Bendix

Aerospace Systems Division

ALSEP Array A-2H Layout

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This ATM delineates the pertinent deployment requirements of the various ALSEP Array A-2H subsystems (including the Heat Flow Experiment) and depicts four ALSEP Array A-2H layouts (which satisfy the aforementioned requirements) for all projected lunar landing sites.

Prepared by: Leslie D. Marrus

L. D. Marrus, Project Engineer
Crew Engineering

The various ALSEP subsystems have different scientific and thermal control requirements that determine their lunar surface deployment requirements. A partial list follows:

1. LM Interrelationship - The ALSEP subsystem must be located with respect to the LM so as to minimize heating from the LM ascent stage exhaust gases and deposition of dust entrained in the LM exhaust, as well as debris torn loose from the LM Descent Stage by the Ascent Stage engine blast.

2. Equatorial Interrelationship - ALSEP subsystems, such as the Central Station, Lunar Surface Magnetometer (LSM), Solar Wind Spectrometer (SWS), Heat Flow Experiment (HFE), and Suprathermal Ion Detector Experiment (SIDE), must be deployed parallel to the equator in order to prevent solar impingement on thermal control surfaces. In line with this requirement, the thermal control design of Central Station, the SWS, and the HFE necessitates that the thermal radiating side of the subsystem be directed away from the equator. The Cold Cathode Ion Guage (CCIG) must also be directed away from the equator (the sun) for scientific reasons.

3. Prime Meridian Interrelationship - The SIDE sensor must be pointed toward the prime meridian for scientific reasons.

4. Sun Relationship - The LSM alignment device (a shadowgraph) is not bidirectional (i.e., there is only one compass rose) and, hence, the LSM and its alignment device require a fixed relationship with the sun in order to utilize the alignment device. Therefore, the LSM has a color-coded lunar support leg which must always be pointed toward the east (which is the sun location at the time of LSM deployment) in order to ensure that the shadowgraph will be capable of functioning as intended.

5. Subsystem View Factors - Various ALSEP subsystems, such as the Central Station, RTG, LSM, SWS, and HFE, have thermal view factor requirements that dictate that they must have a relatively unobstructed view of space in order to satisfactorily radiate excess heat (maintain thermal control within acceptable limits). Hence, there are limitations on the placement of ALSEP subsystems within the view of other subsystem thermal radiating surfaces. Furthermore, the CCIG has a scientific view factor requirement that dictates that the CCIG sensor must be directed away from the LM and all other ALSEP subsystems.

6. Subsystem Interrelationships - All the experiments must be deployed so as to maintain a minimum separation distance between the experiment and the RTG for thermal control and scientific reasons. Two experiments that have a particularly strong concern with respect to this requirement are the HFE and the PSE. Astronaut safety and thermal control requirements also dictate a minimum separation distance between the RTG and Central Station. Furthermore, all the experiments (at least) prefer to maintain a minimum separation distance from the Central Station.

   The PSE and each HFE probe, for scientific reasons, require that no other ALSEP subsystem be closer than a minimum specified distance, as is indicated in Figures 3 through 6. Furthermore, there must be an absolute minimum of cable incursion, debris, astronaut activity, etc., within the circles around each of the probes (depicted in these figures), again for scientific reasons. Finally, these figures also depict a scientific requirement that a minimum separation distance must be maintained between the SIDE and the LSM.

7. Cable Limitations - In order to satisfy various scientific and thermal control requirements that dictate various separation distances between the ALSEP subsystems and in order to minimize the weight and volume impact of providing more cable length than was absolutely required (taking into account the need for some extra cable due to an expected inaccuracy in the astronaut's pacing off distances and to prevent the astronaut's placing a strain on the experiment and central station cable connectors, as well as the need to provide some slack in the cables to allow for thermal expansion and contraction of the cables, central station realignment, subsequent to experiment deployment, that might disturb experiment leveling and alignment, etc.) the various experiment cable lengths delimit, to an appreciable extent, the various ALSEP subsystem emplacement locations. As an example, the PSE-central station separation requirement, taken in conjunction with the present fixed length of the PSE cable, does not permit the PSE to be deployed north or west of the central station (as indicated in Figure 3), unless the cable length is increased to permit this change in deployment location.

   As a design goal, the subsystem cables should not cross over one another.

The following deployment requirements pertain to the layout of the ALSEP subsystems:

1. Central Station

Parameter		Constraint
a.	Distance	Minimum of 300 feet from LM
b.	Direction	Due west, $\pm$ 15°, of LM, preferred (See Figures 1 & 2) Due east, $\pm$ 15°, of LM, acceptable as an alternate
c.	Orientation	Orient Central Station carry handle toward nearest lunar pole

2. Radioisotope Thermoelectric Generator (RTG)

	Parameter	Constraint
a.	Distance	Minimum of 10 feet from all subsystems
b.	Direction	Due west (180^{o} $+20^{o}$ and -0^{o}) of central station, when south of lunar equator (See Figure 1)
		Due east (100^{o} $+0^{o}$ and -20^{o}) of central station, when north of lunar equator (See Figure 2)
c.	Orientation	Orient RTG cable exist toward central station

3. Passive Seismic Experiment (PSE)

	Parameter	Constraint
a.	Distance	Minimum of 8 feet from central station Minimum of 15 feet from RTG Minimum of 10 feet from other subsystems
b.	Direction	East ($8^{o} \pm 3^{o}$) of central station, when south of lunar equator (See Figure 1)
		West ($8^{o} \pm 3^{o}$) of central station, when north of lunar equator (See Figure 2)
c.	Orientation	Orient PSE cable exit toward central station

4. Lunar Surface Magnetometer (LSM)

	Parameter	Constraint
a.	Distance	Minimum of 50 feet from central station Minimum of 80 feet from SIDE
b.	Direction	Southeast ($20^{o} \pm 5^{o}$) of central station, when south of lunar equator (See Figure 1)
		Northwest ($20^{o} \pm 5^{o}$) of central station, when north of lunar equator (See Figure 2)
c.	Orientation	Orient color-coded LSM leg toward east

5. Solar Wind Spectrometer (SWS)

Parameter	Constraint
a. Distance	Minimum of 12 feet from central station
b. Direction	South (90^{o} + 10^{o} and -0^{o}) of central station, when south of lunar equator (See Figure 1)
	North (90^{o} + 0^{o} and -10^{o}) of central station, when north of lunar equator (See Figure 2)
c. Orientation	Orient SWS parabolic reflector array toward nearest pole

6. Heat Flow Experiment (HFE)

Parameter	Constraint
a. Distance	Electronics package shall be a minimum of 30 feet from central station
	Each probe shall be a minimum of 16 feet from the electronics package
	Each probe shall be a minimum of 30 feet from the other probe
	Each probe shall be a minimum of 40 feet from the RTG
	An area of minimum disturbance shall be maintained 17 feet around each probe
b. Direction	South (90^{o} + 0^{o} and -10^{o}) of central station, when south of lunar equator (See Figure 1)
	North (90^{o} + 10^{o} and -0^{o}) of central station, when north of lunar equator (See Figure 2)
c. Orientation	Orient HFE parabolic reflector toward nearest pole

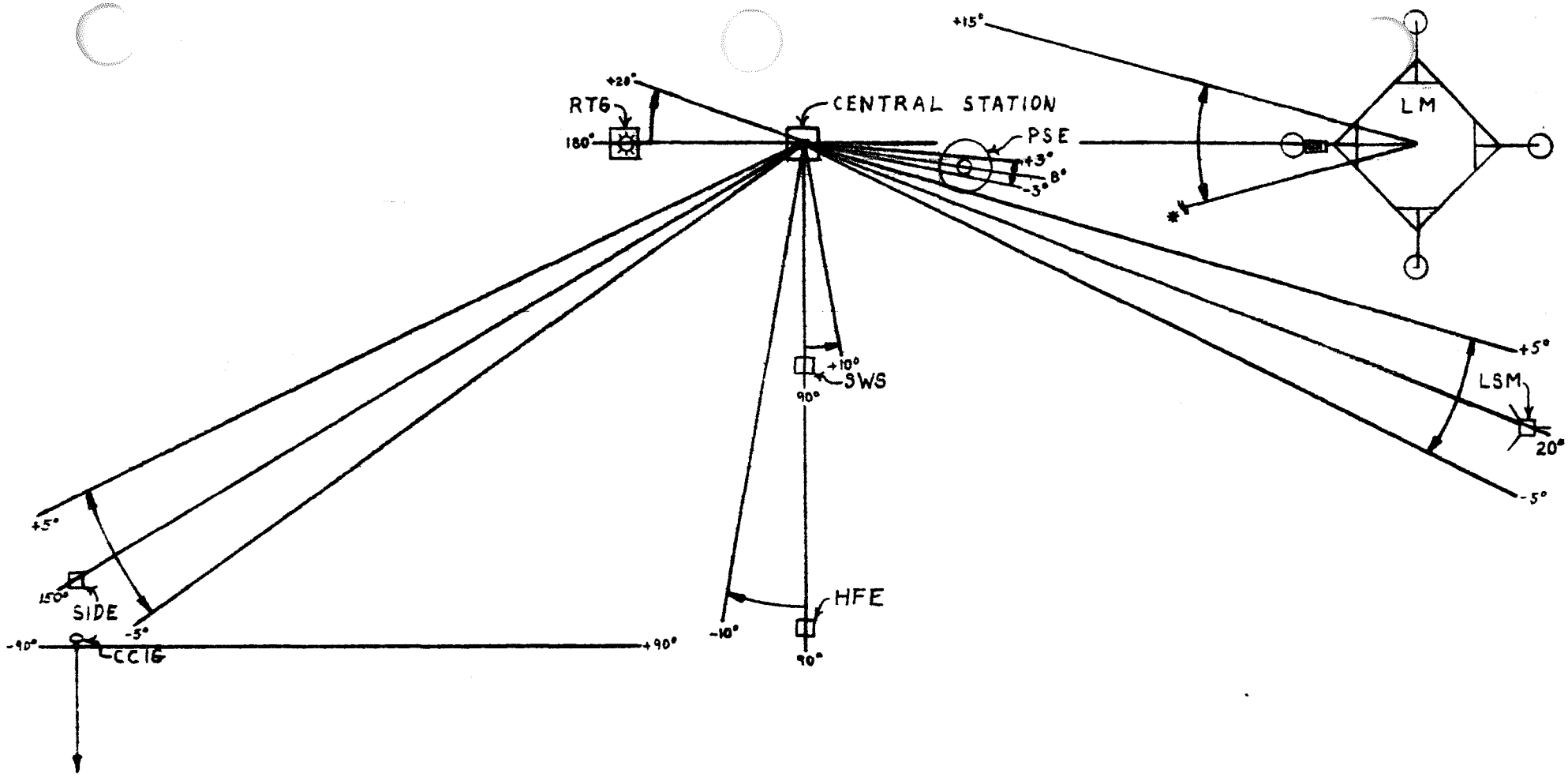
7. Suprathermal Ion Detector Experiment (SIDE)

	Parameter	Constraint
a.	Distance	Minimum of 55 feet from central station
b.	Direction	Southwest ($150^{o} \pm 5^{o}$) of central station, when south of lunar equator (See Figure 1)
		Northeast ($150^{o} \pm 5^{o}$) of central station, when north of lunar equator (See Figure 2)
c.	Orientation	Orient sensor (and directional arrow) toward lunar prime meridian

8. Cold Cathode Ion Guage (CCIG)

	Parameter	Constraint
a.	Distance	Minimum of 3 feet from SIDE
b.	Direction	Nominally south of SIDE, when south of lunar equator (See Figure 1)
		Nominally north of SIDE, when north of lunar equator (See Figure 2)
c.	Orientation	Orient sensor toward nearest pole and away from ($\pm 90^{o}$) all subsystems, LM and sun

The above deployment requirements necessitate the four variant ALSEP Array A-2H layouts depicted in Figures 3 through 6. These figures depict the ALSEP layouts for the near side of the moon, which is bisected by the lunar equator and the lunar prime meridian, respectively, to form four lunar quadrants (southeast, southwest, northwest and northeast quadrants). Each figure depicts the ALSEP Array A-2H layout for all landing sites within each of the four quadrants.



ALSEP ARRAY A-2H
DIRECTIONAL REQUIREMENTS
FOR A SOUTH LANDING SITE

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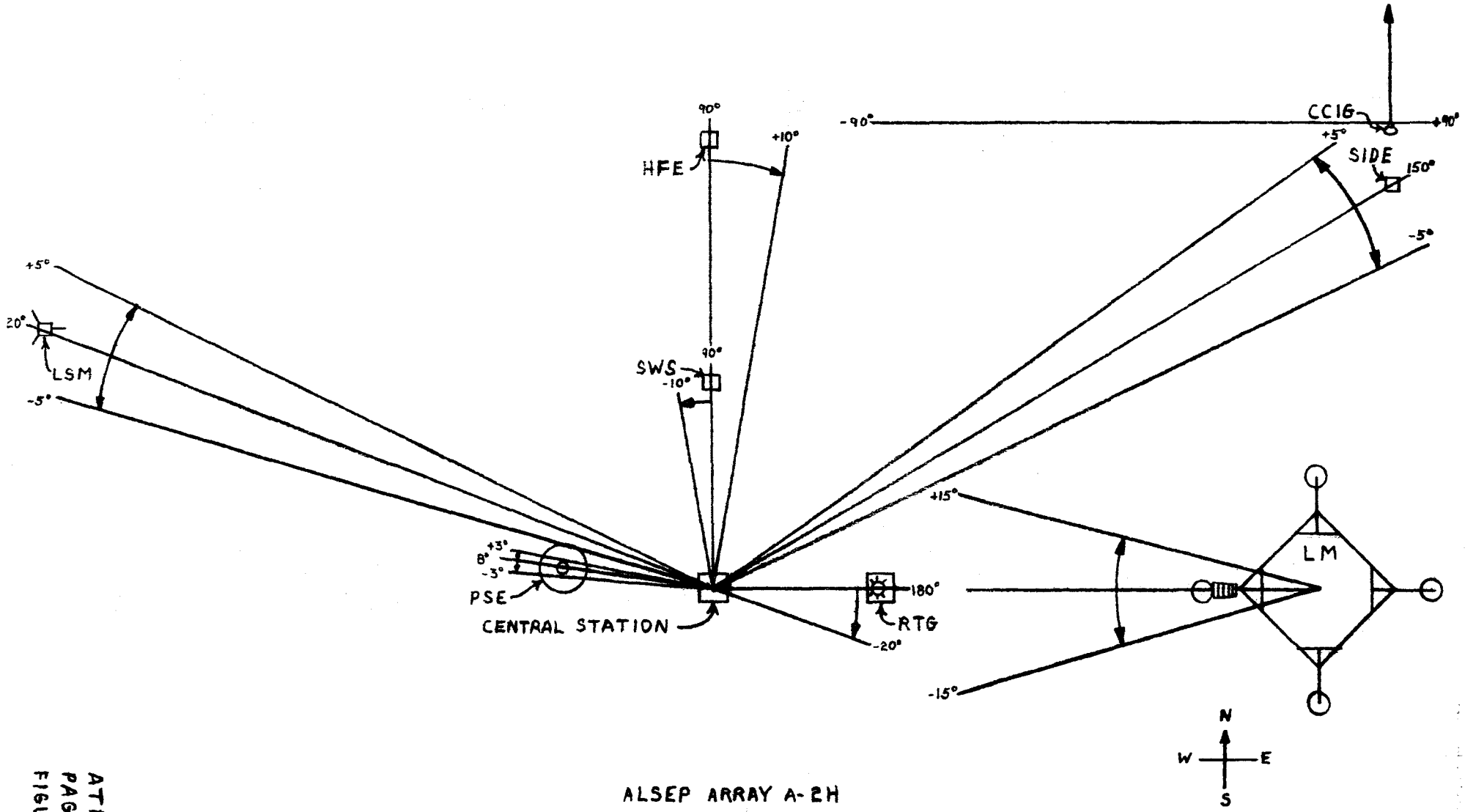
FIGURE #1



ALSEP ARRAY A-2H
DIRECTIONAL REQUIREMENTS
FOR A NORTH LANDING SITE

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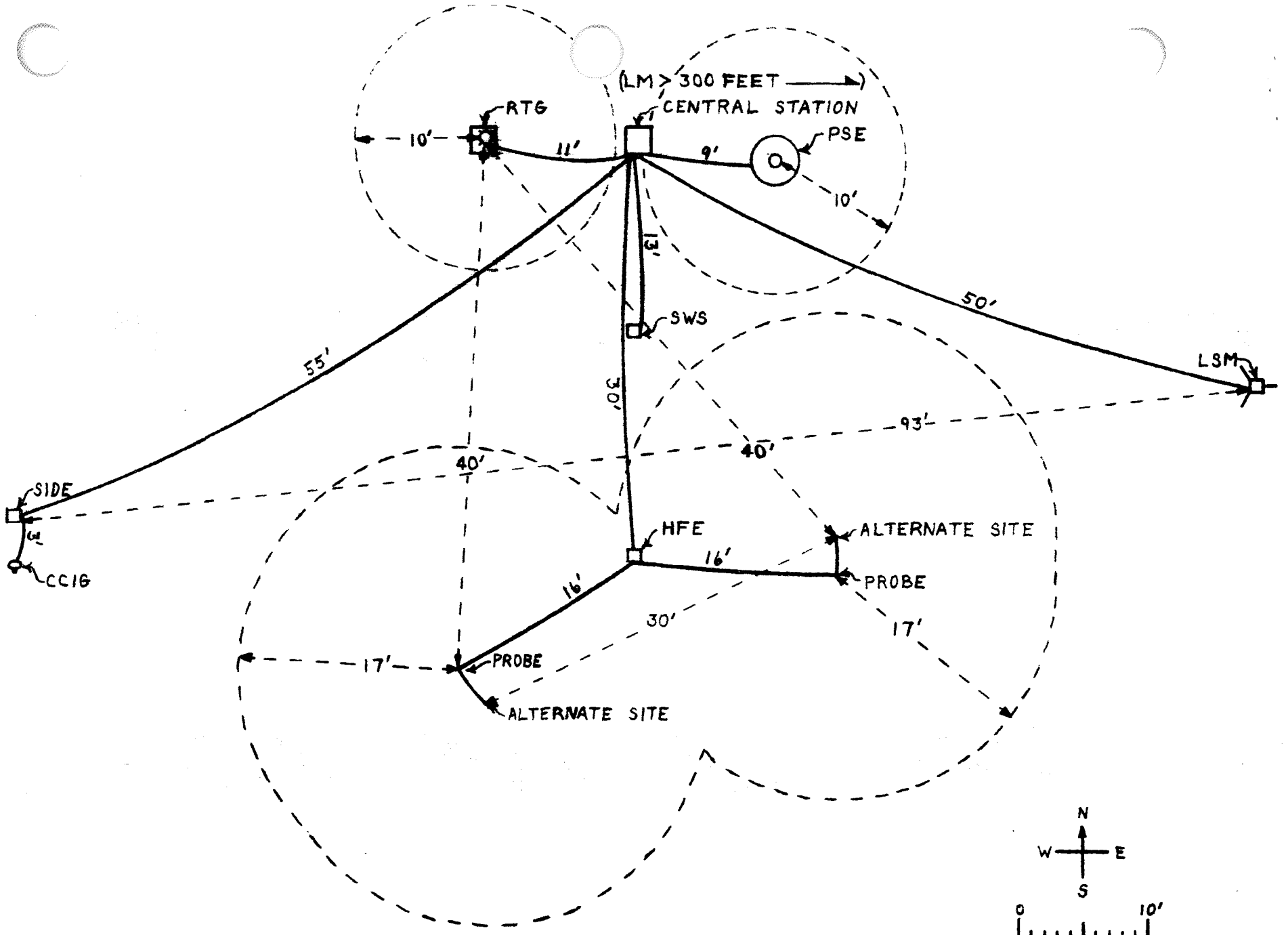
FIGURE #2

LDM



ALSEP ARRAY A-2H LAYOUT
FOR A SOUTHEAST LANDING SITE

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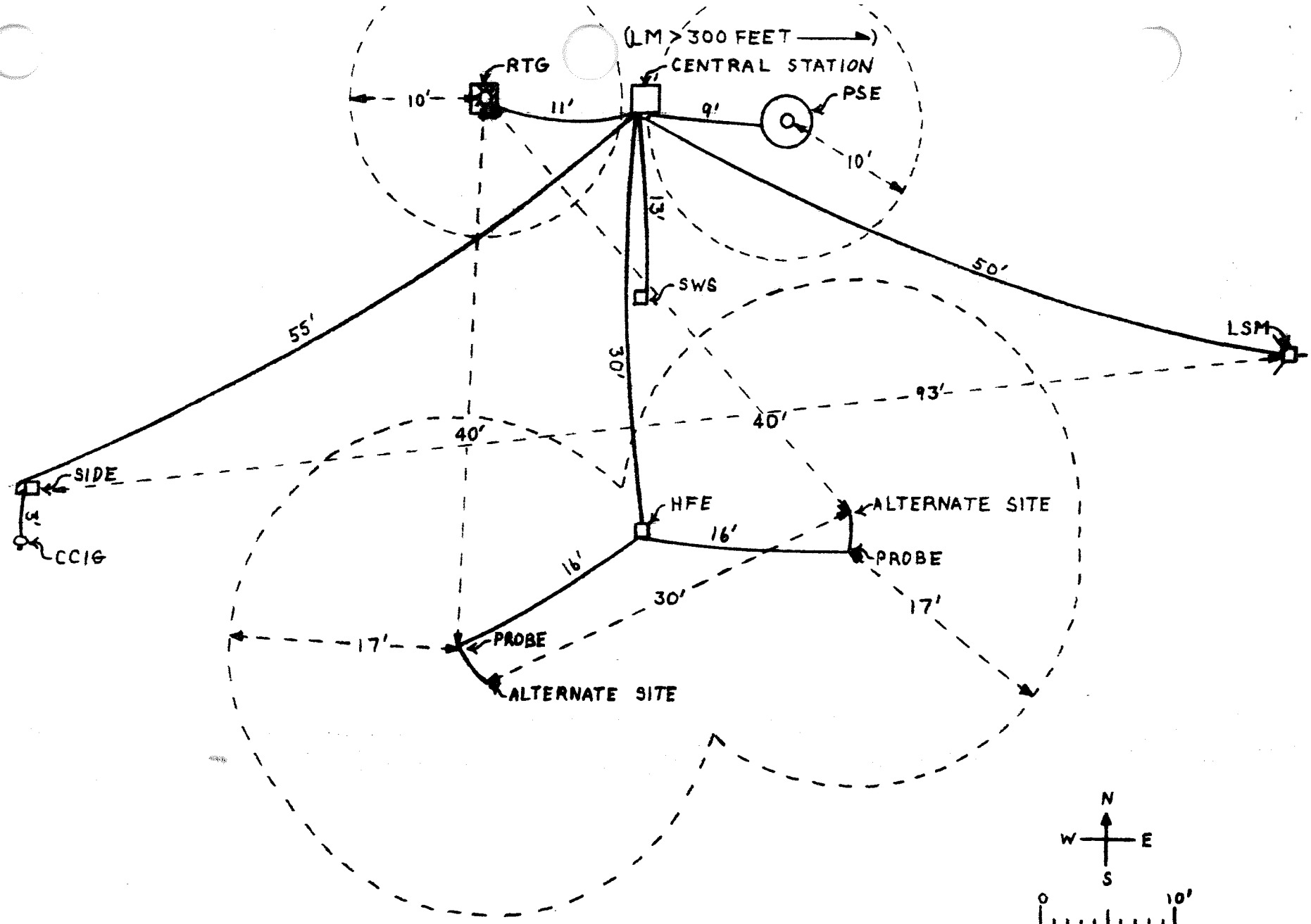
FIGURE #3

LDM



ALSEP ARRAY A-2H LAYOUT
FOR A SOUTHWEST LANDING SITE

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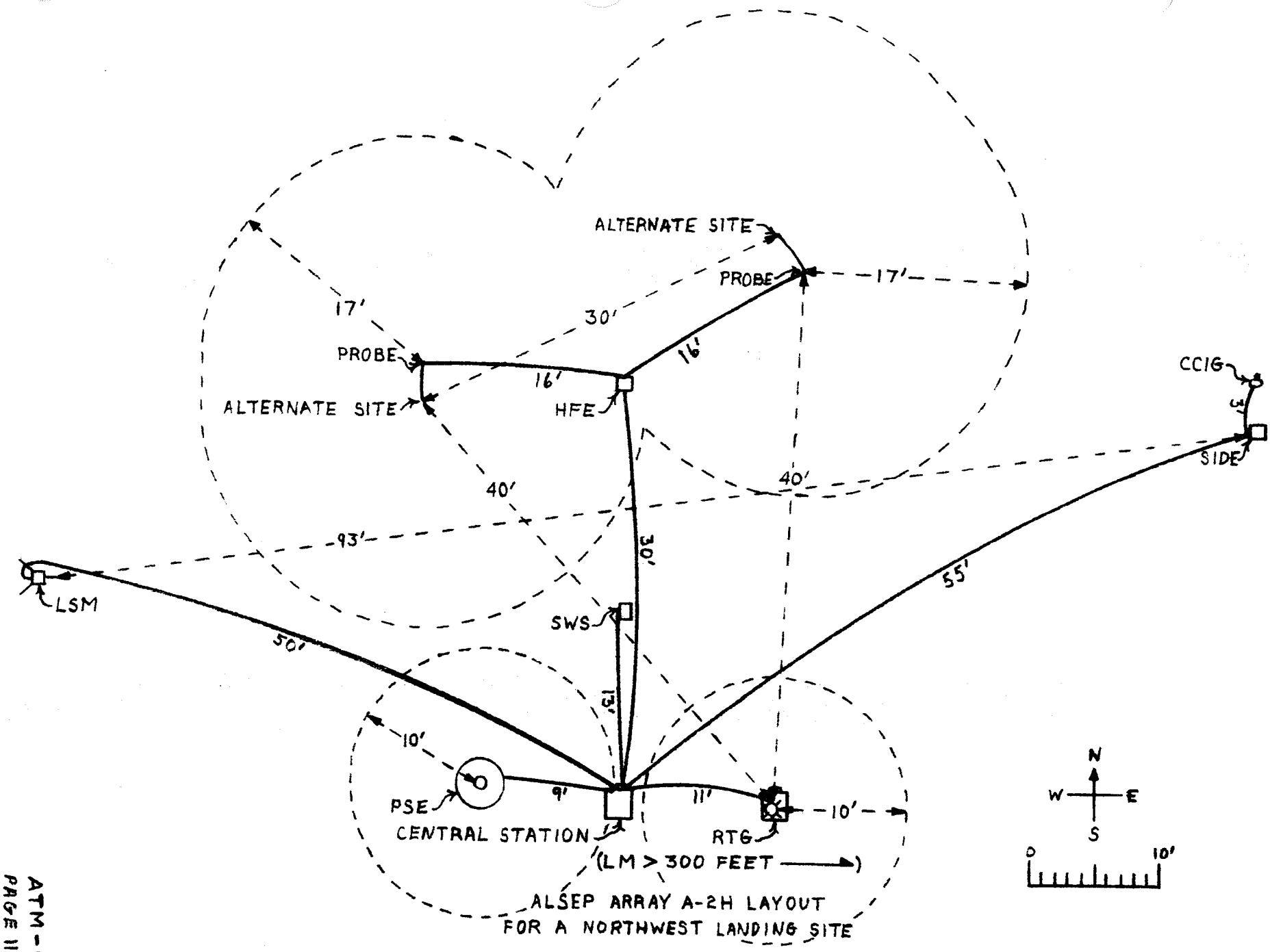
FIGURE #4

LDM



ALSEP ARRAY A-2H LAYOUT
FOR A NORTHWEST LANDING SITE

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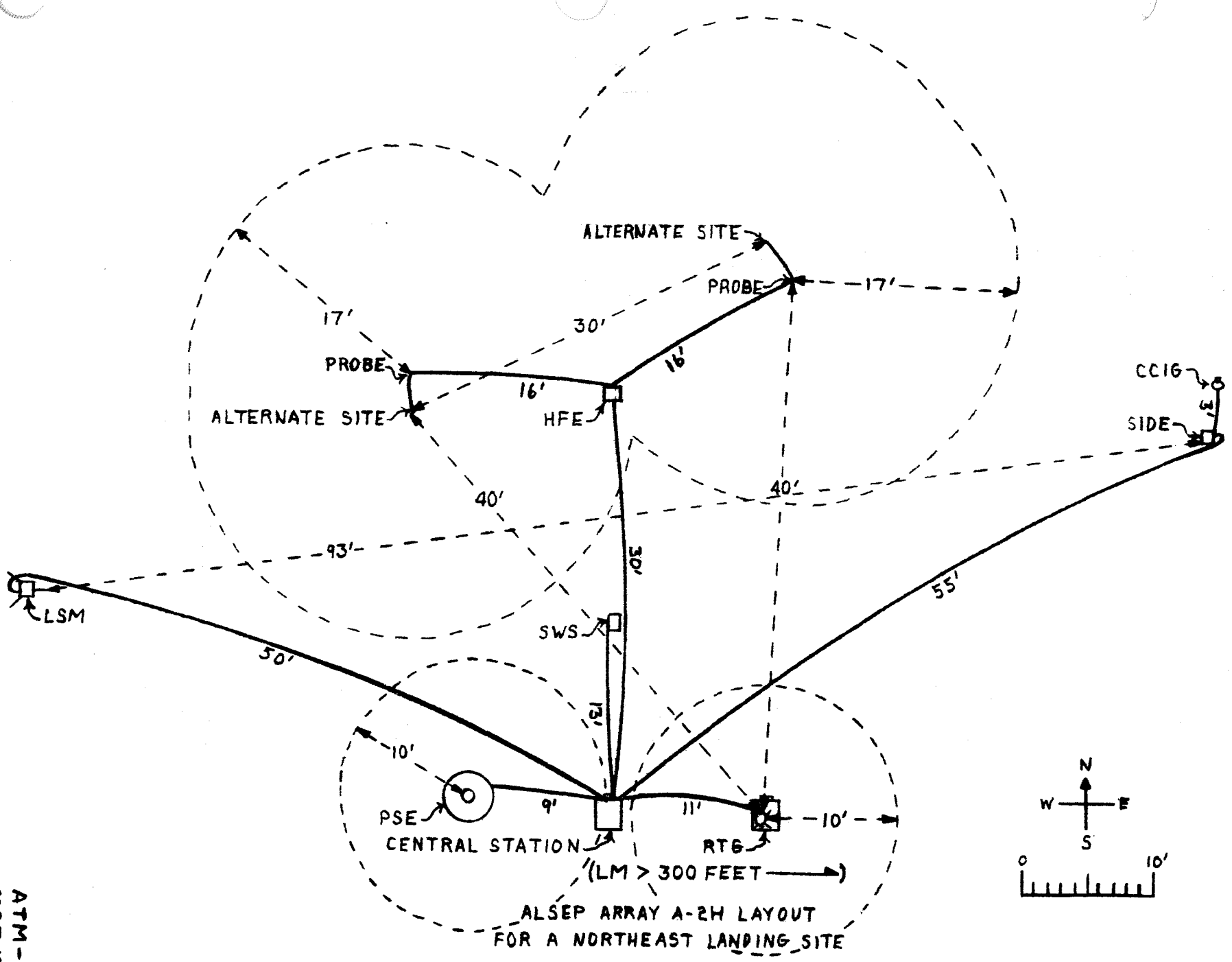
FIGURE #5

LDM



ALSEP ARRAY A-2H LAYOUT
FOR A NORTHEAST LANDING SITE

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FIGURE #6

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