

353001

FINAL REPORT
OFFSHORE NAVIGATION, INC.
PROJECT 491

INTERMARINE SERVICES INC.
FOR

PLANET OIL CO. N.L.

WELL LOCATION SAILFISH NO. 1

BASS STRAIT AUSTRALIA

**PLANET
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SEPTEMBER - OCTOBER 1971

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A B S T R A C T

Project 491 was a Shoran positioned and controlled well location survey for potential mineral deposits in the Bass Strait off the southern coast of Victoria, Australia.

The principal was Planet Oil Co. N.L. (PLANET).

Intermarine Services Inc. was the prime contractor and operator.

Offshore Navigation, Inc. (ONI) employed a Shoran radiolocation system to provide horizontal control for the survey.

TABLE OF CONTENTS

	<u>Page</u>
The Shoran Radiopositioning System	1
Area of Operations	12
Field Operations Recap	12
General Information	15
Well Location Information	18
Basic Control	20
Shoran Three-Way Fixes	22
Shoran Baseline Measurements	23
Personnel	24
Distribution	24
Shoran Base Station Descriptions and Plats . .	25
Area of Operations Legend	31

FIGURES

1. Simplified Block Diagram of Basic Radio Equipment of a Shoran System
2. Area of Uncertainty of Position due to error in range measurement
3. Position Ambiguity in Circular Range System
4. Relative Area of Coverage Circular Ranging System

I. THE SHORAN RADIOPOSITIONING SYSTEM

The Shoran system is a radar transponder type of radio-positioning system. The Shoran mobile station equipment measures the distance from its location to those of two fixed ground beacon stations. The position of the mobile unit is thus fixed at the intersection of the two circular distance or range arcs so determined. The position of the ground beacon stations or base stations is normally accurately known, so that the corresponding position of the mobile station can be accurately computed or determined by graphical methods. Should the position coordinates of the base stations not be accurately known, the mobile station may still be positioned relative to the baseline determined by the base station locations.

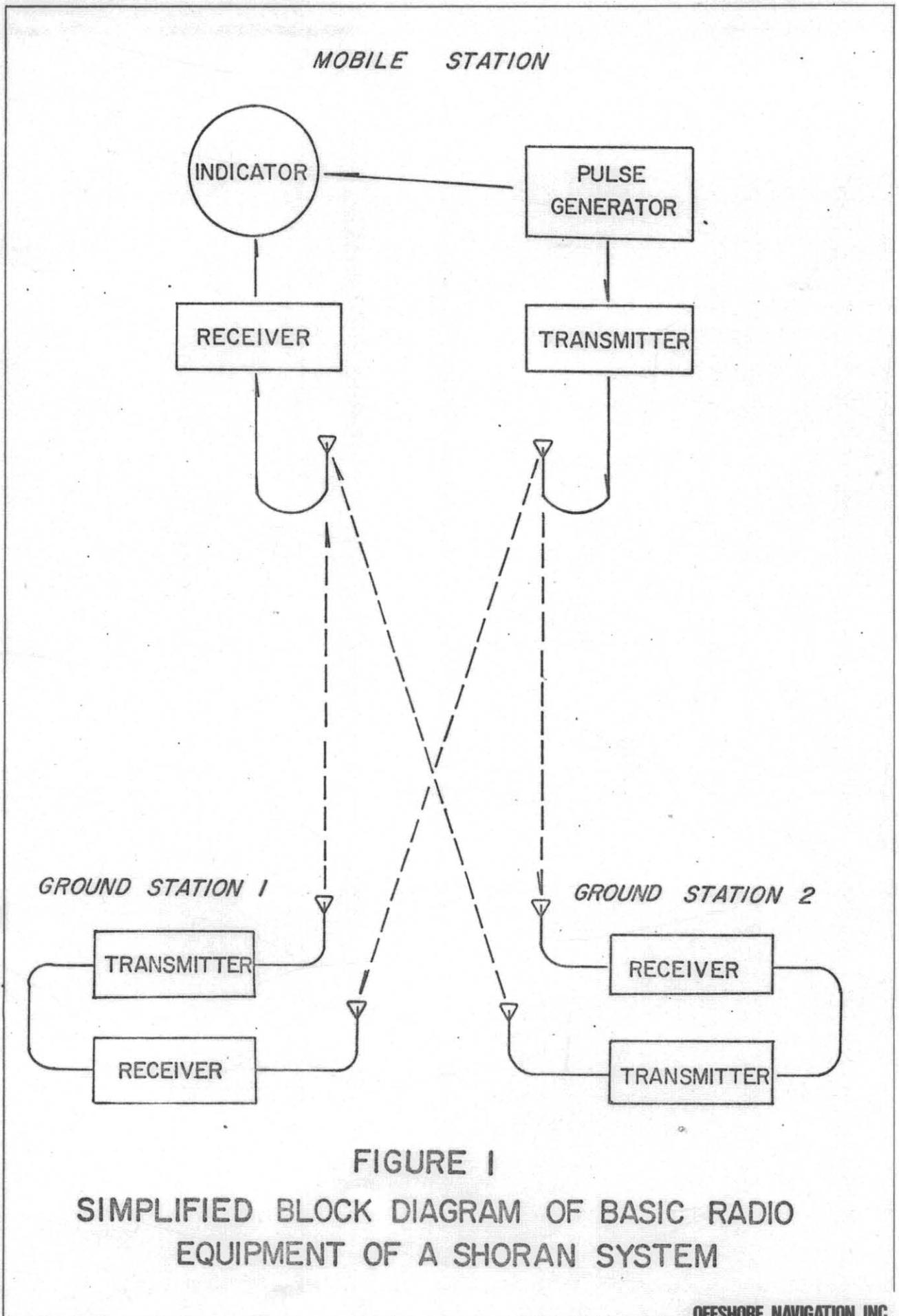
The Shoran mobile unit measures the distance of the two base stations by measuring the time required for pulses of radio signals to travel from the mobile station to each base station and return. The time intervals so measured are related to the corresponding distances by using the highly constant velocity characteristic of radio waves in air through the simple relationship:

Total distance covered = Elapsed time x velocity.

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

Because of this relationship, it is possible to graduate the indicating dials in the mobile unit in terms of distance rather than elapsed time. For example, using radio waves which have a velocity of approximately 186,000 miles per second, the scale of the time-interval measuring system is graduated so that when the time interval required for a round trip of the signal is 1/1000 second, the scale reads 93 miles. (The total distance traveled by the radio signals in 1/1000 second is 186 miles. Since this is round trip distance, it must be halved to obtain the distance between mobile and base stations.) The Shoran dials are graduated in terms of statute miles rather than nautical miles..

The basic equipment units used to create the round trip signals paths originating and terminating at the mobile station are shown in Figure 1. This equipment consists of a signal source (labeled pulse generator in Figure 1), a transmitter, receiver and indicator unit comprising the mobile station, and a receiver coupled to a transmitter at each base station.



I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

Pulse signals originating at the mobile station are radiated from the mobile transmitter and received by one of the base stations. At this base station, the pulse is sent from the output of the receiver to the input of the transmitter, and is then retransmitted back to the mobile station. After passing through the mobile receiver, the pulse is routed to an indicating circuit where its time lag, or lapse, with respect to the original outgoing pulse is determined, and indicated in terms of distance rather than units of time.

Other pulses are transmitted to the second base station, using a different radio frequency to permit their discrimination from those intended for the first base station. These pulses are received and retransmitted by the second base station, and on their return to the mobile station are similarly sent through the indicating circuits for measurement of the time required for their round trip and the indication of corresponding distance. Thus, the equipment provides continuous, essentially simultaneous, indications of the distances to both base stations.

The Shoran system operates in the VHF/UHF portion of the

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

radio spectrum. Normally, three separate frequencies are used. Two of these are transmitted alternately by the mobile station to interrogate each base station in turn, as previously described. The third frequency is utilized by the base stations to retransmit the received pulses back to the mobile station. Both base stations transmit on the single frequency in order to utilize a single receiver at the mobile station.

The propagation characteristics of VHF/UHF radio signals is such that they tend to travel in straight lines. While they are refracted in the atmosphere to some small extent, they do not tend to follow the earth's curvature as do radio signals of considerable lower frequency. They lack the ability to "see" beyond the radio horizon. Thus the Shoran system is essentially a "line of sight" system, with the maximum range being limited, to a large extent, by the heights of the mobile and base station antennas.

The range of the system under particular conditions may be estimated from the relationship

$$d = k (\sqrt{h_1} + \sqrt{h_2}).$$

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

where,

- d = estimated maximum range, in miles
h₁ = height of mobile station antenna, in feet, above sea level
h₂ = height of base station antenna, in feet, above sea level
k = empirical range factor

The factor, k, depends upon several factors among which are included antenna gain, receiver sensitivity, transmitter power and atmospheric refractive index. It will vary in value from 1.5 to 2.5, under normally encountered conditions.

The range formula presumes no obstructions between mobile and base stations. The presence of intervening hills or other obstructions can reduce the otherwise obtainable range.

Under certain conditions, abnormally long Shoran ranges can be obtained by exploiting the existence of an atmospheric phenomenon known as a temperature inversion layer. This is a layer of high refractive index occurring with the first few thousand feet of the atmosphere. It has the effect of confining the radio waves near the earth's

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

surface, and acts as a duct to bend radio waves around the curvature of the earth. Under these conditions the factor, k , may be several times greater than normal. In some marine areas of the world, this phenomenon occurs quite regularly during certain seasons.

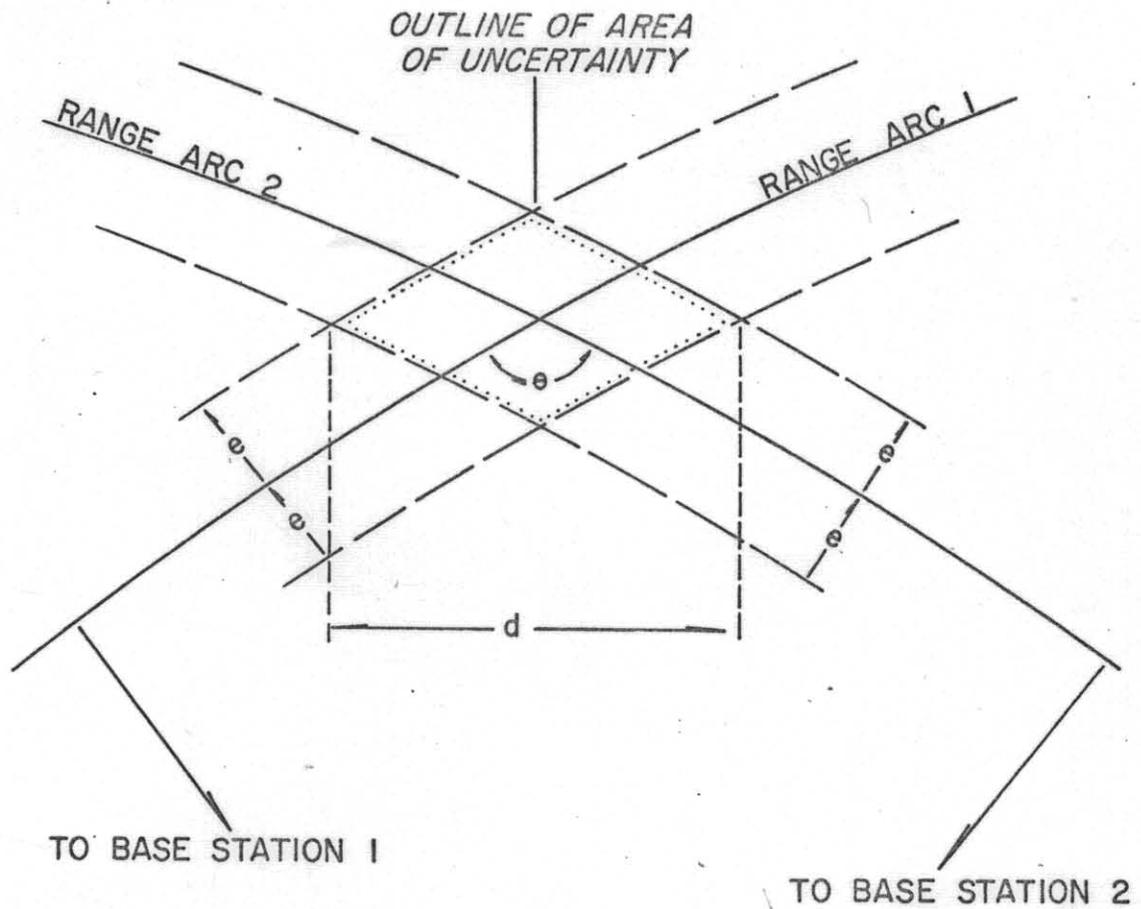
The instrumental accuracy of the Shoran equipment, when properly calibrated, is $\pm 50-75$ feet on a single range. The overall position accuracy is related to the range accuracy by the angle of intersection, at the mobile station, between the two Shoran range circles. This is illustrated in Figure 2. In normal geophysical operations, this angle of intersection is held between 30 and 150 degrees. Refer to Appendix A for examples of areas of coverage for different angles of intersection of the Shoran range circles.

The range accuracy of the Shoran system can be improved, possibly by a factor of 2, by correcting the propagation velocity slightly under varying meteorological conditions, and by the application of more rigid calibration and operating specifications. For most operations, this

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

additional accuracy cannot be economically justified.

In computing (or determining graphically) the position from a pair of Shoran ranges, cognizance must be maintained that a position ambiguity may exist. Each pair of ranges (one to each base station) actually determines two independent positions, one on each side of the Shoran baseline, as illustrated in Figure 3. One position is the "mirror image," so to speak, of the other. Further, the Shoran mileage dials repeat every 100 miles of range. To eliminate this ambiguity one must know, from other means, the correct side of the baseline and the distance to each base station within the proper multiple of 100 miles.



$$d = \frac{2e}{\sin \frac{\theta}{2}} \text{ where}$$

e = RANGE ERROR

θ = INTERSECTION ANGLE OF RANGE CIRCLES

FIGURE 2

AREA OF UNCERTAINTY OF POSITION
DUE TO ERROR IN RANGE MEASUREMENT

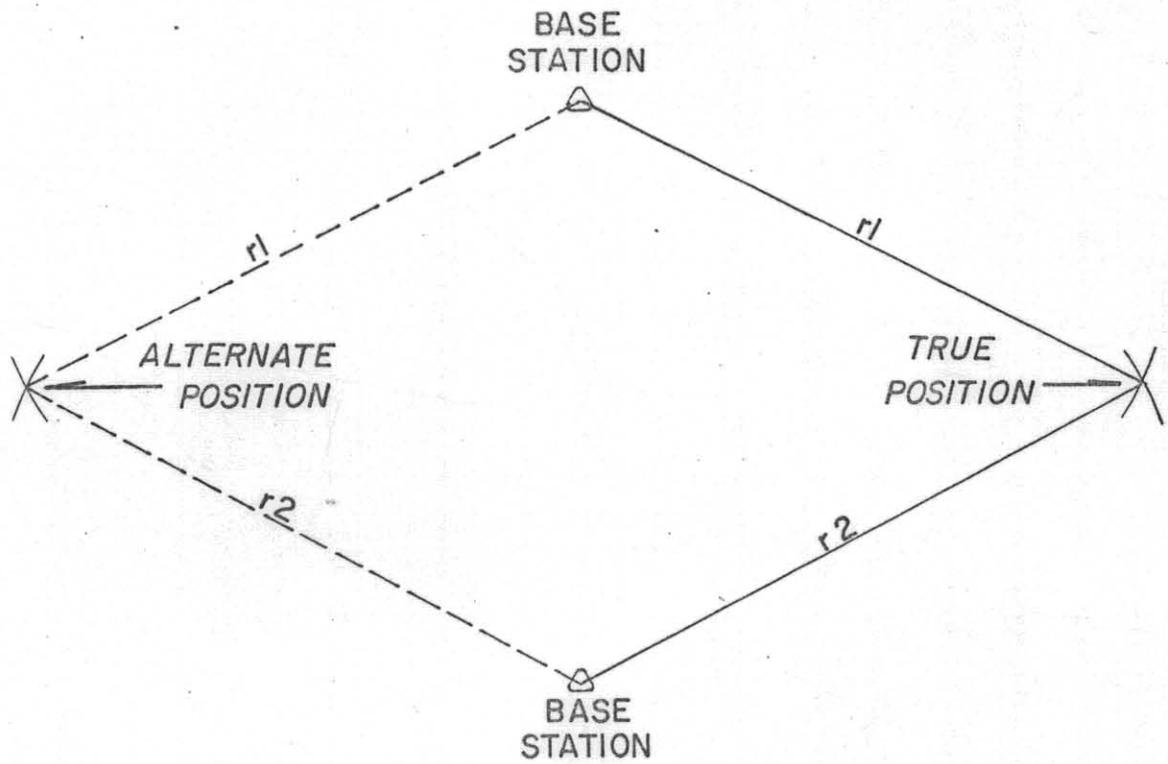
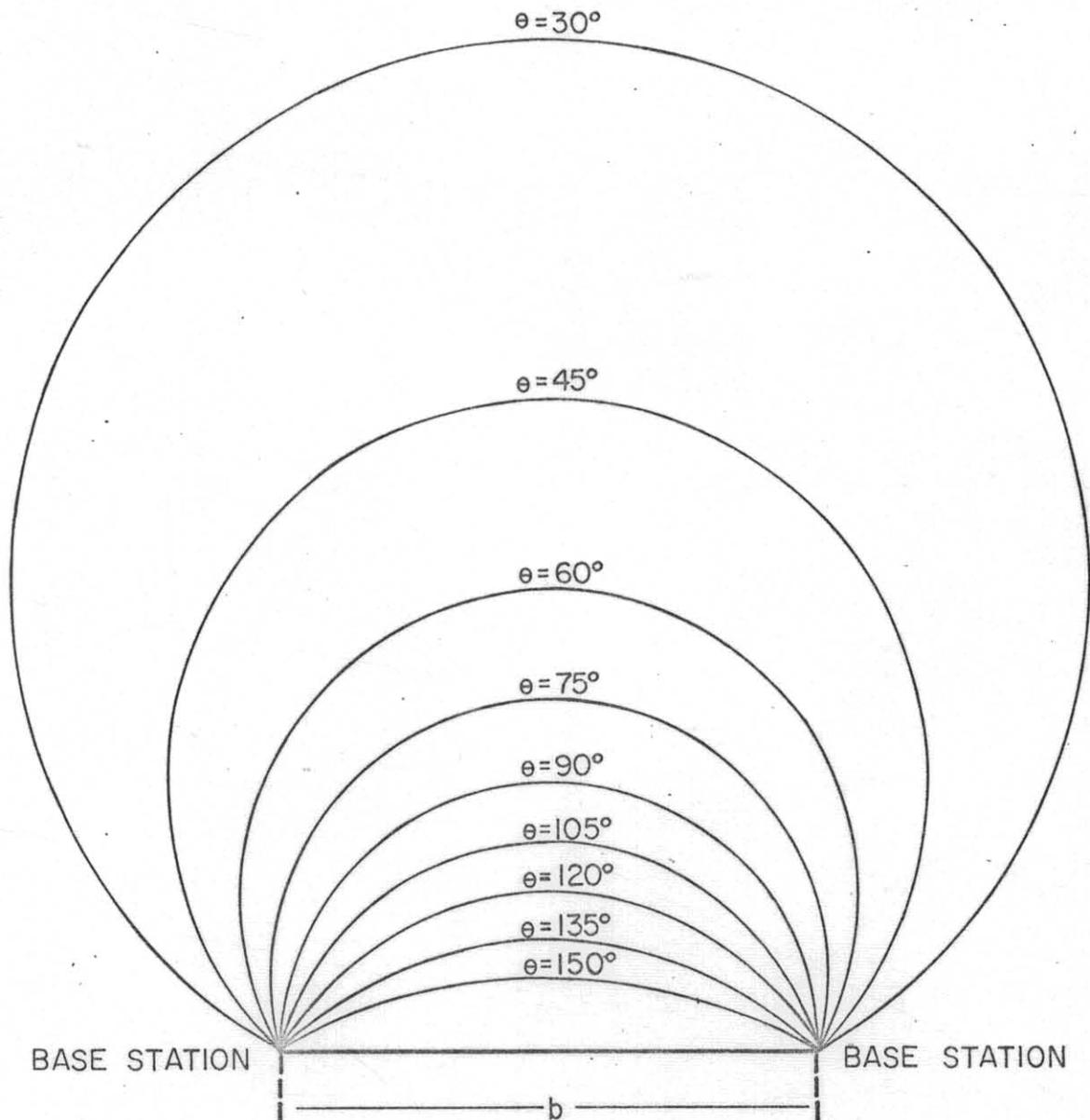


FIGURE 3

POSITION AMBIGUITY IN CIRCULAR RANGE
SYSTEM

5 cm



ALL ARCS ARE PORTIONS OF CIRCLES THROUGH BASE STATION POSITIONS OF RADIUS GIVEN BY

$$r = \frac{b}{2 \sin \theta}$$

WHERE θ IS ANGLE OF INTERSECTION BETWEEN RANGE CIRCLES

FIGURE 4.

RELATIVE AREA OF COVERAGE
CIRCULAR RANGING SYSTEM

5 cm

II. AREA OF OPERATIONS

Operations were conducted in the Bass Strait off the coast of Victoria, Australia. The Drilling Vessel, D/V GLOMAR CONCEPTION, was to be positioned approximately 40 miles northeast of Flinders Island. The well location was designated as:

Well Location SAILFISH NO. 1

The ONI base of operation for this survey was established at Yarram, Victoria 26 September 1971. An alternate base of operation was established at Welshpool, Victoria 27 September 1971.

III. FIELD OPERATIONS RECAP

The ONI advance personnel commenced work on this project 24 September 1971 preparing the Shoran equipment in Sydney prior to its shipment to the work area. All Shoran equipment was transported by truck from Sydney to Yarram, Victoria 26 September 1971 by ONI personnel.

Permission to occupy the Shoran base station sites

III. FIELD OPERATIONS RECAP (continued)

was obtained and preparations were made for the transportation and installation of all Shoran stations. The initial base station installation began 28 September 1971 and was completed 30 September 1971.

The vessel utilized for this operation was the M/V SMIT LLOYD 33, which was equipped with Shoran mobile indication equipment 29 September 1971 and departed Barrys Beach on that date with the Shoran base station equipment to be installed on Deal Island.

Shoran Station Deal Island was installed and operational 30 September 1971, and on this date the first Shoran readings for the client's field production were observed from all stations. A sounding survey and two well location buoys were positioned on this date.

The M/V SMIT LLOYD 33 then returned to Barrys Beach to await the arrival of the D/V GLOMAR CONCEPTION. The M/V SMIT LLOYD 33 departed Barrys Beach 4 October 1971 and arrived at Portland, Victoria 5 October and stood by for the D/V GLOMAR CONCEPTION. The

III. FIELD OPERATIONS RECAP (continued)

vessel departed Portland for the well location area 6 October and arrived at Well Location SAILFISH NO. 1 7 October 1971.

Due to adverse weather conditions, the final Shoran readings on the positioning of the D/V GLOMAR CONCEPTION on Well Location SAILFISH NO. 1 were not observed until 12 October 1971. The positioning was made to the client's satisfaction and the M/V SMIT LLOYD 33 departed for Barrys Beach 12 October 1971. The Shoran mobile indicating equipment was removed from the vessel at Barrys Beach and placed in storage.

The Shoran base stations were dismantled and stored close to their operating positions in anticipation of further well location operations.

The ONI base of operation was closed 14 October 1971 and all ONI personnel released from this survey.

IV. GENERAL INFORMATION

A. Shoran frequencies used were:

Mobile Transmitter 230/250 Mhz

Base Transmitter 300 Mhz

B. Satisfactory radiotelephone communications between all Shoran installations were maintained on the frequency of 4637.5 kilocycles.

C. The Shoran field data was turned over to the ONI New Orleans, Louisiana office for final computation.

D. Three Shoran base station installations were provided by ONI for this survey.

D. Three Shoran base station sites were occupied during this operation. They were:

STATION DEAL ISLAND

STATION MOUNT CANN

STATION WALKERS LOOKOUT

F. Maximum Shoran range observed during the survey was 127 miles.

IV. GENERAL INFORMATION (continued)

- G. In addition to the standard Shoran system, Range Extension (XR) equipment was provided by ONI for this survey. The XR components provided consisted primarily of improved antenna system, transmission lines, receivers, signal processing and power system. All stations were also provided with a solid state pre-amplifier.
- H. Shoran base station equipment was checked for proper calibration prior to its departure from New Orleans, Louisiana by use of a Range Calibration from a surveyed site at the ONI New Orleans office and a site located on the new municipal water tower in Mandeville, Louisiana. The base station equipment was adjusted to read the computed range of 29.893 miles.
- I. The Shoran mobile indicating unit was checked daily during the operation for proper zero set.

IV. GENERAL INFORMATION (continued)

J. There was no lost operation time due to Shoran equipment malfunction during this operation.

V. WELL LOCATION INFORMATION

The following information pertains to the positioning of the D/V GLOMAR CONCEPTION on Well Location SAILFISH NO. 1.

The following Shoran base stations were occupied to control the survey:

STATION DEAL ISLAND:

North = 1,132,191 yards
East = 524,274 yards

STATION MOUNT CANN:

North = 1,352,691 yards
East = 687,592 yards

STATION WALKERS LOOKOUT:

North = 1,062,490 yards
East = 594,215 yards

The Shoran ranges observed for the final well location were:

Mobile antenna to Walkers Lookout	50.832 miles
Mobile antenna to Deal Island	70.235 miles

The drill stem was located 60 feet from the Shoran mobile indicating antenna at a bearing of 340° True.

V. WELL LOCATION INFORMATION (continued)

Mobile antenna to Mount Cann 126.115 miles
(Taken from opposite side of rig to other readings.)

The drill stem was located 60 feet from the Shoran
mobile indicating antenna at a bearing of 160° True.

Final computed coordinates of Well Location SAILFISH
NO. 1, referred to the Australian Transverse Mercator
Projection, Clarke 1858 Spheroid of Reference, Zone 7,
Central Meridian 146° East:

Latitude	39°27'25".139 S	N = 1,134,117 yards
Longitude	148°38'00".877 E	E = 647,911 yards

VI. BASIC CONTROL

The following Shoran base stations, along with their coordinates, were occupied to control this survey.

Australian Transverse Mercator Projection
Clarke 1858 Spheroid
Zone 7
Central Meridian 146° East

STATION DEAL ISLAND:

Latitude	39°29'42"62 S	N = 1,132,191 yards
Longitude	147°19'15"46 E	E = 524,274 yards
Elevation	333 yards	

STATION MOUNT CANN:

Latitude	37°38'55"34 S	N = 1,352,691 yards
Longitude	148°58'45"80 E	E = 687,592 yards
Elevation	585 yards	

STATION WALKERS LOOKOUT:

Latitude	40°03'28"84 S	N = 1,062,490 yards
Longitude	148°04'52"44 E	E = 594,215 yards
Elevation	500 yards	

Universal Transverse Mercator Projection
Australian National Spheroid
Zone 55
Central Meridian 147° East

STATION DEAL ISLAND:

Latitude	39°29'41"36 S	N = 5,628,246 meters
Longitude	147°19'09"23 E	E = 527,449 meters
Elevation	304 meters	

VI. BASIC CONTROL (continued)STATION MOUNT CANN:

Latitude	37°38'54".13 S	N = 5,831,344 meters
Longitude	148°58'39".72 E	E = 674,472 meters
Elevation	534 meters	

STATION WALKERS LOOKOUT:

Latitude	40°03'27".53 S	N = 5,565,271 meters
Longitude	148°04'46".40 E	E = 592,074 meters
Elevation	457 meters	

All of the above coordinates were obtained from the Department of National Mapping, Canberra, Australia.

NOTE: The seismic data shot in the same area in 1969 was done so with Shoran preplots computed from different ATM coordinates for Stations Walkers Lookout and Deal Island only. The Northing and Easting used in 1969 were as follows:

STATION WALKERS LOOKOUT:

North	= 1,062,537 yards
East	= 594,059 yards

DEAL ISLAND:

North	= 1,132,236 yards
East	= 524,112 yards

Unless the seismic map is adjusted accordingly, caution should be used when comparing the SAILFISH NO. 1 site with the 1969 seismic maps.

VII. SHORAN THREE-WAY FIXES

The following Shoran Three-Way Fix was observed 30
September 1971:

Station Walker	50.674 miles
Station Deal	67.524 miles
Station Mt. Cann	124.945 miles

POSITION:

North = 5,634,010 meters
East = 635,927 meters

TIE:

5 meters

VIII. SHORAN BASELINE MEASUREMENTS

The following Shoran baseline measurements were observed during the survey period:

Stations Mount Cann/Walkers Lookout Baseline:

Observed Range	173.122 miles
Computed Range	173.106 miles
DIFFERENCE	26 meters

Stations Mount Cann/Deal Island Baseline:

Observed Range	155.840 miles
Computed Range	155.834 miles
DIFFERENCE	10 meters

IX. PERSONNEL

NAME	POSITION
Woody, D.	Party Chief/Mobile Operator
Fryer, T.	Base Operator
Koningsveld, L.	Base Operator
Miller, T.	Base Operator

X. DISTRIBUTION

Planet Oil Co. N.L.
280 George Street
Sydney, N.S.W. 2000
AUSTRALIA

Four copies

Offshore Navigation, Inc.
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AUSTRALIA

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STATION: DEAL ISLAND

LOCATED: On the southwest end of Deal Island.

ACCESS: Equipment and supplies must be carried from Port Albert, Victoria. This can be arranged by contacting Mr. Frank Gould at Port Albert, telephone 832343. Mr. Gould has a boat in which he makes regular supply runs to Bass Strait lighthouses. Equipment will be unloaded at Jetty which is 2 miles from the site. The lightkeeper has a Land Rover which is available to transport equipment to within 125 yards of the site. From this point it must be packed up a bush track to the site. Water is available at the lighthouse.

MARKER: A metal plate on highest point of hill between two large rocks.

GENERAL: To occupy site, permission must be obtained from the Regional Lighthouse Engineer, Shipping and Transport Department, 497 Collins St., Melbourne, Australia, Phone 620151.

ELEVATION: 333 yards

SKETCH: See next page.

GEOGRAPHICAL COORDINATES		UTM PROJ., AUST. NAT. SPHEROID ZONE 55, C.M. 147° EAST	
Latitude	Longitude	North	East
39°29'41"36 S	147°19'09"23 E	5,628,246 meters	527,449 meters
GEOGRAPHICAL COORDINATES		ATM PROJ., CLARKE 1858 SPHEROID BELT 7, C.M. 146° EAST	
Latitude	Longitude	North	East
39°29'42"62 S	147°19'15"46 E	1,132,191 yards	524,274 yards

STATION DEAL ISLAND - TASMANIA

LAT. $39^{\circ} 29' 41''.36$ S N. 5,628,246 METERS

LONG. $147^{\circ} 19' 09''.23$ E E. 527,449 METERS

ELEV. 289.6 METERS

U.T.M. PROJECTION AUSTRALIAN NATIONAL SPHEROID
ZONE 55 CENTRAL MERIDIAN 147° E.

LAT. $39^{\circ} 29' 42''.62$ S N. 1,132,191 YARDS

LONG. $147^{\circ} 19' 15''.46$ E E. 524,274 YARDS

ELEV. 333 YARDS

AUST. TRANSVERSE MERCATOR PROJECTION CLARKE 1858 SPHEROID
BELT 7 C.M. 146° E. F.N. = 1,000,000 YARDS



STATION: MOUNT CANN

ACCESS: Follow the Princes Highway for approximately 35 miles east of the town of Orbost. Take the first road to the right after crossing the Bemm River bridge, and then turn right onto Paddy's Creek Road. Turn left at the signpost "Mount Cann Tower".

A four-wheel drive vehicle is needed in wet weather. This is a drive-on site. A hut is located at the site.

Permission to occupy it should be obtained from the Forestry Office at Cann River.

MARKER: Standard circular vane marker on steel tripod approximately 15 feet high.

ELEVATION: 585 yards

SKETCH: See next page.

GEOGRAPHICAL COORDINATES		UTM PROJ., AUST. NAT. SPHEROID ZONE 55, C.M. 147° EAST	
Latitude	Longitude	North	East
37°38'54"13 S	148°58'39"72 E	5,831,344 meters	674,472 meters
GEOGRAPHICAL COORDINATES		ATM PROJ., CLARKE 1858 SPHEROID BELT 7, C.M. 146° EAST	
Latitude	Longitude	North	East
37°38'55"34 S	148°58'45"80 E	1,352,691 yards	687,592 yards

STA. (720) MT. CANN - AUSTRALIA

LAT. $37^{\circ} 38' 54.13$ S N. 5,831,344 METERS

LONG. $148^{\circ} 58' 39.72$ E E. 674,472 METERS

ELEV. 534 METERS

U.T.M. PROJECTION AUSTRALIAN NATIONAL SPHEROID

ZONE 55 CENTRAL MERIDIAN 147° E

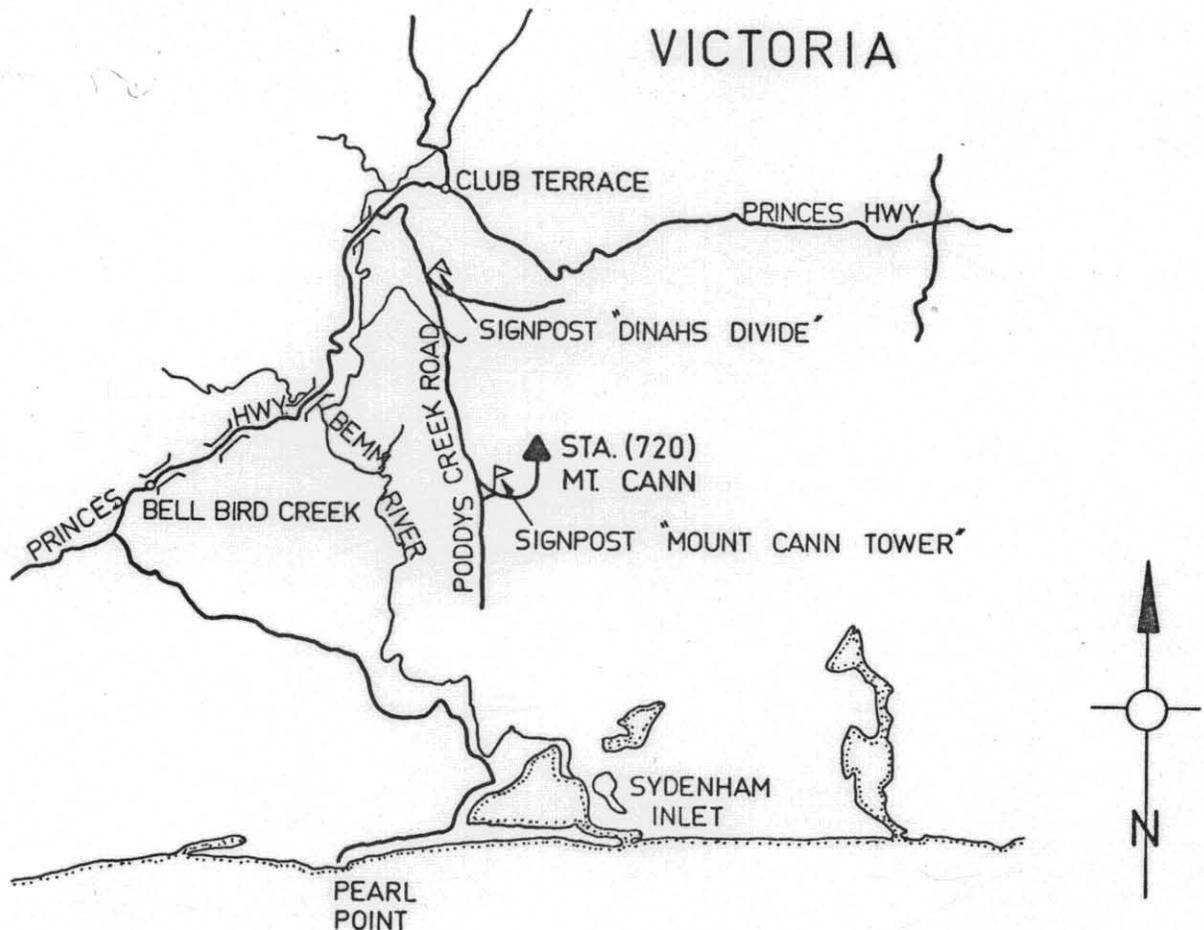
LAT. $37^{\circ} 38' 55.34$ S N. 1,352,691 YARDS

LONG. $148^{\circ} 58' 45.80$ E E. 687,592 YARDS

ELEV. 585 YARDS

AUST. TRANSVERSE MERCATOR PROJECTION CLARKE 1858 SPHEROID

BELT 7 C.M. 146° E.F.N. = 1,000,000 YARDS



STATION: WALKERS LOOKOUT

LOCATED: In the central region of Flinders Island
in the Bass Strait.

ACCESS: Equipment must be flown to Whitemark Airport
from Victoria or Tasmania. Follow road from
airport to Whitemark until Memana turnoff is
reached. Follow the turnoff until a dirt road
is seen on the right about two miles from
turnoff. Follow this road to the top of the
hill and trig. point, a distance of three miles.

MARKER: A wooden post with a four-gallon drum on top.
There are two T.V. towers beside the trig.
marker.

GENERAL: Mr. Walker, a contractor in Whitemark, is
available to transport equipment. Water and
supplies must be carried from Whitemark.

ELEVATION: 500 yards.

SKETCH: See next page.

GEOGRAPHICAL COORDINATES		UTM PROJ., AUST. NAT. SPHEROID ZONE 55, C.M. 147° EAST	
Latitude	Longitude	North	East
40°03'27"53 S	148°04'46"40 E	5,565,271 meters	592,074 meters
GEOGRAPHICAL COORDINATES		ATM PROJ., CLARKE 1858 SPHEROID BELT 7, C.M. 146° EAST	
Latitude	Longitude	North	East
40°03'28"84 S	148°04'52"44 E	1,062,490 yards	594,215 yards

STATION WALKERS LOOKOUT - TASMANIA

LAT. $40^{\circ} 03' 27''.53$ S N. 5,565,271 METERS
 LONG. $148^{\circ} 04' 46''.40$ E E. 592,074 METERS
 ELEV. 457 METERS

U.T.M. PROJECTION AUSTRALIAN NATIONAL SPHEROID
 ZONE 55 CENTRAL MERIDIAN 147° E.

LAT. $40^{\circ} 03' 28''.84$ S N. 1,062,490 YARDS
 LONG. $148^{\circ} 04' 52''.44$ E E. 594,215 YARDS
 ELEV. 500 YARDS

AUST. TRANSVERSE MERCATOR PROJECTION CLARKE 1858 SPHEROID
 BELT. 7 C.M. 146° E. F.N. = 1000 000 YARDS

