Bendix
Aerospace
Systems Division

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LRRR Emplacement Range and Azimuth From LM for Fra Mauro Landing Site

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Object. - Since the lifetime goal of the LRRR is 10 years it is desired to minimize degrading or disabling conditions which could be brought about by LM or other lunar equipment (ALSEP). Potential damage to the LRRR could be caused by excessive heat, dust or kapton contamination of the retro-reflector faces, or physical movement of the LRRR which produces misalignment.

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Considerations.- There are five phenomena which must be considered in the selection of the LRRR emplacement site. These are:

1) heating from LM ascent stage exhaust gas;

2) entrained dust in the LM exhaust;

3) debris torn loose from the descent stage by decent engine blast;

4) dust "kicked-up" by the ALSEP Active Seismic Experiment mortar;

5) the mortar flight path

Heating From LM Exhaust Gas. - A detailed analysis has not been performed of this effect relative to the LRRR since similar work has been performed for the ALSEP. The same criteria, i.e. a deployment distance of 300 feet minimum from the LM, as is in effect for ALSEP, is recommended. Supporting evidence for the adequacy of this criteria is the satisfactory operation of the EASEP LRRR which was deployed about 50 feet from the LM.

Entrained Dust. - It is very probable that lunar surface dust will be entrained in the LM exhaust gas flowing radially outward from the LM. The amount of such dust is impossible to predict since it will depend on the natural dustiness of the site, the amount of dust blown from the site during the landing, and the effectiveness of the descent stage as a blast deflector. These uncertainties, together with the adhesiveness shown by the lunar dust during previous Apollo missions, make it mandatory that the corner reflectors not "see" the LM. The LRRR must accordingly be emplaced in a semi-circular area centered about the LM. The azimuth of the line through the LM which divides the "acceptable" from "unacceptable" is a function of the emplaced LRRR azimuth which in turn is a function of the landing site location.

Descent Stage Debris. - Tests have shown that at ascent stage lift-off some of the kapton which covers portions of the descent stage is torn loose in pieces of various sizes and carried radially away from the LM by the exhaust gases. The amount of such debris varies as a function of azimuth from the LM, given a nominal LM landing orientation. Figure 1 illustrates this situation. It is desirable to locate the LRRR in one of the two diametrically opposed bands of minimum debris ($\pm 17.5^{o}$ from both +Y and -Y direction). However, if such a location presents a conflict with the criteria for location with respect to dust, then the dust criteria should take precedence.

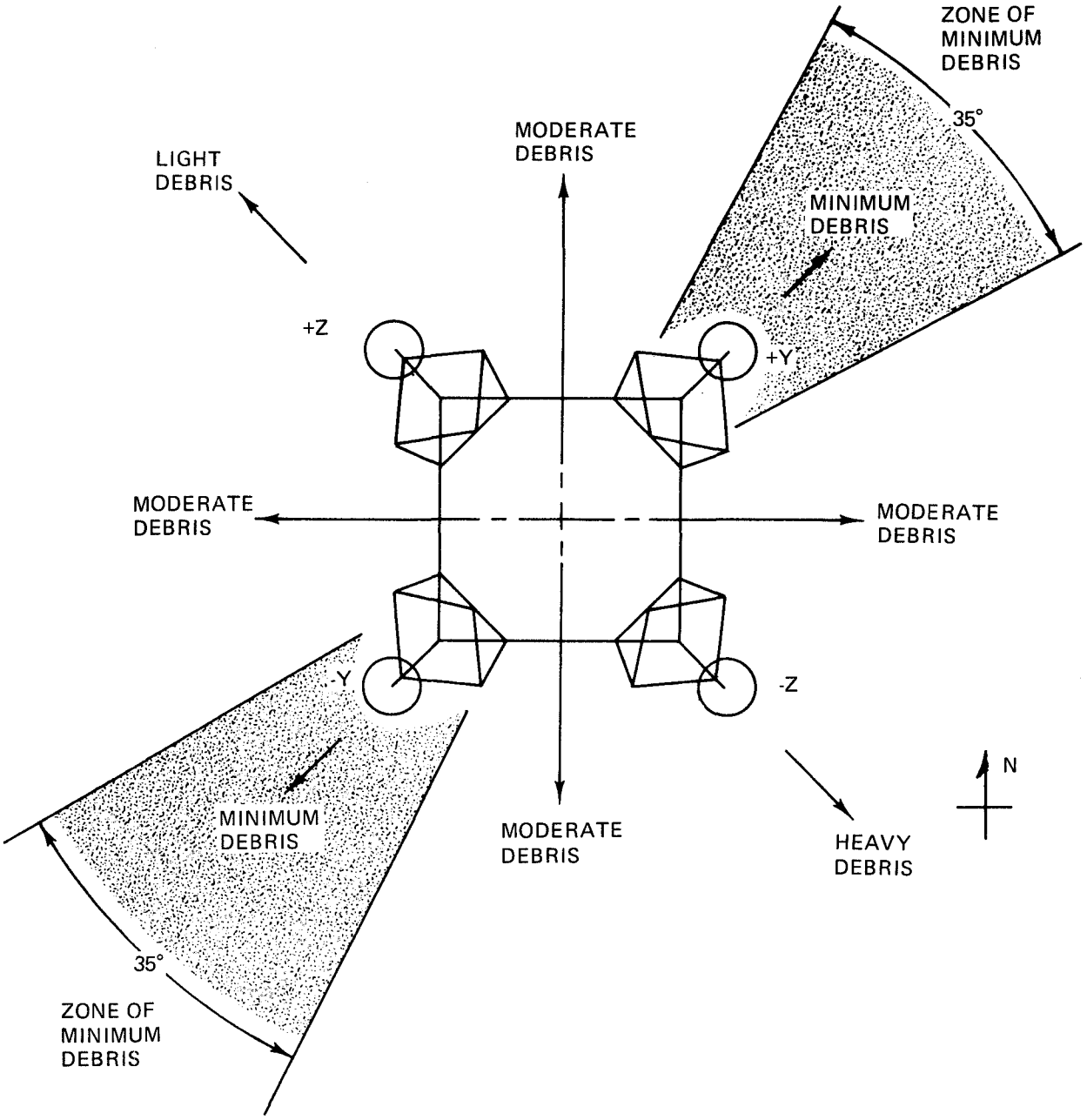

Figure 1 — Kapton Debris Density Relative to LM Orientation

ASE Mortar Dust. - The Active Seismic Experiment uses a mortar to launch explosive charges. The exhaust from this mortar causes some surface dust to be "kicked-up". The area of coverage of this "kicked-up" dust is not definitively known and it is felt that to be safe the LRRR should not be emplaced in the semi-circle "aft" of the mortar. If, because of other constraints, the LRRR must be located aft of the mortar, it should not be emplaced closer than 150 feet from the mortar. Since the ALSEP is to be located essentially due West of the LM and the mortar will be aimed nominally Northwest, the area Southeast from a Southwest-Northeast line through the mortar should be avoided in emplacing the LRRR.

Mortar Flight Path. - Emplacement along the mortar flight path is to be avoided. Neither the crew nor LRRR is to be expected to come within 100 feet of the mortar flight path.

Conclusions

The above stated criteria were applied to the LRRR emplacement at the Fra Mauro site. Since Fra Mauro is west of the Prime Meridian, the face of the LRRR will be oriented essentially east. It is assumed the ALSEP is located due west of the LM at a distance of 300 feet minimum.

Figure 2 shows the site plan and LRRR location (300 or more feet out from LM in the +Y direction) for the Fra Mauro site. This location completely satisfies all criteria. If local terrain makes this location unsuitable, a secondary emplacement location can be found any where along an arc 180 feet long (extending from the illustrated emplacement location 90 feet in both the nominal +Z and -Z directions) around the circumference of a circle 300 or more feet from the LM. The LRRR can be emplaced at a distance greater than 300 feet without adversely affecting performance

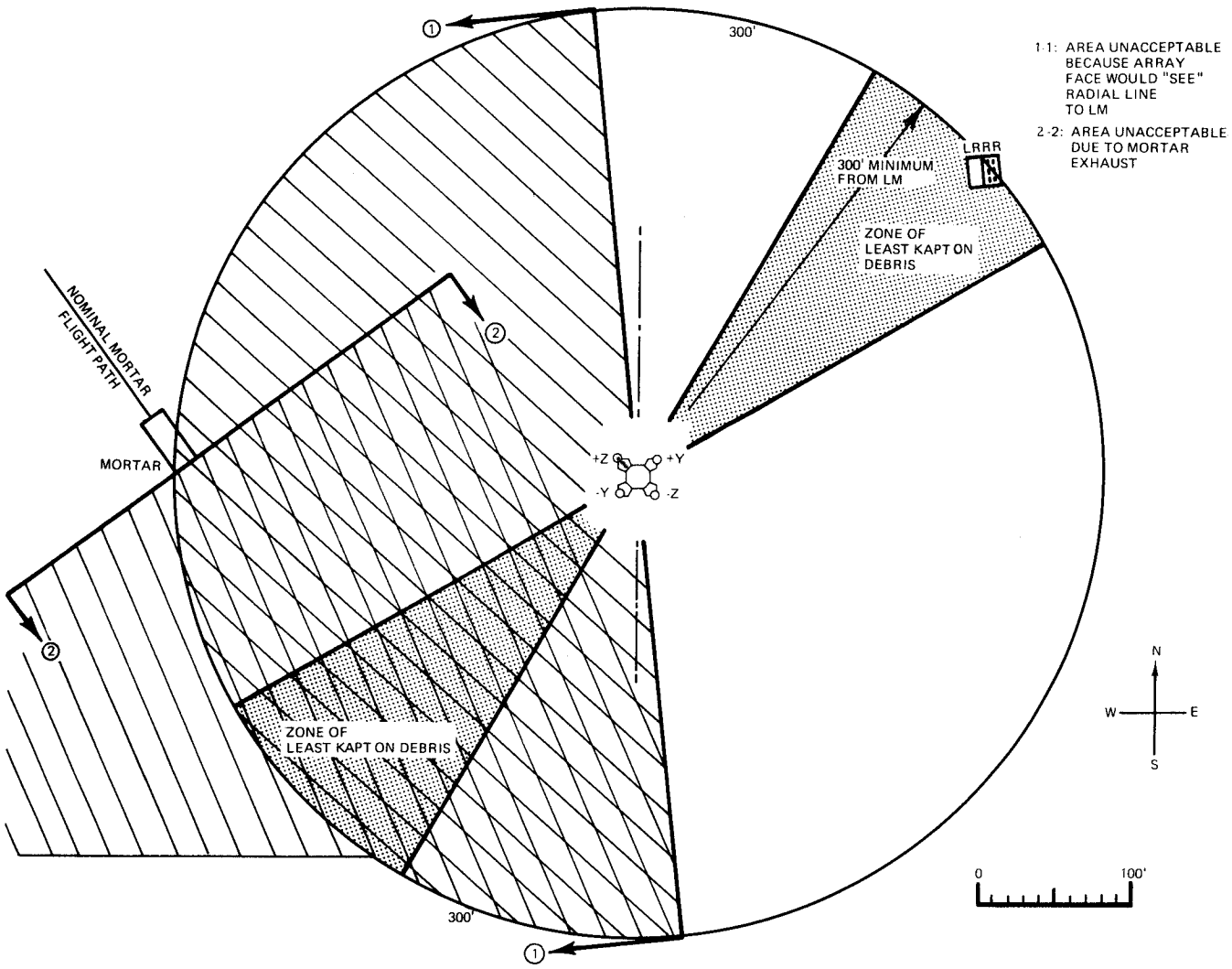

Figure 2 -- Preliminary LRRR Deployment Plan at Fra Mauro Site