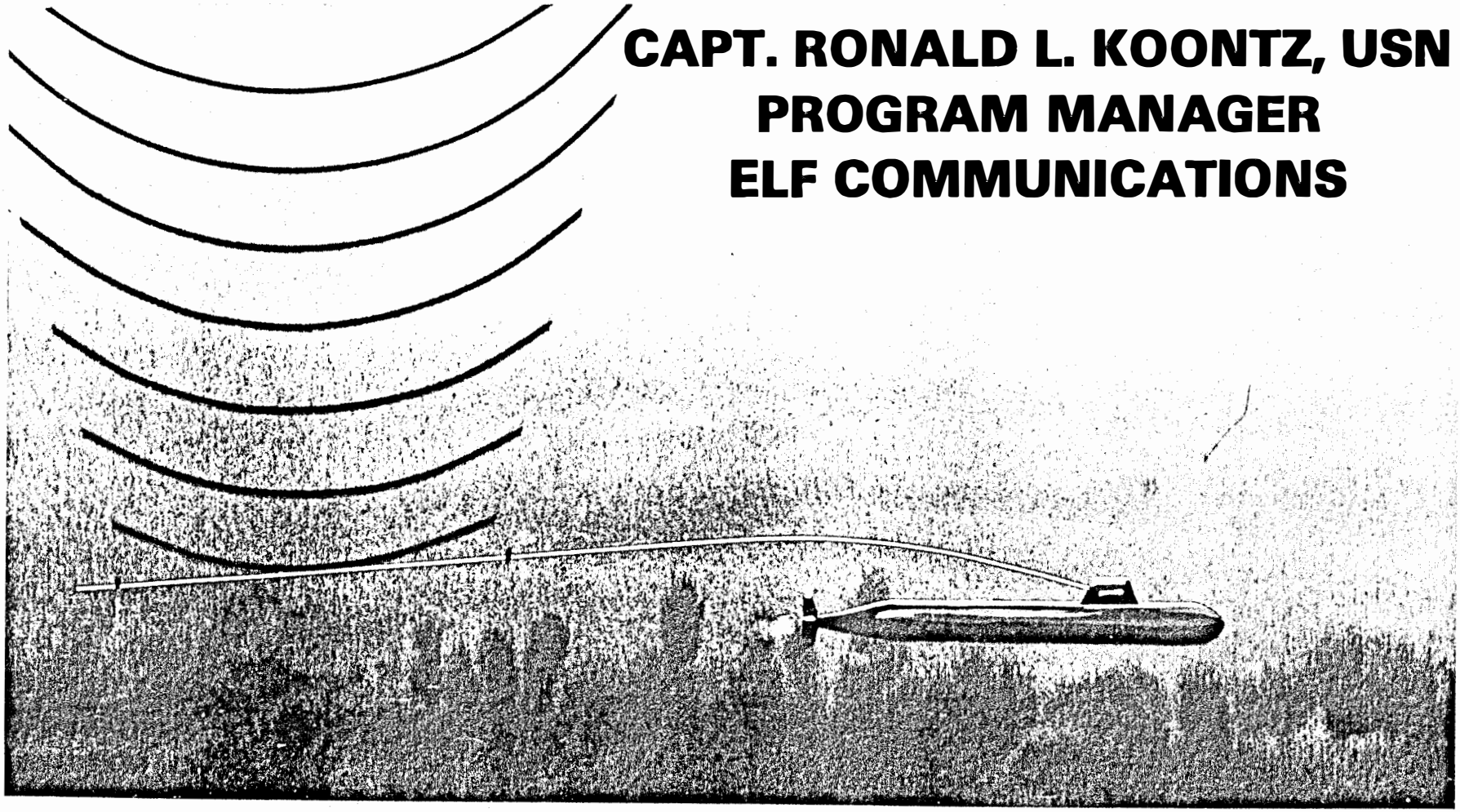
ELF COMMUNICATIONS SYSTEM

CAPT. RONALD L. KOONTZ, USN
PROGRAM MANAGER
ELF COMMUNICATIONS



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THE WHITE HOUSE
WASHINGTON

8 OCT 81 12:45
OFF SECY OF DEFENSE

MEMORANDUM FOR THE HONORABLE CASPAR W. WEINBERGER
The Secretary of Defense

SUBJECT: Extremely Low Frequency (ELF)
Communications System

"... I...HAVE ADVISED THE CONGRESS...TO PROCEED WITH THE ELF COMMUNICATIONS SYSTEM DEPLOYMENT.

THE SYSTEM WILL INCLUDE UPGRADING OF THE EXISTING ELF FACILITY IN WISCONSIN, CONSTRUCTION OF A NEW TRANSMITTER FACILITY...WITH 56 MILES OF ANTENNA IN MICHIGAN, AND ELF RECEIVERS FOR SUBMARINES.

...THE NAVY SHOULD SUPPORT THIS DECISION...THAT WILL PROVIDE AN INITIAL OPERATING CAPABILITY IN...1985"

Ronald Reagan

THE WHITE HOUSE
WASHINGTON

(U) IN 1981, THE PRESIDENT DIRECTED THE SECRETARY OF DEFENSE TO CONDUCT A STRATEGIC CONNECTIVITY REVIEW CHAIRED BY DR. WADE WHICH CONFIRMED THE NEED FOR A SMALL ELF COMMUNICATIONS SYSTEM AS ONE OF SEVERAL INTIATIVES REQUIRED TO IMPROVE STRATEGIC COMMAND AND CONTROL. THE PRESIDENT APPROVED THE SECRETARY OF DEFENSE'S RECOMMENDATION; AND ON 8 OCTOBER 1981, THE PRESIDENT DIRECTED THE DEPLOYMENT OF THE ELF COMMUNICATIONS SYSTEM.

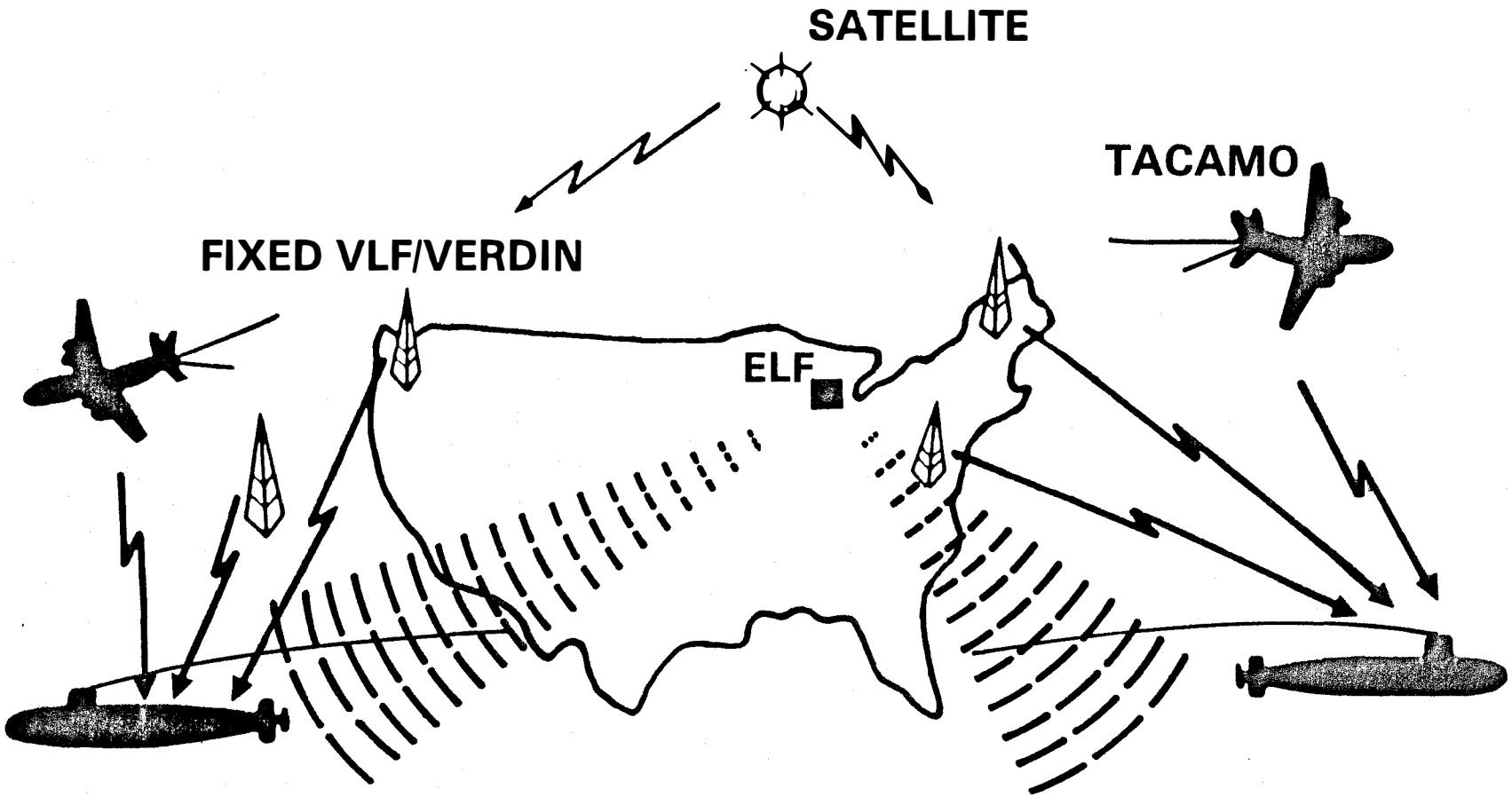
SSBN MISSION OBJECTIVES

- **REMAIN UNDETECTED**
- **MAINTAIN CONTINUOUS COMMUNICATIONS RECEPTION**
- **MAINTAIN A CONDITION OF READINESS WHICH WILL ENSURE SUCCESSFUL LAUNCH OF ALL MISSILES IF AND WHEN DIRECTED BY NCA**

SSBN MISSION OBJECTIVES

THIS VIEWGRAPH POINTS OUT THE ESSENTIAL OPERATIONAL REQUIREMENT. THAT IS, TO REMAIN UNDETECTED WHILE RETAINING THE ABILITY TO RECEIVE COMMUNICATIONS.

COMMUNICATIONS TO SUBMARINES

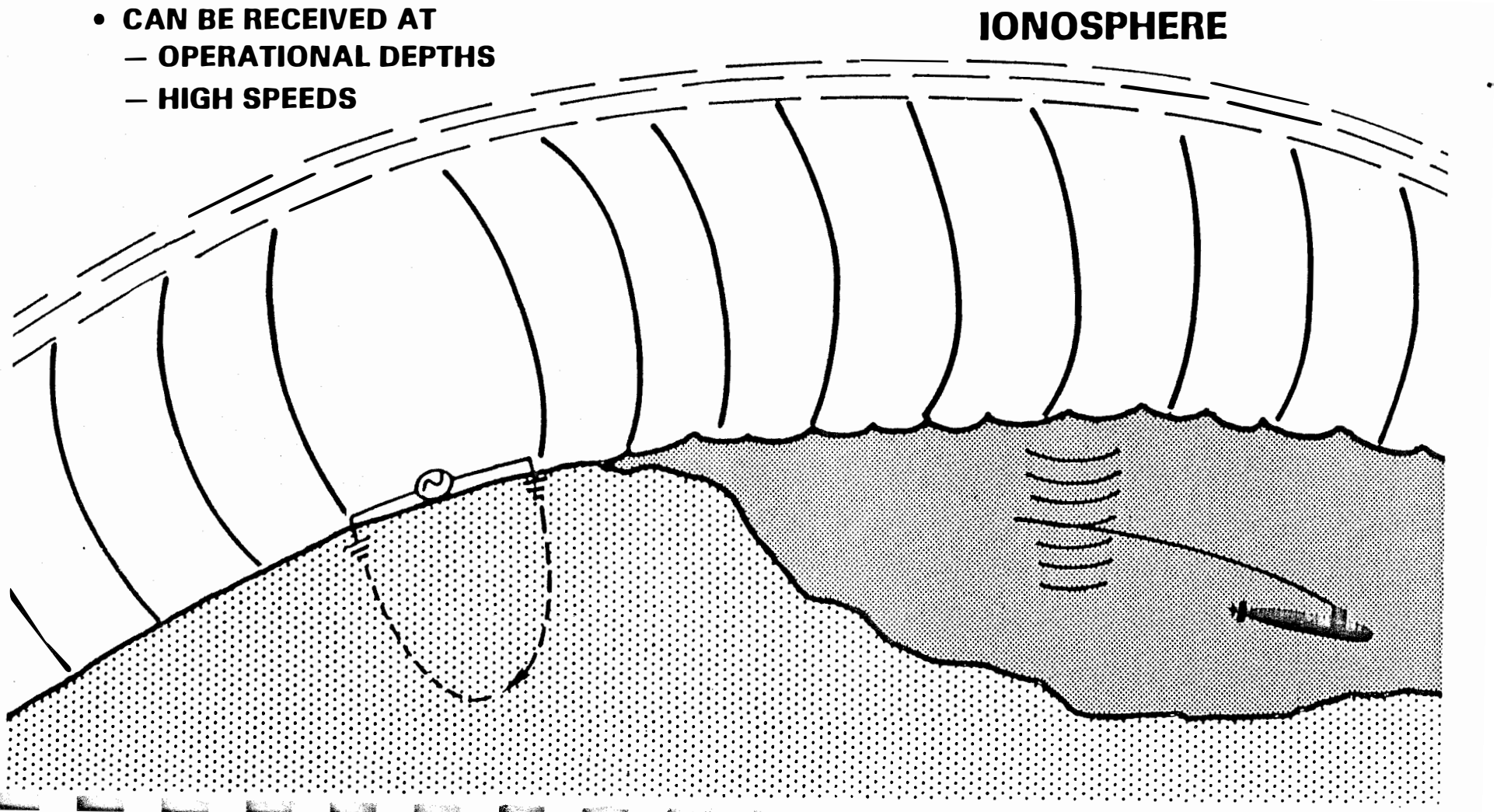


COMMUNICATIONS TO SUBMARINES

(U) PRESENT SUBMARINE COMMUNICATIONS SYSTEMS USE A LARGE PORTION OF THE RADIO FREQUENCY SPECTRUM; FROM VERY LOW FREQUENCY (VLF) TO ULTRA-HIGH FREQUENCY (UHF). EACH OF THE SYSTEMS HAS CERTAIN CAPABILITIES AND INHERENT LIMITATIONS. FOR EXAMPLE, SOME ARE ABLE TO TRANSMIT COMMUNICATIONS INFORMATION AT A VERY HIGH DATA RATE; OTHERS ARE CAPABLE OF BROADCASTING OVER LARGE AREAS. THUS PERMITTING SIMULTANEOUS RECEPTION BY MANY SUBMARINES. STILL OTHERS HAVE THE ABILITY TO PENETRATE THROUGH A DISTURBED ENVIRONMENT SUCH AS THAT CAUSED BY JAMMING OR HIGH ALTITUDE NUCLEAR EXPLOSIONS.

ELF COMMUNICATIONS SYSTEM OVERVIEW

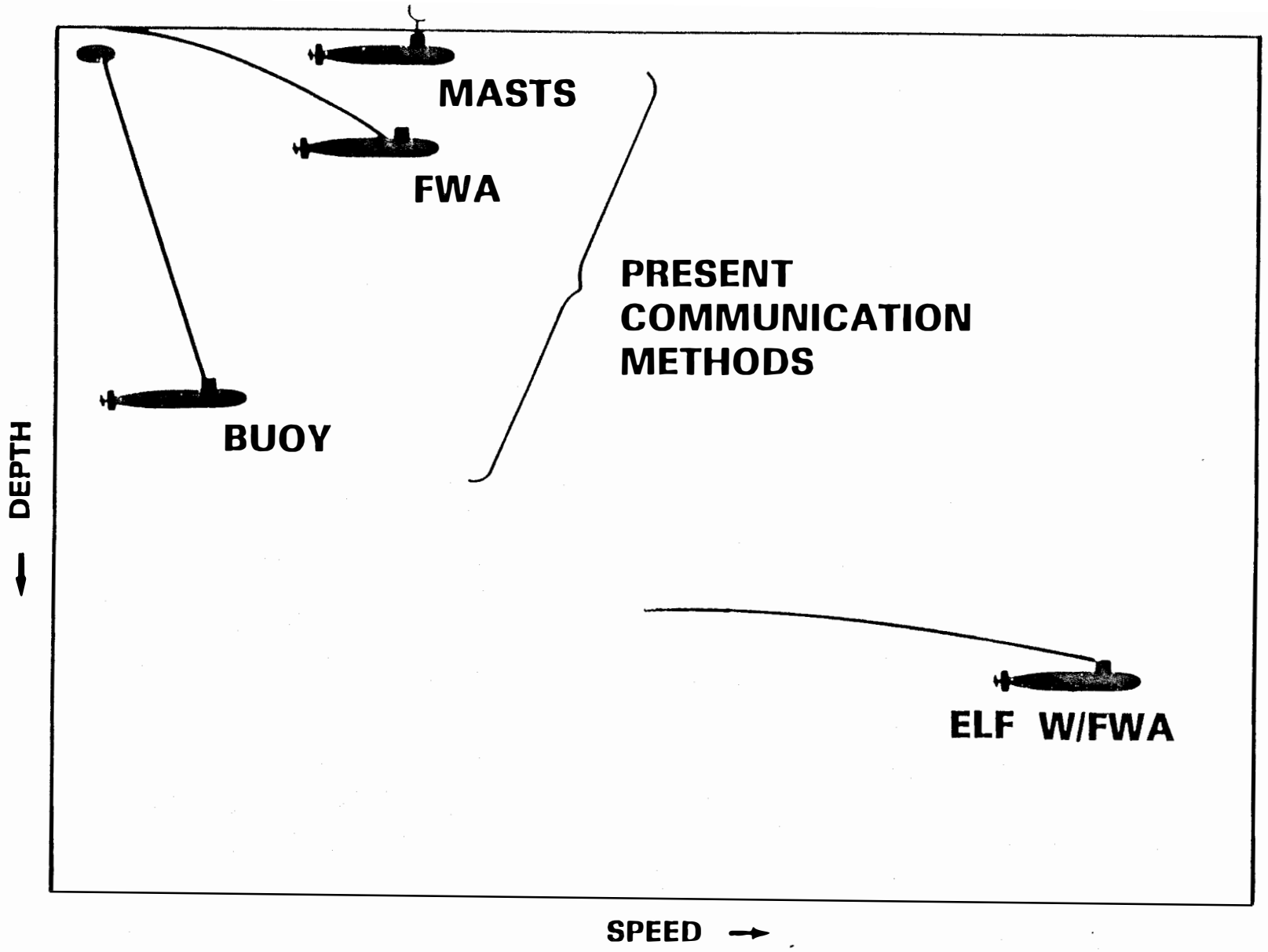
- COVERS LARGE GEOGRAPHICAL AREAS
- RESISTS
  - JAMMING
  - NUCLEAR DISTURBANCES
- CAN BE RECEIVED AT
  - OPERATIONAL DEPTHS
  - HIGH SPEEDS



ELF COMMUNICATIONS SYSTEM
OVERVIEW

- LOW ATTENUATION EARTH-IONOSPHERE DUCT
- LOW SEA WATER ATTENTUATION
- LOW CONDUCTIVITY THAT EXISTS IN NORTHERN WISCONSIN AND MICHIGAN'S UPPER PENINSULA IMPROVES ANTENNA EFFICIENCY

SUBMARINE RECEIVING METHODS



SUBMARINE RECEIVING METHODS

THE ELF SYSTEM WILL FULFILL AN IMPORTANT AND IMMEDIATE SUBMARINE COMMAND AND CONTROL REQUIREMENT. THAT OF ATTAINING A CAPABILITY TO FREE THE SUBMARINE FROM VULNERABILITIES AND LIMITATIONS, OF NEAR SURFACE OPERATION. AS WILL BE DISCUSSED, ONLY ELF OFFERS THIS CAPABILITY.

IN ALL CASES, PRESENT SYSTEMS HAVE ONE MAJOR DEFICIENCY IN THEIR ABILITY TO COMMUNICATE WITH THE SUBMARINE FORCE, AND THAT IS THEY ARE UNABLE TO PENETRATE THE OCEAN MORE THAN A FEW TENS OF FEET. TO OBTAIN COMMUNICATIONS AT PRESENT, A SUBMERGED SUBMARINE MUST HAVE A RECEIVING ANTENNA AT OR VERY NEAR THE SURFACE OF THE WATER.

ELF SYSTEM SHOWN AT THE RIGHT WILL ALLOW COMMUNICATIONS WHILE THE SUBMARINES ARE AT GREATER OPERATIONAL SPEEDS AND DEPTHS.

ELF COMMUNICATIONS OPERATIONAL CAPABILITIES

- **SUPPORTS NUCLEAR DETERRENCE BY ENSURING THE CONTINUED INVULNERABILITY OF SUBMARINE BALLISTIC MISSILE FORCE DURING PEACETIME**
  - **PERMITS SUBMARINES TO RECEIVE AT OPERATIONAL DEPTHS AND SPEEDS**
  - **REQUIRES SUBMARINES TO TRANSITION TO HIGHER DATA RATE COMMUNICATIONS ONLY WHEN NECESSARY TO RECEIVE OPERATIONAL MESSAGES**
- **ELF SYSTEM DOES NOT PROVIDE A FIRST STRIKE CAPABILITY**
  - **LOW DATA RATE AND RESTRICTED MESSAGE LENGTH MAKES IT INCAPABLE OF TRANSMITTING MESSAGES REQUIRED FOR RELEASE OF NUCLEAR WEAPONS**
- **DETERS SOVIET FIRST STRIKE**

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ELF COMMUNICATIONS OPERATIONAL CAPABILITIES

- SYSTEM HELPS MAINTAIN OUR SUBMARINE BASED BALLISTIC MISSILES AS THE MOST SURVIVABLE MEANS OF NUCLEAR DETERRENT

- ASSURING INVULNERABILITY OF THE SUBMARINE BALLISTIC MISSILE FORCE ENHANCES NUCLEAR DETERRENCE
  - ASSURES THAT A RETALIATORY RESPONSE TO AN ATTACK BY AN AGGRESSOR EXISTS THUS DISCOURAGING THE INITIATION OF A STRIKE BY THE AGGRESSOR
  - CONSISTENT WITH THE CONCEPT OF DETERRENCE WHICH HAS BEEN A NATIONAL POLICY SINCE 1945

- NO ILLUSION ABOUT CONSEQUENCES OF NUCLEAR WAR - ELF SYSTEM IS BEING BUILT TO DISCOURAGE AN ATTACK AGAINST <u>ANY</u> TARGET IN THE U.S. BY ASSURING THE SURVIVABILITY OF A RETALIATORY CAPABILITY IN THE SSBN FORCE AT SEA

ELF COMMUNICATIONS SYSTEM MILITARY TARGET VALUE

- **PLANNED USE OF ELF COMMUNICATIONS SYSTEM NOT A THREAT TO SOVIET UNION IN WARTIME SITUATION**
  - — OPERATIONAL CAPABILITIES NOT CONSISTENT WITH HIGH VALUE MILITARY TARGETS
  - — LOSS OF ELF SIGNAL ALERTS SUBMARINES TO COPY OTHER MORE CAPABLE COMMUNICATIONS SYSTEM
- **POTENTIAL SOVIET TARGETS IN NORTHERN MICHIGAN AREA ALREADY EXIST**
  - — URBAN POPULATION CENTERS
  - — INDUSTRIAL FACILITIES
  - — TRANSPORTATION RESOURCES
  - — NEARBY MILITARY BASES AND FACILITIES

ELF COMMUNICATIONS SYSTEM - MILITARY TARGET VALUE

- ANY DEFENSE RELATED SYSTEM COULD BE A POTENTIAL TARGET
- ELF PROBABLY WOULD NEITHER DIMINISH NOR ENHANCE ANY THREAT OF ATTACK IN NORTHERN MICHIGAN
- EXISTING POTENTIAL TARGETS ARE SUCH CITIES AS CHICAGO, MINNEAPOLIS-ST. PAUL; IRON ORE FACILITIES AT DULUTH; THE SAC BASE AT K.I. SAWYER AFB; THE LOCKS AT SAULT STE. MARIE
- FALLOUT COULD ENVELOPE THE AREA AFTER AN ATTACK ON THESE TARGETS

ELF COMMUNICATIONS SYSTEM CHRONOLOGY

1958 • COMMENCED BASIC ELF C^3 RESEARCH

1963 • FIRST SUBMARINE ELF RECEPTION

1969 • COMPLETED WISCONSIN TEST FACILITY

1972 • NATIONAL ACADEMY OF SCIENCES TECHNICAL FEASIBILITY REPORT

1973 • COMMENCED CONCEPT VALIDATION PHASE

1975 • COMMENCED DESIGN VALIDATION

ELF COMMUNICATIONS SYSTEM CHRONOLOGY (CONTINUED)

1976 — ELF RECEIVERS INSTALLED ON SSBNs/SSNs

1977 — FILED FINAL ENVIRONMENTAL IMPACT STATEMENT

NATIONAL ACADEMY OF SCIENCES BIO/ECO EFFECTS REPORT

1978 — DEPARTMENT OF DEFENSE ELF PROGRAM REVIEW

SEAFARER TERMINATED

DIRECTION PROVIDED TO PURSUE AUSTERE MICHIGAN/WISCONSIN SYSTEM

1978 — WISCONSIN FACILITY PLACED IN CARETAKER STATUS

1981 — PRESIDENT DECISION TO REACTIVATE WTF AND FINAL DECISION

CURRENT SYSTEM

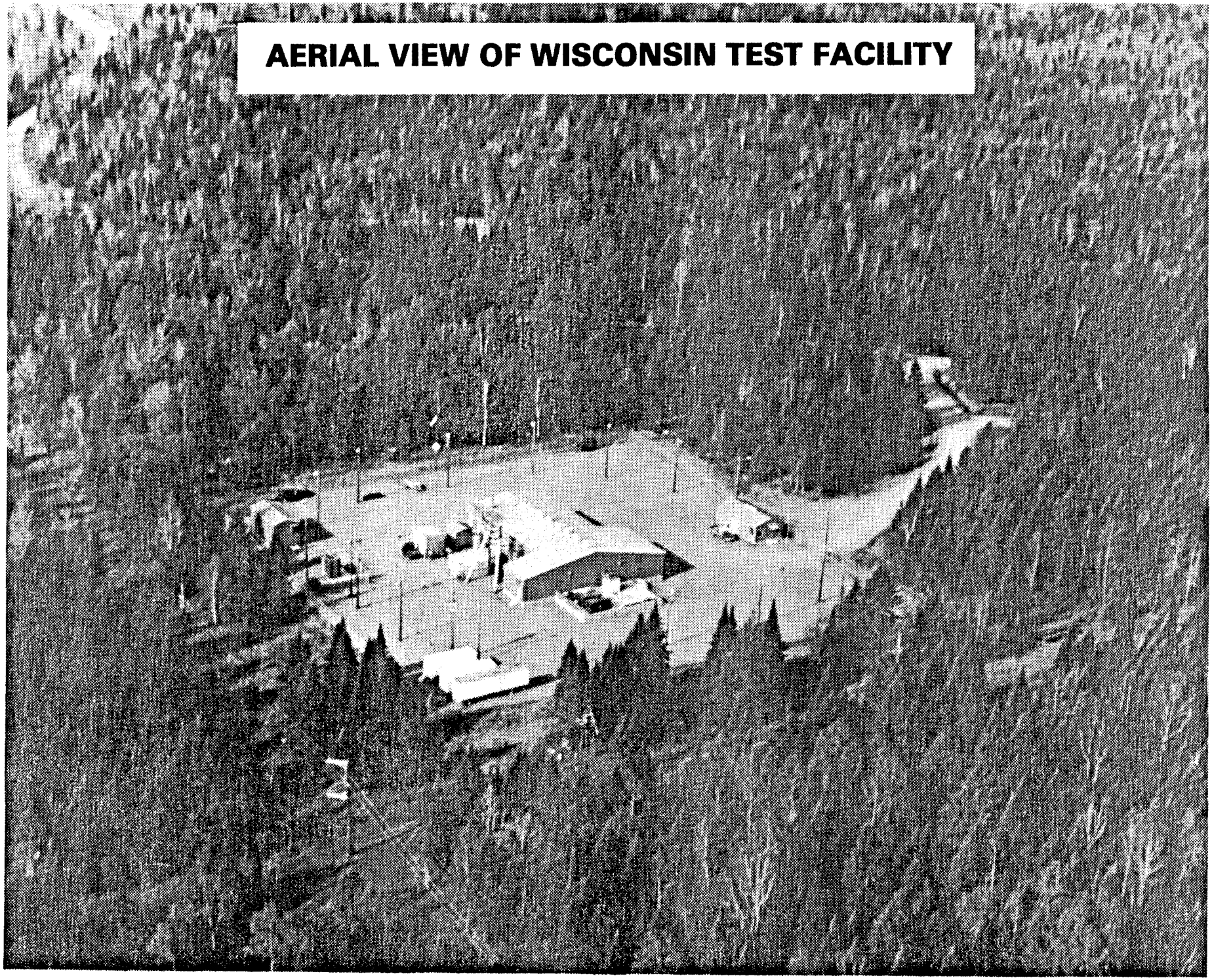
- EXPERIMENTAL SYSTEM
- WTF AND EXPERIMENTAL RECEIVERS
- PERIOD OF OPERATION: 1976-1978; 1981-1984
- VALIDATED ELF CONCEPT
  - TECHNICAL
  - OPERATIONAL

CURRENT SYSTEM

- ELF IS A LOW RISK TECHNOLOGY THAT HAS BEEN TESTED MANY TIMES. ELF COMMUNICATIONS WAS VERIFIED BY THE NATIONAL ACADEMY OF SCIENCES IN 1972. PRACTICAL FEASIBILITY HAS BEEN DEMONSTRATED BY THE SYSTEM EVALUATION OPERATIONS (SVO) IN TESTS CONDUCTED BETWEEN 1976 AND 1978; AND WHICH WERE RESUMED IN OCTOBER 1981. THE SYSTEM CONSISTS OF A TEST TRANSMITTER IN WISCONSIN AND EXPERIMENTAL RECEIVERS ABOARD SELECTED SUBMARINES.

- 7 RECEIVERS AVAILABLE FOR INSTALLATION

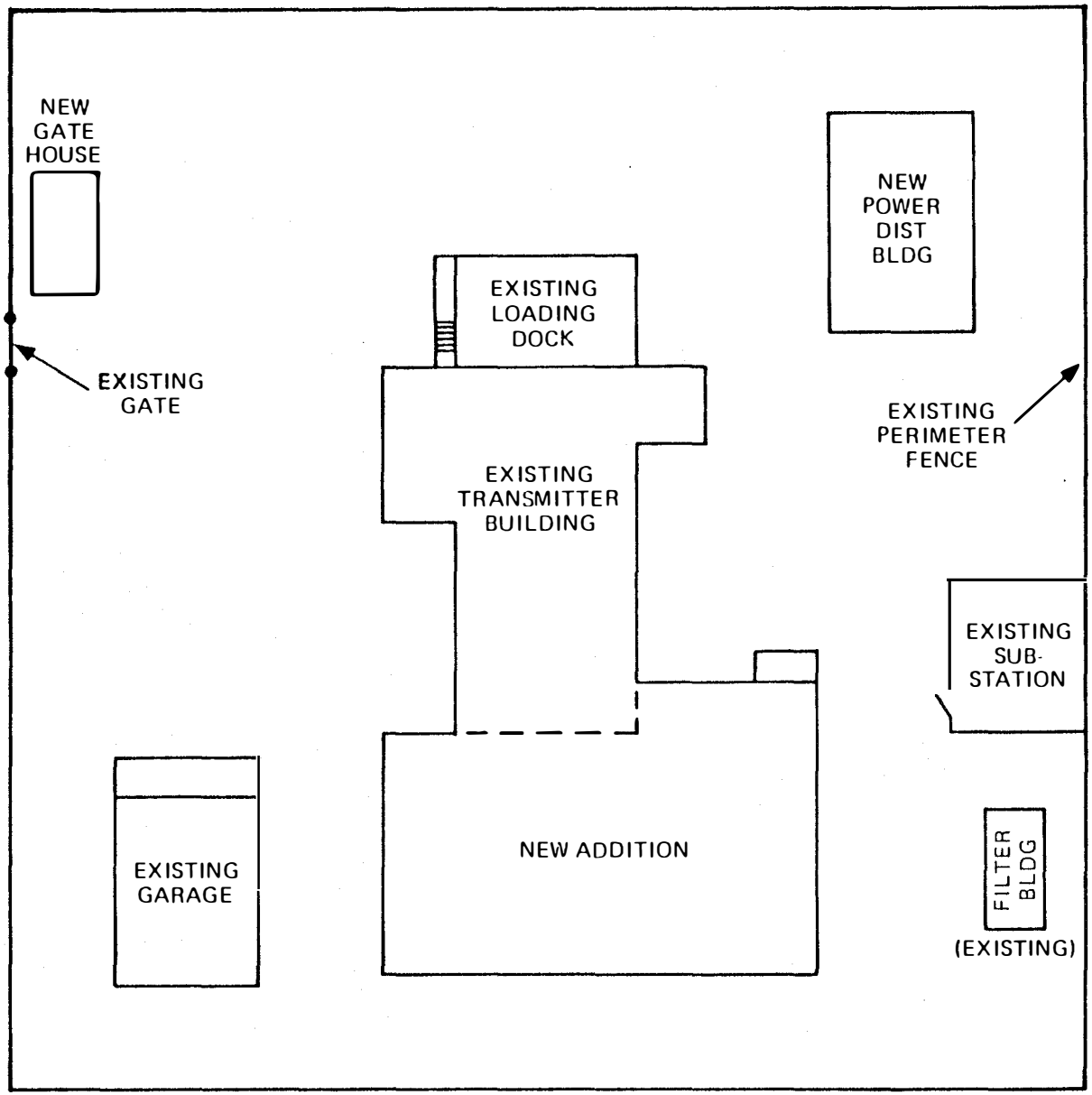
AERIAL VIEW OF WISCONSIN TEST FACILITY



AERIAL VIEW OF WISCONSIN TEST FACILITY

- o CONSTRUCTED IN 1969
- o TO DEMONSTRATE INTERFERENCE MITIGATION
- o 2.1 ACRE PLOT IN NATIONAL FOREST OF OVER 800,000 ACRES

WISCONSIN TRANSMITTER SITE

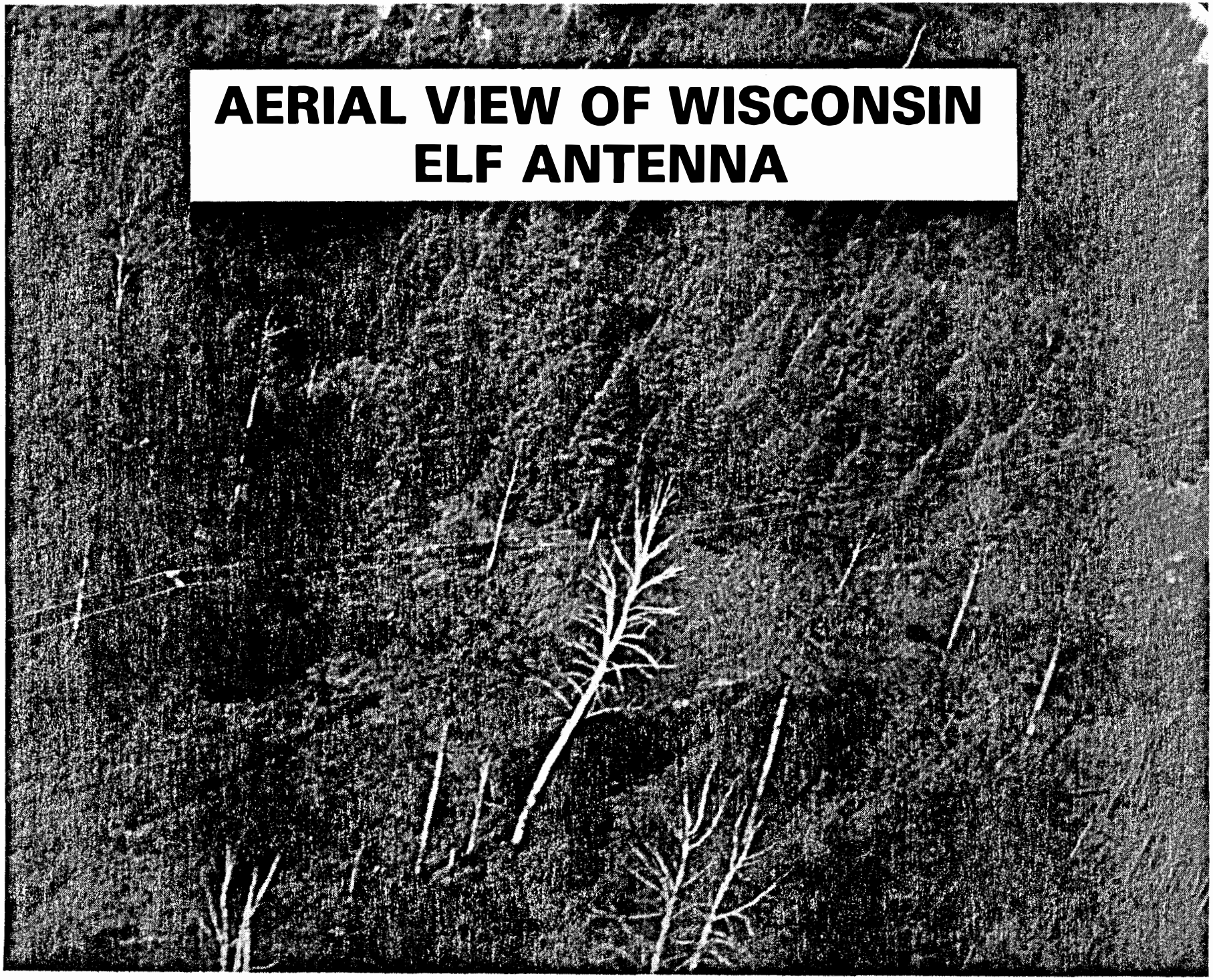


SCALE: NONE

83-1542-23 84-4461-6

WISCONSIN TRANSMITTER SITE

- WTF UPGRADE INCLUDES:
  - NEW GATEHOUSE
  - NEW POWER DISTRIBUTION BUILDING
  - EXPANDED TRANSMITTER BUILDING
  - OPERATIONAL, VICE TESTING AND EXPERIMENTAL EQUIPMENT
  - ALL THE UPGRADING IS DONE WITHIN THE CONFINES OF ORIGINAL TEST FACILITY



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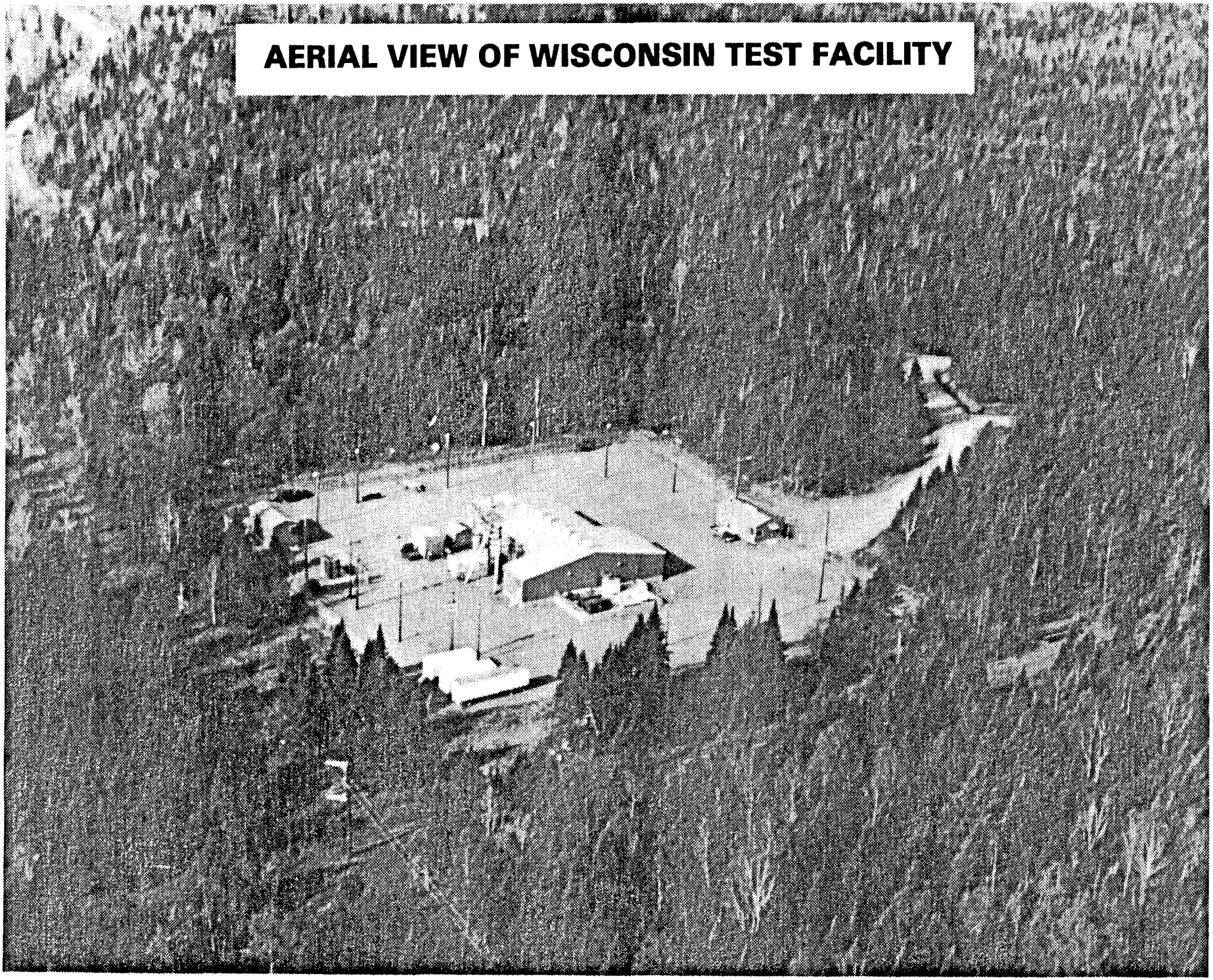
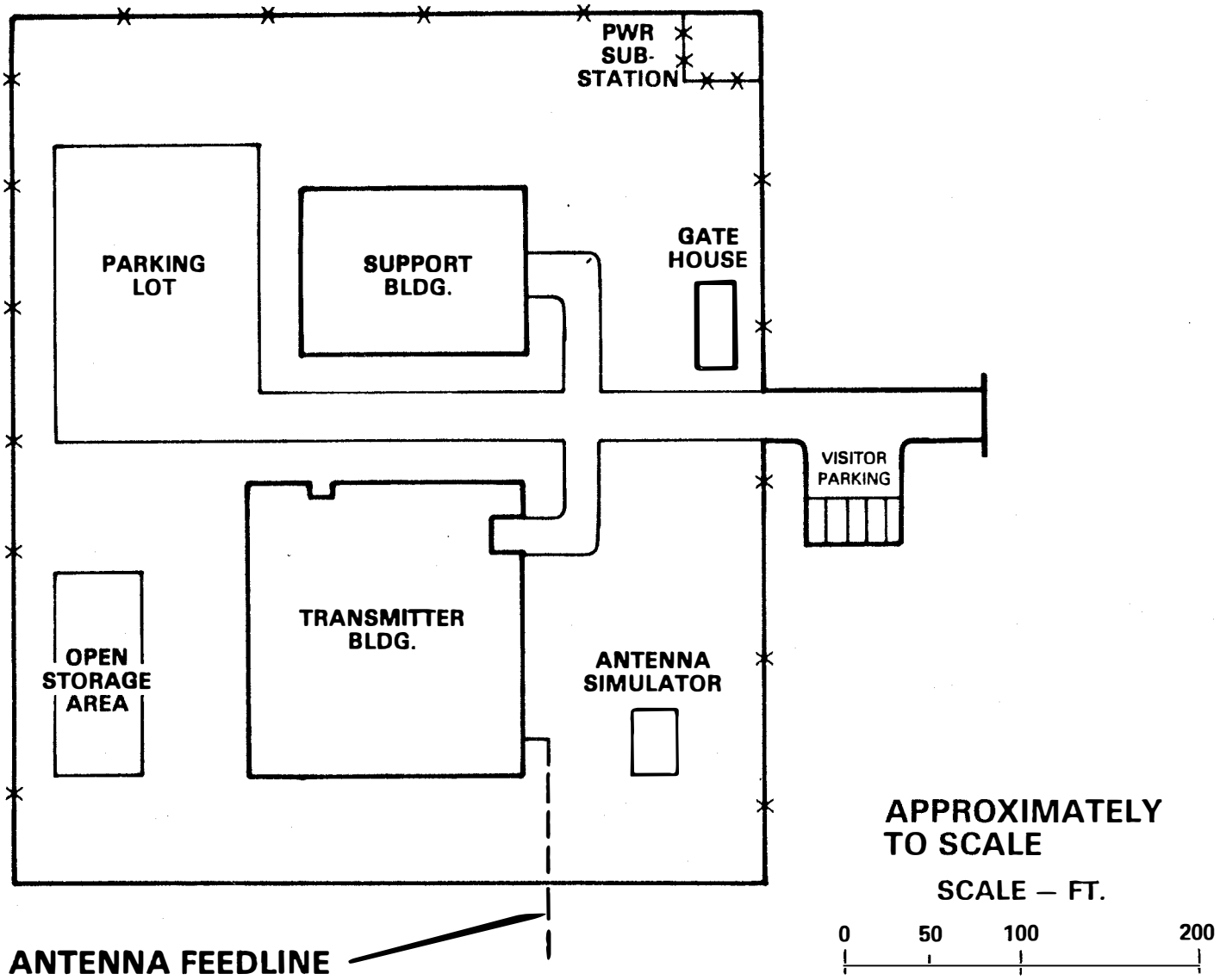
AERIAL VIEW OF WISCONSIN ELF ANTENNA

- 14 X 14 MILES OF ANTENNA
- MICHIGAN ANTENNA SIMILAR WITH ONE WIRE, APPROXIMATELY 1 INCH DIAMETER

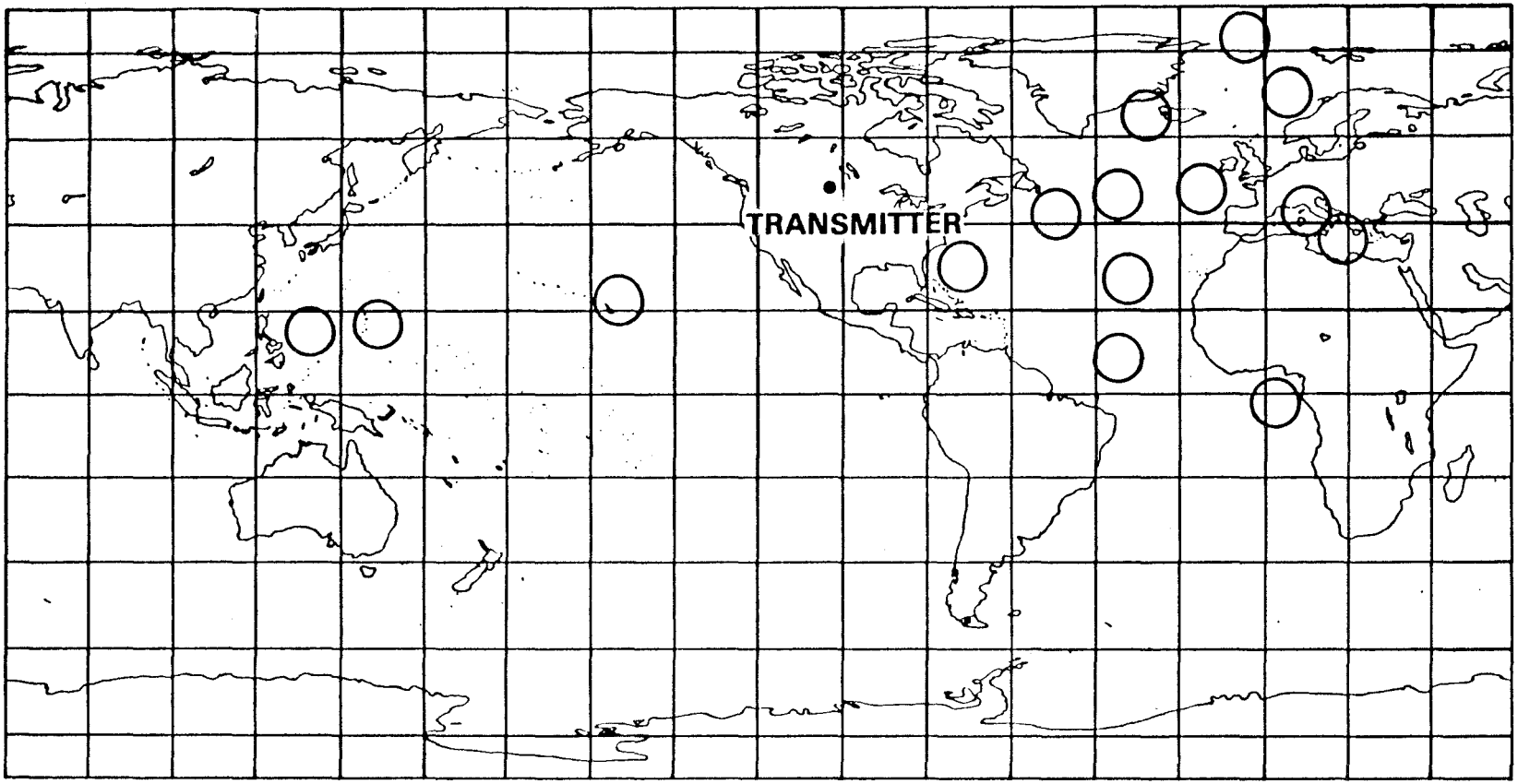
AERIAL VIEW OF WISCONSIN TEST FACILITY



MICHIGAN TRANSMITTER SITE LAYOUT



ELF RECEPTION EXPERIENCE



ELF RECEPTION EXPERIENCE

- "WORLD WIDE" RECEPTION
- UNDER POLAR ICE
- PERFORMANCE IS A FUNCTION OF
  - HEADING
  - SPEED
  - DEPTH

TEST RESULTS

- **COMMUNICATIONS TESTS DEMONSTRATE:**
  - **VALIDITY OF ELF CONCEPT**
  - **STRATEGIC CONNECTIVITY CAN BE MAINTAINED WITH SUBMARINES OPERATING AT SPEED AND DEPTH IN OPERATIONAL AREAS**
  - **SYSTEM PERFORMANCE AS GOOD AS, OR BETTER THAN, PREDICTED**
  - **SECOND TRANSMITTER NEEDED TO COVER ALL STRATEGIC OPERATIONAL AREAS**
- **USS OHIO SUCCESSFULLY DEMONSTRATED ELF RECEPTION DURING HER FIRST PATROL**

TEST RESULTS

- RECEIVERS INSTALLED ON 21 SUBMARINES OVER THE YEARS

SUBMARINE SKIPPERS' COMMENTS

USS BATFISH, OCTOBER 76

...SIGNIFICANT IMPROVEMENT IN SUBMARINE COORDINATION, COMMUNICATIONS, COMMAND AND CONTROL

USS SIMON BOLIVAR, JUNE 78

FREEING THE SUBMARINE FROM THE SURFACE ZONE FOR COMMUNICATIONS RECEPTION – A TRUE SUBMARINE

USS L. MENDEL RIVERS, MAY 83

AN ELF SYSTEM SATISFIES COMMUNICATION REQUIREMENTS FOR AN ATTACK SUBMARINE WHILE CARRYING OUT THE PRIME ASW MISSION – WE MUST PROCEED WITH IMPLEMENTING THE FULL ELF SYSTEM WITH THE GREATEST URGENCY

SUBMARINE SKIPPERS' COMMENTS

HERE ARE SOME COMMENTS FROM COMMANDING OFFICERS WHO HAVE HAD THE SYSTEM ABOARD THEIR SHIPS IN RECENT TIMES.

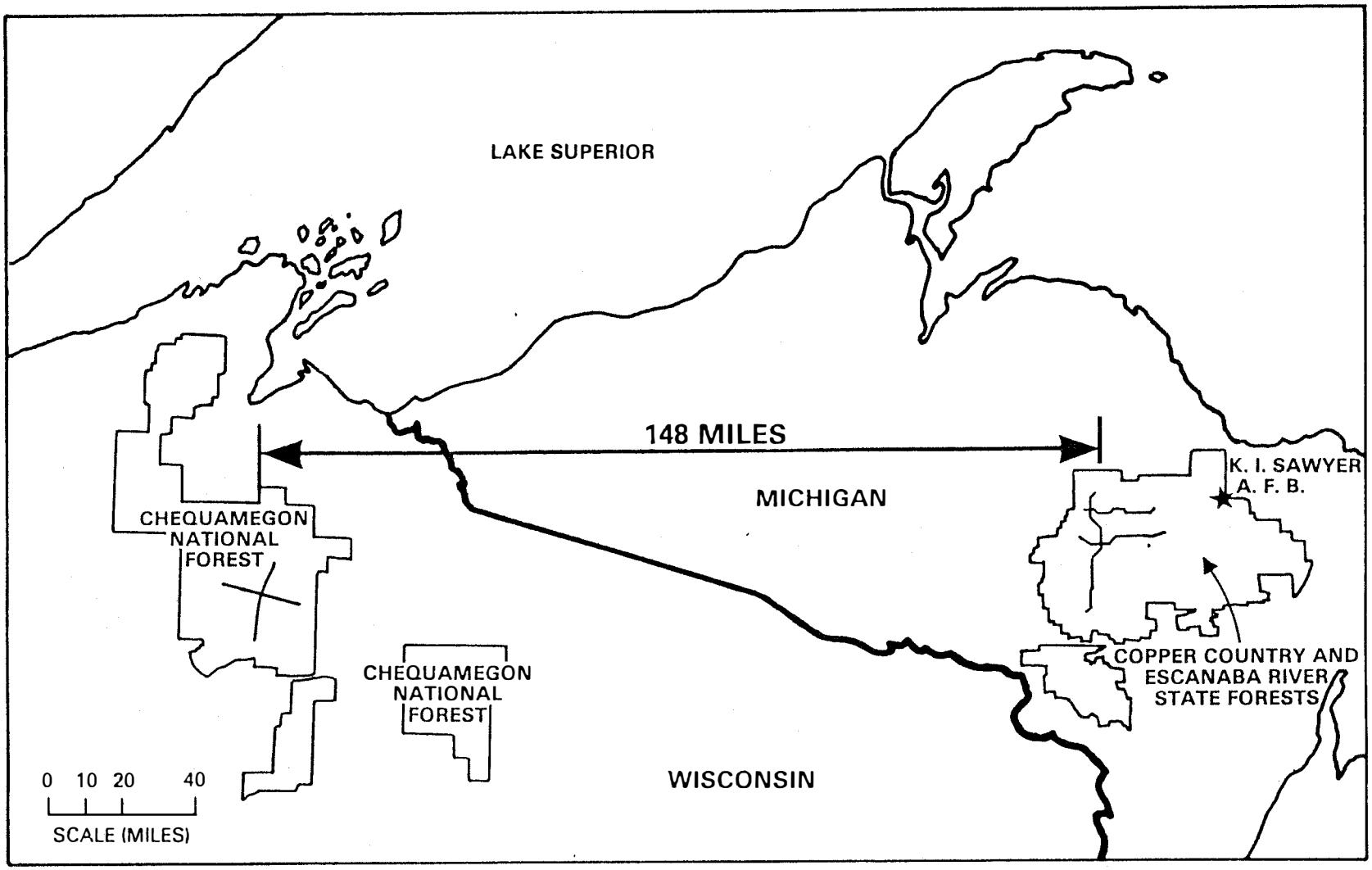
CURRENT ELF SUBMARINE TEST SUMMARY

- TESTS PERFORMED
  - ON OPERATIONAL SUBMARINES
  - USING THE WISCONSIN TRANSMITTER
  - USING EXPERIMENTAL RECEIVERS BUILT IN 1975
- CURRENT RECEIVER DEPLOYMENTS (3/84)
  - USS HENRY CLAY
  - USS JAMES MONROE
  - USS HAWKBILL
  - USS VON STEUBEN
  - USS OHIO
- PLANNED RECEIVER DEPLOYMENTS
  - SSN (PAC)
- TESTS ARE USED TO DEMONSTRATE ELF PERFORMANCE AND TO DEVELOP DETAILED OPERATIONAL PROCEDURES FOR USING THE SYSTEM

CURRENT ELF SUBMARINE TEST SUMMARY

- ELF HAS WORKED AND CONTINUES TO WORK
- SURPRISINGLY, A 1979 GENERAL ACCOUNTING OFFICE REPORT SAID THE SYSTEM DIDN'T WORK! THIS BAFFLED THE NAVY
- IN 1982, THE GAO ESSENTIALLY WITHDREW THAT STATEMENT, YET THE NAVY CONTINUES TO GET COMMENTS FROM PEOPLE THAT THE SYSTEM DOESN'T WORK. NOT SO!

WISCONSIN/MICHIGAN ELF SITES



WISCONSIN/MICHIGAN ELF SITES

(U) IN MICHIGAN, 56 MILES OF ANTENNA AND TRANSMITTER EQUIPMENT WILL BE INSTALLED WITHIN THE STATE FOREST, NEAR K.I. SAWYER AIR FORCE BASE. AFTER DESIGN AND SURVEY WORK.

(U) THE WISCONSIN AND MICHIGAN ELF TRANSMITTER AND ANTENNA SITES WILL BE SEPARATED BY 148 MILES. CONTROL OF THE SYSTEM WILL BE IN MICHIGAN AT FACILITIES ON K.I. SAWYER AIR FORCE BASE. THE CONTROL SYSTEM WILL LINK THE TWO SITES TOGETHER ELECTRICALLY TO PROVIDE SYNCHRONOUS OPERATION.

ENVIRONMENTAL IMPACT STATEMENT CHRONOLOGY

FEB 77	FILED DRAFT EIS
MAR/APR 77	PUBLIC HEARINGS
SEPT 77	SUPPLEMENT - NATIONAL ACADEMY REPORT
	SUPPLEMENT - SYNCHRONOUS OPERATION OF MICHIGAN AND WISCONSIN TEST FACILITIES
DEC 77	FILED FINAL EIS
OCT 83	ENVIRONMENTAL ASSESSMENT FOR MICHIGAN
FEB 84	INITIATED PREPARATION OF SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT ON BIOLOGICAL/ ECOLOGICAL EFFECTS

ENVIRONMENTAL IMPACT STATEMENT

CHRONOLOGY

JAN 84 THE U.S. DISTRICT COURT FOR THE WESTERN DISTRICT OF WISCONSIN GRANTED A PERMANENT INJUNCTION AND ENJOINED THE NAVY FROM CONTINUING:

- CONSTRUCTING THE MICHIGAN FACILITY
- UPGRADING THE EXISTING WISCONSIN FACILITY
- SUPPLYING SUBMARINES WITH ELF RECEIVERS

UNTIL THE NAVY PREPARES AND FILES A SUPPLEMENTAL EIS

FEB 84 NAVY INITIATED PREPARATION OF A SEIS ON BIOLOGICAL AND ECOLOGICAL EFFECTS

CONGRESSIONAL SUPPORT

SASC (5 JULY 1983)

"THE ADMINISTRATION REQUESTED $58.5 MILLION FOR CONTINUED RESEARCH AND DEVELOPMENT ON THE EXTREMELY LOW FREQUENCY SYSTEM IN FISCAL YEAR 1984. THE ELF COMMUNICATIONS SYSTEM WILL ENHANCE THE SURVIVABILITY AND EFFECTIVENESS OF OUR SUBMARINE FORCE BY ALLOWING IT TO MANEUVER, TRANSIT, AND PERFORM ITS MISSION AT OPERATIONAL SPEEDS AND DEPTHS WITHOUT LOSING ESSENTIAL COMMUNICATIONS CONNECTIVITY. THE COMMITTEE HAS STRONGLY SUPPORTED THE ELF PROGRAM OVER THE YEARS DURING WHICH THE REQUIREMENT FOR THIS SYSTEM HAS BEEN DEBATED AND REDEFINED. THE COMMITTEE IS PLEASED TO NOTE THAT RECENT TESTS OF THE REACTIVATED EXTREMELY LOW FREQUENCY SITE HAVE BEEN MOST ENCOURAGING AND REAFFIRMS THE COMMITTEE'S CONFIDENCE IN THE ULTIMATE UTILITY OF THIS STRATEGIC COMMUNICATIONS SYSTEM. THE COMMITTEE RECOMMENDS THE AUTHORIZATION OF THE REQUESTED AMOUNT FOR RESEARCH AND DEVELOPMENT OF THE ELF SYSTEM."

CONGRESSIONAL SUPPORT

THIS STATEMENT REPRESENTS THE VIEW OF THE MAJORITY OF THE MEMBERS OF THE SENATE ARMED SERVICES COMMITTEE. SENATOR LEVIN HAS BEEN A MINORITY MEMBER OF THIS COMMITTEE WITH REGARDS TO ELF.

KEY ATTRIBUTES OF MICHIGAN TRANSMITTER SITE

- LAURENTIAN SHIELD GEOLOGICAL FORMATION PROVIDES LOW ELECTRICAL CONDUCTIVITY REQUIRED FOR ANTENNA EFFICIENCY

- PROXIMITY TO WISCONSIN TRANSMITTER FACILITY ENABLES SYNCHRONOUS TWO-SITE OPERATION WITH MINIMUM SIGNAL DEGRADATION

- LOW POPULATION DENSITY REDUCES AMOUNT OF INTERFERENCE MITIGATION

- TERRAIN FEATURES ALLOW COST-EFFECTIVE CONSTRUCTION OF ANTENNA AND FACILITIES

- LABOR SKILLS READILY AVAILABLE IN AREA

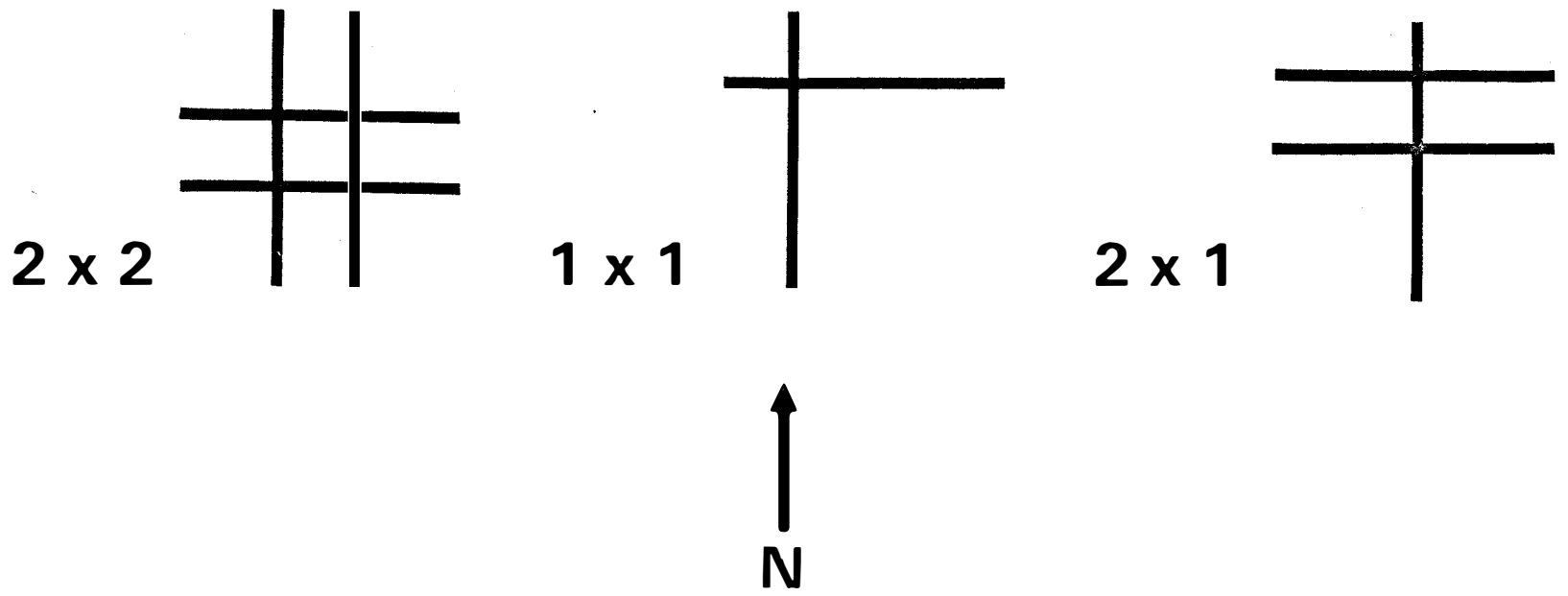
KEY ATTRIBUTES OF MICHIGAN TRANSMITTER SITE

- THIS VIEWGRAPH DESCRIBES THE REASONS WHY MICHIGAN WAS SELECTED AS THE SITE FOR AN ELF TRANSMITTER FACILITY

  - THE LAURENTIAN SHIELD, A PRE CAMBRIAN GEOLOGICAL FORMATION, UNDERLIES THE MICHIGAN AND WISCONSIN AREAS AND HAS THE LOW CONDUCTIVITY REQUIRED TO MAKE THE ANTENNA MORE EFFICIENT THUS REDUCING THE SIZE OF THE ANTENNA REQUIRED TO ACHIEVE A GIVEN LEVEL OF PERFORMANCE.

  - THE CLOSE PROXIMITY OF THE TWO TRANSMITTERS IS NECESSARY TO ENABLE THE RECEIVER ON SUBMARINES TO RECEIVE A SIGNAL WHICH APPEARS TO HAVE BEEN TRANSMITTED FROM A SINGLE TRANSMITTER. THE FURTHER APART THE TRANSMITTERS, THE MORE SIGNAL DEGRADATION WOULD OCCUR DURING SYNCHRONOUS OPERATIONS.

MTF ANTENNA CONFIGURATIONS CONSIDERED



MTF ANTENNA CONFIGURATIONS CONSIDERED

FACTORS CONSIDERED

- MAXIMIZE ANTENNA EFFICIENCY (LOW EARTH CONDUCTIVITY)
- AVOID POPULATED AREAS
- STAY WITHIN STATE FOREST AREAS
- MINIMIZE INTERFERENCE MITIGATION
- ACHIEVE OMNI AZIMUTHAL ANTENNA PATTERN
- TOTAL EFFECTIVE ANTENNA LENGTH RESTRICTED TO 56 MILES OR LESS

MTF ANTENNA SITE SELECTION EVALUATION FACTORS

FIRST ORDER

CONDUCTIVITY (SYSTEM PERFORMANCE)
NUMBER OF PRIVATE/CORPORATE PARCELS AFFECTED (CROSSED)
PERCENT OF SYSTEM ON STATE LAND
INTERFERENCE MITIGATION REQUIREMENTS

CORRIDOR CONFIGURATION vs. PROPERTY OWNERSHIP*

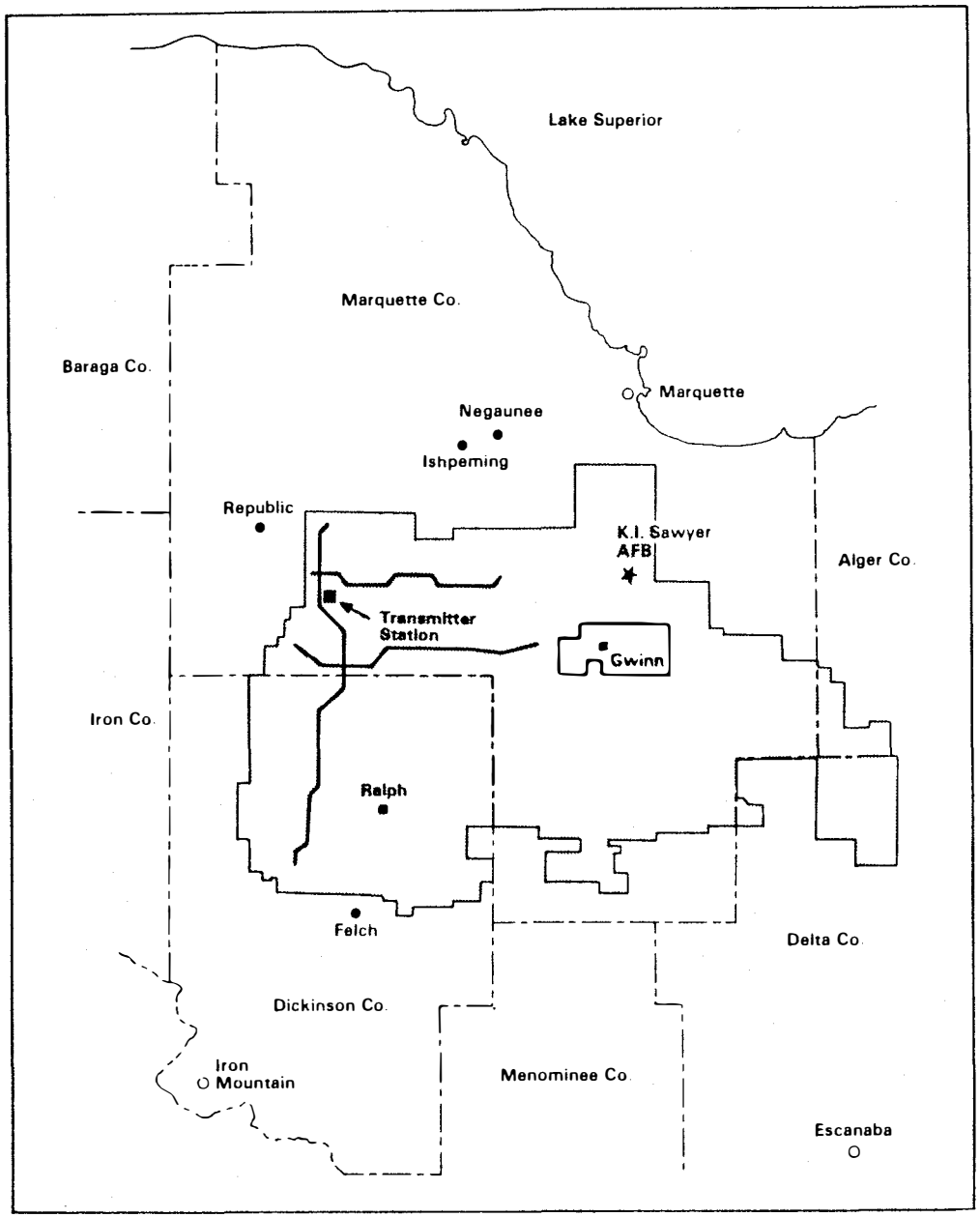
ARRAY	NUMBER PRIVATE/ CORPORATE PARCELS	% OF SYSTEM ON STATE LAND
2 x 2	25	89
1 x 1	37	81
2 x 1	9	96
1 x 2	41	78
2 x 2 (SKEWED)	56	66

* DOES NOT INCLUDE GROUND #3 PROPERTY WHICH IS ALL STATE LAND

SECOND ORDER

PRIVATE/CORPORATE PARCELS
INHABITED AREAS
CRITICAL OR SENSITIVE HABITATS
STREAM AND/OR ROAD CROSSINGS
WETLANDS AND WATERBODIES
POTENTIAL HISTORIC/CULTURAL/ ARCHEOLOGICAL RESOURCES
PRIME FOREST LANDS

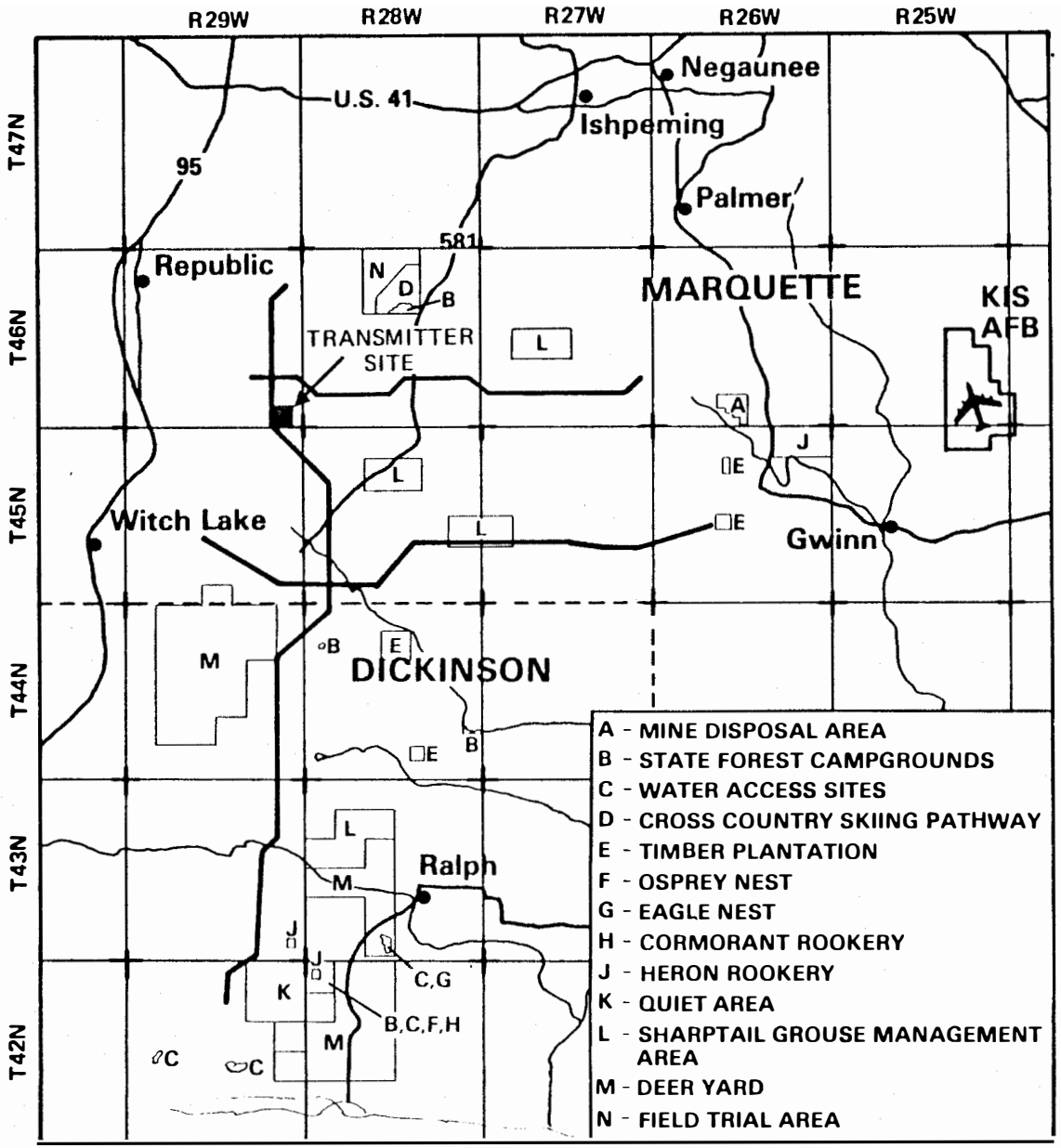
MICHIGAN ELF TRANSMITTING SITE



MICHIGAN ELF TRANSMITTING SITE

- 56 MILES OVERHEAD ANTENNA
- 6 GROUND TERMINALS
- 6.7 ACRES TRANSMITTER SITE
- 7 MILES SE OF REPUBLIC

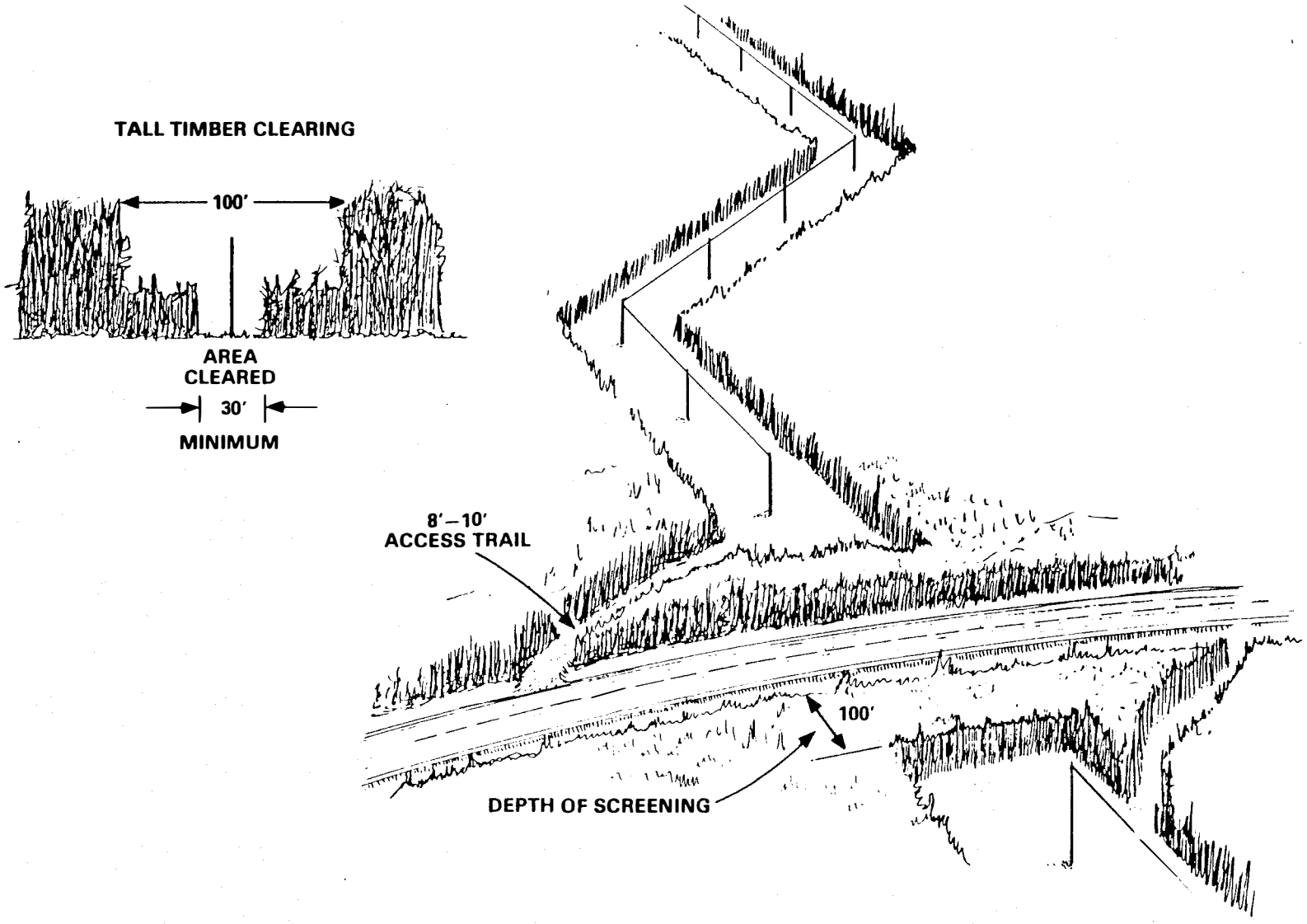
AVOIDANCE AREAS



AVOIDANCE AREAS

- ENRIE HALL, A FORMER DNR MARQUETTE FIELD OFFICE EMPLOYEE, SERVED AS A CONSULTANT TO THE NAVY FOR ANTENNA ROUTING.

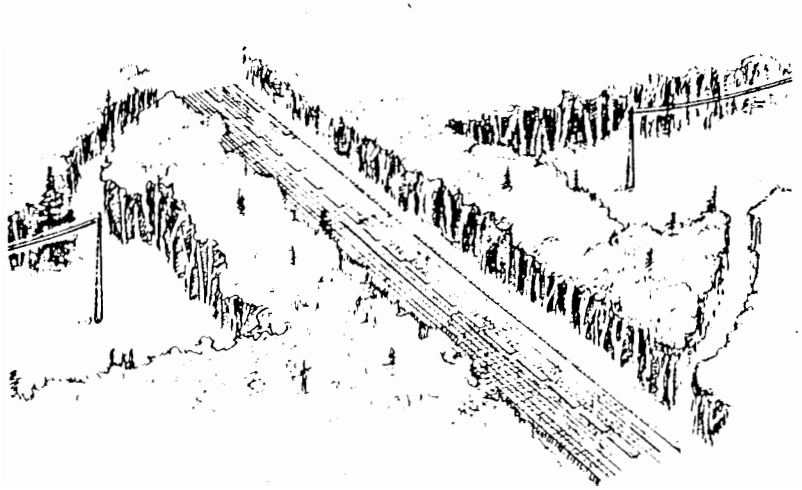
EASEMENT SCREENING TECHNIQUE



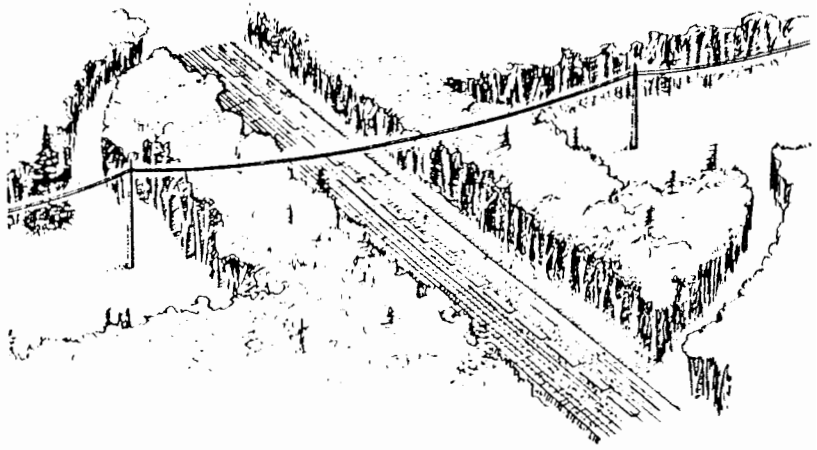
EASEMENT SCREENING TECHNIQUE

- COMPLIES WITH DNR GUIDANCE
- NO NEED TO INSTALL MAINTENANCE ROADS
- PROVIDES WELCOME FIRE BREAK
- ENHANCES WILDLIFE HABITAT BY CREATING WILDLIFE OPENINGS

EASEMENT SCREENING ROADS



BURYING



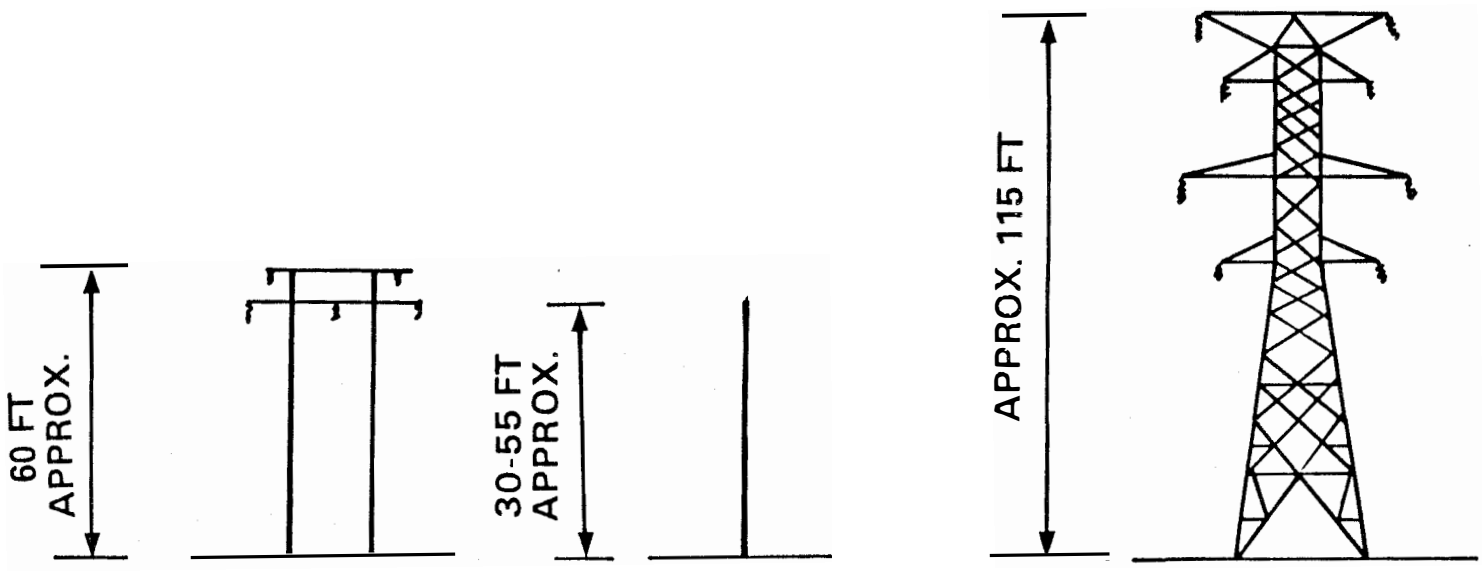
SPANNING

5/83

EASEMENT SCREENING ROADS

- PREFERENCE FOR SPANNING/BURYING ANTENNA SELECTED BY DNR STAFF MEMBERS
- ORIGINALLY, THE TOTAL ANTENNA SYSTEM, THEN CALLED SANGUINE, SEAFARER, AND EARLIER VERSIONS OF ELF, WAS TO BE BURIED.
- THIS SYSTEM WAS REVIEWED FOR COST BEFORE FULL SCALE DEVELOPMENT BEGAN. IT WAS CONCLUDED, FROM AN ENGINEERING STANDPOINT, THAT SAME ANTENNA EFFECTIVENESS WAS OBTAINED BY HAVING IT ON POLES.
- FURTHER, THE COST WAS LESS; THE ENVIRONMENTAL IMPACT WAS LESS.

TYPICAL ELF ANTENNA
AND
POWER TRANSMISSION POLES



138 kV
TRANSMISSION

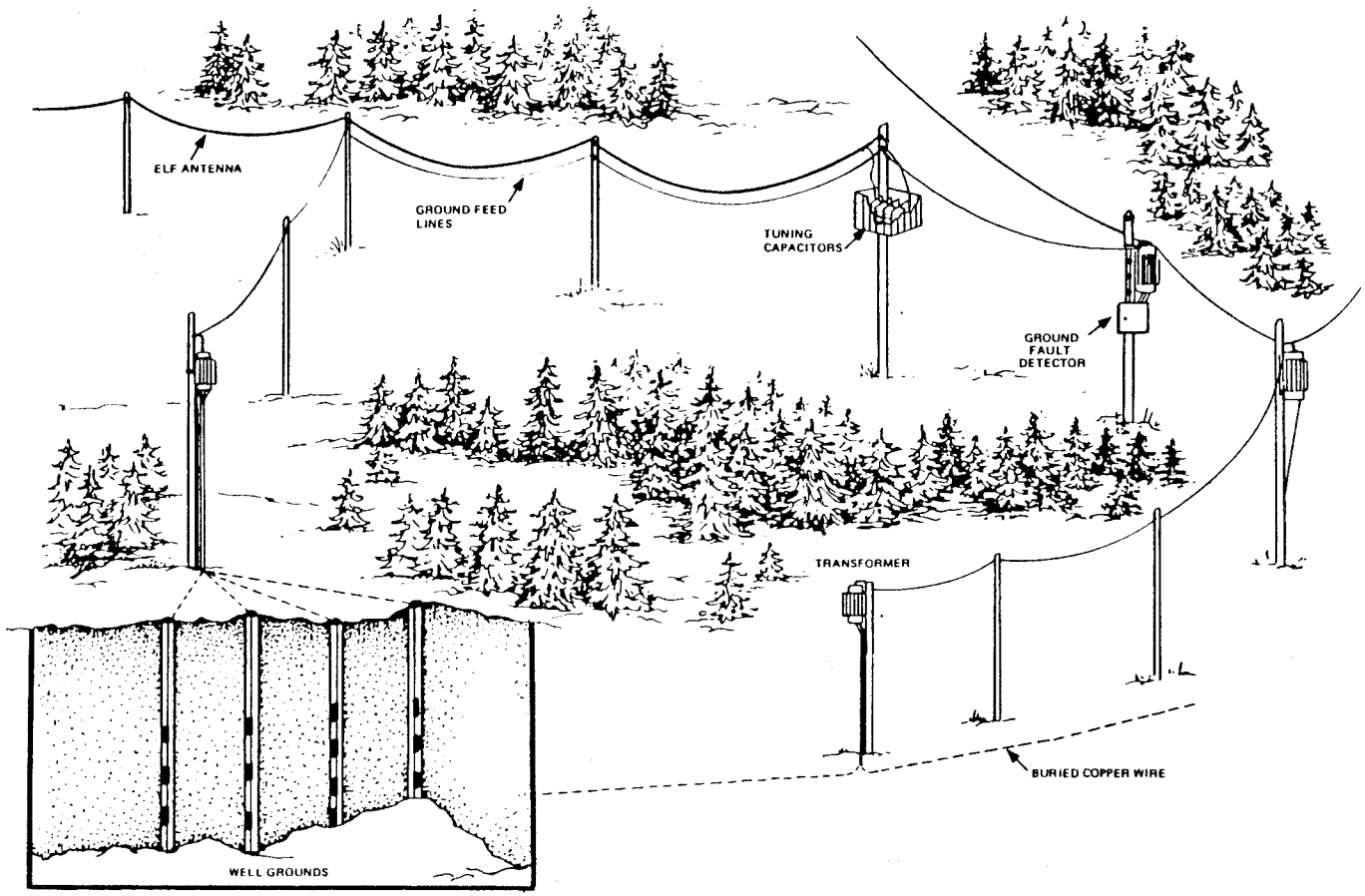
ELF
ANTENNA

HIGH
VOLTAGE
TRANSMISSION

TYPICAL ELF ANTENNA AND POWER TRANSMISSION POLES

- DEPICTS WHAT TYPICAL ELF ANTENNA LOOKS LIKE RELATIVE TO MEDIUM AND HIGH VOLTAGE TRANSMISSION LINES
- POWER INTO THE TRANSMITTER SITE ALSO EXPECTED TO USE SINGLE POLES WITH CROSS ARMS

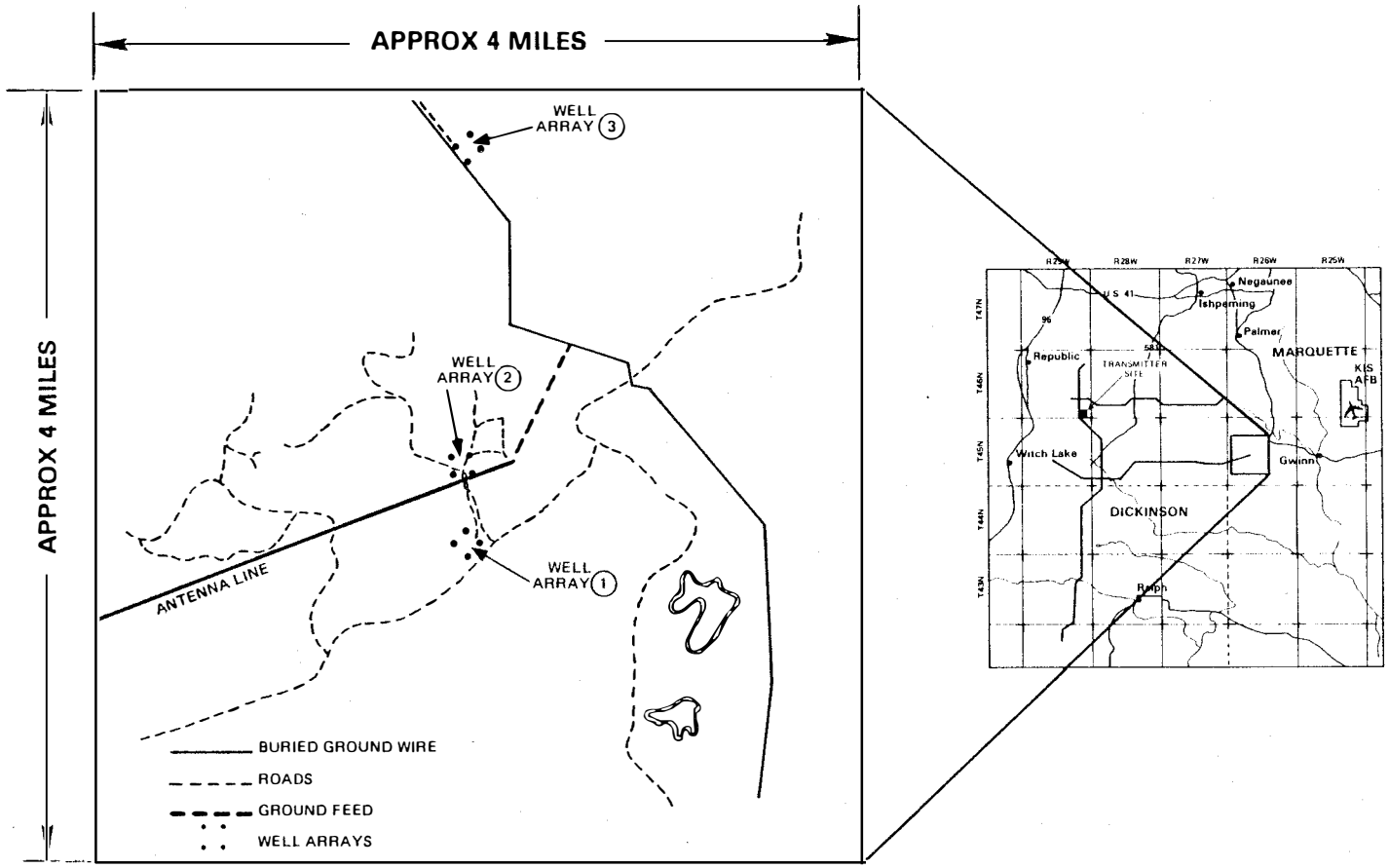
TYPICAL HYBRID GROUND (SKETCH)



TYPICAL HYBRID GROUND (SKETCH)

- DISTRIBUTES ANTENNA SIGNAL INTO GROUND TWO WAYS
  - BURIED CABLE
  - VERTICAL WELLS
- USES OVERHEAD FEEDLINES
- APPROXIMATELY 3 MILES OF BURIED CABLE FOR EACH TERMINAL GROUND
- VARYING CLUSTERS OF WELL GROUNDS
  - USED TO REDUCE BURIED GROUND CABLE LENGTH
  - WELL GROUNDS APPROXIMATELY 100' DEEP

GROUND AREA 3



SCALE: 1 MILE

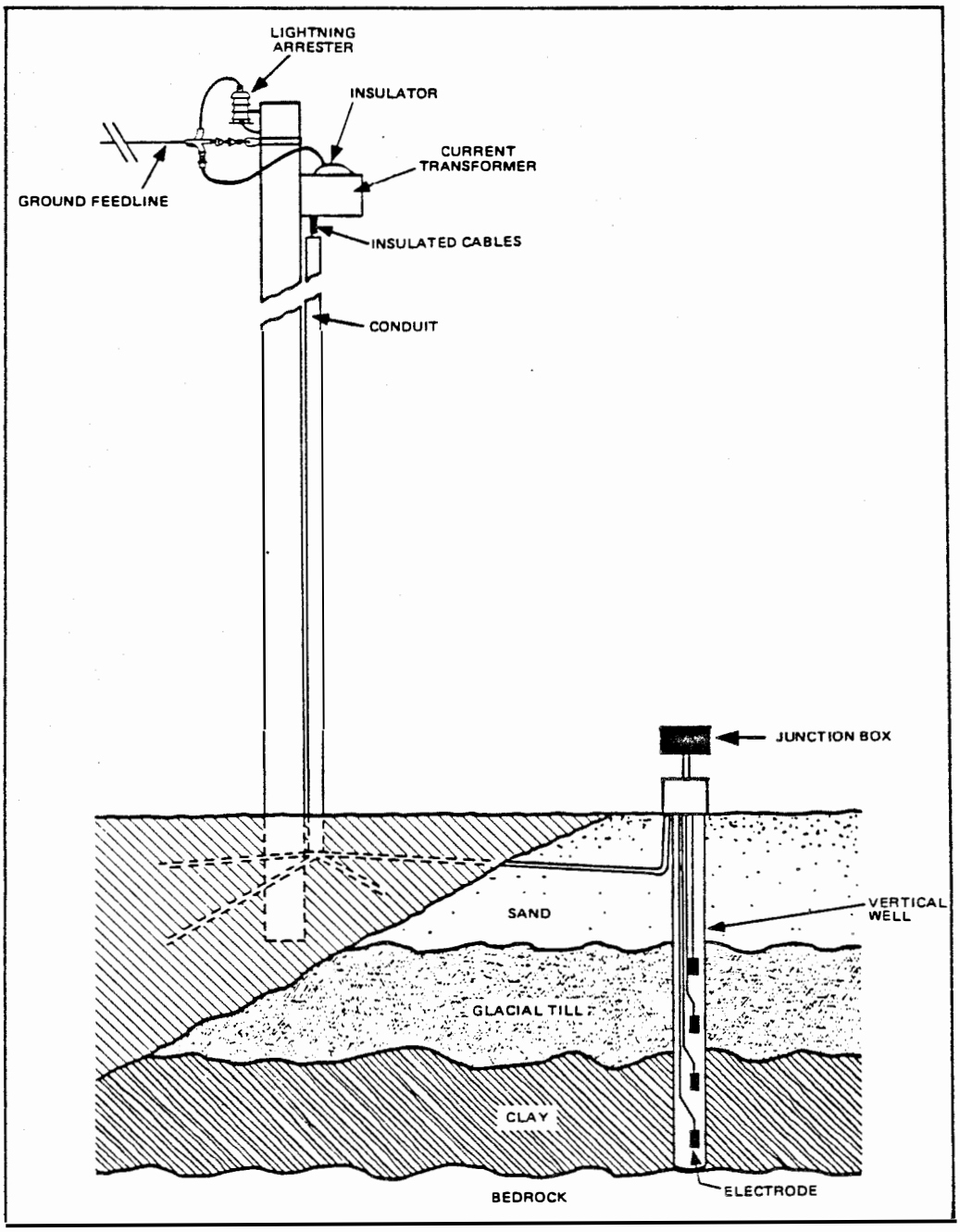
GROUND AREA THREE

- NOTE PROXIMITY OF KIS AFB AND HOW THE GROUND IS SITUATED RELATIVE TO MARQUETTE

- IN THE LARGER PICTURE, THE SOLID LINE REPRESENTS THE HORIZONTAL GROUNDS WHICH, WHEN COMBINED WITH THE VERTICAL WELL ARRAYS, ARE DESIGNED TO OPTIMIZE GROUNDING EFFICIENCY WHILE MINIMIZING THE REAL ESTATE REQUIRED.
  - APPROXIMATELY 3 MILES OF BURIED CABLE
  - 3 CLUSTERS OF 4 WELLS EACH
  - INSTALLED BETWEEN 21 NOVEMBER 1983 AND 30 JANUARY 1984

- TO MAINTAIN ALL RIGHTS-OF-WAY, NAVY WILL NOT USE HERBICIDES; RATHER, ONLY MECHANICAL BRUSHING HAS BEEN AND WILL BE USED.

TRANSITION FROM OVERHEAD FEEDLINE TO VERTICAL WELL ARRAY



TRANSITION FROM OVERHEAD FEEDLINE TO VERTICAL WELL ARRAY

- THIS ILLUSTRATES ANOTHER TYPE OF GROUNDING SYSTEM CHARACTERIZED BY VERTICAL WELLS.

- IT ALSO SHOWS THE VARIOUS TYPES OF EARTH OR ROCK THAT EXPERIENCE HAS SHOWN WE MUST PENETRATE TO GET TO THE BEDROCK NEEDED TO ACHIEVE THE REQUIRED CONDUCTIVITY

ECONOMIC PROJECTIONS IN MICHIGAN
EMPLOYMENT

PHASES	MICHIGAN RESIDENTS	AVERAGE EMPLOYMENT	TOTAL MAN YEARS
SITE DEVELOPMENT	DIRECT	33	66
PLANNING	INDUCED	34	68
	TOTAL	67	134
CONSTRUCTION &	DIRECT	159	279
INSTALLATION	INDUCED	172	301
	TOTAL	331	580
TEST & EVALUATION	MILITARY STAFF	14	14
	DIRECT	87	87
	INDUCED	70	70
	TOTAL	171	171
LONG-TERM OPERATIONS	MILITARY STAFF	14	14
(ANNUALLY)	DIRECT	68	68
	INDUCED	56	56
	TOTAL	138/YR	138/YR

EXPLANATORY DATA

DIRECT EMPLOYMENT	— JOBS DIRECTLY RELATED TO THE ELF PROJECT AND FILLED BY STATE RESIDENCES.
DIRECT WAGES	— SALARIES DIRECTLY RELATED TO THE ELF PROJECT, ALL ENTERING THE STATE ECONOMY.
DIRECT COMMERCE	— PURCHASE OR RENTAL OF CONSTRUCTION EQUIPMENT AND MATERIALS; 75% OF TRAVEL AND PER DIEM ALLOWANCES FOR VISITING GOVERNMENT/CONTRACTURAL ENGINEERS AND OBSERVERS; COMMERCIAL UTILITIES BILLS; AND PURCHASE OF CONSUMMABLES, ALL ENTERING THE STATE ECONOMY AND ALL DIRECTLY RELATED TO THE ELF PROJECT.
INDUCED EMPLOYMENT INDUCED COMMERCE	— JOBS, THEIR WAGES AND ADDITIONAL COMMERCE GENERATED BY THE ECONOMIC MULTIPLIER EFFECT OF ELF FUNDS SPENT IN THE STATE. JOBS ARE FILLED BY STATE RESIDENCES. MULTIPLIER ESTABLISHED BY DEPARTMENT OF COMMERCE AND OBTAINED IN 1983.
ESCALATION	— ALL ESTIMATES ESCALATED TO APPROPRIATE FISCAL YEAR.

ECONOMIC PROJECTIONS IN MICHIGAN

INCOME

PHASES		$MILLIONS DIRECT	INDUCED
SITE DEVELOPMENT	PROJECT WAGES	3.5	1.2
PLANNING	COMMERCE	1.1	2.1
(CY 81-83)	TOTAL	4.6	3.3
CONSTRUCTION &	PROJECT WAGES	14.3	5.2
INSTALLATION	COMMERCE	8.5	11.6
	TOTAL	22.8	16.8
TEST & EVALUATION	PROJECT WAGES	3.6	1.2
	COMMERCE	1.1	2.2
	TOTAL	4.7	3.4
LONG-TERM OPERATIONS	PROJECT WAGES	3.0	1.0
(ANNUALLY)	COMMERCE	.8	1.8
	TOTAL	3.8/YR	2.8/YR

ECONOMIC PROJECTIONS IN WISCONSIN

EMPLOYMENT

PHASES	WISCONSIN RESIDENTS	AVERAGE EMPLOYMENT	TOTAL MAN-YEARS
SITE DEVELOPMENT	DIRECT	67	117
PLANNING	INDUCED	25	44
(CY81-83)	TOTAL	92	161
CONSTRUCTION &	DIRECT	92	139
INSTALLATION	INDUCED	80	120
	TOTAL	172	259
TEST & EVALUATION	MILITARY STAFF	7	11
	DIRECT	76	115
	INDUCED	65	97
	TOTAL	148	223
LONG-TERM OPERATIONS	MILITARY STAFF	7	
(ANNUALLY)	DIRECT	40	
	INDUCED	51	
	TOTAL	98/YR	

ECONOMIC PROJECTIONS IN WISCONSIN

INCOME

PHASES		$MILLIONS DIRECT	INDUCED
SITE DEVELOPMENT PLANNING	PROJECT WAGES	1.3	.5
(CY81-83)	COMMERCE	.07	.9
	TOTAL	2.0	1.4
CONSTRUCTION & INSTALLATION	PROJECT WAGES	4.2	1.3
	COMMERCE	2.2	3.0
	TOTAL	6.4	4.3
TEST & EVALUATION	PROJECT WAGES	2.9	1.0
	COMMERCE	1.5	2.0
	TOTAL	4.4	3.0
LONG-TERM OPERATIONS	PROJECT WAGES	1.7	.5
(ANNUALLY)	COMMERCE	0.6	1.0
	TOTAL	2.3/YR	1.5/YR

ELF ELECTROMAGNETIC FIELDS

- **NAVY DECISION IN OCTOBER 1981 TO BUILD AN ELF SYSTEM BASED ON CONCLUSION THAT LOW-LEVEL, CONTINUOUS WAVE, MODULATED ELECTROMAGNETIC FIELDS PRODUCED BY ELF ANTENNAS WOULD NOT AFFECT BIOLOGY OR HEALTH**

  - **NO EXPERIMENTAL EVIDENCE OF EFFECTS EXISTED**
  - **NO SCIENTIFIC THEORIES SUGGESTED EFFECTS**
  - **NO KNOWN ELECTRICAL OR BIOLOGICAL MECHANISMS SUGGESTED EFFECTS**
  - **NO PUBLIC HEALTH RECORD OF EFFECTS EXISTED**
  - **ALL NATIONAL AND INTERNATIONAL REGULATIONS, STANDARDS, AND GUIDELINES PERMITTED UNLIMITED EXPOSURE TO FIELDS ORDERS OF MAGNITUDE HIGHER**

84-4545-5

ELF ELECTROMAGNETIC FIELDS

- IN OCTOBER 1981, AFTER CAREFUL CONSIDERATIONS, EXPERTS FORESAW NO REASON TO EXPECT THAT LOW LEVEL, CONTINUOUS WAVE, MODULATED FIELDS PRODUCED BY THE ANTENNA WOULD AFFECT BIOLOGY OR HEALTH.

- PROVABLE THROUGH SCIENTIFIC EVIDENCE THEN AVAILABLE"

- NO SCIENTIFIC THEORIES TO SUGGEST ANY ADVERSE EFFECTS

- THE ELF EM FIELDS GENERATED AT FULL POWER ARE WELL BELOW PROMULGATED INTERNATIONAL STANDARDS

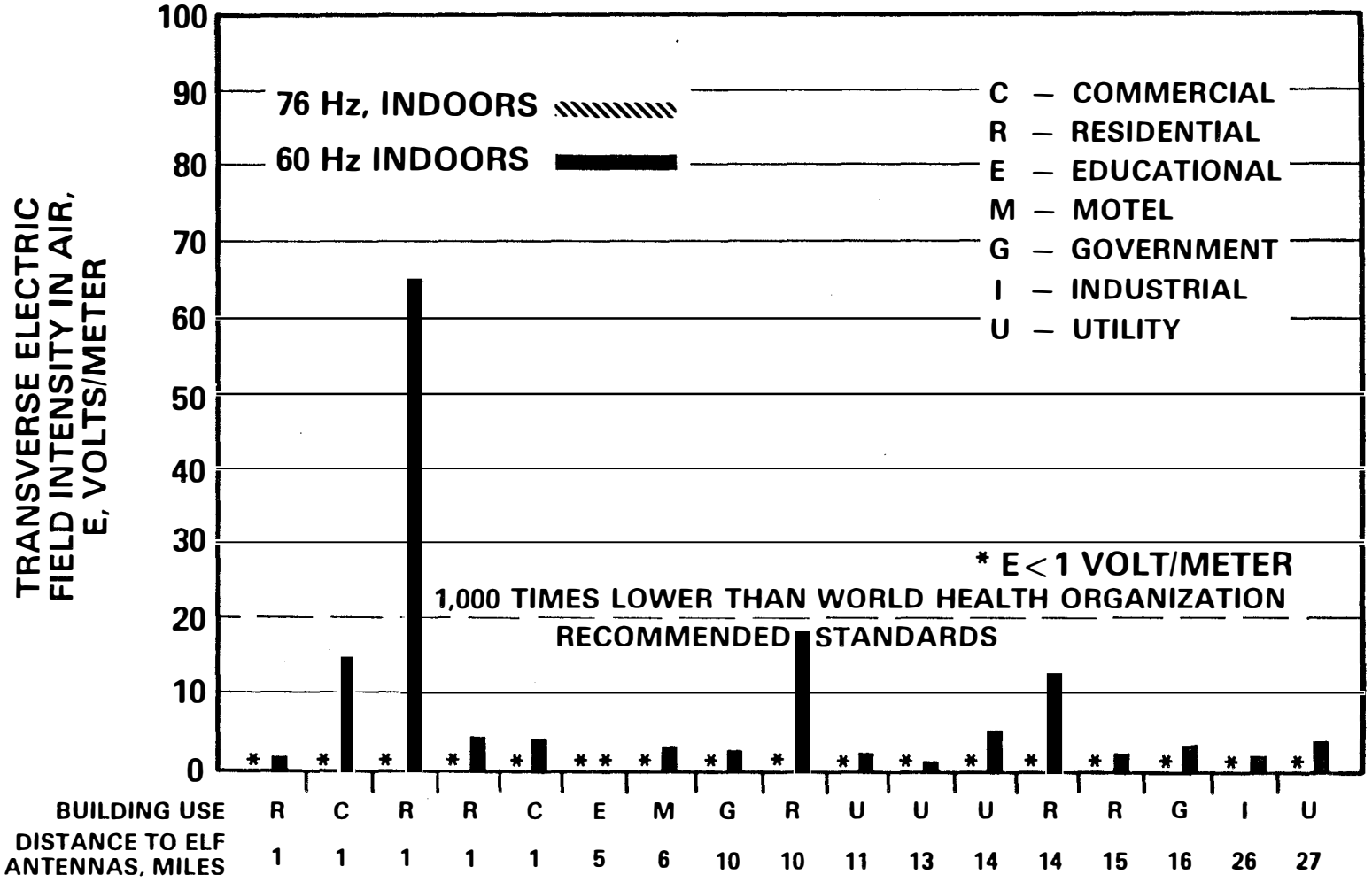
COMMON DC ELECTRIC FIELDS

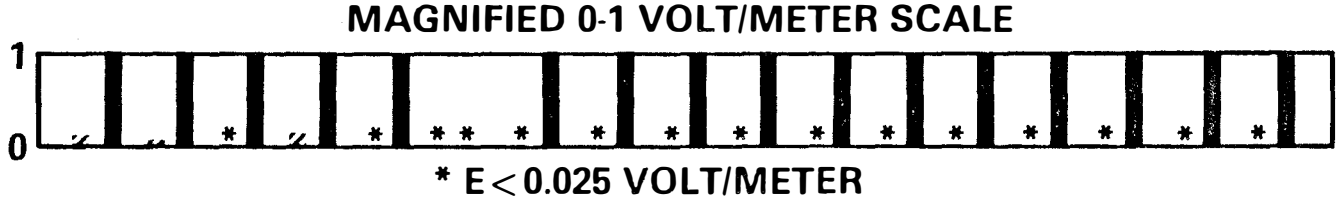
200 V/M NORMAL
100,000 V/M STORMS

1.5 V/CM

MEASURED ELECTRIC FIELD INTENSITIES IN AIR AT INHABITED PLACES NEAR THE CLAM LAKE ELF FACILITY

(INDOOR MEASUREMENTS)



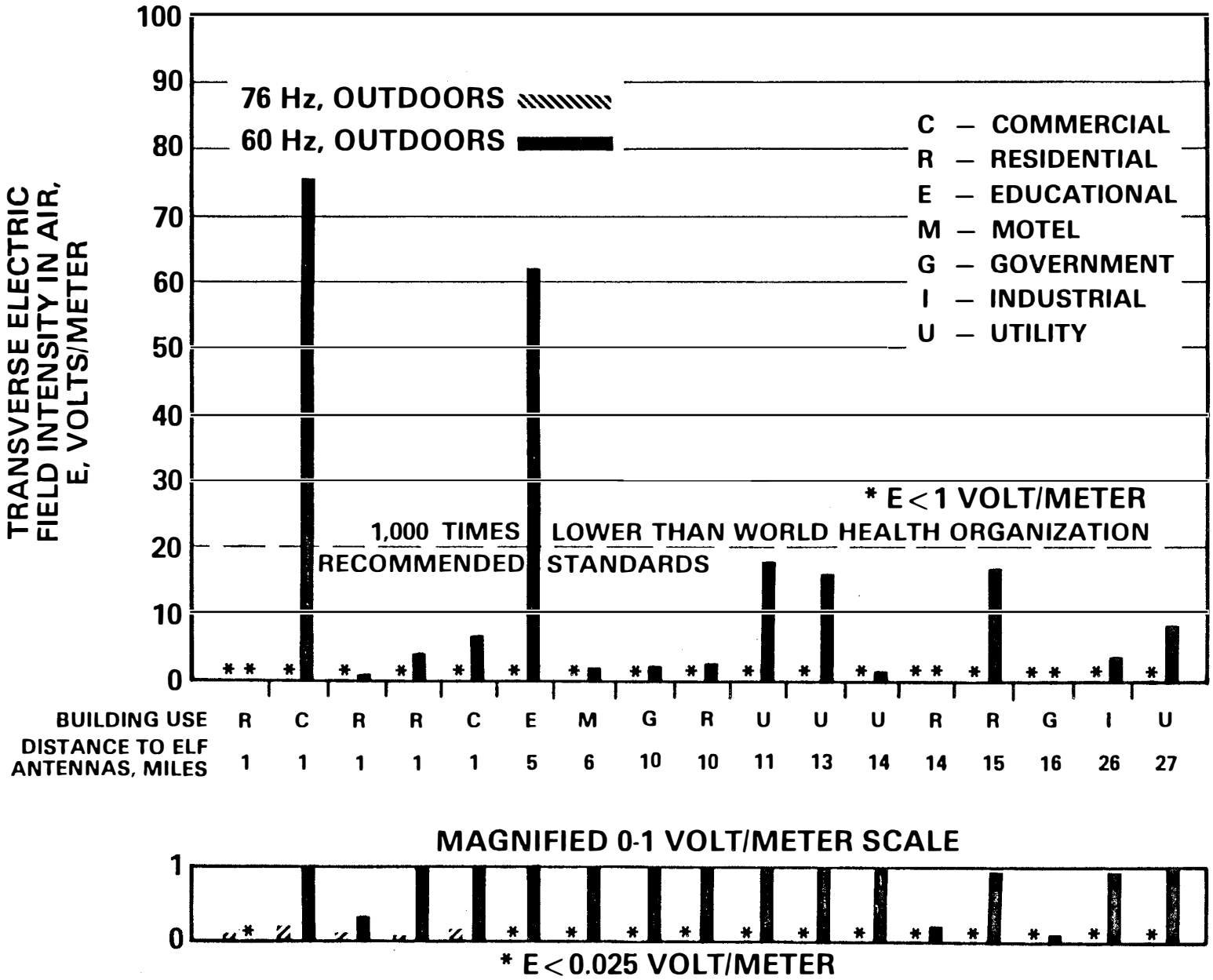


MEASURED ELECTRIC FIELD INTENSITIES IN AIR AT INHABITED PLACES NEAR THE CLAM LAKE ELF FACILITY - INDOOR MEASUREMENTS

- ANTENNA AGAIN AT 100% POWER
- NOTE THAT 20 VOLTS/METER IS 1000 TIMES LOWER THAN WORLD HEALTH ORGANIZATION RECOMMENDED STANDARDS
- THE 65 V/M SPIKE IS FROM A 60 CYCLE SIGNAL AT RESIDENTIAL HOUSE, ONE MILE FROM THE ELF ANTENNA - PROBABLY IN THE VICINITY OF A POWERLINE
- WHEN MEASURING V/M OF THE ELF (76 Hz) SIGNAL, THE READING WAS LESS THAN 0.025 V/M

MEASURED ELECTRIC FIELD INTENSITIES IN AIR AT INHABITED PLACES NEAR THE CLAM LAKE ELF FACILITY

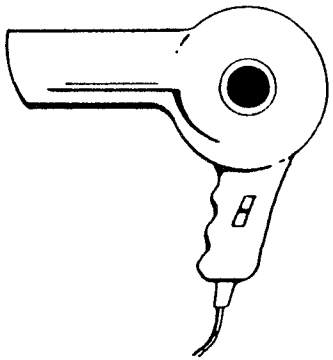
(OUTDOOR MEASUREMENTS)

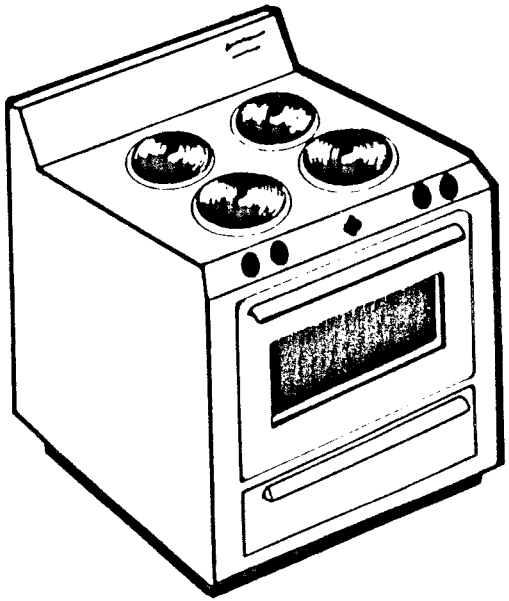


MEASURED ELECTRICAL FIELD INTENSITIES IN AIR AT INHABITED PLACES NEAR THE CLAM LAKE ELF FACILITY - OUTDOOR MEASUREMENTS

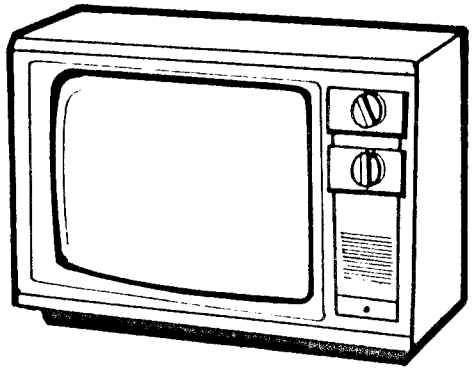
- ANTENNA IS AT 100% POWER
- THE 75 V/M SPIKE OF 60 Hz WAS FROM COMMERCIAL POWER ONE MILE FROM THE ELF ANTENNA
- NO WHERE CAN ONE FIND AN ELECTRIC FIELD OF ANY CONSEQUENCE GENERATED BY THE ELF SIGNAL
- OUR COUNTRY HAS HAD 60 CYCLES POWER FOR YEARS WHICH HAS NOT ALARMED THE COUNTRY. YET THAT SIGNAL ALWAYS GENERATES ORDER-OF-MAGNITUDE LARGER ELECTRICAL FIELDS THAN THE 76 Hz ELF SIGNAL

COMMON AC MAGNETIC FIELDS





1-25 GAUSS



UNDER POWER LINES
NEAR HOMES
3 GAUSS

*240 AMPERES/METER
EQUIVALENT

WORLD HEALTH
ORGANIZATION
RECOMMENDED
STANDARD

3 GAUSS*

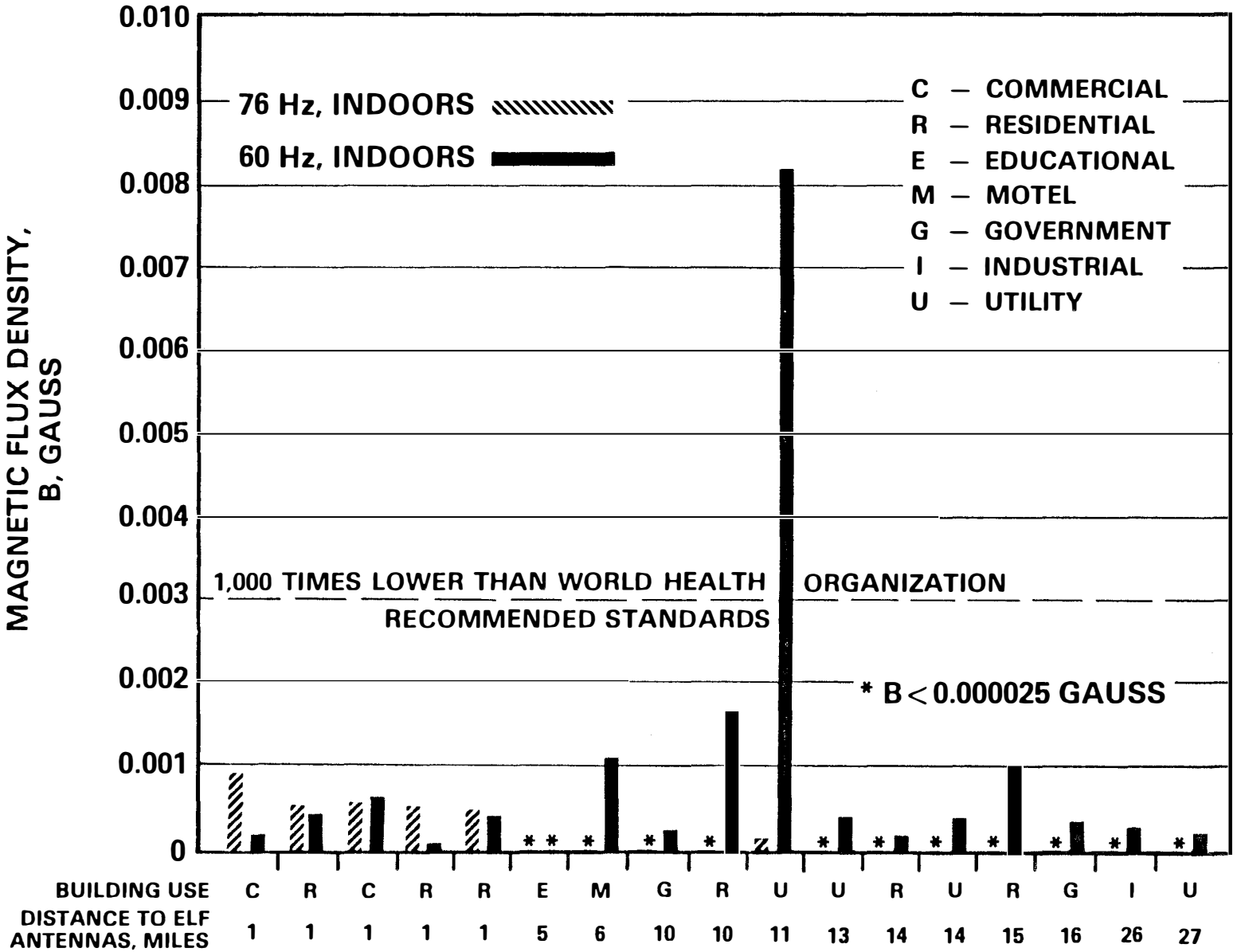
UNDER ELF
ANTENNA
0.03 GAUSS

U-81

83-1625-22 84-4396-4

MEASURED MAGNETIC FIELD INTENSITIES AT INHABITED PLACES NEAR THE CLAM LAKE ELF FACILITY

(INDOOR MEASUREMENTS)



MEASURED MAGNETIC FIELD INTENSITIES AT INHABITED PLACES
NEAR THE CLAM LAKE FACILITY - INDOOR MEASUREMENTS

- THESE FIELDS WERE MEASURED WITH THE WISCONSIN ANTENNA OPERATING AT 100% POWER
- 76 Hz AND 60 Hz FIELDS WERE MEASURED IN THE SAME MANNER USING THE NATIONAL BUREAU OF STANDARDS APPROVED MEASURING TECHNIQUES
- NOTE THAT 0.003 GAUSS IS 1000 TIMES LOWER THAN THE WORLD HEALTH ORGANIZATION RECOMMENDED STANDARD OF 3 GAUSS
- THE HIGHEST READING WAS 0.008 GAUSS, INDOORS, AT A UTILITY

ELF INTERFERENCE MITIGATION

- ENGINEERING CHANGES MADE TO POWER AND TELEPHONE CIRCUITS TO PREVENT INTERFERENCE TO CONSUMERS
- CHANGES DESIGNED BY UTILITIES
- SUCCESSFULLY DEMONSTRATED SINCE 1968 AT CLAM LAKE

ELF INTERFERENCE MITIGATION

- NEUTRALIZING TRANSFORMERS INSTALLED IN TELEPHONE LINES
- VARIOUS TECHNIQUES FOR POWER LINES; MULTIGROUNDED NEUTRAL CHANGED TO PHASE TO PHASE CONNECTION (USED MOST FREQUENTLY) PHASE REVERSAL TRANSFORMERS
- ANNUAL CERTIFICATION BY IITRI

NATIONAL ACADEMY OF SCIENCES

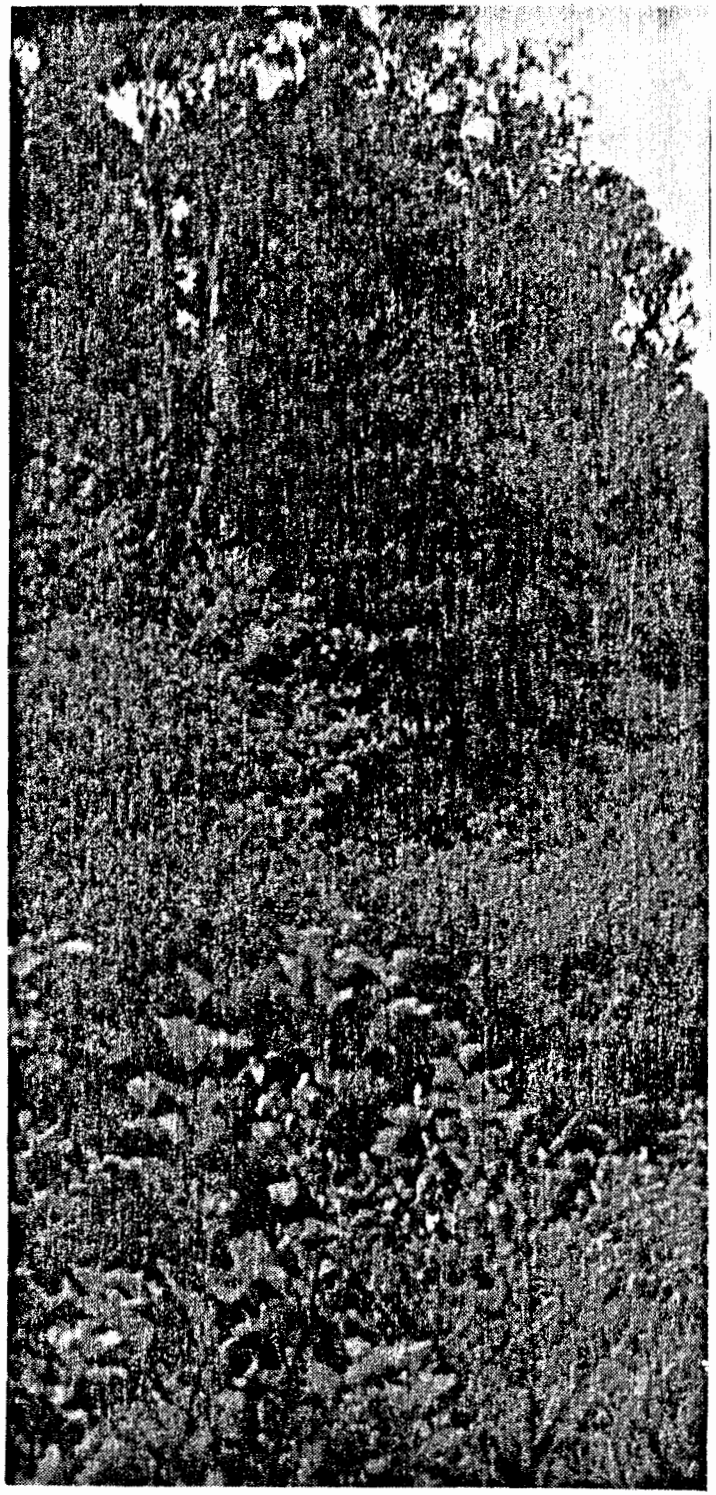
COMMITTEE ON ELF BIOSPHERE

FINAL REPORT 1 AUGUST 1977

- CONCERNS ABOUT ENVIRONMENTAL CONTAMINATION ARE UNWARRANTED
- REMAINING CONCERNS:
  - — STEP POTENTIAL AT ANTENNA GROUNDS
  - — ANTENNA FAULT DETECTION
- PRESENT DESIGNS ALLEVIATE CONCERNS

NATIONAL ACADEMY OF SCIENCES

- HAS FOLLOWED NAVY'S ELF WORK FOR A NUMBER OF YEARS
- IN 1977 STATED THAT ENVIRONMENTAL CONTAMINATION CONCERNS WERE UNWARRANTED
- REMAINING CONCERNS AS YOU SEE HERE; AND THAT IS WHY RESEARCH AND DEVELOPMENT WORK ON GROUNDS AND FAULT DETECTOR WERE PURSUED
- THE RESULTING DESIGN HAS BEEN COMPLETED, CHECKED OUT, AND THE NAVY IS CONFIDENT THAT IT WORKS



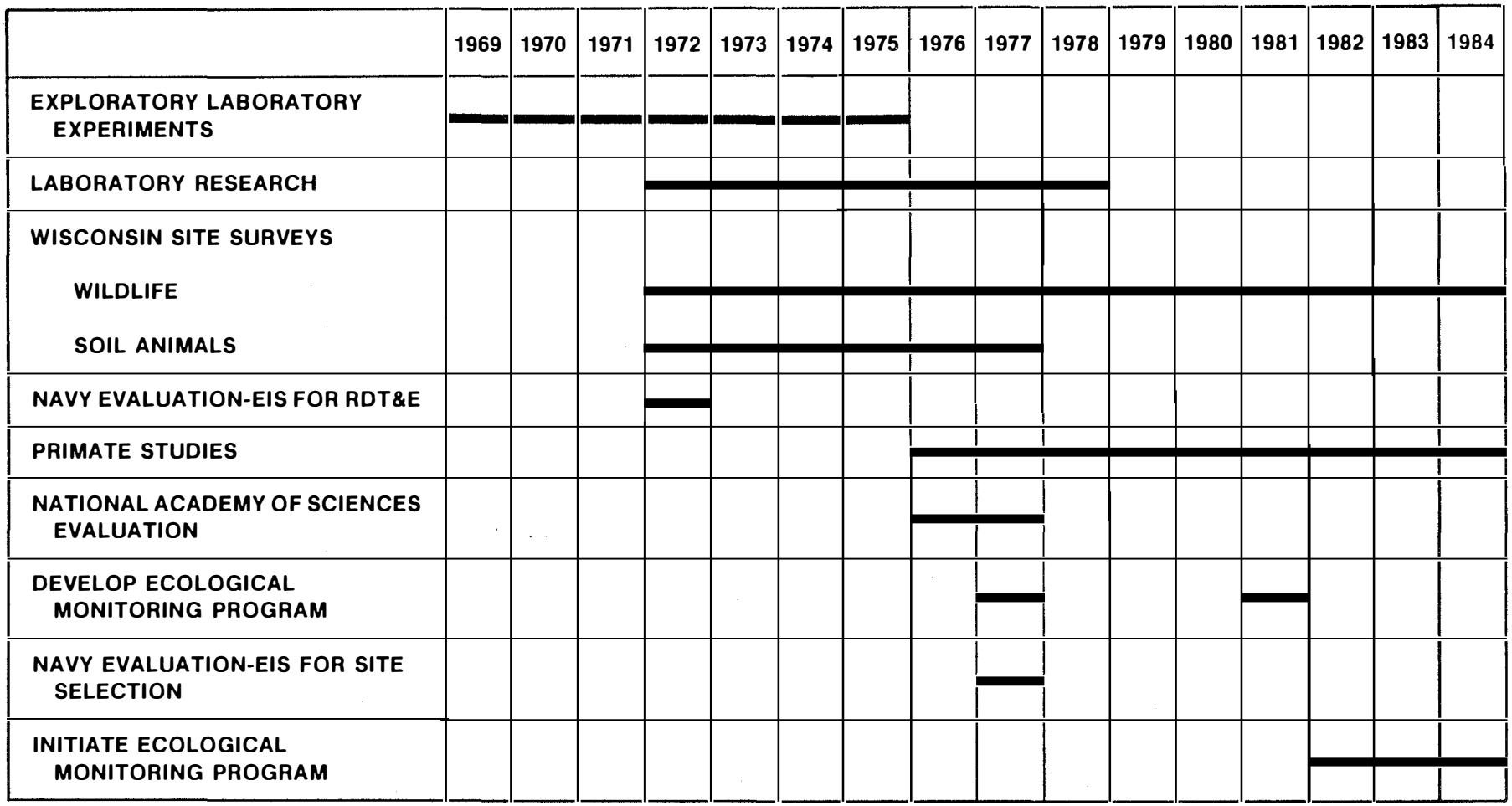
BIOLOGICAL/ECOLOGICAL MONITORING

- **ESTABLISH BASELINE MONITORING PROGRAM IN MICHIGAN AREA**
- **CONTINUE STUDIES IN WISCONSIN**
- **ACCOMPLISH ADDITIONAL STUDIES RECOMMENDED BY NATIONAL ACADEMY OF SCIENCES AND OTHERS, INCLUDING:**
  - **SOIL ANIMALS (e.g., EARTHWORMS)**
  - **TERRESTRIAL HABITAT/AVIAN SPECIES**
  - **AQUATIC HABITAT**
  - **POLLINATING INSECTS & VEGETATION**
  - **MIGRATING BIRDS**
  - **WETLANDS COMMUNITIES**

ECOLOGICAL MONITORING PROGRAM

BIOLOGICAL INDICATOR	PRINCIPAL INVESTIGATOR(S) INSTITUTION
MICHIGAN	
UPLAND FLORA	DR. M. F. JURGENSEN — MTU
SOIL MICROFLORA	DR. V. M. BRUHN — MTU
SOIL AMOEBAE	DR. R. W. BAND — MSU
SOIL ARTHROPODS & EARTHWORMS	DR. R. J. SNIDER — MSU
	DR. R. M. SNIDER — MSU
NATIVE BEES	DR. R. L. FISCHER — MSU
SMALL MAMMALS & NESTING BIRDS	DR. D. L. BEAVER — MSU
ALGAE, AQUATIC INSECTS & FISH	DR. T. M. BURTON — MSU
	DR. R. J. STOUT — MSU
	DR. R. W. MERRITT — MSU
	DR. W. W. TAYLOR — MSU
WISCONSIN	
WETLAND FLORA	DR. F. STEARNS — UW/M
SLIME MOLDS	DR. E. M. GOODMAN — UW/P
BOTH	
MIGRATING BIRDS	DR. R. P. LARKIN — UI
	DR. S. A. TEMPLE — UW/MA

BIOLOGICAL/ECOLOGICAL PROGRAMS



BIOLOGICAL/ECOLOGICAL PROGRAMS

- NAVY'S CONCERN BEGAN IN 1969
- AS TIME PASSED, MORE CONCERNS WERE ADDRESSED BY THE NAVY
- TODAY, THERE ARE ONGOING WISCONSIN SITE WILDLIFE SURVEYS BEING CONDUCTED BY THE U.S. FOREST SERVICE; PRIMATE STUDIES BEING CONDUCTED BY NAVY MEDICAL RESEARCH AND DEVELOPMENT; AND AN ONGOING ECOLOGICAL MONITORING PROGRAM UNDERWAY BY THE NAVY
- IF AND WHEN NEED CAN BE SHOWN, ADDITIONAL STUDIES CAN BE INITIATED
- THE NAVY ALSO KEEPS CURRENT IN THE LITERATURE AND DEVELOPMENT OF LOW LEVEL, NON-IONIZING, ELECTROMAGNETIC TRANSMISSIONS

PRIMATE STUDY

- SIMILARITY OF PRIMATES TO HUMANS
- CONTROL AND EXPOSED GROUPINGS ESTABLISHED
- TEST ANIMALS REMAINED HEALTHY IN TWO EXPERIMENTS
- SLIGHT WEIGHT GAIN NOT OF CLINICAL SIGNIFICANCE

PRIMATE STUDY

RHESUS MONKEYS

FIRST EXPERIMENT

12 PAIRS MALES, 14 PAIRS FEMALES 1975 TO 1979;11% WEIGHT GAIN OBSERVED IN MALE MONKEYS BETWEEN 51 AND 61 MONTHS OF AGE

TEST ANIMALS REMAIN HEALTHY

SECOND EXPERIMENT

15 PAIRS MALES, 13 PAIRS FEMALES 1979 TO PRESENT; SLIGHT WEIGHT GAIN OBSERVED IN MALE MONKEYS BETWEEN 30 AND 48 MONTHS OF AGE

TEST ANIMALS ALL REMAINED HEALTHY

SUMMARY

ALL TEST ANIMALS MEET OR EXCEED HEALTH STANDARDS FOR CAGED ANIMALS

SLIGHT WEIGHT GAIN NOT OF CLINICAL SIGNIFICANCE

NAS AWARE OF PRIMATE STUDIES AND REVIEWED RESULTS

SUMMARY

- ELF SYSTEM IS OPERATIONALLY REQUIRED
- EXPERIENCE DEMONSTRATES THAT SYSTEM WORKS
- STRONG SUPPORT EXISTS ON NATIONAL LEVEL BOTH IN CONGRESS AND THE WHITE HOUSE
- ELF SHORE SYSTEM DESIGN CLOSELY COORDINATED WITH DNR
- SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT BEING PREPARED

"It is customary in democratic countries to deplore expenditures on armaments as conflicting with the requirements of the social services; there is a tendency to forget that the most important social service that a government can do for its people is to keep them alive and free."

British Air Marshall
Sir John Slessor