute Explosives in Rock





# The History of Explosives A Thumbnail Sketch

TIMELINE



B

 EXAMPLES OF
 CAPS
 FUSES

 DETONATORS
 Image: Caps
 Image: Caps
 Image: Caps

 Blasting Cap
 Safety Fuse ... control detonation with length
 Image: Caps

n-1----

# UEI(0)(1) The History of Explosive A Thumbnall Sketch

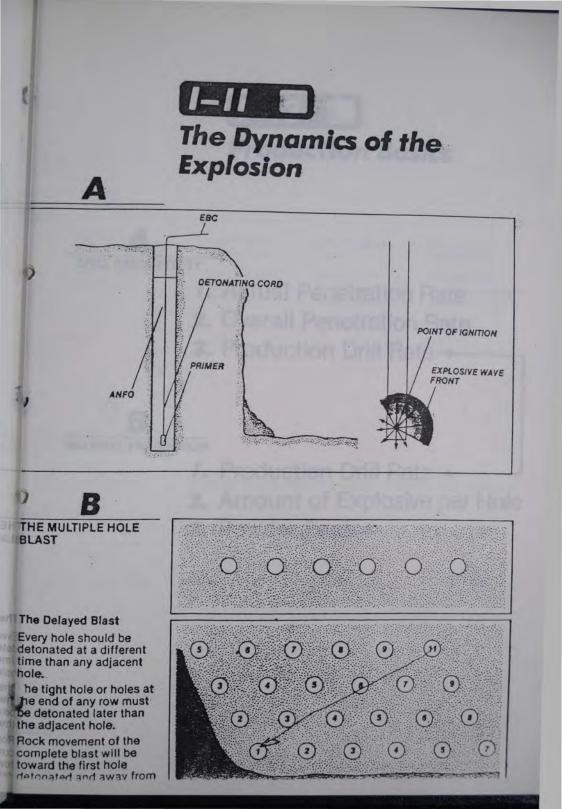


· defonation with

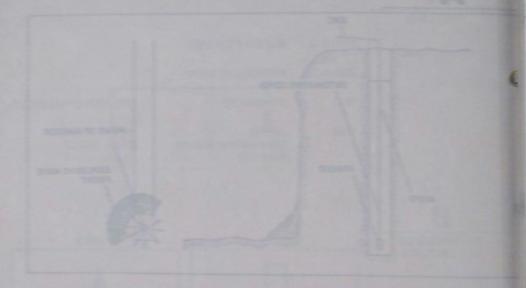
.

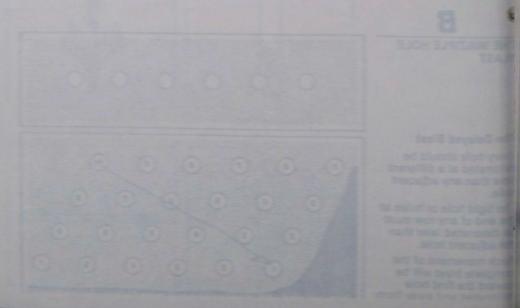
EXAMPLES OF

. y. water and the second of t

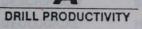


# [E]] The Dynamics of the Explosion









- I. Actual Penetration Rate
- 2. Overall Penetration Rate
- 3. Production Drill Rate -

# 

- I. Production Drill Rate -
- 2. Amount of Explosive per Hole
- 3. Powder Factor .

# Production Basics

Actual Penetration Rate
 Overall Penetration Rate
 Production Drill Rate

MATERIAL PRODUCTION

Production Drill Rate ←
 Amount of Explosive per Hole
 Powder Factor.



GENERAL

-

GEOLOGICAL DEFINITION

# Very Heavy, Strong Rock

Hard Igneous, Diorites Granites Intermediate Rock

Medium-to-Hard Limestones, Soft Igneous Very Soft, Weak Rock

Soft Shales, Weak Sandstones, Soft Limestones



# DRILLABILITY AND PRODUCTION FACTORS

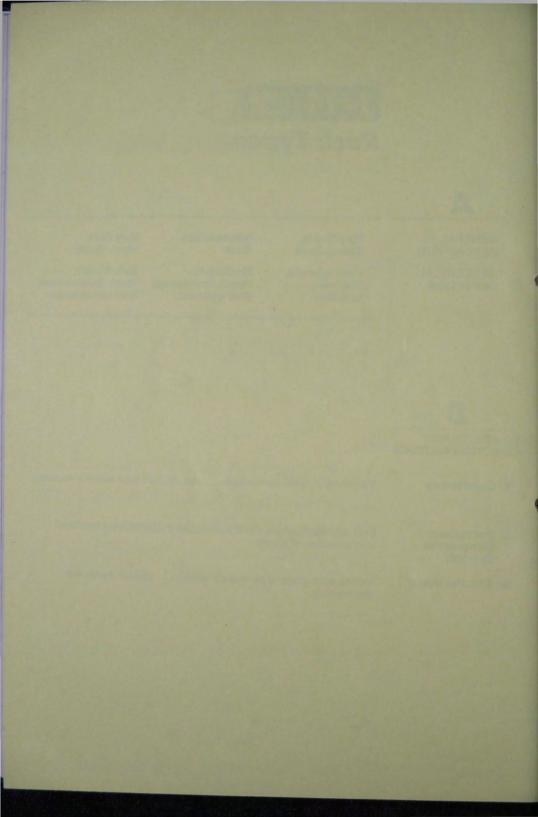
1. Consistency

Varies with local formation . . . ask drillers and superintendent

2. Unconfined Compressive Strength Drill and explosives must overcome material's unconfined compressive strength

3. Abrasive Index

Varies with grain size and structure ... obtain samples for testing



## SECTION 7 : DRILLING ACCESSORY USEAGE

The nature of the Tokelau exercise will have a small requirement for drill accessories.

The drill rods can be expected to have a good  $1\frac{1}{2}$  times the normal life since only half the rod is being used in the hole. However, sea water may have an effect on the thread life. Similarly, couplings, because the material is soft, which take little wear and a good life can be expected. Shank ends should also have an extended life. Drill bits may take on a certain amount of annular wear at the bit body, with the wear constant from water and limestone mix, causing a mild grinding paste.

It is recommended that the following be carried on the project site.

(A)	Shank ends	3
(B)	10' drill rods	5
(C)	Couplings	10
(D)	2-1/4" button bits	5

In order to achieve maximum life from your accessories, a good quality thread grease must be used.

## SECTION 7 1 DATELING ACCESSION USLAND

The nature of the lokelou exercise will have a small requirement for drill accessories.

The drill rode can be aspected to have a good of times the normal life since only half the rod is being used in the hole. However, see water any have an affect on the thread life. Similarly, couplings, because the esterial is soft, which take little was and a good life can be expected. Shark on a cortain enough of annular weat at the bit body, with the weat constant from water and limestone mix, causing a mile or inding pants.

It is reconnerded that the following be catting on the

In order to achieve maximum life from your accessoryees, a mood quality thread grasse sust be used.

# IR38 SPI-RAL® steel and button bits

ah halakaha

I

Patented full-length lubricating groove

# INGERSOLL-RAND DRILLING EQUIPMENT

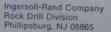
# 

# Ingersoll-Rand IR38 Spi-Ral<sup>®</sup> Steel System: Up to 4<sup>"</sup> (102-mm) holes

STRIKING BAR		-	38 mm DF	RILL STE	EEL	BUTTO	BUTTON BITS			
SYMBOL	DRIFTER	COUPLING	SYMBOL	LEN	GTH	SYMBOL	BIT SIZE			
STMBOL	MODEL	SYMBOL	1997 B. 1997	FT.	M		IN.	MM		
			E38SB10	10	3.1	21/2B38S	21/2	63		
SB38S3B	VL-120/140				3.1	3 B38S	3	76		
	F-170	- C38SBB		1	0.7	31/2B38S	31/2	89		
SB38F17A		- 10	E38SB12	12	3.7	4 B38S	4	102		

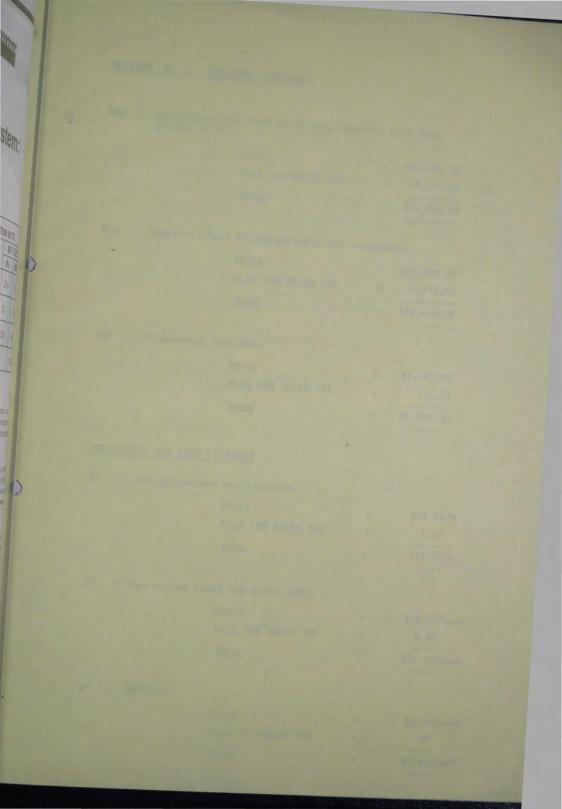
- Full length reconditionability The steel is threaded over its full length. When an end wears, it can be simply cut off and the remaining length chamfered and put back into service. This can extend steel life as much as six times compared with ordinary steel, reducing inventory and overall drilling costs.
- Rolled thread reforms the grain structure of the steel, giving greater shear strength than with cut threads. Rolling also improves tensile strength.
- Case hardening provides extra toughness for wear resistance, minimizes fatigue and retards corrosion.
- Lubrication groove in the crest of each thread (an I-R patent) retains lubricant and assures easy detachability.

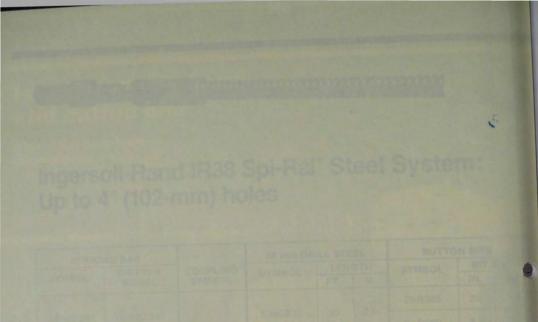
- Easier detachability— IR38 thread form has a steeper helix angle that requires less torque to break thread connections, saving time and extending steel life.
- Longer thread life— The thread also has more flank area and greater contact area between mating threads. This reduces thread deformation and wear, contributing to longer thread life between reconditionings.
- Corset® button bits— Advanced metallurgy provides the best combination of carbide wear and bit erosion, to maintain proper button exposure. Precision manufacture prevents stress concentrations.



INGERSOLL-RAND

Form 4508-A E 1980, 1981 Ingersoll-Rand Company Printed in U.S.A.





- Fully approved and the second attraction of the first approximation on one would be provide the complete and approximation and would be specific to any second and approximation on and would be specific to any second approximation of the specific to an approximation of the specific to any specific to an approximation of the specific to any specific to an approximation of the specific to any specific to an approximation of the specific to any specific to an approximation of the specific to any specific to an approximation of the specific to any specific to an approximation of the specific to any specific to any specific to an approximation of the specific to any specific to any specific to an approximation of the specific to any specific to an approximation of the approximation of the specific to an approximation of the specific to an approximation of the approximation of the specific to an approximation of the specific to an approximation of the approximation of the specific to an approximation of the specific to an approximation of the approximation of the specific to an approximation of the s
- \*Adual interest, robusts the grain of the second of the surface gaving gravity shear strength, then bells for belowing interest strengther strength.
- Care menter for provider art in the Source between encoded to be share and water restricted to the second
- Calification gradient in the cost of each charged lanin-4 calification integration and assessment even described gate.
- ingerste danne Soneher Roth Dell Straler Rothersprig til settig i -

- Basian destaulorishing (1993) Dormal Boog strayed racid angle Live countries have us torough thread colourishings serving over same toil have the
- \* Longert should dry The thread over how there are and greater endines are been int periods. This relates the being thread determine eres. Constant of the longer thread, the beter are constant and are being thread.
  - Galaxyan human, hits-, Adampert mutation and alates use these contramination of particular sector and employees to environment propherosystem against

# SECTION 8 : PRICING SCHEDULE

One : Ingersoll-Rand LM100 drill rig, complete with YD90 drifter drill.

PRICE	:	\$63,188.00
PLUS 10% SALES TAX	:	6,318.80
TOTAL	:	\$69,506.80

One : Ingersoll-Rand P375SD portable air compressor.

3,310.90
\$36,419.90

50' : 2" diameter air hose.

PRICE	:	\$1,163.00
PLUS 10% SALES TAX	:	116.30
TOTAL	:	\$1,279.30

## ADDITIONAL AIR LINE FITTINGS

2" : Dia galvanised air pipeline.

PRICE	:	\$11.44/M
PLUS 10% SALES TAX	:	1.14
TOTAL	:	\$12.58/M

2" : Mac unions (used one every 10M).

PRICE	:	\$28.47/each
PLUS 10% SALES TAX	:	2.84
TOTAL	:	\$31.31/each

2" : Sockets.

PRICE	:	\$4.91/each		
PLUS 10% SALES TAX	:	.49		
TOTAL	:	\$5.40/each		

## SECTION 8 1 PRICING SCHEDULE

One : Ingerunli-Rand LM100 drill rig, complete sile 1090 drifter drill.

PRIEC 107 SALES TAX 1 107.108.00 PLUS 107 SALES TAX 1 107.00 107.4L 1 107.4L 1 107.4L

Ore i Ingerestl-Rend P1755 periable air compression PRICE : \$33.107.00 PRICE 102 SALES TAX : 3,310.90 TOTAL : \$36,619.90

PRICE 51, 165.00 PRICE 154 1165.00 PRICE 104 SALES 1AX 1 116.30 TOTAL 1 51, 279, 30

ADDITIONAL AIR LINE FITTINGS

 2": Mac unions (used one every 10H).
 r \$25.87/aach

 PRICE
 r \$25.87/aach

 PLUS 10%\*SALES TAX
 r \$25.37/aach

 TOTAL
 s \$31.31/aach

Sockets.
 P8102
 P8102
 P103
 SALES TAX
 SS.40/each
 SS.40/each

# DRILLING ACCESSORIES

UTAL	
61.70	
646.20	
31.00	
65.10	
231	6.20

DELIVERY

All items can be available ex Auckland within eight to ten weeks from receipt of your firm order.

DELIVERY POINT : Free into store Linton.

:

# CONDITIONS OF SALE : As per form attached.

All proves to come the property of the provest provest for excerning provide the board on excerning exactly provide the providence of the

## DRILLING ACCESSORIES

ELIWERT + All items can be available as Auckland within eight to tan weeks from receipt

DELIVERY PULNT : Free into store Linton.

CLMDITIONS UN SALE I As par form attached.

# CONDITIONS OF SALE

Definition

à.

Payment

In the following General Conditions, reference to the 'Company' shall mean Ingersoll-Rand Division Schlage (N.Z.) Ltd

Unless otherwise stated, payment shall be net cash by the 20th of the month following date of despatch of goods.

#### Guarantee and Liability

The Company warrants that the apparatus delivered herewith shall be of the kind and quality described herein but no other warranty or condition whether with respect to description quality merchantability or fitness for any particular purpose whether express or implied by statute or otherwise shall bind the Company. The Company will repair at its factory or replace without charge f.o.b. factory any part or parts within 90 days from the date upon which the apparatus is first used by the purchaser being a date not more than oneyear after the date of despatch shall be proved to have been defective when despatched, provided that the purchaser shall promptly notify the Company in writing of such despatch and promptly deliver the defective part or parts to the factory where made, delivery prepaid. No allowance will be granted for any repairs or alterations made by the purchaser without the Company's written consent. The Company reserves the right to make, at any time, such changes in detail of design, construction, arrangement, or equipment as shall in its judgment, constitute an improvement over former practice. Upon payment of an extra charge the Company will make tests for economy and performance. Because of varying conditions of installation and operation, all guarantees of performance are subject to a variation of 3%. Equipment and accessories furnished by third parties are guaranteed only to the extent of the original manufacturer's guarantee to the Company. In case of failure of the Company to fulfil any performance guarantee, it is agreed that the Company may remove and reclaim apparatus covered by this Contract at its own expense and discharge all liability by repayment to the purchaser of all sums received on account of the purchase price. The liability of the Company (except as to the warranty of title and on the liability respecting any performance guaranteel arising out of the manufacture or sale of said apparatus, or its use, whether on warranties or otherwise, shall not in any case exceed the cost of repairing or replacing defective parts as aforesaid, and, upon the expiration of the said one year, all such liability shall terminate. The Company shall not be held liable for any special, indirect or consequential damages arising out of this Contract or any breach thereof, or any defect in or failure or malfunction of the apparatus furnished hereunder, nor shall the Company be liable for any loss or damage of any kind whatsoever caused by force majeure or circumstances beyond its control.

All prices are quoted exclusive of Sales Tax. In the event of any additions or alterations in Sales Tax and Government imposts being brought into force before delivery of the goods which the Company has to pay and/or collect, the prices mentioned herein shall be varied by the amount of such tax, impost or imposts and this condition shall be deemed a term of the contract of sale.

All prices guoted for goods manufactured or procured by the Company are based on wages awards conditions and material

costs as at the date of quotation and all prices quoted for overseas goods are based on current manufacturer's prices, freight rates, insurance, exchange rates and customs duties, as at the date of quotation. The Company reserves the right to adjust quoted prices to compensate for any alteration therein and any such adjustments will be to the purchaser's account.

Prices

Tax

Delivery

Any period or date of despatch quoted is given and intended as an estimate only and the Company will not be liable for any loss or damage arising out of any delay in despatch howsoever caused.

Exclusion of other terms

The above conditions shall apply to all quotations given and orders accepted by the Company to the exclusion of any other terms and conditions contained in any document submitted to the purchaser to the extent that such last mentioned terms or conditions are inconsistent therewith or with any rights of the Company expressed or implied by law. No modification hereof shall be binding upon the parties hereto or either of them unless such modification shall be in writing duly executed by the purchaser and approved by a Director or Secretary of the Company.

