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Code 5
BYE-51911-70
12 August 1970

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From: Director, Naval Research Laboratory, Washington, D. C. 20390
To: Director, Program "C"

Subj: POPPY Support to the Ocean Surveillance requirement

Ref: (a) CNO 171853Z JUL 1970

Encl: (1) NRL BYE-51910-70, Subj: POPPY Support to the Ocean Surveillance requirement, Copies 1 and 2 of 4 copies

1. In response to reference (a), enclosure (1) is forwarded.

H. O. LORENZEN
By direction

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Introduction

Four alternatives for site enhancement for ocean surveillance are provided, with Alternative A being the proposed NSA approach. Alternative B is substituting the priority sorting (PDE) for the additional Quality Control (QC) analysis complex. Alternative C is the new generation computer with an additional QC position. Alternative D, the NRL favored approach, has the new generation computer, and the priority sorter. The analysis-time required is outlined for each approach the first time it is discussed. Alternative D is favored on this basis.

The discussion on the ZI site is tenative, without knowking the full details of where the site will be, what condition the equipment from [redacted] is in, etc. In the cost comparison of the C and D Alternatives with the A and B Alternatives, further savings can result if the SEL-810 Computer is required at another POPPY site. In addition to the ZI site, others which might need a computer are [redacted] (not for location alalysis, just for digitizing) or second computers for [redacted] for national processing.

The requirements for Ocean Surveillance have continued to build in importance since the time that the architecture for Mission 7107 was completed. It is now essential that the capability of Mission 7107 for Ocean Surveillance be assessed. The Naval Research Laboratory would like to consider certain small changes in the Frequency coverage particularily in the "S-Band" and "X-Band" so that the ship signals would be better addressed in the design capability of Mission 7107. In order for the Laboratory to assess the Mission 7107 capability against the various Ocean Surveillance threats we must have the best information of the number of occurances versus RF observed and accuracy of collection system in reading frequency, particularily for the "YANKEE" class Submarine threat and selected Ship Missile threats.

NRL is investigating the possibility of employing the fifth spacecraft of Mission 7107 for providing certain operational capabilities in the Ocean Surveillance arena, and a proposal along these lines is forthcoming.

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Alternative A

A. Approach

1. Second 810A to [redacted] (3 months)

2. Second Q.C. to [redacted] (5 months)

B. Cost

		Bld.	Personnel	Recurring Cost
Digital	414,850	$ 37K	15 [redacted]	136.2 personnel
Analog	180,000		6	23.0 equipment
	$ 594,850		6	159.2 K/year
Total	$ 631,850		27 Total	

C. Capability

Site	National	Ocean Surveillance	NSA (Cost effect on Nat'l processing)
[redacted]	Slight Increase	Increased	No Change
	Decreased	Increased	Increased
	Decreased	Increased	Increased

D. Future Potentials

Limited future growth

E. Risk

None

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Processing for "L" Band or "S" Band

Approach A using Q.C. augmentation

Cumulative Time in Minutes	Steps
0	Start intercept
16	End intercept, start to prepare for processing
31	Trailer identification, rewind tape, move to analog Q.C. room, run analog Q.C.
76	End of Q.C., start computer processing by reformatting tape
96	Reformatting complete, start R.F. band sort
104	Second pass starts
108	End R.F. band, sort, start PRF sort
120	Second pass ends
123	End PRF sort, start collapsing data into bursts
148	Finish collapsing data into bursts, start listing and review
163	Complete burst listing, start running Doppler PRI and
173	End Doppler PRI, start locations
183	First location
193	Second location
203	Third location
208	Start of third pass

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Processing "X" Band at [redacted]

Approach A using Q.C. augmentation

Cumulative Time in Minutes	Steps
0	Start intercept
16	End intercept, prepare for processing
31	Tape Trailer added, tape rewound, transfer to Q.C. room, start analog Q.C.
91	End analog Q.C., start reformatting
104	Start second pass
120	End second pass
191	End reformatting, start band sort
208	Start third pass
224	End third pass
251	End band sort, start PRF sort
312	Start fourth pass
326	End PRF sort, start collapsing data to bursts
328	End fourth pass
416	Start Fifth pass
432	End fifth pass
451	Finish burst collapsing, start listing and review
501	End listing and review, start obtaining doppler PRF and [redacted]
520	Start sixth pass
531	End obtaining doppler PRF and [redacted] start running locations
536	End sixth pass
541	First location
551	Second location
561	Third location

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OPTION FUNDING (A)

	FY 71	FY 72	FY 73	FY 74	FY 75	TOTALS
A. One Time Cost						
Equipment						
Recieving Equipment	180					180
Processing Equipment	415					415
Construction						
Operations						
Building	37					37
Air Conditioning						
Electrical Power						
Berthing						
TOTALS	632					632
B. Annual Cost (Recurring)						
Personnel	136	136	136	136	136	680
Equipment O&M	23	23	23	23	23	115
Facilities O&M (Utilities, TDY) (Supplies, etc.)						
TOTALS	159	159	159	159	159	795
TOTALS	791	159	159	159	159	1427

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Alternative B

A. Approach

1. Second 810 to [redacted] (3 months)

2. Perishable Data Extractor to [redacted] (7 months)

B. Cost

Equipment	Bld.	Personnel	Recurring
Digital 414,850 Analog 150,000 $564,850	$37 K	15 [redacted]	84 personnel 10 equipment 94 K/year

Total $ 601,850

C. Capability

Site	National	Ocean Surveillance	NSA (Cost effect on Nat'l processing at NSA)
[redacted]	Slight Increase	Increased	No Change
	Increased	Increased	No Change
	Increased	Increased	No Change

D. Future Potential

Limited future growth

E. Risk

Slight - Perishable Data Extractor is same basic hardware and techniques as used in two previous generation formatting systems.

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Processing of "L" or "S" Band

Approach B using Perishable Data Extractor (PDE)

Cumulative Time in Minutes	Steps
0	Start intercept, start data to computer with RF band sorted, reformatted for computer PRI sorting
16	End pass, reformatting and sorting, start collapsing data into bursts
41	Finish burst collapsing, start burst listing and review
56	Finish review, start running doppler PRI and Δt calculations
66	End Δt calculations, start locations
76	First location
86	Second location
96	Third location
	Stop for next pass
104	Start next pass

Processing "X" Band at [redacted]

Approach B using Perishable Data Extractor

Cumulative Time in Minutes	Steps
0	Start intercept, start data to computer with R.F. band sorted, and reformatted (density is too high to run PRF sort simultaneously)
16	End - pass, R.F. band sort, and reformatting, start PRF sort
91	End PRF sort, start collapsing data into bursts
104	Start second pass
120	End second pass
208	Start Third pass
216	Finish collapsing data into bursts, start bursts listing and review
224	End third pass
266	End burst listing and review, start obtaining Doppler PRF and [redacted]
296	Finish Doppler PRF and [redacted] start first location
306	First location
312	Start fourth pass
316	Second location
326	Third location
328	End fourth pass

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OPTION FUNDING (B)

	FY 71	FY 72	FY 73	FY 74	FY 75	TOTALS
A. One Time Cost						
Equipment						
Reveiving Equipment	150					150
Processing Equipment	415					415
Construction						
Operations						
Building	37					37
Air Conditioning						
Electrical Power						
Berthing						
TOTALS	602					602
B. Annual Cost (Recurring)						
Personnel	84	84	84	84	84	420
Equipment O&M	10	10	10	10	10	50
Facilities O&M (Utilities, TDY) (Supplies, etc.)						
TOTALS	94	94	94	94	94	470
TOTALS	696	94	94	94	94	1072

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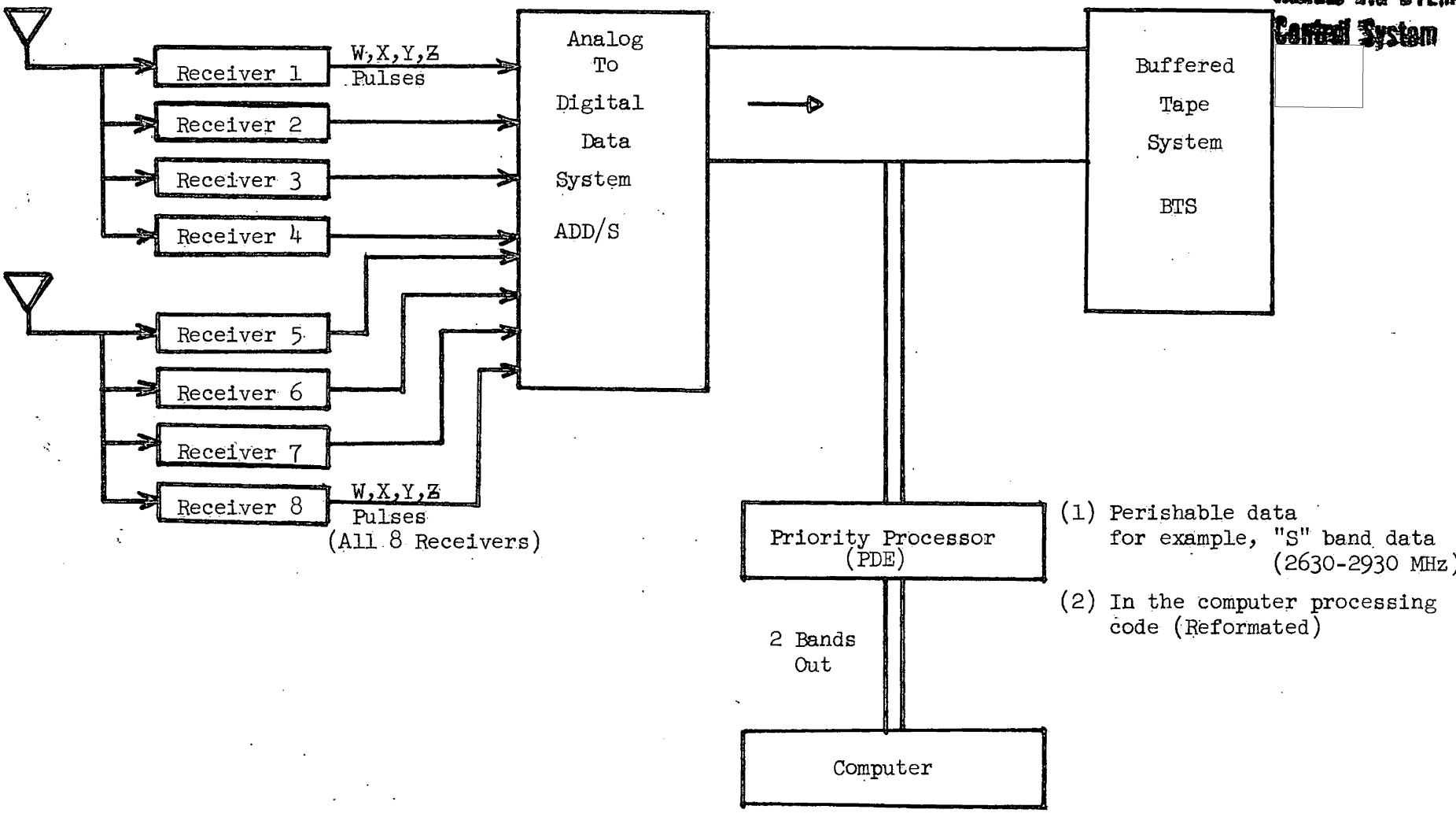
(1) All data multiplexed in very compact coding
(High Packing Density)

(2) Standard data sent for NSA processing



POPPY Site Enhanced With Priority Processor (PDE)

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Alternative C

A. Approach

1. Second 810A to [redacted] (3 months - temporary shipment of computer used for training and checkout installed in van)
2. Second Q.C. to [redacted]
3. Second generation computer to [redacted] (10 months at this time return training computer and original computer is available for another site)

B. Cost

Equipment	Bld.	Personnel	Recurring
Digital 973 K (115K Software)	--	15 [redacted] (1 yr)	136 K personnel
Analog 180 K		6 [redacted]	46 K equipment
$1153 K		6 [redacted]	182 K/year
		27 Total	

C. Capability

Site	National	Ocean Surveillance	NSA (Cost effect on)
[redacted]	Increased (400%)	Increased (10-1)	Reduced
	Reduced	Increased	Increased
	Reduced	Increased	Increased

D. Future Potential

Large

E. Risk

None - new computer only deployed when ready, schedule has two months extra time

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[redacted]

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Processing of "X" Band at [redacted]

Approach C using new computer and Q.C. augumentation

Cumulative Time in Minutes	Steps
0	Start intercept
16	End intercept, prepare for processing
31	Tape trailer added, tape rewound, transfer to Q.C. room, start analog Q.C.
91	End analog Q.C., start reformatting
104	Start second pass
120	End second pass
191	End reformatting, start band sort
208	Start third pass
224	End third pass
251	End band sort, start PRF sort
259	End PRF sort, start collapsing data to bursts
272	End collapsing data into bursts, start burst listing and review
282	End review, start obtaining doppler PRF and [redacted]
285	End running doppler PRF and [redacted] start locations
286	First location
287	Second location
288	Third location

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[redacted]

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OPTION FUNDING (C)

	FY 71	FY 72	FY 73	FY 74	FY 75	TOTALS
A. One Time Cost						
Equipment						
Receiving Equipment	180					180
Processing Equipment	973					973
Construction						
Operations						
Building						
Air Conditioning						
Electrical Power						
Berthing						
TOTALS	1153					1153
B. Annual Cost (Recurring)						
Personnel	136	57	57	57	57	365
Equipment O&M	46	46	46	46	46	230
Facilities O&M (Utilities, TDY) (Supplies, etc.)						
TOTALS	172	103	103	103	103	584
TOTALS	1202	103	103	103	103	1737 (5 yr cost)

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Alternative D

A. Approach

1. Second 810A to [redacted] (3 months - temporary shipment of computer used for training and checkout installed in van)
2. Perishable Data Extractor to [redacted] (7 months)
3. Second generation computer to [redacted] (10 months - at this time return training computer and original [redacted] 810A is available for another site)

B. Cost

Equipment	Bld.	Personnel	Recurring
Digital$ 1173 K (115 K software)	--	15 [redacted] (1 year)	84 K (1 yr. only) personnel 33 K equipment 117 K

C. Capability

Site	National	Ocean Surveillance	NSA (Cost effect on)
[redacted]	Increased (400%)	Increased (10-1)	Reduced
	Increased	Increased	No change
	Increased	Increased	No change

D. Growth Potential

Large

E. Risk

Slight - see Alternatives B and C

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Processing of "X" Band at [redacted]

Approach D using new computer and Perishable Data Extractor

Cumulative Time in Minutes	Steps
0	Start intercept, R.F. band sorting and reformatting
16	End intercept, start PRF sort
24	End PRF sort, start collasping data into bursts
37	Finish collapsing data into bursts, start burst listing and review
47	End review, start obtaining doppler PRF and [redacted]
50	End running doppler PRF and [redacted], start locations
51	First location
52	Second location
53	Third location

OPTION FUNDING

	FY 71	FY 72	FY 73	FY 74	FY 75	TOTALS
A. One Time Cost						
Equipment						
Receiving Equipment						
Processing Equipment	1173					1173
Construction						
Operations						
Building						
Air Conditioning						
Electrical Power						
Berthing						
TOTALS	1173					1173
B. Annual Cost (Recurring)						
Personnel	84					84
Equipment O&M	33	33	33	33	33	165
Facilities O&M (Utilities, TDY) (Supplies, etc.)						
TOTALS	117	33	33	33	33	249
TOTALS	1075	33	33	33	33	1422

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ZI Facility ~~EARPOP~~ [redacted]

The establishment of a new facility can be made at minimum cost, if alternatives C or D are chosen as the current [redacted] computer would be available for this site. Further, a large percentage of the analog equipment from [redacted] would be available.

For the basic site the following is an estimate of the funding necessary to either buy new equipment or refurbish equipment from other sites, however, without a careful inspection of returned equipment these are tentative.

Analog	165 K
Digital	158 K
Flooring, air conditioning	35 K
Installation	14 K
	372 K

If Option C or D were not approved then an additional 415 K would be required for the installation, or

372 K
415 K

787 K

Considering the other work load, availability of equipment, and refurbishing time, it is estimated that approximately 10 months would be required to make the installation, however, without knowing the actual site this is a tentative estimate.

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Excluded from automatic downgrading and declassification

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C. 20350

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IN REPLY REFER TO
Op-092/kfg
BYE 66391/70
19 AUG 1970

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MEMORANDUM FOR THE DISTRIBUTION LIST

Subj: Navy Ocean Surveillance Requirement

Encl: (1) Op-092 BYE 66385/70 of 17 August 1970

1. Enclosure (1) is a statement of the Navy Ocean Surveillance requirement to be performed by SIGINT Satellite Systems, and was forwarded in response to a charge from the Director, National Reconnaissance Office to the Director, Program C.

2. The enclosure is forwarded for your information and retention.

CAPTAIN, U. S. NAVY

DISTRIBUTION LIST:
Director, Defense Intelligence Agency (DIAXX)
Director, National Security Agency
Commander, Naval Security Group Command
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NRL B-00093-70

TR 785-70

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DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C. 20350

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BYE 66385/70

17 AUG 1970

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MEMORANDUM FOR THE DIRECTOR, NATIONAL RECONNAISSANCE OFFICE

Subj: Navy Ocean Surveillance Requirement

1. The United States Intelligence Board recently approved a statement of the requirement for ocean surveillance to be performed by SIGINT Satellite systems. This statement of requirement is general in nature, and does not delineate fully the requirement, which is predicated by the necessity of providing Command with information which is essential to the successful prosecution of its missions. The timely collection, processing and dissemination of ocean surveillance information provides Command with strategic warning through indications of changes in normal patterns of activity, and provides information necessary for planning and conducting naval operations. In order to assist the National Reconnaissance Office in planning for support of this requirement, the following additional detail is provided.

2. The Ocean Surveillance requirement is bounded by limits which dictate locating and reporting on the position of threat emitters within 500 nautical miles of friendly forces within 20 minutes, to an accuracy of 5 nautical miles, and locating and reporting of all shipborne emitters within 6 hours, to an accuracy of 50 nautical miles. The requirement for timeliness of reporting is governed by an interplay of four variables; viz., proximity of own forces to area of interest, geographic area, political climate, and platform.

3. The following weighting factors for these variables are provided to define the requirement:

a. Own forces: Within area - 0.4; within 200 nautical miles - 0.3; within 500 nautical miles - 0.2; within 1500 nautical miles - 0.1.

b. Geographic area: Mediterranean, Tonkin Gulf - 0.3; North Sea, GI/UK Gap, Norwegian Sea, Sea of Japan, Barents Sea - 0.2; Eastern Atlantic, North Pacific - 0.1; South Pacific, Indian Ocean (0.05).

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c. Political Climate: Hot war - 0.3; Limited war - 0.2; Tension - 0.1; Calm - 0.0

d. Platform: SSBN, SSB -0.5; SSGN, CLG, DLG, SSG -0.4; CHG, DDG -0.3; PGM, Small Missile combatants - 0.2; Major non-missile naval units - 0.1; High interest auxiliaries - 0.05; Other auxiliaries - 0.0.

Specifically, for any combination of the four variables with a total factor of 0.8 or greater, the most stringent locational accuracy and reporting timeliness is required. For any combination of the four variables totaling 0.3 or less, the least stringent locational accuracy and reporting timeliness is required.

(See Annex A for detailed requirements for locational accuracies and reporting timeliness required for all value combinations.)

4. The probability of intercept, given that an emitter is radiating, varies with the situation. Generally, the following probabilities define the requirement:

Probability of Intercept	Situation
99.7%	Missile equipped unit is capable of launching strike against friendly forces.
95.4%	Conventionally armed naval force within 500 nautical miles of friendly forces
68.3%	For all other cases

5. The requirement specified above is applicable for collection by SIGINT Satellite systems, and is representative of the ocean surveillance requirement for space systems. As more information is obtained, and state of the art advances are made, the requirement will become more definitive.

/s/ F. J. HARLFINGER

ANNEX A - Locational Accuracy and Reporting Timeliness Criteria

LOCATIONAL ACCURACY AND REPORTING TIMELINESS CRITERIA

Weighting Factor: (a) + (b) + (c) + (d) = KW

I 0 (a) 0.40: Importance placed upon proximity of own forces, to area of primary interest

OWN FORCES:

(1) 0.40: Major friendly forces within area of primary interest

(2) 0.30: Major friendly forces within 200 NM of area of primary interest

(3) 0.20: Major friendly forces within 500 NM of area of primary interest

(4) 0.10: Major friendly forces over 1500 NM from area of primary interest

II 0 (b) 0.30: Improtance placed upon operation arena

GEOGRAPHIC AREA:

(1) 0.30: Eastern Mediterranean, Tonkin Gulf

(2) 0.20: North Sea, Sea of Japan, Norwegian Sea, GI/UK Gap, Barents Sea

(3) 0.10: Eastern Atlantic, North Pacific

(4) 0.05: South Pacific, Indian Ocean

(5) 0.00: Antartic, South Indian Ocean

III 0 (c) 0.30: Importance placed upon political climate

POLITICAL CLIMATE:

(1) 0.30: Hot war situation

(2) 0.20: Limited war situation

(3) 0.10: Tension

(4) 0.00: Calm

ANNEX A

IV 0 (d) 0.50: Importance placed upon platform

PLATFORM:

(1) 0.50: SSBN, SSB

(2) 0.40: SSGN, CLG, DLG, SSG

(3) 0.30: CHG, DDG

(4) 0.20: Small SSM Combatants

(5) 0.10: Major Non-missile Naval Units

(6) 0.05: High Interest Auxiliary Units

(7) 0.00: Other Auxiliary Units

ANNEX A

To EXT/... 2Q Paper to NRO 14 Aug '70

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MEMORANDUM FOR THE DIRECTOR, NATIONAL RECONNAISSANCE OFFICE

Subj: Navy Ocean Surveillance Requirement

1. The United States Intelligence Board recently approved a statement of the requirement for ocean surveillance to be performed by SIGINT Satellite systems. This statement of requirement is general in nature, and does not delineate fully the requirement, which is predicated by the necessity of providing Command with information which is essential to the successful prosecution of its missions. The timely collection, processing and dissemination of ocean surveillance information provides Command with strategic warning through indications of changes in normal patterns of activity, and provides information necessary for planning and conducting naval operations. In order to assist the National Reconnaissance Office in planning for support of this requirement, the following additional detail is provided.

2. The Ocean Surveillance requirement is bounded by limits which dictate locating and reporting on the position of threat emitters within 500 nautical miles of friendly forces within [redacted] and locating and reporting of all shipborne emitters within [redacted] to an accuracy of [redacted] The requirement for timeliness of reporting is governed by an interplay of four variables; viz., proximity of own forces to area of interest, geographic area, political climate, and platform.

3. The following weighting factors for these variables are provided to define the requirement:

a. Own forces: Within area - 0.4; within 200 nautical miles - 0.3; within 500 nautical miles - 0.2; within 1500 nautical miles - 0.1.

b. Geographic area: Mediterranean, Tonkin Gulf - 0.3; North Sea, GI/UK Gap, Norwegian Sea, Sea of Japan, Barents Sea- 0.2; Eastern Atlantic, North Pacific - 0.1; South Pacific, Indian Ocean (0.05).

c. Political Climate: Hot war - 0.3; Limited war - 0.2; Tension - 0.1; Calm - 0.0

d. Platform: SSBN, SSB - 0.5; SSGN, CLG, DLG, SSG - 0.4; CHG, DDG - 0.3; PGM, Small missile combatants - 0.2; Major non-missile naval units - 0.1; High interest auxiliaries - 0.05; Other auxiliaries - 0.0.

Specifically, for any combination of the four variables with a total factor of 0.8 or greater, the most stringent locational accuracy and reporting timeliness is required. For any combination of the four variables totaling 0.3 or less, the least stringent locational accuracy and reporting timeliness is required. (See Annex A for detailed requirements for locational accuracies and reporting timeliness required for all value combinations.)

4. The probability of intercept, given that an emitter is radiating, varies with the situation. Generally, the following probabilities define the requirement:

Probability of Intercept	Situation
99.7%	Missile equipped unit is capable of launching strike against friend forces.

95.4%	Conventionally armed naval force within 500 nautical miles of friendly forces
68.3%	For all other cases

5. The requirement specified above is applicable for collection by SIGINT Satellite systems, and is representative of the ocean surveillance requirement for space systems. As more information is obtained, and state of the art advances are made, the requirement will become more definitive.

Annex A- Locational Accuracy and Reporting Timeliness Criteria

LOCATIONAL ACCURACY AND REPORTING TIMELINESS CRITERIA

Weighting Factor: ((a) + (b) + (c) + (d) = Kw

I $0 < (a) < 0.40$: Importance placed upon proximity of own forces, to area of primary interest

[redacted] Own Forces:

(1) 0.40: Major friendly forces within area of primary interest

(2) 0.30: Major friendly forces within 200 NM of area of primary interest

(3) 0.20: Major friendly forces within 500 NM of area of primary interest

(4) 0.10: Major friendly forces over 1500 NM from area of primary interest

II $0 < (b) < 0.30$: Importance placed upon operation arena

[redacted] Geographic Area:

(1) 0.30: Eastern Mediterranean, Tonkin Gulf

(2) 0.20: North Sea, Sea of Japan, Norwegian Sea, GIUK Gap, Barents Sea,

(3) 0.10: Eastern Atlantic, North Pacific

(4) 0.05: South Pacific, Indian Ocean

(5) 0.00: Antarctic, South Indian Ocean

III $0 < (c) < 0.30$: Importance placed upon political climate

[redacted] Political Climate

(1) 0.30: Hot war situation

(2) 0.20: Limited war situation

(3) 0.10: Tension

(4) 0.00: Calm

IV $0 < (d) < 0.50$: Importance placed upon platform

[redacted] PLATFORM

(1) 0.50: SSBN, SSB

(2) 0.40: SSGN, CLG, DLG, SSG

(3) 0.30: CHG, DDG

(4) 0.20: Small SSM Combatants

(5) 0.10: Major non-missile naval units

(6) 0.05: High interest auxiliary units

(7) 0.00: Other auxiliary units

ANNEX A

18 Aug '70

~~SECRET~~ Draft for [redacted] to CAO

The DSB Herzfeld Committee has completed its study of the capabilities of existing NRO ELINT collection and processing systems to perform ocean surveillance. Their preliminary findings indicate that the Navy's POPPY system has by far the greatest potential for meeting the requirements of an interim system.

It is my understanding that adaptation of the POPPY system to ocean surveillance is being inhibited by tasking and funding problems: namely, that tasking for strategic collection is being reflected as a limitation on tasking for ocean surveillance, and that funding is being reflected as an internal Navy matter, with the source of funds unidentified to date.

If there are in fact problems in either or both of these areas --or in any related area, for that matter--wherein DDR&E could possibly be of assistance, we would appreciate being advised at an early date, for we believe that the course of action being advocated by the Herzfeld Committee is basically feasible and desirable. The tasking problem could very well be traceable to under-utilization of the spacecraft, and the amount of funds required for the interim improvements being recommended appears to be reasonable in relation to the reported importance of the Navy's requirement.

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~~SECRET~~ [redacted]

SECRET [redacted]

The [redacted]veness of the current POPPY system in an ocean surveillance role can be significantly improved by expanding and re-orienting the tasking assignments to take advantage of built-in existing system capability. A second major improvement can be obtained through the introduction of Priority Data Extractors at the three present collection sites. In conjunction with the PDE's, the introduction of an SEL 86 high-speed computer at the site in West Germany, where ~~xxxxxx~~ data density is highest, ~~xxx~~ should be able to provide operational intelligence within [redacted] of collection. The combination of the PDE's and the high-speed computer could result in an overall increase of system capacity (on the order of four times the present processing capability on national requirements and ten times the present capacity for ocean surveillance).

It has been estimated that the foregoing improvements of POPPY to achieve an early (approximately one year from start) satellite capability for ocean surveillance would cost a total of about one and one-half million dollars.

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DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C. 20350

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17 AUG 1970

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MEMORANDUM FOR THE DIRECTOR, NATIONAL RECONNAISSANCE OFFICE

Subj: Proposal for POPPY Support to Ocean Surveillance

Ref: (a) NRO verbal requirement, subject as above

Encl: (1) POPPY Support to the Ocean Surveillance Requirement

1. In accordance with reference (a), various alternatives, including the alternative submitted by the Director, National Security Agency, were examined in context with the proposal forwarded to the Deputy Secretary of Defense by the Secretary of the Navy on 11 June 1970. The enclosed study is a recommended alternative to the Secretary of the Navy proposal, and is forwarded herewith.

F. J. HARLFINGER, II
Director, Program "C"

Copy to:
Director, NSA
Director, DIA
Director, NRL
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POPPY SUPPORT TO THE OCEAN SURVEILLANCE REQUIREMENT

1. On 11 June 1970, the Secretary of the Navy forwarded to the Deputy Secretary of Defense a proposal for Ocean Surveillance Processing Centers, utilizing the POPPY Elint Satellite. The Deputy Secretary of Defense requested comments from various officials of the Department of Defense. Several of these officials, notably the Director of the National Security Agency, while endorsing the requirement, suggested alternative methods of solution. The Director, National Reconnaissance Office requested that the Director, Program C,examine alternatives to the Secretary of the Navy proposal, and forward to him a recommended alternative.

2. The Program Director's staff met with interested parties from the National Reconnaissance Office, the National Security Agency, the Defense Intelligence Agency, the Naval Security Group, and the Naval Research Laboratory. A recommended alternative to the Secretary of the Navy proposal is presented in this paper. Although each of the above listed agencies provided representation and valuable assistance in the preparation of this alternative proposal, the paper has not been formally endorsed by these agencies.

3. In Tab A, an austere augmentation of existing Navy manned overseas field activities is addressed. The recommendation for augmentation of these field activities specifies the acquisition of a new computer for [redacted] a new Perishable Data Extractor for each site; and the temporary deployment of an existing computer van to [redacted] Personnel augmentation is not required for sites other than [redacted] at this site, 15 enlisted personnel are required. Initial operational dates begin as early as 1 January 71; and the total capability will be operational by 1 July 72. Total costs, both recurring and non-recurring for FY 71 is $1,246,000. Annual recurring costs are $33,000. The increase in processing capability derived from this augmentation for national tasking is 400% at [redacted] and 80% for the other two sites. The increased capability for ocean surveillance processing is 1000% at [redacted] and 80% for the other sites. It is also recommended that consideration be given to acquiring a new generation computer for [redacted] in FY 73 and for [redacted] in FY 75. Cost of ~~each~~ both

computer is approximately $858,000. It is also indicated that modifications to mission 7107 can greatly enhance POPPY's collection capability for ocean surveillance. Specific proposals in this regard will be forwarded within 60 days.

4. In Tab B, it is recommended that a POPPY ground facility be established at [redacted] Although it is recognized that other sensors provide coverage of the North Atlantic, it is shown that such a facility can provide significant input to the ocean surveillance requirement, and that such a facility can be obtained at minimum costs, utilizing, to a large extent, refurbished equipment from [redacted] and [redacted] Such a facility would serve both operational and training functions, and could be operational in October 72. Total non-recurring costs are $1,187,000 (including $815,000 Navy milcon). Total yearly recurring costs are $275,000.

5. In Annex A, four alternative augmentations are examined in detail, and rationale for the alternative selected is verified. In Annex B (to be forwarded within 60 days) specific proposals for optimizing POPPY mission 7107 against the ocean surveillance requirement is discussed. Annex C contains a comparison of available computers, including the Model 86, and a functional diagram of the Perishable Data Extractor. Annex D justified the requirement for a facility on the eastern U. S. coast, examines alternative sites, and recommends building the POPPY ground facility at [redacted]

6. Due to the uncertainty associated with establishment of an austere communications facility at [redacted] and the on-going deliberations in Congress, establishment of a POPPY ocean surveillance facility has not been addressed in this paper. Rather, it is believed that the Secretary of the Navy proposal delineates the minimum expenditure of funds necessary for the [redacted] site. It is therefore recommended that such a facility be addressed in conjunction with the on-going Congressional deliberations, and not in conjunction with this specific paper.

7. In summary, the paper presents an alternative by which both national and ocean surveillance processing capabilities of the POPPY satellite system are significantly increased at low cost. Additionally, acquisition of the new generation equipment permits extensive system growth. Minimal augmentation of existing personnel strengths are required by this proposal.

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TAB A

OVERSEAS SITE AUGMENTATION

1. The recommended augmentation of the existing Navy manned POPPY ground facilities indicates an immediate deployment of an existing SEL 810A computer van to and the deployment of one Perishable Data Extractor (PDE) to The additional computer would be utilized until the acquisition of an SEL Model 86 computer, at which time the SEL 810A would be returned to CONUS for use in a CONUS facility. After on-site check out and engineering evaluation, including determination of such items as mean time between failures, the SEL 810A van could be returned to CONUS for other uses. The PDE's would become an integral part of the processing facility at each location. The recommended equipment augmentation, therefore, is:

Site	Equipment
	Perishable Data Extractor, SEL Model 810A*, SEL Model 86
	Perishable Data Extractor
	Perishable Data Extractor

*Temporary deployment of existing equipment, pending delivery of Model 86

2. The additional maximum capability to be derived from deployment of this equipment, in terms of processing, is summarized below:

Site	National	Ocean Surv	NSA (Hdqtrs Process)
	Increased 400%	Incr. 1000%	Reduce Cost
	Increased 80% (approx)	Incr. 80%	No change
	Increased 80% (approx)	Incr. 80%	No change

The increased capability for [redacted] is derived from increased computer capacity, coupled with digital formatting accomplished by the Perishable Data Extractor (PDE). For example, utilizing the Model 86 permits processing of X-band signals within approximately 50 minutes after intercept, with additional locations becoming available approximately at one minute intervals. This compares with the maximum current processing capability in X-band, utilizing existing equipment, of 9 hours, with additional locations at intervals of approximately 10 minutes. Increased collection capability is recommended, and can be obtained by optimizing frequency band assignment in mission 7107, by employing the fifth spacecraft of mission 7107 for providing certain operational capabilities in the ocean surveillance arena, by utilization of the third transmitter in each of the four primary spacecraft for ocean surveillance, and by including S-band coverage in the X-band pair. This combination of improvements could increase collection opportunity by 40-50 percent. Detailed proposals concerning these recommended changes to 7107 spacecraft will be forwarded to the NRO within 60 days.

3. The cost, both one time, and recurring, of adopting this proposal is summarized below:

COSTS (IN THOUSANDS OF DOLLARS)

	FY 71	FY 72	FY 73	FY 74	FY 75	TOTAL
A. One Time Cost						
Equipment	1147 Spec		~~858*~~ 574 Spec 2		~~858*~~ 631	1147 (~~2823~~) * 2352
B. Annual Cost (Recurring)			(110K)	110K	120K	
Personnel	84	0**	0**	0**	0**	84 424K
Equipment	33	33	33 27 66	33 66	33 96K	165 294
TOTAL	1264	33	~~33~~ (~~891~~) * 750K	~~33~~ 176	~~33~~ (~~891~~) * 847	1396 (~~3112~~) * (3070)

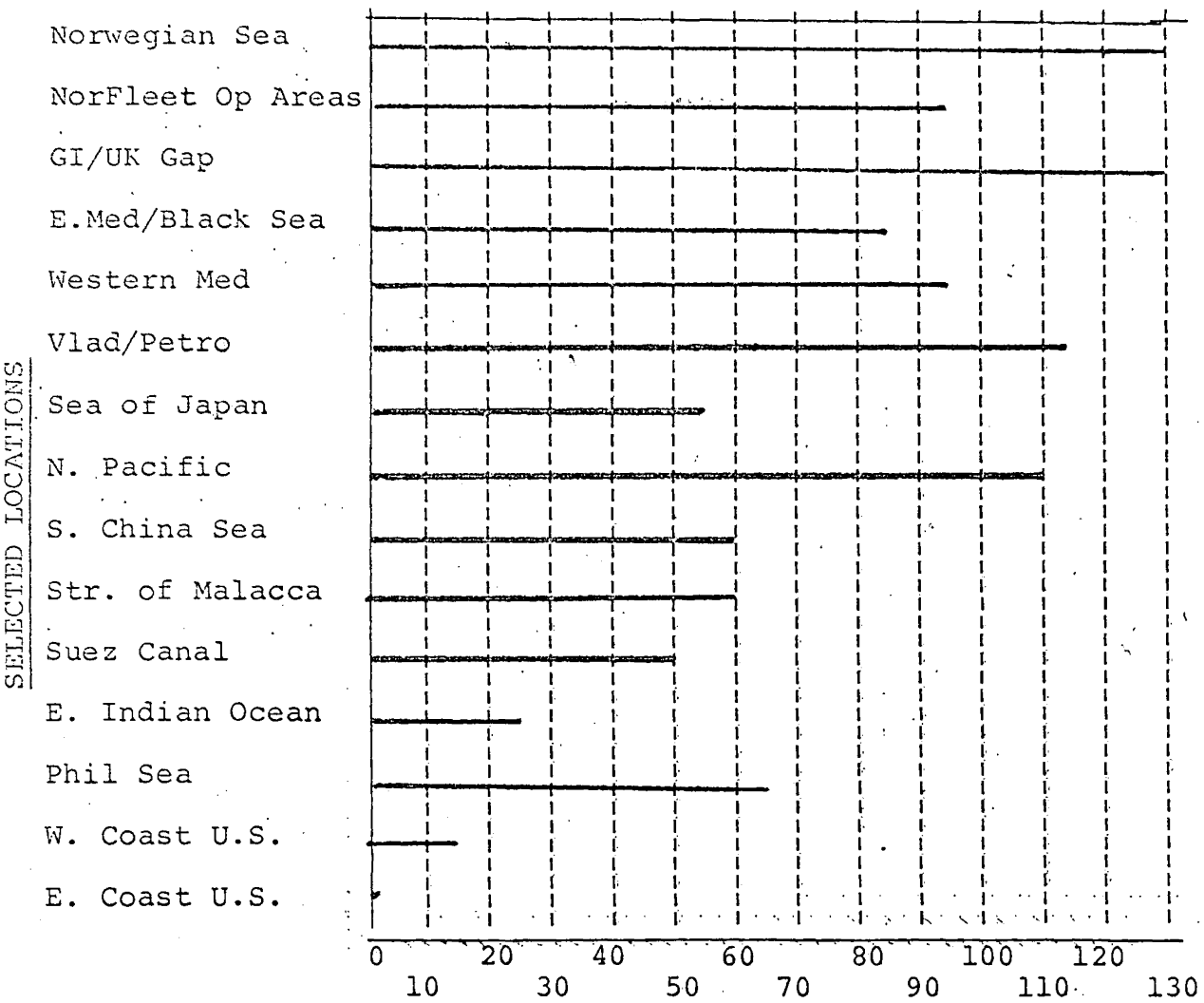
* After evaluation of SEL Model 86 at [redacted] it is recommended that consideration be given to deployment of a Model 86 at [redacted] in FY 73, and to [redacted] in FY 75.

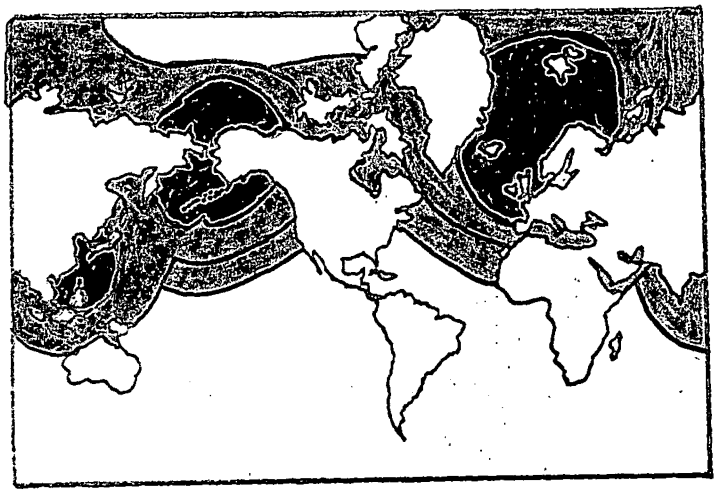
** A small increase in the personnel manning level of [redacted] may be required on a full time basis in view of the increased capabilities for processing, locating and reporting attendant with the Model 86.

Advantages of implementing this proposal, from a cost standpoint, are that initial costs are small, and additional annual recurring costs are negligible.

4. Personnel required to implement the recommended augmentation are 15 enlisted personnel at [redacted] who would be utilized to man the augmented SEL 810A. As experience is gained with the SEL 86, a slight increase in the CCP billet authorization for [redacted] is a distinct possibility. Justification for this increase will be submitted via the normal CCP channels.

SELECTED OCEAN SURVEILLANCE CAPABILITY





RED - 60-130 Minutes

GREEN - 15-60 Minutes

BLUE - 0-15 Minutes

SCHEDULE

	SEP70	NOV70	JAN71	MAR71	MAY71	JUL71	JAN72	JUL72	JAN74	JUL74
[redacted]	A									
Facilities	NONE REQUIRED									
Equipment										
SEL 810A	C	D	E			C[1]	C[2]			
SEL 86	B			C	D	E				
PDE	B		C	D	E					
Personnel	F		E				G[3]			
[redacted]	A									
Facilities	NONE REQUIRED									
Equipment										
PDE	B		C	D	E					
SEL 86							A	BC		
Personnel	NONE REQUIRED									
[redacted]	A									
Facilities	NONE REQUIRED									
Equipment										
PDE	B		C	D	E					
SEL 86										ABCDE
Personnel	NONE REQUIRED									

CODE: A - Decision
B - Order
C - Ship
D - Install and Check-out
E - IOC (Initial Operational Capability)
F - Identify and Order
G - Reassign Personnel

[1]To CONUS [2]Van to CONUS [3]If Required

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FUNDING (FY-71)

SITE		AMOUNT
[redacted]		
Equipment		
SEL 810A Van (Ship, Re-Ship)		24,000
SEL 86 Computer, including shipment and install		858,000
Software		115,000
PDE		50,000
Personnel*		84,000
Equipment O&M		27 11,000
	Sub-Total	1,142,000

*Personnel required should be derived from billets currently occupied at [redacted] Recommend combination of voluntary one year extensions, and absorption from forced reduction in other assigned missions at [redacted]

[redacted]		
Equipment		
PDE		50,000
Equipment O&M		3 11,000
	Sub-Total	61,000
[redacted]		
Equipment		
PDE		50,000
Equipment O&M		3 11,000
	Sub-Total	61,000
MDA Personnel (site dependent)		
	TOTAL	$1,264,000

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TAB B

CONUS OCEAN SURVEILLANCE FACILITY

1. Summary. The desirability of obtaining an ocean surveillance processing and training facility on the east coast of the continental United States has been examined. The facility has been determined to represent a valid requirement, due in large measure to the lack of coverage of known ballistic missile hold areas for Soviet SSBN's, the increasing scale of Soviet surface unit deployments into this area, and the necessity for establishing a training facility to standardize operating procedures, and to relieve operational units of the necessity of conducting large scale on the job training. A careful survey of available facilities on the East Coast indicates an optimum location at [redacted] This decision was influenced by the following factors; availability of support and security facilities; availability of communications; low RFI; and maximum coverage of the major threat areas.

Total cost of this facility is $1,462,000, itemized as follows:

Non-recurring

Equipment	$372,000*
Building	$815,000

Recurring

Personnel	$250,000
Equipment O&M	$ 25,000

*Predicated on acquiring new equipment, refurbishing equipment from [redacted] and utilization of the SEL 810A currently deployed to [redacted] Command and interrogation functions will be accomplished from the [redacted] engineering facility.

Personnel necessary to provide a cadre for training, and to man the operational site, total 1 officer and 42 enlisted personnel, as itemized below:

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Officer in Charge	
Material Maintenance Men	(5)
Digital Processors	(6)
Collection Operators	(16)
Collection Supervisors	(4)
Analogue Pre-processing/ And Analysis	(4)
Senior Supervisor/Analysts	(3)
Training Supervisors	(4)

2. Coverage. Unique coverage provided by a ground processing facility at [redacted] for selected geographic areas is provided below:

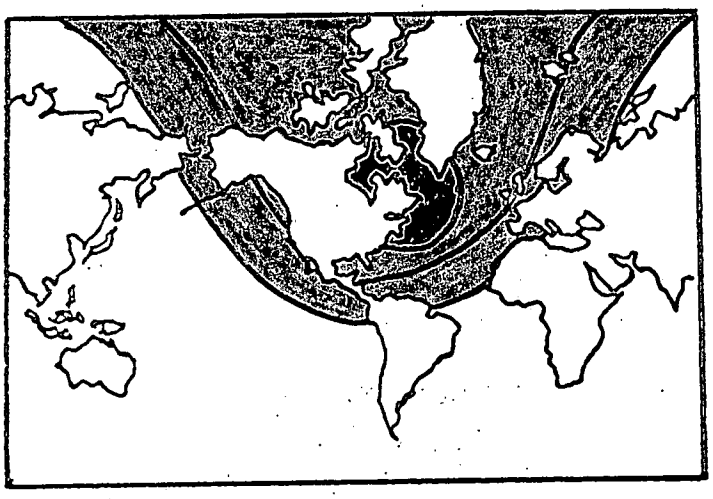
Cuba:	30-50 minutes per day
Mid-Atlantic:	50-80 minutes per day
Soviet SSBN Patrol:	50-100 minutes per day
Panama Canal:	10-30 minutes per day

Coverage obtained both from [redacted] is reinforced by [redacted], particularly in those areas of primary strategic importance; ie, SSBN patrol areas, choke points, areas through which Soviet surface and sub-surface units must pass for out of area deployments, and major operating areas. Specifically, the coverage from [redacted], in minutes per day POPPY satellite series, is as shown.

RED - 100 plus minutes

GREEN - 30-100 minutes

BLUE - 0-30 minutes



EQUIPMENT

The following primary listing of equipment would be available at [redacted] Some of the equipment, such as the 810A computer, would be acquired from [redacted] other equipment would be refurbished; still other equipment must be acquired new.

Digital

SEL 810A computer mainframe — refurbished from [redacted]
TM-11 Digital Tape transporters (3)
Magnetic Tape Control Unit
Moveable Head Disc
Fixed Head Disc and Controller
Anelex Line Printer
Graphics display console
High speed paper tape reader/punch
Paper tape spooler
X-Y plotter
Perishable Data Extractor — 50K
Support Spare Package

Sub-Total - $165,000

Analog

CEC GR 2800 analog tape recorder
Tektronics 565 oscilloscope (W/3 A-1 PI)
Distribution Amplifier (DA-1)
CEI speaker
ESL pulse rate synthesizer
Video disc recorder
Brush Oscillographic recorder (8 ch)
Astrodata 6200 time code translator
Electronic counter HP 5216A
Test Oscillator HP-204C
Timing Generator Tek 184
Audio signal monitor AM01
Oscillographic recording camera Polaroid manual
Support spare package
RS-1A Receiver (9) (11) — 90K

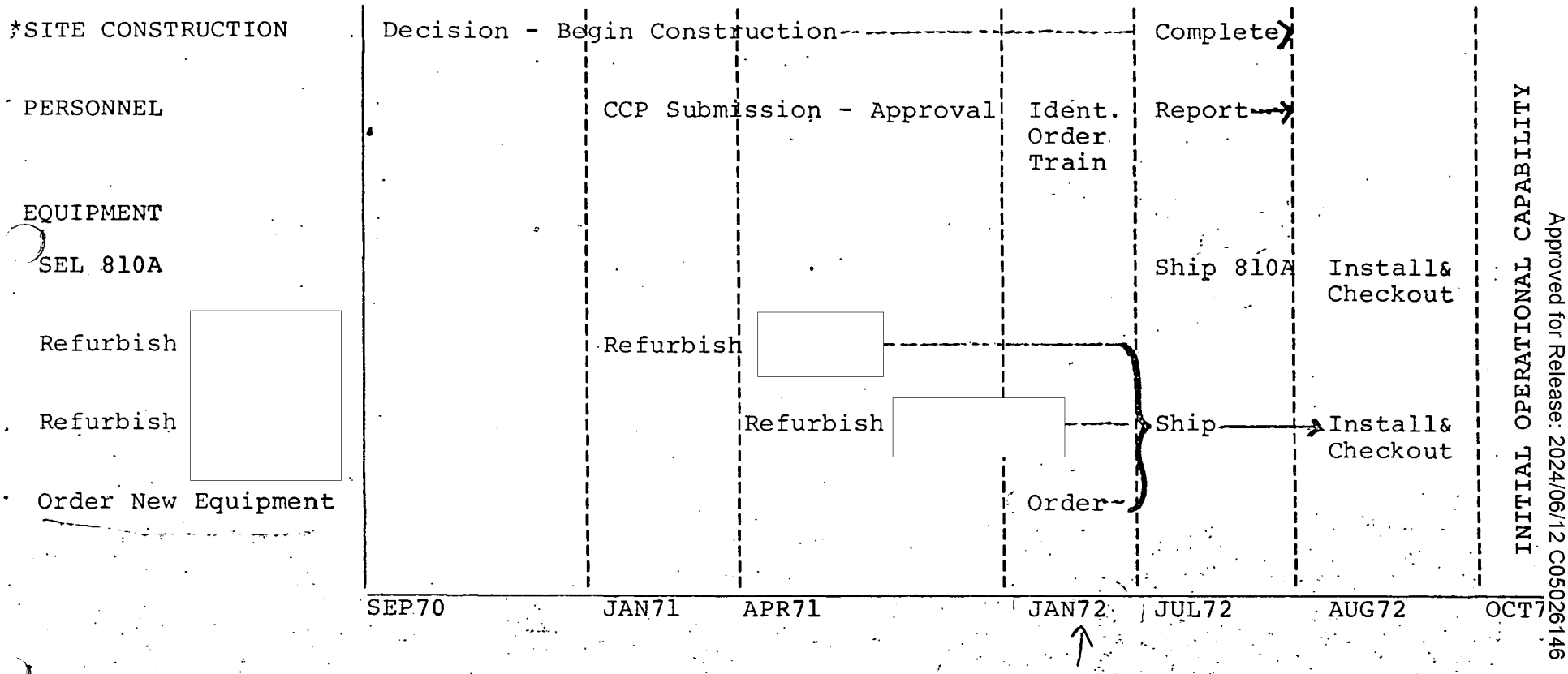
Sub-Total - $158,000

Flooring, air-conditioning, installation, and incidental costs

Sub-Total - $ 49,000

TOTAL - $372,000

SCHEDULE



*Pacing Factor

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FUNDING

1. As indicated in paragraph 1 above, non-recurring funding totals $1,187,000, while recurring funding totals $275,000.

Non-recurring	
Equipment	$372,000
Building	$815,000
Recurring	
Personnel	$250,000
Equipment O&M	$ 25,000

Introduction

Four alternatives for site enhancement for ocean surveillance are provided, with Alternative A being the proposed NSA approach. Alternative B is substituting the priority sorting (PDE) for the additional Quality Control (QC) analysis complex. Alternative C is the new generation computer with an additional QC position. Alternative D, the NRL favored approach, has the new generation computer, and the priority sorter. The analysis-time required is outlined for each approach the first time it is discussed. Alternative D is favored on this basis.

The discussion on the ZI site is tenative, without knowking the full details of where the site will be, what condition the equipment from [redacted] is in, etc. In the cost comparison of the C and D Alternatives with the A and B Alternatives, further savings can result if the SEL-810 Computer is required at another POPPY site. In addition to the ZI site, others which might need a computer are [redacted] (not for location alalysis, just for digitizing) or second computers for [redacted] for national processing.

The requirements for Ocean Surveillance have continued to build in importance since the time that the architecture for Mission 7107 was completed. It is now essential that the capability of Mission 7107 for Ocean Surveillance be assessed. The Naval Research Laboratory would like to consider certain small changes in the Frequency coverage particularily in the "S-Band" and "X-Band" so that the ship signals would be better addressed in the design capability of Mission 7107. In order for the Laboratory to assess the Mission 7107 capability against the various Ocean Surveillance threats we must have the best information of the number of occurances versus RF observed and accuracy of collection system in reading frequency, particularily for the "YANKEE" class Submarine threat and selected Ship Missile threats.

NRL is investigating the possibility of employing the fifth spacecraft of Mission 7107 for providing certain operational capabilities in the Ocean Surveillance arena, and a proposal along these lines is forthcoming.

[redacted]

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Alternative A

A. Approach

1. Second 810A to [redacted] (3 months)
2. Second Q.C. to [redacted] (5 months)

B. Cost

		Bld.	Personnel	Recurring Cost
Digital	414,850	$ 37K	15	136.2 personnel
Analog	180,000		6	23.0 equipment
	$594,850		6	159.2 K/year
Total	$631,850		27 Total	

C. Capability

Site	National	Ocean Surveillance	NSA (Cost effect on Nat'l processing
[redacted]	Slight Increase	Increased	No Change
	Decreased	Increased	Increased
	Decreased	Increased	Increased

D. Future Potentials

Limited future growth

E. Risk

None

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Processing of "L" or "S" Band

Approach B using Perishable Data Extractor (PDE)

Cumulative Time in Minutes	Steps
0	Start intercept, start data to computer with RF band sorted, reformatted for computer PRI sorting
16	End pass, reformatting and sorting, start collapsing data into bursts
41	Finish burst collapsing, start burst listing and review
56	Finish review, start running doppler PRI and Δt calculations
66	End Δt calculations, start locations
76	First location
86	Second location
96	Third location
	Stop for next pass
104	Start next pass

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Processing "X" Band at [redacted]

810 only

Approach A using ~~Q.C.~~ augmentation

Cumulative Time in Minutes		Steps
	86+DDE	
0		Start intercept
16	16	End intercept, prepare for processing
31		Tape Trailer added, tape rewound, transfer to Q.C. room, start analog Q.C.
91		End analog Q.C., start reformatting
104		Start second pass
120		End second pass
191		End reformatting, start band sort
208		Start third pass
224		End third pass
251	16	End band sort, start PRF sort
312		Start fourth pass
326		End PRF sort, start collapsing data to bursts
328		End fourth pass
416		Start Fifth pass
432		End fifth pass
451		Finish burst collapsing, start listing and review
501		End listing and review, start obtaining doppler PRF and [redacted]
520		Start sixth pass
531		End obtaining doppler PRF and [redacted], start running locations
536		End sixth pass
541		First location
551		Second location
561		Third location

OPTION FUNDING (A)

	FY 71	FY 72	FY 73	FY 74	FY 75	TOTALS
A. One Time Cost						
Equipment						
Recieving Equipment	180					180
Processing Equipment	415					415
Construction						
Operations						
Building	37					37
Air Conditioning						
Electrical Power						
Berthing						
TOTALS	632					632
B. Annual Cost (Recurring)						
Personnel	136	136	136	136	136	680
Equipment O&M	23	23	23	23	23	115
Facilities O&M (Utilities, TDY)						
(Supplies, etc.)						
TOTALS	159	159	159	159	159	795
TOTALS	791	159	159	159	159	1427

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Alternative B

A. Approach

1. Second 810 to [redacted] (3 months)
2. Perishable Data Extractor to [redacted] (7 months)

B. Cost

Equipment		Bld.	Personnel	Recurring
Digital	414,850	$37 K	15 [redacted]	84 personnel
Analog	150,000			10 equipment
	$ 564,850			94 K/year
Total	$ 601,850			

C. Capability

Site	National	Ocean Surveillance	NSA (Cost effect on Nat'l processing at NSA)
[redacted]	Slight Increase	Increased	No Change
	Increased	Increased	No Change
	Increased	Increased	No Change

D. Future Potential

Limited future growth

E. Risk

Slight - Perishable Data Extractor is same basic hardware and techniques as used in two previous generation formatting systems.

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Processing "X" Band at [redacted]

Approach B using Perishable Data Extractor

Cumulative Time in Minutes	Steps
0	Start intercept, start data to computer with R.F. band sorted, and reformatted (density is too high to run PRF sort simultaneously)
16 / 15	End - pass, R.F. band sort, and reformatting, start PRF sort
91	End PRF sort, start collapsing data into bursts
104	Start second pass
120	End second pass
208	Start Third pass
216	Finish collapsing data into bursts, start bursts listing and review
224	End third pass
266	End burst listing and review, start obtaining Doppler PRF and [redacted]
296	Finish Doppler PRF and [redacted] start first location
306	First location
312	Start fourth pass
316	Second location
326	Third location
328	End fourth pass

Reformatting 00

OPTION FUNDING (B)

	FY 71	FY 72	FY 73	FY 74	FY 75	TOTALS
A. One Time Cost						
Equipment						
Reveiving Equipment	150					150
Processing Equipment	415					415
Construction						
Operations						
Building	37					37
Air Conditioning						
Electrical Power						
Berthing						
TOTALS	602					602
B. Annual Cost (Recurring)						
Personnel	84	84	84	84	84	420
Equipment O&M	10	10	10	10	10	50
Facilities O&M (Utilities, TDY) (Supplies, etc.)						
TOTALS	94	94	94	94	94	470
TOTALS	696	94	94	94	94	1072

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(1) All data multiplexed in very compact code (High Packing Density)

(2) Standard data sent for NSA processing

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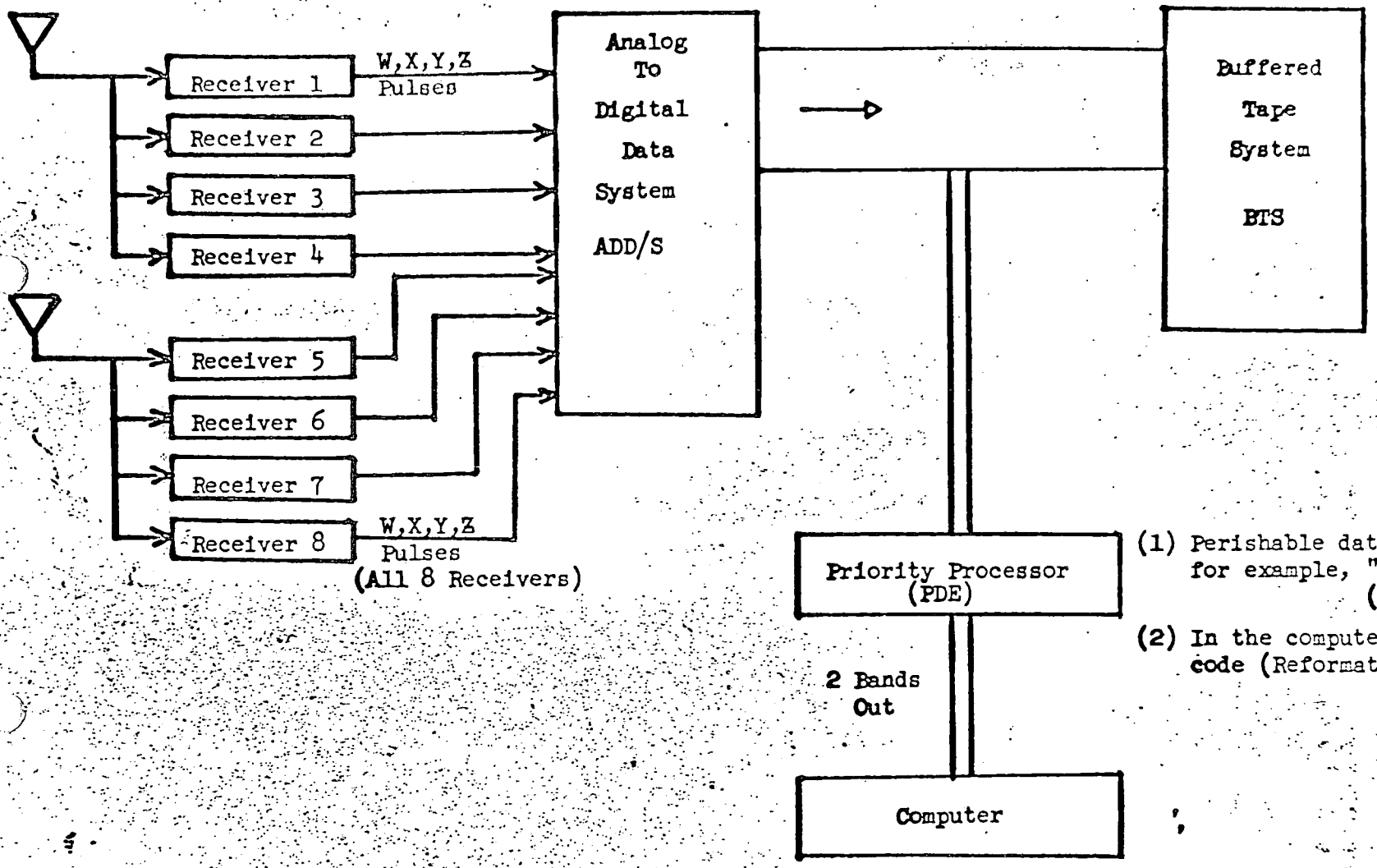

(1) Perishable data for example, "S" band data (2630-2930 MHz)

(2) In the computer processing code (Reformated)

POPPY Site Enhanced With Priority Processor (PDE)

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Alternative C

A. Approach

1. Second 810A to [redacted] (3 months - temporary shipment of computer used for training and checkout installed in van)
2. Second Q.C. to [redacted]
3. Second generation computer to [redacted] (10 months at this time return training computer and original computer is available for another site)

B. Cost

Equipment	Bld.	Personnel	Recurring
Digital 973 K (115K Software)	--	15 [redacted] (1 yr).	136 K personnel
Analog 180 K		6 [redacted]	46 K equipment
$ 1153 K		6 [redacted]	182 K/year
		27 Total	

C. Capability

Site	National	Ocean Surveillance	NSA (Cost effect on)
[redacted]	Increased (400%)	Increased (10-1)	Reduced
	Reduced	Increased	Increased
	Reduced	Increased	Increased

D. Future Potential

Large

E. Risk

None - new computer only deployed when ready, schedule has two months extra time

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Processing of "X" Band at [redacted]

Approach C using new computer and Q.C. augumentation

Cumulative Time in Minutes	Steps
0	Start intercept
16	End intercept, prepare for processing
31	Tape trailer added, tape rewound, transfer to Q.C. room, start analog Q.C.
91	End analog Q.C., start reformatting
104	Start second pass
120	End second pass
191	End reformatting, start hand sort
208	Start third pass
224	End third pass
251	End band sort, start PRF sort
259	End PRF sort, start collapsing data to bursts
272	End collapsing data into bursts, start burst listing and review
282	End review, start obtaining doppler PRF and [redacted]
285	End running doppler PRF and [redacted], start locations
286	First location
287	Second location
288	Third location

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OPTION FUNDING (C)

	FY 71	FY 72	FY 73	FY 74	FY 75	TOTALS
A. One Time Cost						
Equipment						
Receiving Equipment	180					180
Processing Equipment	973					973
Construction						
Operations						
Building						
Air Conditioning						
Electrical Power						
Berthing						
TOTALS	1153					1153
B. Annual Cost (Recurring)						
Personnel	136	57	57	57	57	365
Equipment O&M	46	46	46	46	46	230
Facilities O&M (Utilities, TDY) (Supplies, etc.)						
TOTALS	172	103	103	103	103	584
TOTALS	1202	103	103	103	103	1737 (5 yr cost)

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Alternative D

A. Approach

1. Second 810A to [redacted] (3 months - temporary shipment of computer used for training and checkout installed in van)
2. Perishable Data Extractor to [redacted] (7 months)
3. Second generation computer to [redacted] (10 months - at this time return training computer and original [redacted] 810A is available for another site)

B. Cost

Equipment	Bld.	Personnel	Recurring
Digital $1173 K (115 K software)	--	15 [redacted] (1 year)	.84 K (1 yr. only) personnel 33 K equipment 117 K

150 K POE
265
1173
265
908

C. Capability

Site	National	Ocean Surveillance	NSA (Cost effect on)
[redacted]	Increased (400%)	Increased (10-1)	Reduced
	Increased	Increased	No change
	Increased	Increased	No change

D. Growth Potential

Large

E. Risk

Slight - see Alternatives B and C

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Processing for "L" Band or "S" Band

Approach A using Q.C. augmentation

Cumulative Time in Minutes	Steps
0	Start intercept
16	End intercept, start to prepare for processing
31	Trailer identification, rewind tape, move to analog Q.C. room, run analog Q.C.
76	End of Q.C., start computer processing by reformatting tape
96	Reformatting complete, start R.F. band sort
104	Second pass starts
108	End R.F. band, sort, start PRF sort
120	Second pass ends
123	End PRF sort, start collapsing data into bursts
148	Finish collapsing data into bursts, start listing and review
163	Complete burst listing, start running Doppler PRI and [redacted]
173	End Doppler PRI, [redacted] start locations
183	First location
193	Second location
203	Third location
208	Start of third pass

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Processing of "X" Band at [redacted]

Approach D using new computer and Perishable Data Extractor

Cumulative Time in Minutes	Steps
0	Start intercept, R.F. band sorting and reformatting
16	End intercept, start PRF sort
24	End PRF sort, start collasping data into bursts
37	Finish collapsing data into bursts, start burst listing and review
47	End review, start obtaining doppler PRF and [redacted]
50	End running doppler PRF and [redacted] start locations
51	First location
52	Second location
53	Third location

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OPTION FUNDING

	FY 71	FY 72	FY 73	FY 74	FY 75	TOTALS
A. One Time Cost						
Equipment						
Receiving Equipment						
Processing Equipment	1173					117
Construction						
Operations						
Building						
Air Conditioning						
Electrical Power						
Berthing						
TOTALS	1173					117
B. Annual Cost (Recurring)						
Personnel	84					84
Equipment O&M	33	33	33	33	33	165
Facilities O&M (Utilities, TDY) (Supplies, etc.)						
TOTALS	117	33	33	33	33	249
TOTALS	1075	33	33	33	33	1422

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ZI Facility

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The establishment of a new facility can be made at minimum cost, if Option C or D are chosen as the current [redacted] computer would be available for this site. Further, a large percentage of the analog equipment from [redacted] would be available.

For the basic site the following is an estimate of the funding necessary to either buy new equipment or refurbish equipment from other sites, however, without a careful inspection of returned equipment these are tentative.

Analog	165 K
Digital	158 K
Flooring, air conditioning	35 K
Installation	14 K
	372 K

see B/E 16.442-70 (270ct)
447K for Blue Complex
75K =

If Option C or D were not approved then an additional 415 K would be required for the installation, or

372 K
415 K

787 K

Considering the other work load, availability of equipment, and refurbishing time, it is estimated that approximately 10 months would be required to make the installation, however, without knowing the actual site this is a tentative estimate.

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	SEL 86	XDS SIGMA 5	STANDARD COMP. IC 4000	EBM 360/44	HONEYWELL H632	HONEYWELL DDP 324	GMR ADVANCED WCC SERIES	CDC 3100	CDC 3500	PDP-10
FIRST DELIVERY DATE	8/??	1/68	?/68	9/66	1/69	7/68	1/68	2/65	6/68	9/67
MONTHLY (K$) RENTAL	2.1-13.4	2.5-20	7-14	5-25	2.2	4.1	2.5-12	3-17	6-28	6-30
TYPE OF COMPUTER	SMALL TO MEDIUM SCIENTIFIC	→	→	→	REAL TIME →	→	→	→	MED. TO LARGE SCIENTIFIC →	→
PROCESSOR SPEED										
1. CYCLE TIME (MS)	.6	.65	2	1.0	.85	1.75	1.9	1.75	1.3	1
2. ADD TIME (MS)	1.2	2.0	4	1.75	1.7	1.75	3.8?	3.5	.9	2.5
3. # OF ACCUMULATORS	5	7	4	16	16	2	2			16
4. # OF BITS TRANSFERRED PER MS BY CPU	53.33	37.65	18.00	32.	37.65	13.71	12.69	13.71	26.67	36.00
STORAGE CHARACTERISTICS										
1. CAPACITY	8-131	4-131	32K	8-64	8-131	8-64	8-32	8-32	8-262	8-262
2. WORD SIZE	32	32	36	32	32	24	24	24	24	36
3. FLOAT-POINT PRECISION	24 or 56	56	27	56	50		39	36	36	27
INSTRUCTION SET										
1. OP CODES	151	89	125	109	144	48	111	164	201	365
2. INDIRECT ADDRESSING	∞	1	1		∞	∞	∞	∞	∞	∞
3. INDEX REGISTERS	3	7	7		7	1	3	3	3	15
4. EXTENSIVENESS	XE[M] XAP	XE XAP	ALL	ALL XAP	XE CIM	XB XAPS	XBE[M] CIM	XE CIM	RF ALL	XE XP
I/O CHARACTERISTICS										
1. # OF CHANNELS	16	192	3	3	8	4	8	4	8	128
2. TRANSFER RATE	5M	6.4M	?	1M	200K	56K	3.1M	1:1 4-4M	4.4M	1.8M
SOFTWARE										
1. ALGEBRAIC COMPILER	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
2. MONITOR	GR	GRT	G	GRT	R	?	GRT	GRT	GAT	GRT

R = Real Time
G = Batch
T = Time Share

ANNEX C