Sea Fish Industry Authority
Industrial Development Unit

CONVERSION OF OIL RIGS TO FISH REEFS – A CONCEPT INTO USING WHOLE OR PARTIAL OIL/GAS RIG INSTALLATIONS AS ARTIFICAL REEFS FOR FISH AGGREGATION

Internal Report No. 1238

August 1985.
Ken Knox,
Manager Kingfisher Charts

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SUMMARY

By 1992 the first decommissioning of oil rigs will take place in the North Sea. The process will be very expensive and one rig may cost as much as £160 million to dismantle to a safe level, which the oil companies are obliged to do under the United Nations Law of Sea Convention.

Different sea users will have differing views on the removal of the rigs, but it is possible that the rigs could provide an unexpected benefit to the fishing industry by creating an aggregation zone in much the same way as wrecks do at present. It is, therefore, desirable that an industry viewpoint is formed before the dismantling process begins. There are several redundant structures already in the North Sea, which could be used for monitoring trials and observations of fish behaviour.

This report outlines the opportunities for the fish industry and includes an appendix setting out the difficulties facing the oil industry in the 1990's.

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1. INTRODUCTION

The removal of oil installations, either total or partial, is of major concern to both Government and oil/gas producing companies. The problem is not so severe for the gas producing companies owing to the smaller design of rig.

The tremendous physical tasks involved are only surmounted by the astronomical costs estimated for the removal both of steel and concrete rigs (see the Worldwide Survey of Timing, Technology and Anticipated Costs) Appendix I. The cost of dismantling completely one rig in the North Sea may be as high as £160 million.

Naturally everyone concerned with this problem has been looking at various ways and means of reducing the high costs they are faced with, but unfortunately have many more factors against them than for them. Costs can, of course, be reduced by partial dismantling of rigs or toppling them in situ. There are naturally a number of objectors to such policies.

a. The Ministry of Defence is expected to show great concern on behalf of submarine operations (especially hostile submarines which could use the rigs for sonar confusion.

b. Merchant Vessel Owners are more likely to require total removal in busy shipping lanes, e.g. Flamborough Head and Humber - Continent, Pentland Firth, S.E.England - Continent and in shallow water areas.

c. The Fishing Industry are almost certain to insist on total removal in certain areas, e.g. anchor and fly seining.

d. MAFF. The Ministry is understood to be unconvinced that the "Rigs to Reef" concept will help to accumulate fish stocks.

e. DAFS have shown an interest in the reef concept as they have already begun work on an artifical reef formed by rock fill in the Firth, see Notice to Mariners, 1304(T) May 1984.

f. Static Fishermen e.g. gill netters, line fishermen, crab and lobster potters, jig fishing and angling clubs. In all probability, all of these fishermen will approve of the idea of rigs and pipelines being left as artificial reefs and breeding ground areas.

2. POSSIBILITIES OF USING RIGS AS REEFS

There are numerous points to consider and discuss on the subject of "Rigs to Reefs" and using Appendix I as a reference, it can be seen that the first de-commissioning will be in 1991 (estimate), only six years hence. This is a very short time considering the huge amount of work to be carried out. The oil companies have suggested eight methods for complete removal and six methods for partial removal. All are at considerably high cost from £31 to £160 million. Each case, however, is different and some rigs would need special treatment.

A brief meeting has taken place between Ken Knox, Manager Kingfisher Charts, and Mr. A. D. Read, with the following observations by Ken Knox.

a. We discussed the fishing by Whitby/Grimsby gill netters and angling parties on the Brazilian oil rig jacket, sunk 18 miles off Whitby approximately four years ago. This jacket (see attached photocopy of a similar installation) was taken down to a safe navigable level, below sea level, by explosives. There must, therefore, be many sharp and jagged edges left on it. This, plus strong tides during springs, results in excessive damage to gill/tangle nets and occasional loss of lines by anglers. Good catches of cod have been caught on it, especially after the winter period when poor weather conditions keep most boats away from the area. As soon as a good catch is reported or observed, the jacket is soon overfished. The jacket is lying on a soft sandy bottom and prior to it sinking, this was a very poor fishing area almost barren of commercial fish.

b. As illustrated by the photocopy, a jacket is just a large section of scaffolding which will probably cause strong tidal eddies on the tidal lee of the jacket and, no doubt, affect both fish and fishing gear. This tidal condition and the chances of equipment fouling between the individual sections of the jacket's scaffolding design, would, I think make an experienced fisherman keep his gear well clear of this type of structure.

c. The possibility of fish spawning and aggregating more profusely on the submerged complete rig tops containing accommodation modules, etc., would seem more likely. Fishing on or around these structures would be very similar to fishing on or around large wrecks which has been successful for many years now. Both seine vessels and bottom trawlers would be able to carry out fishing operations quite happily alongside these structures.

d. Besides the Brazilian jacket already mentioned, there are one or two other possible rigs on which research into aggregation could be carried out, which would have far more potential than the Brazilian jacket.

(i) Box 36/22. Pumping station placed on the Ekofisk-Tees pipeline. This station was not required and so has been unused and unmanned for several years. Occasional checks are carried out to maintain necessary safety standards and navigation lights were fitted. Regulatory Control of this pumping station is shared by the UK (Department of Energy) and the Norwegian Pipelines Inspectorate.

(ii) Frigg Field, Elf Oil Company, (French). A full complete rig sank whilst being placed on site seven years ago and is standing upright, located just in the Norwegian sectors.

(iii) Sea Gem. Sank in 1967 in waters close to Humberside. This rig is on most fishermen's plots and any information required could be easily obtained.

(iv) Beryl Field. Leg collapsed on a rig causing it to sink in the centre of a development area. This also should be completely untouched as far as fishing is concerned.

e. Coincidentally, I have been given a contact who could provide videos on offshore sub-sea installations which show clearly large shoals of fish gathering around them. Contact will be made to obtain copies of these videos.

f. A meeting is to take place in London during the second or third week in August so that we may compare notes, discuss more details, and to meet with E&P Forum. Mr. Read also suggests that in the near future a day's period might be arranged for a meeting of personnel from interested industrial parties.

We should adopt a guarded approach at this time. Whilst there are clear benefits to some sections of our industry, the whole issue is likely to become a considerable political matter and until we have more information, we should not raise any false hopes of support to the oil companies.

3. CONTACTS

Mr. Anthony D. Read,
Deputy Executive Secretary, E&P Forum,
25/28 Old Burlington Street,
London, W1X 1LB.
Tel.No. 01 437 6291.

Mr. W. C. F. Butler,
Oil Division, Department of Energy,
Thames House South,
Millbank, London SW1.
Tel.No. 01 211 3701
Secretary 01 211 4886.

Other parties involved in alternative uses of oil rigs:

The Institute of Offshore Engineering,

Heriot Watt University of Edinburgh.

(In 1983 these consultants were given a £50,000 grant by the Science of Engineering Research Council, which is administered by the Department of Education and Science. In October a one day seminar is to be held in Edinburgh by the Institute of Offshore Engineering.)

Marine Tech NW

(An amalagamation of the Universities of Manchester, Liverpool and Bangor N. Wales.)

4. RECOMMENDATIONS

a. Consideration of the SFIA's position on the use of rigs as artificial reefs. We should, however, discuss the matter thoroughly with MAFF, to be clear on Government policy.

b. AGH to contact Mr. W. Butler, Department of Energy.

c. Obtain as much evidence as is available on fish activities on or around sub-sea installations from fishermen and video film.

d. Obtain invitations to a seminar to be held by the Institute of Offshore Engineering, but as observers only.

e. Prepare cost estimates of a charter vessel to carry out gill netting on one or possibly two of the rigs mentioned in 2(d). This charter may be paid for by the oil companies.

f. Prepare large chart of the North Sea with overlays for oil fields, fishing grounds, shipping lanes, possible dumping ground for any installations not required for fish aggregation.

Ken Knox,
Manager Kingfisher Charts

E&P Forum

APPENDIX 1

THE DE-COMMISSIONING OF OFFSHORE INSTALLATIONS - A WORLD-WIDE SURVEY OF TIMING, TECHNOLOGY AND ANTICIPATED COSTS

by

The Oil Industry International Exploration & Production Forum

Report 10.5/108

December 1984

25-28 Old Burlington Street
London W1X 1LB

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PLATFORM REMOVAL QUESTIONNAIRE EXERCISE - RESULTS
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E & P FORUM PLATFORM REMOVAL TECHNICAL WORKSHOP 15 September 1983
Consensus on Practicalities of Complete and Partial Removal of 3 Categories of Platform

1. INTRODUCTION

The de-commissioning of offshore oil installations is not a new activity - such operations have been carried out in the Gulf of Mexico for a number of years, but these have mostly involved small shallow water structures. The prospect of production ceasing at a number of larger offshore structures during the next 10-15 years has prompted a number of oil companies world-wide to initiate studies on the technology and costs involved in their full and partial removal.

The findings from these studies have been brought together by the Oil Industry International Exploration and Production Forum (E & P Forum) through a questionnaire exercise and industry workshop.

The results of these two activities, which are considered in this report, have led to broad consensus on the regulation of these activities which has been summarised in a paper entitled "Removal of Offshore Installations - An Industry Position Paper". (E & P Forum Report N° 95) (May 1984).

2. BACKGROUND

Under the 1958 Geneva Convention signatory states are obliged to require the complete removal of offshore installations following the cessation of operations. That obligation has not been repeated in the 1982 United Nations Law of the Sea Convention (UNLOSC). Instead the new Article 60.3 requires that

> 'Any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation, taking into account of any generally accepted international standards established in this regard by the competent international organization. Such removal shall have due regard to fishing, the protection of the marine environment and the rights and duties of other States. Appropriate publicity shall be given to the depth, position and dimensions of any installations or structures not entirely removed.'

The competent organisation referred to is the International Maritime Organisation (IMO) and it is considered likely that it will be asked at some stage to start to develop an international standard for installation removal. The timing will be influenced by the progress, or otherwise on the coming into force of UNLOSC (as of October '84, 134 states had signed the convention, but only 15 had ratified).

The development of such standards will involve the resolution of legal, conflict of interest and practical engineering problems.

The E & P Forum sought to examine the latter area through the organisation of :

(i) a questionnaire exercise, and
(ii) a workshop meeting

on the practicabilities and costs of full and partial removal of installations. The results of the questionnaire exercise are given in Annex 1, copies of the key viewgraphs shown in presentations at the workshop in Annex 2, and a summary of the consensus reached there on the practicabilities and costs of full and partial removal of four main types of structures in Annex 3. Summaries of the conclusions drawn from these two activities are given below.

3. QUESTIONNAIRE EXERCISE (details at Annex 1)

Returns were received from 29 companies covering some 1519 fixed structures - approximately one quarter of the world's estimated population of 6000 fixed installations.

They revealed:-

(i) Most information was available on the anticipated timing of platform removal. (Tables 1 and 2 in Annex 1)

(ii) Removal of small platforms in the Gulf of Mexico is an ongoing activity, but work on the decommissioning of the larger North Sea type structures will not commence until around 1995, when world-wide some 150 platforms per year are likely to become redundant. (Tables 1 and 2)

(iii) Complete and partial removal studies had been carried out relating to some 43% (Tables 3 and 4) and 3.8% (Tables 6 and 7), respectively, of the platforms covered in the survey. (The fact that most of the studies only examined complete removal should not be regarded as too surprising in view of the nature of the requirement in the 1958 Geneva Convention).

(iv) Some 90% of the complete removal studies had involved the questionnaire option 'Remove installation to sea-bed - bring everything ashore' (i.e. progressive dismantling and removal from the top). Those studies on concrete installations involved re-flotation of the base with or without prior removal of topsides. (Tables 4 and 5)

(v) In only 6% of the removal studies was salvage and possible re-use of part of the structure considered viable. In only 0.5% of cases was re-use at a new location of the whole or major part part of the structure considered practicable (Table 4). This may be partly a reflection of the survey's concentration on deep water platforms.

(vi) Costs for the complete removal of a platform in 40-75 metres water were estimated to be:

- Gulf of Mexico	$ 1.4 mm
- Middle East Gulf	$ 0.7 mm
- California	$ 8.0 mm
- North Sea	$70.0 mm

The large (10+) factor between the cost of removal of a North Sea platform over those in less turbulent regions was typical of those for other platform types. This is partly due to the North Sea structures being more massive than their mild weather area counterparts, and partly due to the high cost involved in providing logistic support for any prolonged activity in severe weather areas.

The total cost of removal of the 15 largest platforms reported on was estimated to be $2,784 mm (average $186 mm).

(vii) The cost savings that would result from the adoption of partial removal would increase with the depth of water involved, in both absolutely and as a percentage of total removal cost (Table 6 and 9). Studies revealed few savings available from the adoption of partial removal in shallow waters, savings of around 27% in 40-75 m as compared with 87% in 250+ m of water.

(viii)The only approach which appeared likely to more than halve removal costs was toppling in-situ (Table 11).

On the basis of platform number and removal cost data contained in the questionnaire responses, estimates have been made in Table A of the total cost in 1983$ of removing the 1467 platforms covered in the survey. It will be seen that the total estimated cost for the 1467 platforms is $9,967 mm, and that $6,731 mm of this relates to 36 North Sea platforms in the 75-250m water depth range, i.e. 67.5% of the total estimated cost is associated with 2.5% of the total number.

There will be large costs associated with the removal of Gulf of Mexico platforms as well, but this is more due to their number rather than unit removal costs.

4. <u>WORKSHOP MEETING</u>

(Copies of key viewgraphs shown at Annex 2, Consensus summary on removal options at Annex 3)

This meeting was held in London on 15th September 1983. It was attended by some 32 experts representing 16 companies and 3 oil industry associations.

TABLE A – ESTIMATES OF THE TOTAL COST* OF REMOVAL OF PLATFORMS COVERED IN QUESTIONNAIRE RETURNS, BROKEN DOWN BY GEOGRAPHICAL AREA AND WATER DEPTH

WATER DEPTH	GULF OF MEXICO			NORTH SEA			MIDDLE EAST GULF			WEST AFRICA			TOTAL*	N° OF PLATF.
m	N° of Platf.	Unit Cost* $mm	Total* $mm	N° of Platf.	Unit Cost* $mm	Total* $mm	N° of Platf.	Unit Cost* $mm	Total* $mm	N° of Platf.	Unit Cost* $mm	Total* $mm	$mm	
<40	380	2.22	844	42	7.6	319	352	0.9	317	37	4.2	155	1635	811
40–75	409	1.41	577	5	68.7	343	93	0.7	65	12	NA		985	519
75–150	95	2.54	241	25	183	4575							4816	120
150–250	1	NA		11	196	2156							2156	12
>250	5	75	375										375	5
	890		2037	83		7393	445		382	49		155	9967	1467

* Total costs given are the product of No. of platforms and estimated mean cost/unit.

Participants were provided with information on the likely scale of the removal problem in the form of a breakdown of the current and estimated future distribution of offshore installations by location and water depth. However the main part of the meeting was spent in consideration of three presentations on the practicabilities and costs of full and partial removal of:-

(i) Steel platforms in up to 100 m water

(ii) Deep water steel platforms in excess of 100 m water

(iii) Concrete Platforms

Each of the speakers provided information on the techniques envisaged in removal, a breakdown of anticipated costs, and estimates of the time period required for removal. They highlighted the main areas of uncertainty and the large cost items in their budgets.

There was a general consensus that the high anticipated costs of removal of the large structures of the North Sea type were associated with:-

(i) the large mass of the structures, which precluded their being lifted out intact, and necessitated their break-up to small (approx. 500 tonne) pieces for removal,

(ii) the high day rates of large crane barges with the vertical lift capability, required to remove modules, etc.

(iii) the weather limitations associated with the loading of material onto barges, and the delays and costs associated with these limitations.

The three experts then led a discussion aimed at identifying for each installation type, which full and partial removal methods were considered practicable, and which approaches would be likely to incur lowest costs. - reference was made to the codified list of removal options used in the questionnaire exercise (see Annex 1).

Reference should be made to Annex 3 for full details of the consensus reached. Those methods identified with the greatest potential for cost reduction are highlighted in Table B.

The only identified method thought likely to be capable of more than halving removal costs was toppling in-situ. The adoption of those methods involving partial removal and the taking away of removed items could result in some savings, which would increase both relatively and absolutely with water depth.

TABLE B - SUMMARY OF WORKSHOP CONSENSUS ON PRACTICABILITIES AND COSTS OF PARTIAL REMOVAL OF PRINCIPLE PLATFORM TYPES (see Annex 3 for further detail)

PLATFORM TYPE	BASE CASE	PARTIAL REMOVAL METHODS INVOLVING		
		Similar order of costs to	40 - 70% of Base Case costs	<40% of Base Case costs
Steel < 50m	A*	J2	J3	None
Steel 50 - 100m	A		J1, J2, J3	H
Steel > 100m	A		I, J1. J2. J3	H
Concrete	E2 or D*		I, J2, J3	H

* A.D. etc. see codified list of removal options in Annex 1

5. SENSITIVITY OF REMOVAL COST TO VARIATIONS IN KEY ELEMENTS IN STANDARD

Workshop participants were then canvassed on the likely impact on removal cost to variations in the following key elements in any removal standard:-

(i) depth of clear water to be required above residues to permit safe passage of surface ships - variation in cost between providing 40m and 70m clear water;

(ii) acceptance of toppling in-situ leaving 40 m clear water, as against a requirement for bringing removed items ashore;

(iii) acceptance of toppling/disposal in-situ, as against disposal at an approved deep water distant site 200+ miles away

(iv) severity of requirement on cleanliness of unremoved/disposed items.

It will be seen from the summary of the consensus reached given in Table C that for most deep water structures (ii) and (iii) are the key factors. There will be arguments in the development of any standard on the depth of clear water allowable over any residue. This factor will be expected to have a critical effect on partial removal costs for a small number of platforms in marginal water depths. Additionally, for the small number of large concrete platforms, acceptance of toppling in-situ or disposal at an approved deep water site will be essential to permit technically sound disposal options for the small number of large concrete platforms. However, the critical cost determining factor for larger structures will be whether or not disposal in-situ or toppling gains acceptance.

6. CONCLUSIONS FROM QUESTIONNAIRE EXERCISE AND WORKSHOP

1. The costs of complete removal of small/medium platforms in Gulf of Mexico/Arabian Gulf appear to be relatively modest, and there appears to be limited scope for reduction through the acceptance of partial removal. Extension of the artificial reefs concept to include in-situ disposal may lead to further benefits. Acceptance of disposal for such purposes at some remote location appears unlikely to lead to much reduction.

2. In contrast the cost of complete removal of the large North Sea structures would be very high (estimated $6,371 mm for the 36 covered in the questionnaire survey). There appear to be potential for reducing these costs by around 15-25% by gaining

TABLE C - SENSITIVITY CHART

PARAMETERS IN STANDARD / PLATFORM TYPE	SMALL STEEL JACKET < 50m water	MEDIUM STEEL JACKET 50-100m water	LARGE STEEL JACKET > 100m water	CONCRETE
Variation of depth of removal requirement 40 - 75m	NA	Low	Low	Low
Acceptance of toppling in-situ - leaving 40m clear water (rather than bring ashore requirement)	NA	High	High	High
Acceptance of disposing in-situ rather than 200 miles from platform site	NA	High	High	High
Requirements on cleanliness of toppled/disposed material	Very Low	Very Low	Very Low	Very Low

SENSITIVITY:

High	> 50% cost of total removal
Medium	20-50% cost of total removal
Low	5-20% cost of total removal
Very Low	< 5% cost of total removal

acceptance for partial removal (i.e. with those parts removed being transported elsewhere for disposal). The cost savings for steel structures increases with water depth both absolutely and as a proportion of total removal cost. However the only method identified considered capable of achieving substantial further cost reductions is toppling in-situ.

3. All the studies on concrete platforms have envisaged re-flotation with or without prior removal of topsides. Considerable refitting of pipework and installation of new instrumentation would be necessary to achieve this. The only lower cost alternative considered has been cutting the columns sub-sea with explosives.

4. The E & P Forum is of the view that the costs involved in the complete removal of all installations are out of proportion to the benefits to other users of the sea that would accrue from the activity. The cost of removing the installations covered in the Forum's survey (approximately 25% of the total) would be around 10 billion dollars in 1983 money. Much of this expenditure would be expected to be effectively borne by governments by way of reduced taxation revenues. The adoption by governments of procedures/requirements targetted at the removal of any hazard to shipping could be achieved for less than half that sum. The E & P Forum contends that the benefits which might accrue from the expenditure of the other 50% in achieving complete removal are minimal, and totally disproportionate to the costs involved.

ANNEX 1

PLATFORM REMOVAL QUESTIONNAIRE EXERCISE

RESULTS

Analysis of Questionnaires Received

NUMBER OF COMPANIES RESPONDING 29

NUMBER OF PLATFORMS : - timing details 1519
- complete removal date 653
- partial removal date 58

TABLE 1 - ANTICIPATED PLATFORM REMOVAL DATES - LOCATION

ANTICIPATED DATE / LOCATION	NUMBER TO BE REMOVED IN SPECIFIC PERIOD Before 1985	86-90	91-95	96-2000	2001-10	1011+	TOTAL
North Sea			2*	13	59	9	83
Gulf of Mexico	28	157	230	175	81	219	890
Middle East						445	445
Africa			1	18	18	12	49
Far East		2					2
Other location not specified		3	21	9	11	6	50
TOTAL	28	162	254	215	169	691	1519

TABLE 2 - ANTICIPATED PLATFORM REMOVAL DATES - WATER DEPTH

ANTICIPATED DATE / WATER DEPTH	NUMBER TO BE REMOVED IN SPECIFIC PERIOD Before 1985	86-90	91-95	96-2000	2001-10	1011+	TOTAL
<40m	17	68	118	104	67	437	811
40 - 75m	9	71	105	71	76	235	567
75 - 150m	2	23	31	38	15	15	124
150 - 250m				1	9	2	12
>250m				1	2	2	5
TOTAL	28	162	254	215	169	691	1519

COMPLETE REMOVAL COST DATA SUPPLIED ON FOLLOWING NUMBER OF PLATFORMS :-

(i) TYPE

Concrete 14
Steel jacket 636
Special 3

(ii) TABLE 3 — LOCATION AND WATER DEPTH OF PLATFORMS SUBJECTED TO REMOVAL STUDIES

LOCATION	NUMBER OF PLATFORMS IN WATER DEPTHS (m) <40	40-75	75-150	150-250	>250
Gulf of Mexico	43	247	65		1
North Sea	19	18	30	3	
West Africa	75	12			
Middle East	92	44			
U.S. West Coast & Alaska	1	2			
TOTAL	230	323	95	3	1

TABLE 4 - COMPLETE REMOVAL - Methods Considered

METHOD	N° OF PLATF.
A. Remove to seabed - bring everything ashore	569
B. Remove to seabed - dispose in deep water at some other location	13
C. Refloat whole installation and bring ashore for dismantling	1
D. Refloat whole installation and dispose in deep water	23
E1. Refloat base after removing top-sites - bring everything ashore	2
E2. Refloat base after removing top-sides - bring top-sides ashore and dispose base in deep water	38
E3. Refloat base after removing top-sides - dispose everything in deep water	4
F. Remove whole/major part for re-use at new location	3

FOR FISHING PURPOSES. DISPOSE OF TOPSIDE IN DEEP WATER & BRING BASE ASHORE.

TABLE 5 - COMPLETE REMOVAL - Methods Considered, broken down by Type and Water Depth

DEPTH \ METHOD	A	B	C	D	E1	E2	E3	F
1. STEEL: < 40m	229							1
40 - 75m	274	5		19		20	2	2
75 -150m	64	7				11	2	
150m	1	1						
>250m	1							
2. CONCRETE : < 40m								
75 -150m				4		7		
150m					2			

TABLE 6 - PARTIAL REMOVAL - Methods Considered

METHOD		N° OF PLATF.	COST % TOTAL REMOVAL
H.	Toppled whole installation in situ	1 14	10 35
J1.	Lift off top-sides and jacket down to specified depth - place removed items along side residue	10 1	50 13
J2.	Lift off top-sides and jacket down to specified depths - take removed items ashore	2 2 2	500 63 73
J3.	Lift off deck - bring ashore. Take jacket down to specified depth - place removed items alongside residue	4	30-50
K/J3	Lift off deck - bring ashore. Take jacket down to specified depth - dispose items in deep water	13	100
L.	Leave template, flow lines and/or gravity base on sea-bed - removed items disposed in deep water (removal of all these items assumed in complete removal studies on relevant platforms)	2 1 1 1	12.8 23.8 66.5 97.9

TABLE 7 - PARTIAL REMOVAL - Methods Considered, broken down by Type and Water Depth

DEPTH \ METHOD	H	J1	J2	J3	K/J1	K/J3	L
1. STEEL < 40m							
40- 75m	15	2				13	
75 -150m		8	6	4			3
150-250m		1					
>250m		1					
2. CONCRETE 75-150m							1

TABLE 8 - ESTIMATED MEAN COSTS FOR COMPLETE REMOVAL OF INDIVIDUAL STEEL AND CONCRETE PLATFORMS ($ millions)

LOCATION \ WATER DEPTH	40	40-75m	75-150m	150-250m	250m
1. STEEL					
North Sea	7.6 (19)	68.7 (22)	183 (12)	196 (3)	
Gulf of Mexico	2.22(34)	1.41 (230)	2.54(70)		75(1)
California		8 (2)			
Middle East Gulf	0.9 (92)	0.7 (44)			
Nigeria	4.2 (37)				
Alaska	12 (1)				
2. CONCRETE					
North Sea		183 (1)	176 (9)	169 (4)	

TABLE 9 - ESTIMATED COSTS FOR PARTIAL REMOVAL OF STEEL PLATFORMS ($ millions)

LOCATION \ WATER DEPTH	40m	40-75m	75-150m	150-250m
North Sea		31 (14)	170 (2)	54 (1)
Gulf of Mexico		1.23 (18)	0.88 (10)	

TABLE 10 - PARTIAL REMOVAL COSTS AS % TOTAL REMOVAL FOR PARTICULAR STEEL PLATFORMS

LOCATION \ WATER DEPTH	40	40-75m	75-150m	150-250m	>250m
North Sea			62 (6)		
Gulf of Mexico	100	73 (18)	48 (10)		13 (1)

TABLE 11 - DEMOLITION - IN-SITU - TOPPLING COSTS AS % TOTAL FOR PARTICULAR STEEL PLATFORMS

LOCATION \ WATER DEPTH	40m	40-75m	75-150m	150-250m
North Sea		45 (14)		20 (1)

( ) = number of platforms involved in given mean estimate.

APPENDIX - Description of Proposed Method of De-commissioning

COMPLETE REMOVAL

A - Remove to seabed - bring everything ashore

B - Remove to seabed - disposed in deep water at some other location

C - Refloat whole installation and bring inshore for dismantling

D - Refloat whole installation and dispose in deep water

E - Refloat base after removing topsides,
E1 - Bring everything ashore
E2 - Bring topsides ashore & dispose of base in deep water
E3 - Dispose everything in deep water

F - Remove whole/major part of installation for re-use at new location

G - Other - please specify

PARTIAL REMOVAL

J - Lift off topsides and jacket down to specified depth below sea level,
J1 - See below 'Dismantling/Topple in-situ'
J2 - Take removed items ashore
J3 - Dispose removed items in deep water/other location

K - Other - please specify

DISMANTLING/TOPPLE IN-SITU

I - Removal/partial removal of topsides - topple residue in-situ

J1 - Lift off topsides and jacket down to specified depth below sea level - place removed items alongside residue

H - Topple whole installation in-situ

OTHER

L - Leave - other use

M - Do nothing

N - Leave - maintain lights

APPENDIX -

ANNEX 2

E & P FORUM PLATFORM REMOVAL TECHNICAL WORKSHOP 15TH SEPTEMBER 1983

Selection of viewgraphs displayed :

A. Steel platforms in up to 100m water depth. Partial removal options and cost implications.

Typical Lifting Operation-elevation
Jacket Lifting Sequence

B. Deep water steel platforms (>100m water). Partial removal options and cost implications.

Estimated Costs for Total Temoval of Steel Platform in Water Depths >100 metres.

Estimated Costs for Toppling Deepwater Steel Platform in Water Depths >100 metres.

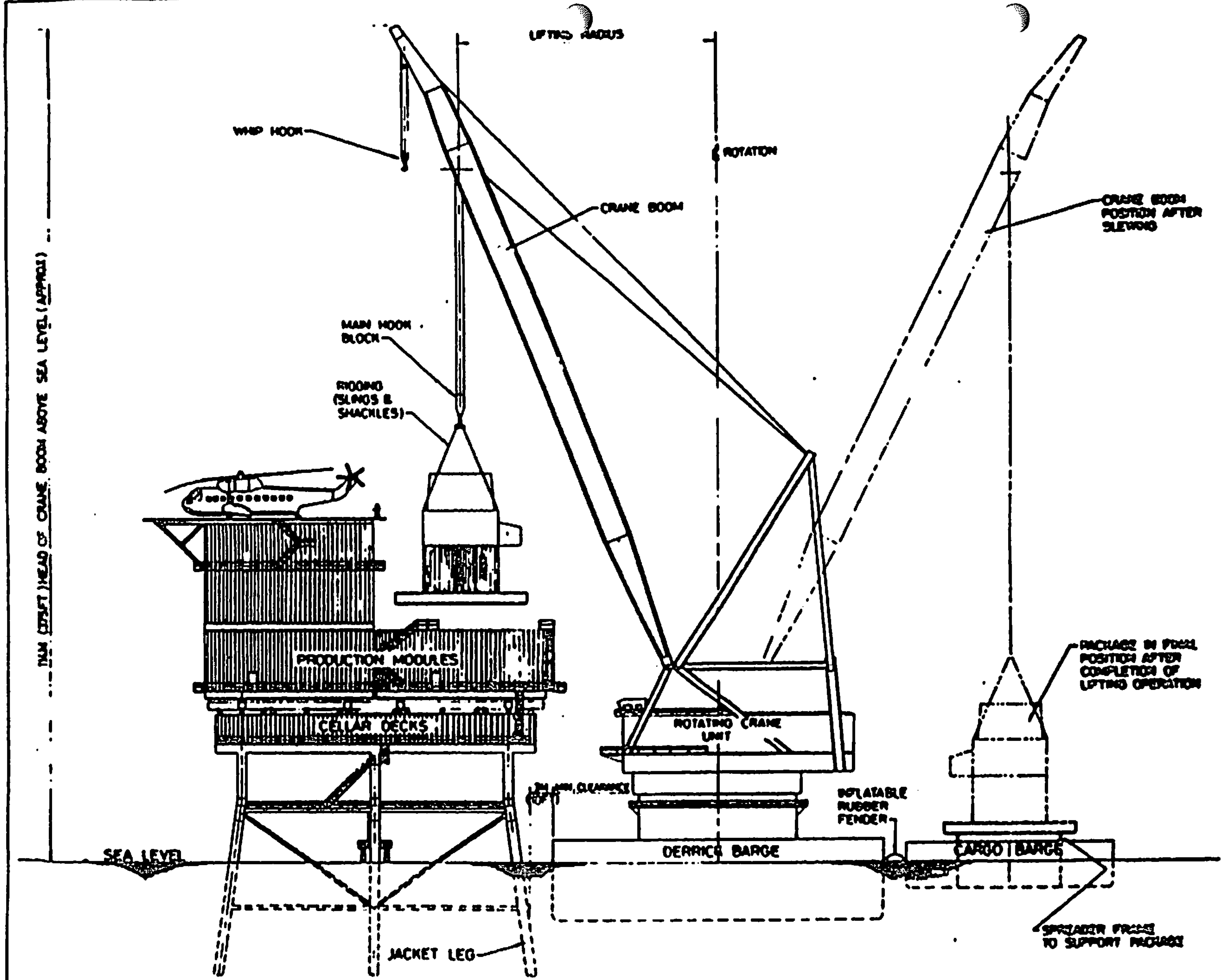
Relative Costs of Abandonment Methods for a Steel Structure in Deep Water >100 metres.

Work Schedule for Total Removal - Steel Platform in circa 160 M.

Work Schedule for Partial Removal by Toppling.

C. Concrete platform. Main Structural Components.

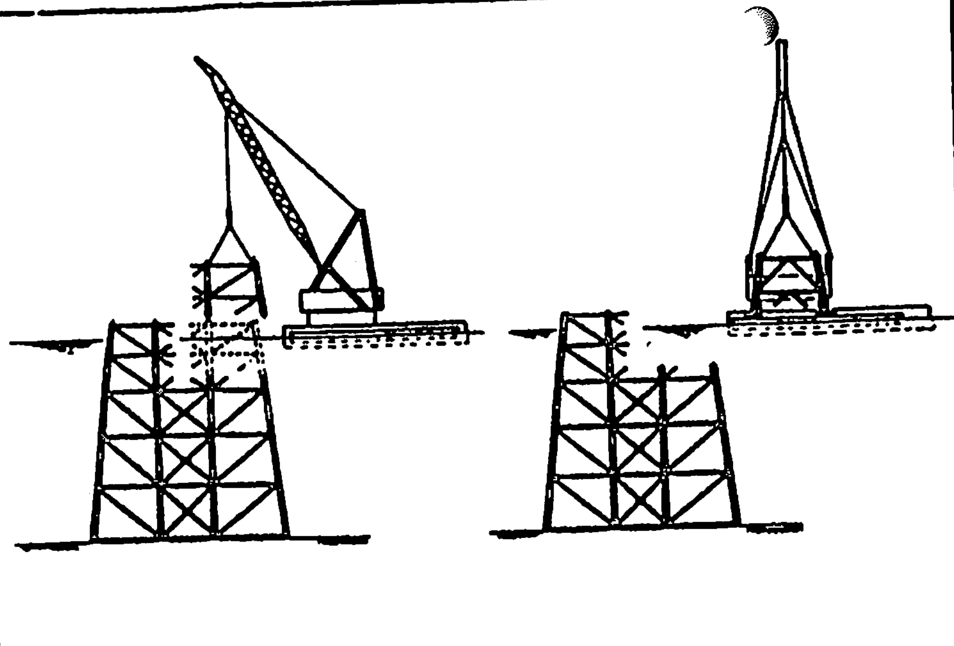
Side view of Brent B Sub-structure
Method of Removal
Steps for Sub-structure Removal
Refloatation Equipment
Water Injection Piping on top of Caisson
Water Injection Point at Skirt
Towing arrangement



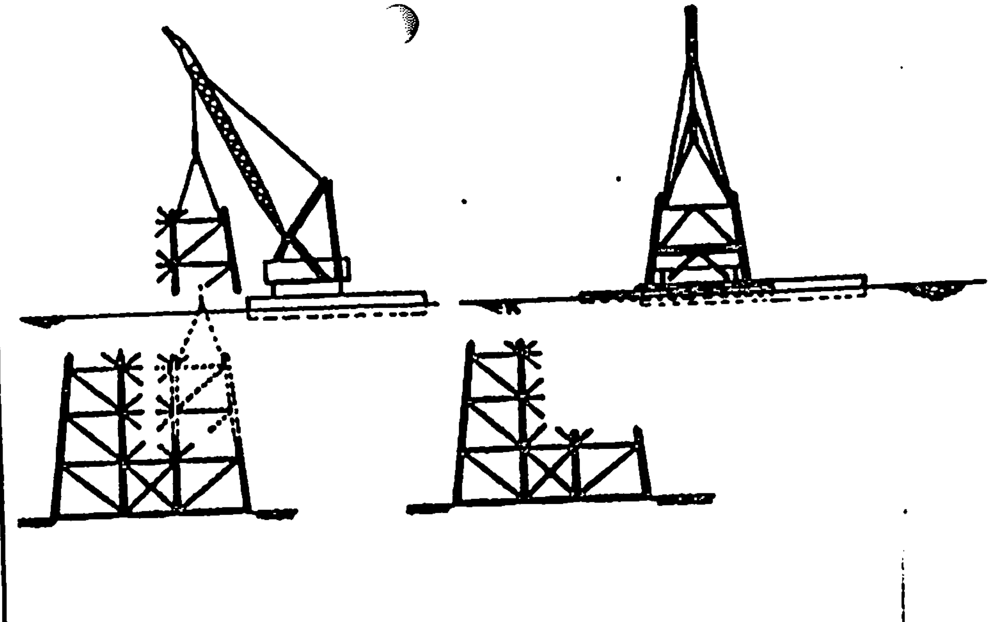
NOTE
THIS ILLUSTRATION SHOWS A TYPICAL HEAVY LIFT OPERATION INVOLVING THE REMOVAL OF A DRILLING PACKAGE FROM A PRODUCTION PLATFORM BY MEANS OF LIFTING WITH A [illegible] REVOLVING DERRICK BARGE & SETTING ON TO A [illegible] CARGO BARGE

TYPICAL LIFTING OPERATION
ELEVATION

PLATE 2-18

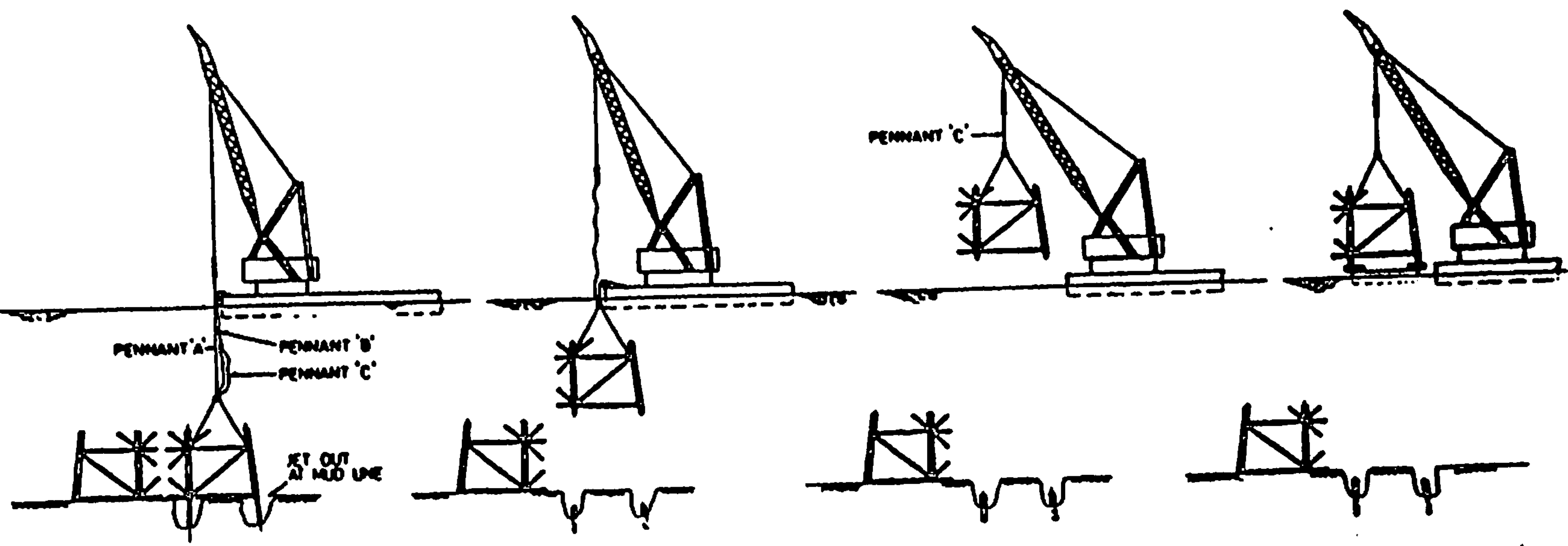


SEQUENCE OF LIFTING FOR JACKET SECTIONS 1 & 2



SEQUENCE OF LIFTING FOR JACKET SECTIONS 3 & 4

NOTES



SEQUENCE OF LIFTING FOR JACKET SECTIONS 5 & 6

JACKET LIFTING SEQUENCE

PLATE 2.10

Estimated Costs for Total Removal of Steel Platform in Water Depth greater than 100 metres

	£000
Project Team	1,700
Abandon Wells	10,800
Clean and Make Safe	3,800
Topsides Removal	50,100
Disconnect Pipeline and Risers	300
Pile Cutting	930
Jacket Leg Cutting	46,500
Clean Seabed + Survey	1,500
Sub Total (A)	115,630
Ancillary Costs (6% of ST(A) + £250,000)	7,188
Sub Total (B)	122,818
Contingency @ 30% of ST(B)	36,845
Total	159,663

Approx £160 million ($240 million)

Estimated Costs for Toppling Deepwater Steel Platform in Water Depth greater than 100 metres

	£000
Project Team	500
Abandon Wells	10,800
Clean and Make Safe	5,930
Remove Floatables	1,980
Disconnect Pipeline and Risers	300
Jacket Demolition	2,253
Survey	700
Sub Total (A)	22,463
Ancillaries (6% of ST(A) + £250,000)	1,598
Sub Total (B)	24,061
Contingency @ 30% of ST(B)	7,218
Total	31,279

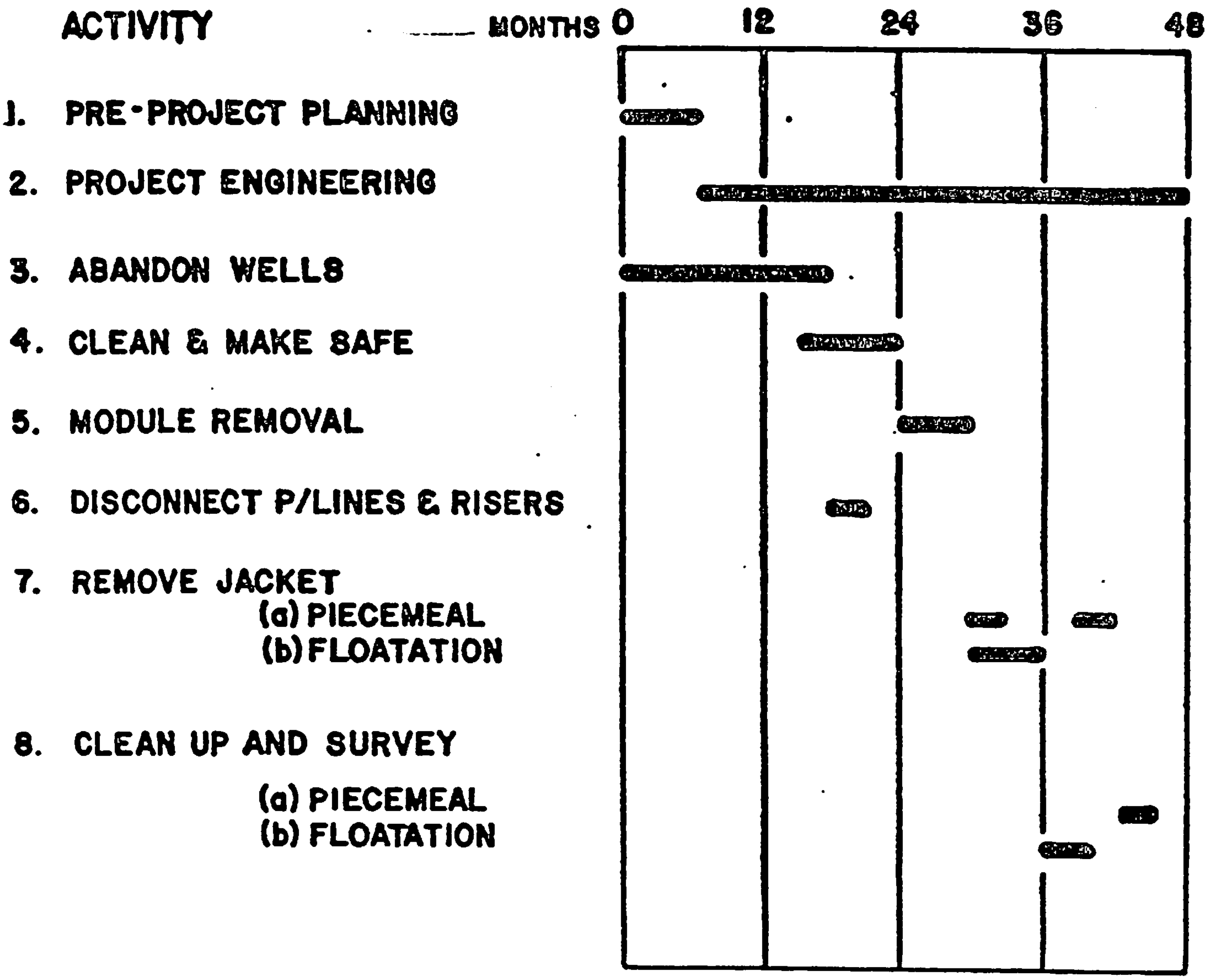
Approx £31.3 million ($47 million)

RELATIVE COSTS OF ABANDONMENT METHODS FOR A STEEL STRUCTURE IN DEEP WATER > 100 METRES.

	£ MILLIONS
TOTAL REMOVAL -5 METRES BELOW SEABED	160
PARTIAL REMOVAL TO -50 METRES	120
TOPPLING COMPLETE PLATFORM TO GIVE 50 METRES CLEARANCE TO SURFACE	32

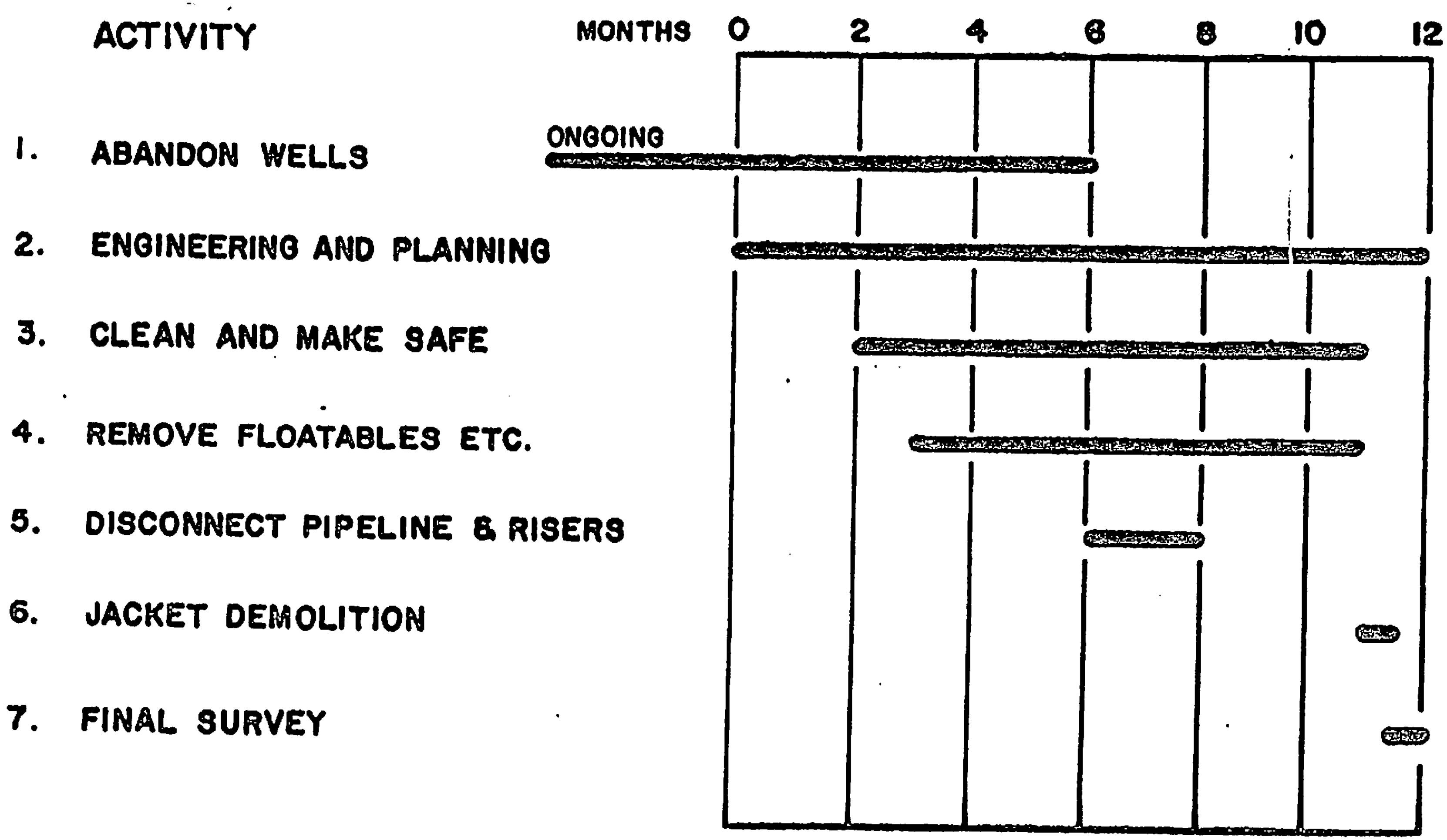
TOPPLING IS 27% COST OF PARTIAL REMOVAL
AND ONLY.......20% OF COST OF TOTAL REMOVAL

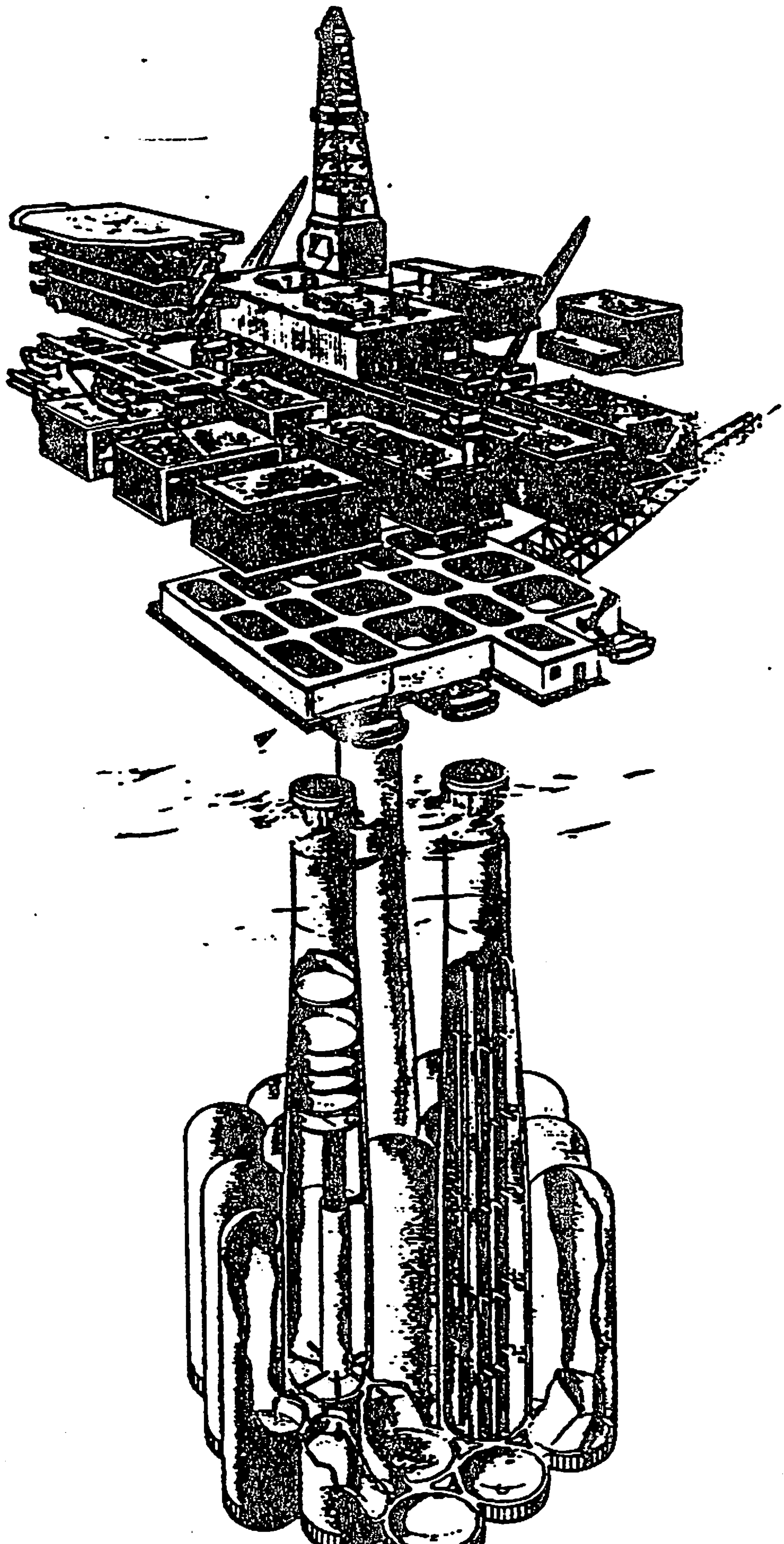
WORK SCHEDULE FOR TOTAL REMOVAL
STEEL PLATFORM WATER DEPTH CIRCA.160M



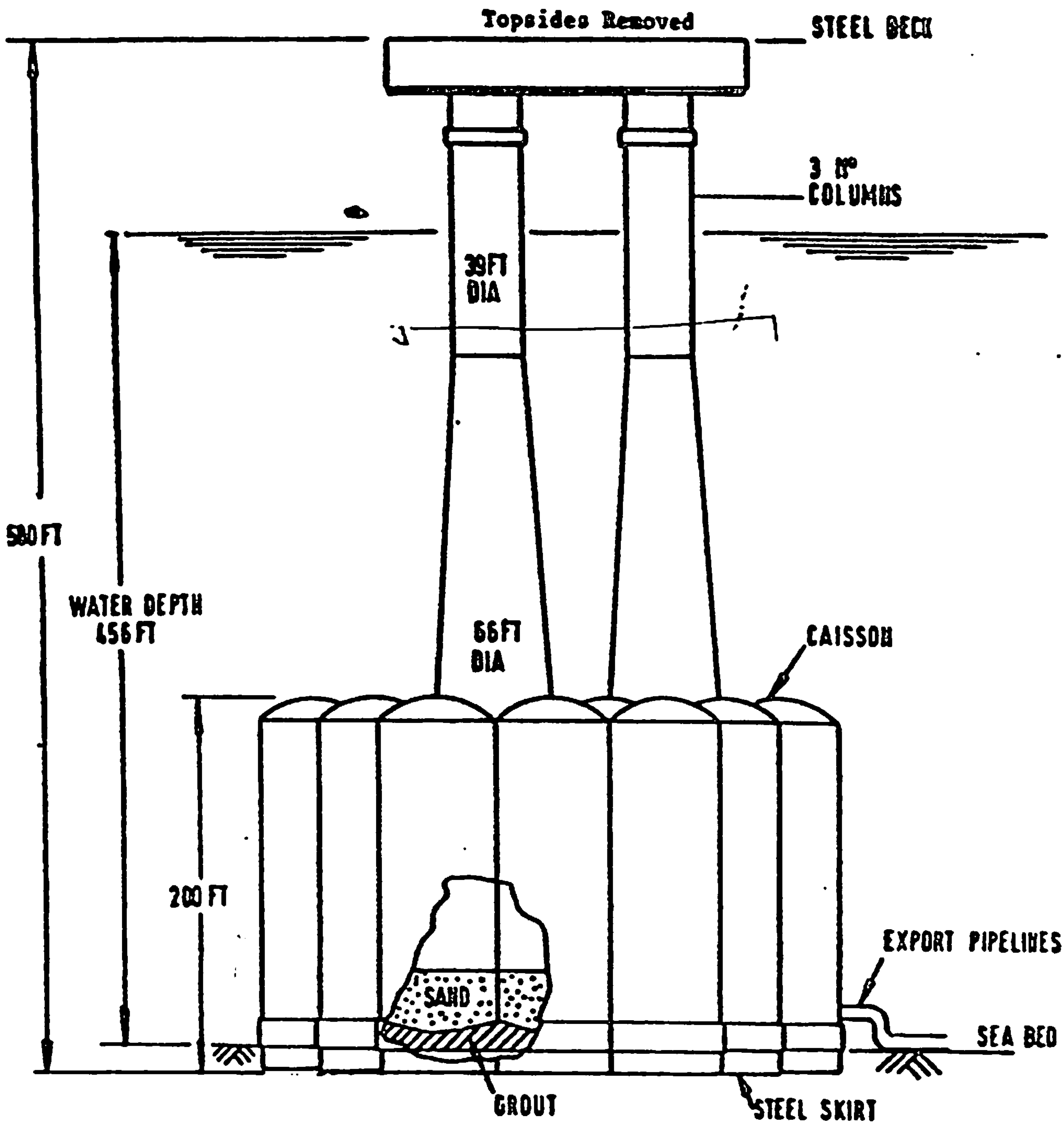
WORK SCHEDULE FOR PARTIAL REMOVAL BY TOPPLING

STEEL PLATFORM WATER DEPTH CIRCA. 160M

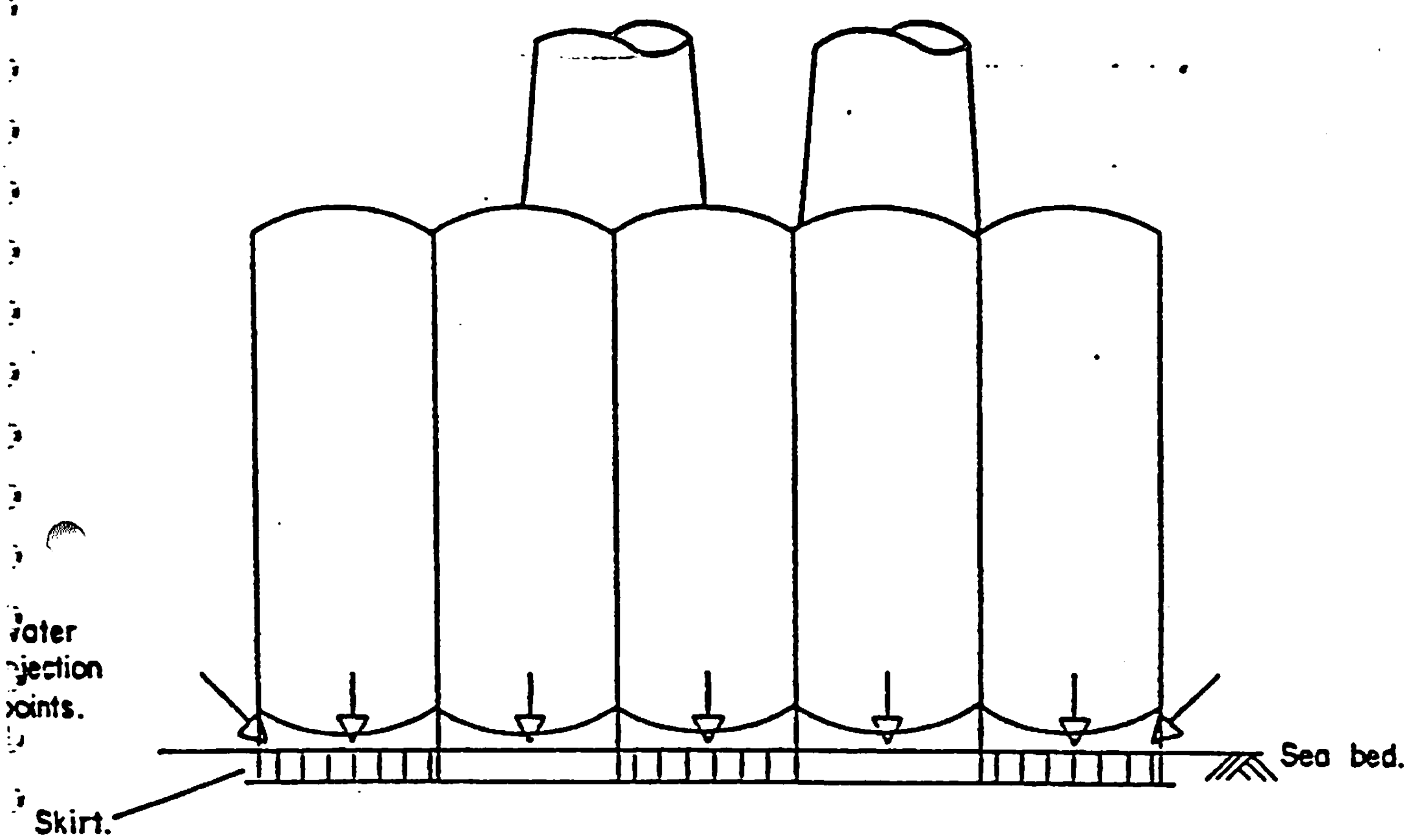




MAIN STRUCTURAL COMPONENTS



SIDE VIEW OF SUBSTRUCTURE



REQUIREMENTS FOR REMOVAL :

1. DEBALLAST.
2. UPWARD FORCE TO OVERCOME FRICTION.
3. INJECT WATER TO OVERCOME SUCTION.

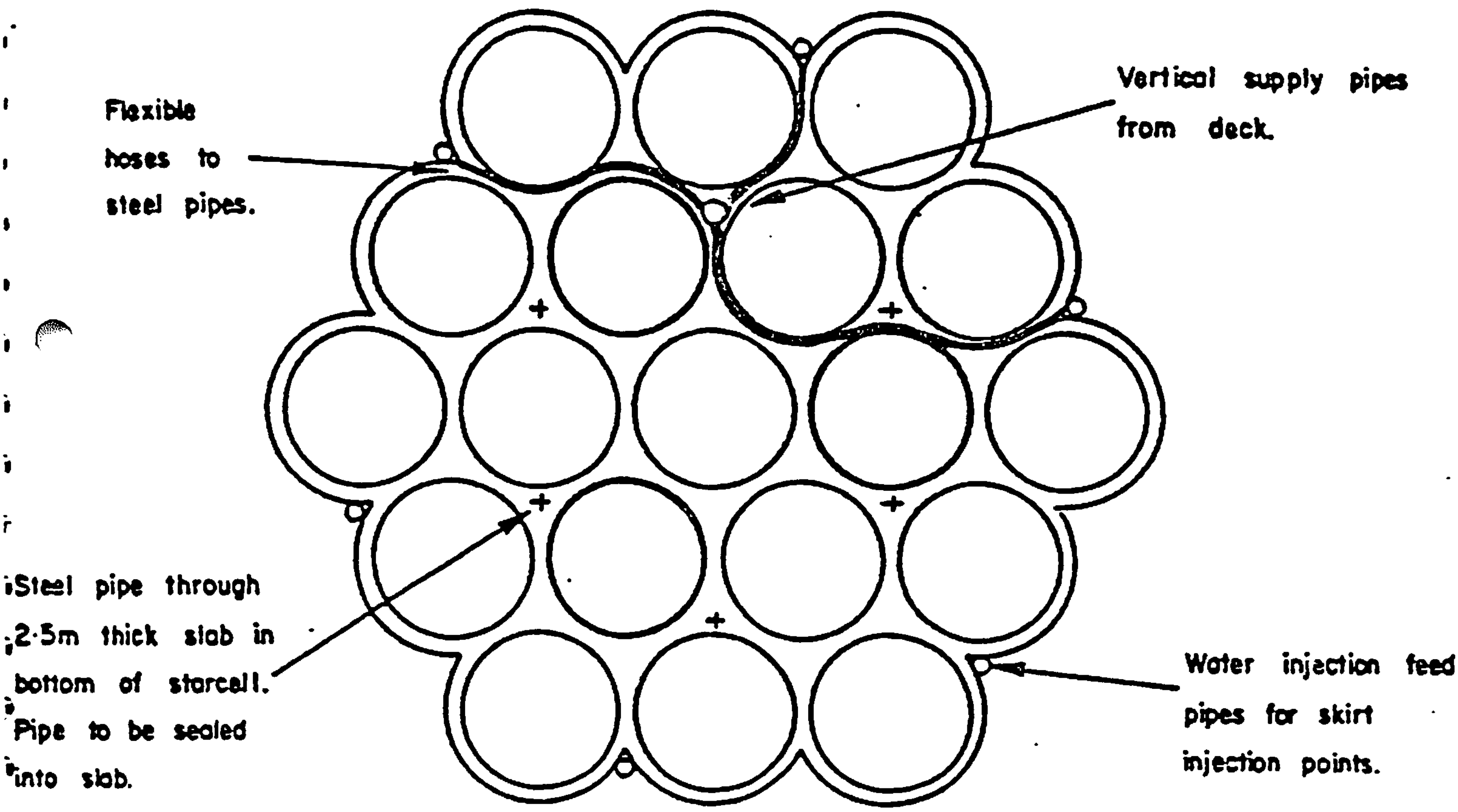
METHOD OF REMOVAL

STEPS FOR SUBSTRUCTURE REMOVAL

1. SURVEY OF STRUCTURE
2. ENGINEERING AND PLANNING
3. REMOVE TOPSIDES
4. DISCONNECT SEABED CONNECTIONS
5. INSTALL REFLOATATION PACKAGES
6. ATTACH TOWING POINTS
7. INSTALL/RECONNECT/TEST RE-FLOATATION PIPEWORK AND INSTRUMENTS
8. REFLOAT STRUCTURE
9. TOW AND SCUTTLE

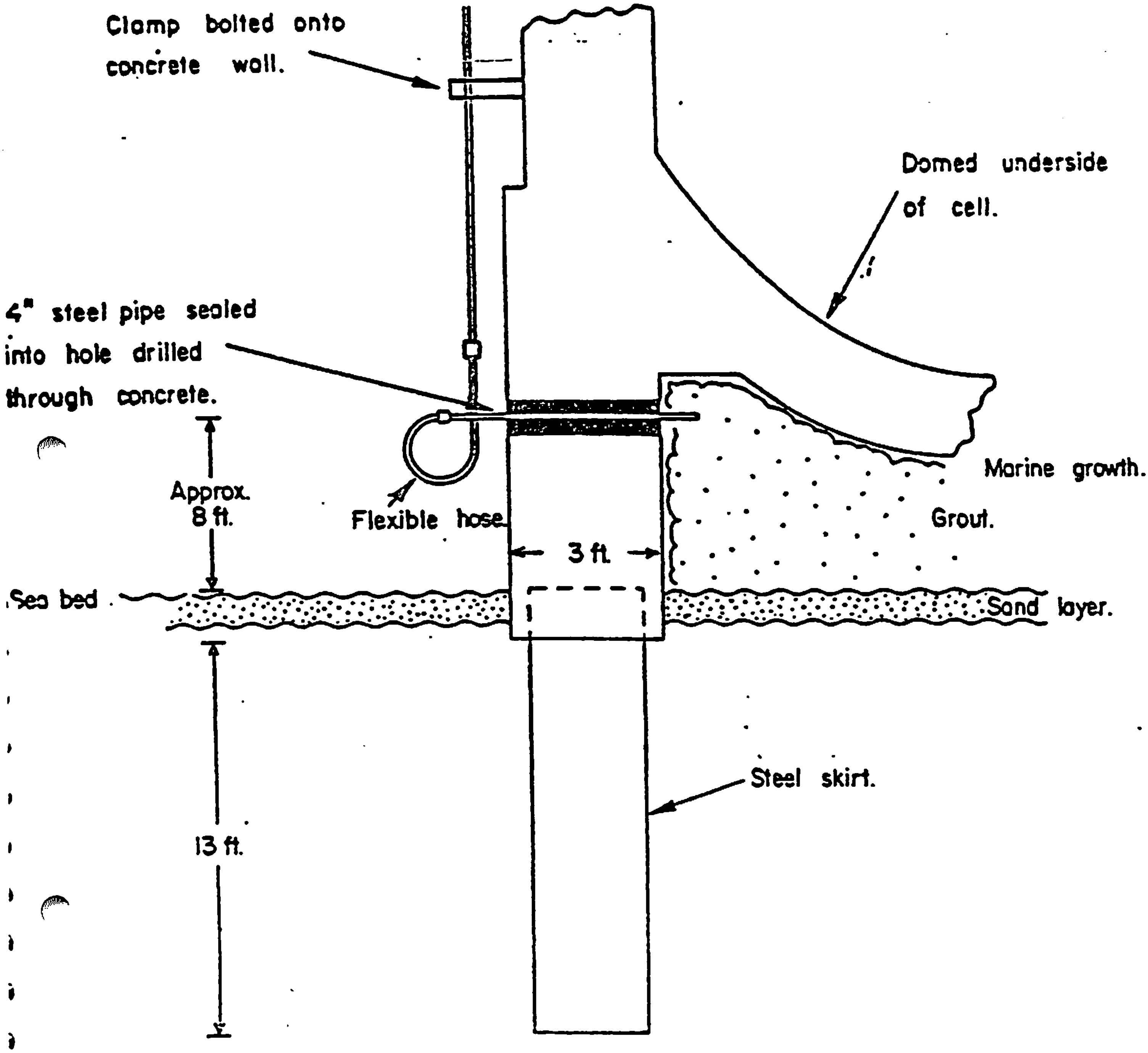
REFLOATATION EQUIPMENT

HELIDECK
CRANEAGE
LIFEBOATS
FULL ACCOMODATION OR SURVIVAL QUARTERS
DECKING, WALKWAYS, HANDRAILS
BALLASTING PUMPS AND PIPEWORK
WATER INJECTION PUMPS AND PIPEWORK
REMOTE CONTROL EQUIPMENT
INSTRUMENTATION
CONCRETE DRILLING EQUIPMENT

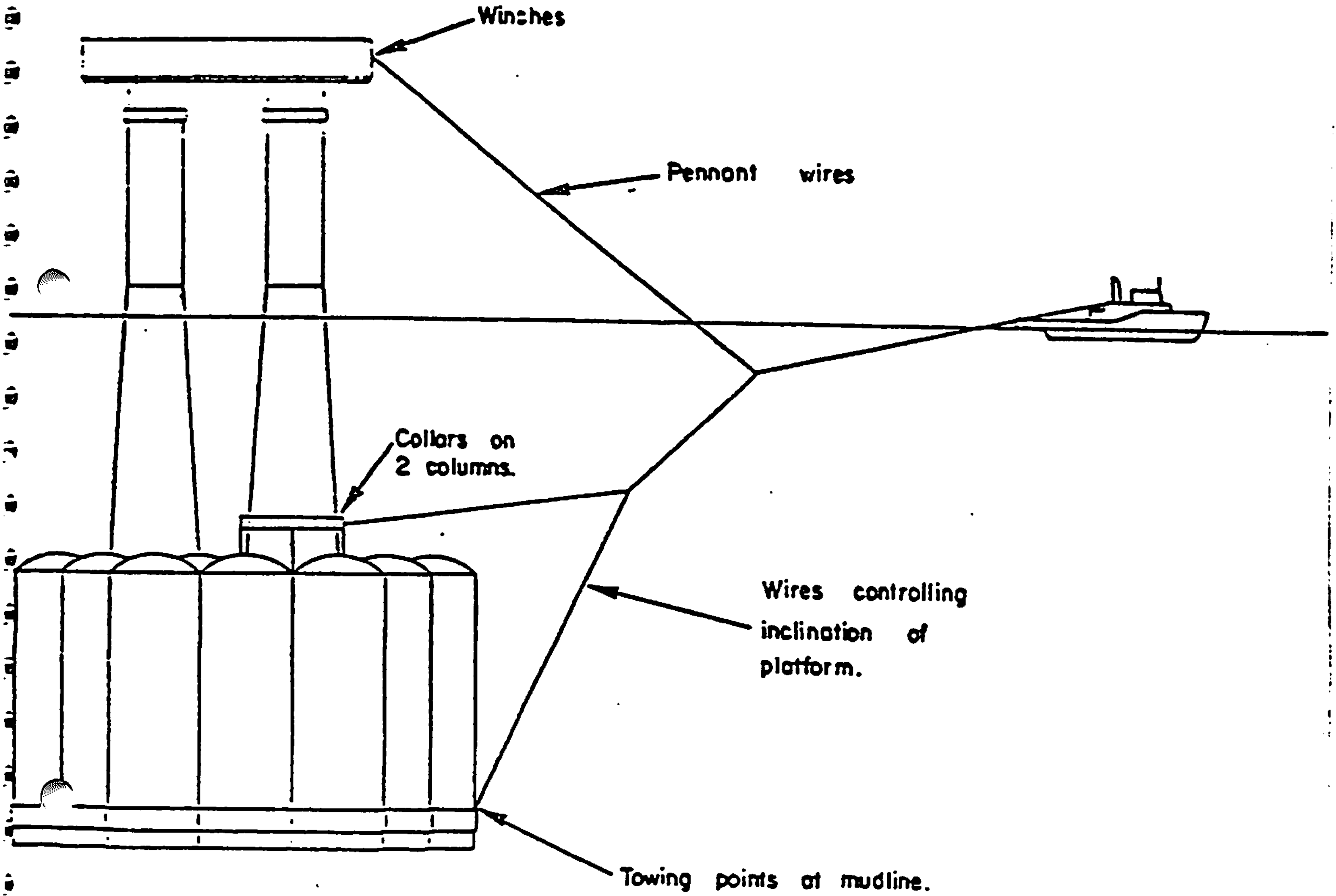


PLAN ON TOP OF CELLS SHOWING PART OF PIPE LAYOUT IN VALLEYS BETWEEN DOMES.

WATER INJECTION PIPING
ON TOP OF CAISSON.



WATER INJECTION POINT AT SKIRT.



TOWING ARRANGEMENT.

E & P FORUM PLATFORM REMOVAL TECHNICAL WORKSHOP, 15 September 1983

Consensus on Practicalities of Complete and Partial Removal of 3 Categories of Platform

Following presentations by the three experts on platform removal, workshops participants discussed and agreed on the following for small, medium and large steel jackets and for concrete installations.

1. SMALL STEEL JACKETS - i.e. in < 50m water

(a) Complete removal

(i) Base Case (BC)

A* Remove to seabed - bring everything ashore.

(ii) Other technically feasible solutions involving similar order of costs (within 70-130% of (BC) :

B. Remove to seabed - disposal in in deep water at some other location.

E1. Refloat base after removing topsides - bring everything ashore.

E2. " " " " " - bring topside ashore and dispose of base in deep water.

E3. " " " " " - dispose of everything in deep water.

(iii) Approaches considered impractical as long term de-commissioning options :

C. Refloat whole installation and bring inshore for dismantling.

D. Refloat whole installation for disposal in deep water.

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* Key based on Appendix attached to Annex 1 'Description of Proposed Method of De-commissioning'

(b) Partial removal

(i) Technically feasible solutions involving similar order of costs (within 70-130% of BC) :

J2. Lift off topsides and jacket down to specified depth below sea level - take removed items ashore.

(ii) Technically feasible solutions involving lower costs (within 40-70% of BC)):

J3. Lift off topsides and jacket down to specified depth below sea level - dispose of removed items in deep water/at other location.

(iii) Approaches considered impractical as long term de-commissioning options :

I** Removal/partial removal of topsides - topple residue in-situ.

H** Topple whole installation in-situ.

J1 Lift off topsides and jacket down to specified depth below sea level - place removed items alongside residue.

L. Leave - other use.

M. Do nothing.

N. Leave - maintain lights.

(iv) Technically feasible solutions identified involving substantially lower costs (less than 40% of BC) considered likely to be acceptable to coast authorities: None.

2. MEDIUM STEEL JACKETS - i.e. in 50-100m water

(a) Complete removal
as for small steel jackets.

** Unless creation of shallow water reef is acceptable at specific location.

(b) Partial removal

(i) Technically feasible solutions involving lower costs (within 40-70% of BC) :

I. Removal/partial removal of topsides - topple residue in-situ.

J1. Lift off topsides and jacket down to specified depth below sea level - place removed items alongside residue.

J2. as J1, but take removed items ashore.

J3. as J1, but dispose of removed items in deep water/at other location.

(ii) Approaches considered impracticable as long term de-commissioning options :

L. Leave other use.

M. Do nothing.

N. Leave - maintain lights.

(iii) Technically feasible solutions identified involving substantially lower costs (less than 40% of BC) considered likely to be acceptable to coast authorities :

H. Topple whole installation in-situ.

3. LARGE STEEL JACKETS - in > 100m water

(a) Complete removal

(i) BC :

A. Remove to seabed - bring everything ashore

(ii) Other technically feasible solutions involving similar order of costs (within 70-130% of BC) :

B. Remove to seabed - disposal in deep water or some other location.

E2. Refloat base after removing topsides - disposal of base in deep water.

E3. as E2, but disposal of all components in deep water.

(iii) Approaches considered impracticable as long term option :

C. Refloat whole installation and bring inshore for dismantling.

D. Refloat whole installation for disposal in deep water.

E1. Refloat base after removing topsides - bring everything ashore.

F. Remove whole/major part of installation for re-use at new locations.

(b) Partial removal

(i) Technically feasible solutions involving lower costs (within 40-70% of BC) : I, J1, J2, J3. (as medium steel jacket)

(ii) Approaches considered impracticable as long term de-commissioning options : L, M, N. (as for medium steel jacket)

(iii) Technically feasible solutions identified involving substantially lower costs (less than 40% of BC) considered potentially acceptable to coast authorities :

H. Topple whole installation in-situ.

4. CONCRETE

(a) Complete removal

(i) Base Case :

E2. Refloat base after removing topsides - bring topsides ashore and dispose of base in deep water.

(ii) Technically feasible solutions involving similar order of costs (within 70-130% of BC) :

E3. As E2, but dispose of base and topsides in deep water.

D. Refloat whole installation for disposal in deep water (for some installations***).

*** except for a small number of concrete platforms which were designed to be floated with topsides in place.

(iii) Approaches considered impracticable as long term de-commissioning options :

A. Remove to seabed - bring everything ashore.

B. Remove to seabed - disposal in deep water at some other location.

C. Refloat whole installation and bring ashore for dismantling.

D.***Refloat whole installation for disposal in deep water.

E1. Refloat base after removing topsides - bring everything ashore.

(b) Partial removal

(i) Technically feasible solutions involving lower costs (within 40-70% of BC) :

I. Remove/partial removal of topsides - topple residue in-situ.

J2. Lift off topsides and jacket down to specified depth below sea level - take removed items ashore.

J3. as J2, but with disposal of removed items in deep water (only for some platforms*).

(ii) Approaches considered impracticable as long term de-commissioning option in most cases :

L. Leave other use.

M**. Do nothing.

N**. Leave - maintain lights.

(iii) Technically feasible solutions identified involving substantially lower costs (less than 40% of BC) considered potentially acceptable to coast authorities :

H. Topple in-situ.

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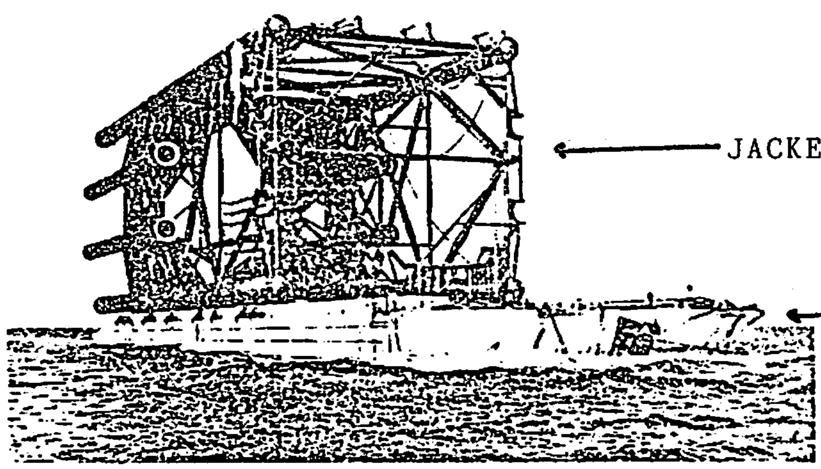
* There were doubts whether savings of this order would be obtainable with all structures of this type.

** Technically possible options, but considered likely to be unacceptable to coast authorities at most locations.

*** Except for a small number of concrete platforms which were designed to be floated with topsides in place.

APPENDIX 2



BRAZILIAN JACKET