CO-ORBITING MECHANICS

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JOHNSON SPACE CENTER
JUNE 22, 1982

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MOTION OF CO-ORBITING SATELLITES

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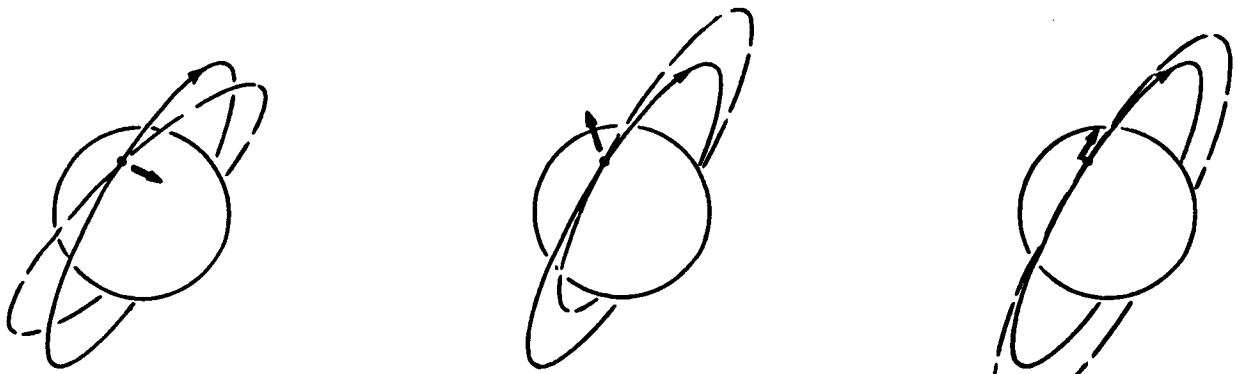
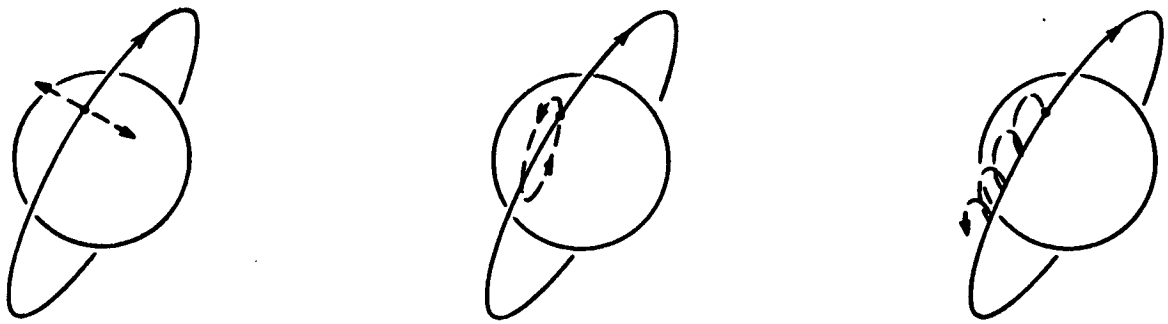


RELATIVE TO EARTH



RELATIVE TO SERVICING BASE

DIFFERENTIAL ORBIT DECAY

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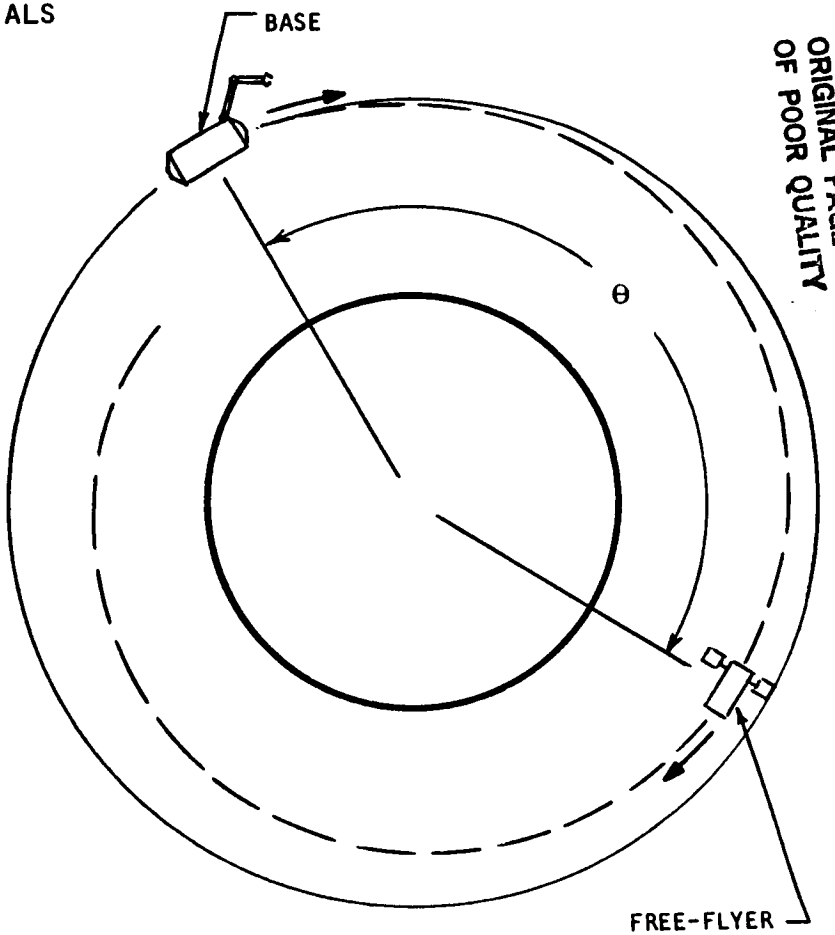
- SOME FREE-FLYING SATELLITES (E.G., MATERIALS PROCESSING OR LARGE TELESCOPES) REQUIRE:
  - EXTENDED PERIODS WITHOUT PROPULSIVE MANEUVERS OR OTHER DISTURBANCES.
  - PERIODIC SERVICING.
- ORBITING IN THE VICINITY OF A PERMANENT BASE FACILITY COULD PERMIT SERVICING AS REQUIRED WITHOUT DEDICATED SHUTTLE FLIGHTS.
- EVEN MODERATE ORBIT DECAY REDUCES PERIOD OF FREE-FLYER ENOUGH TO CAUSE RAPID SEPARATION FROM BASE.
- IF BASE ORBIT IS NOT MAINTAINED, IT WILL GENERALLY DECAY AT DIFFERENT RATE, REDUCING BUT NOT ELIMINATING THE DIFFERENTIAL.



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ATMOSPHERIC MODELS

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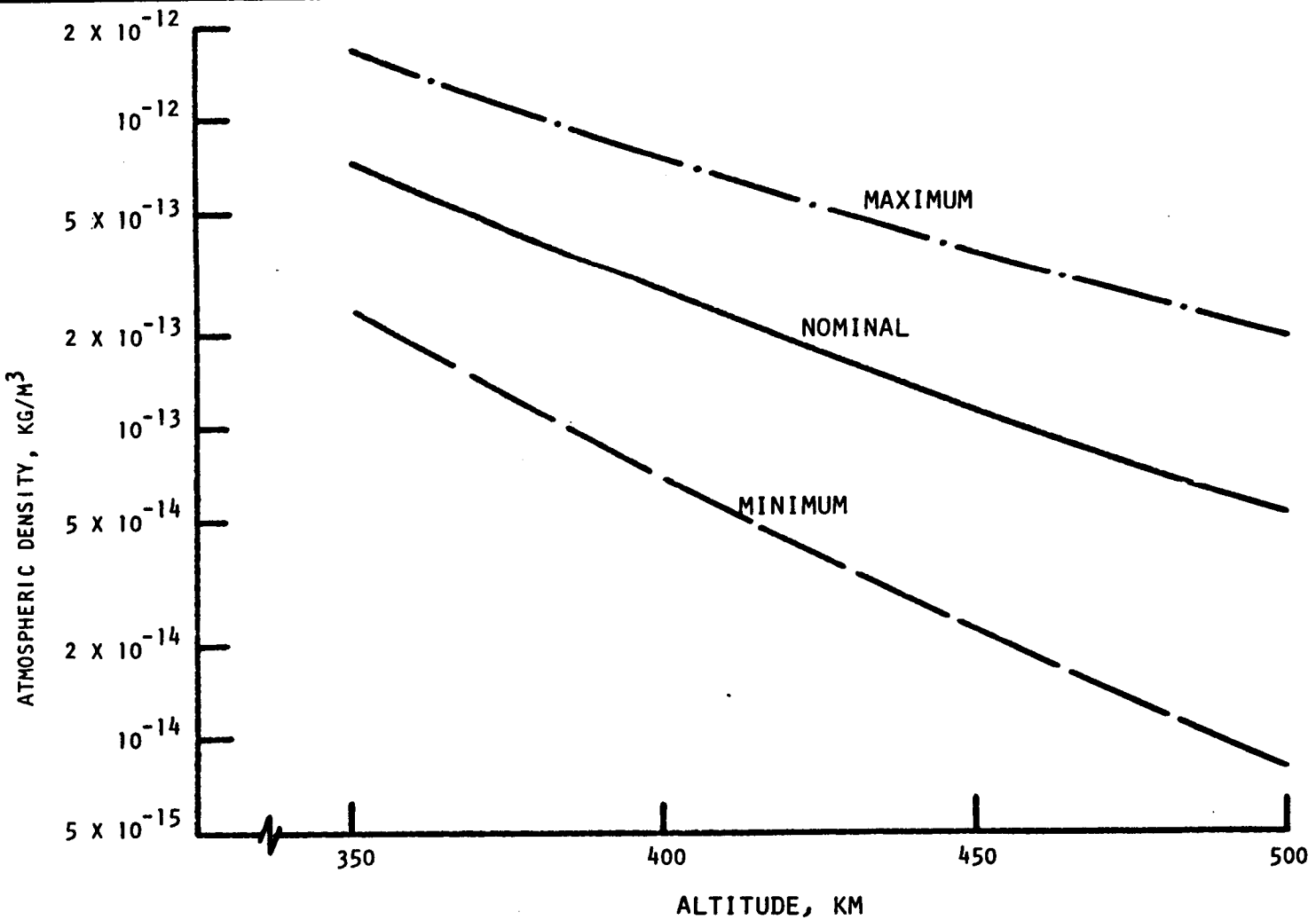

FREE-FLYER DISTANCE FROM BASE

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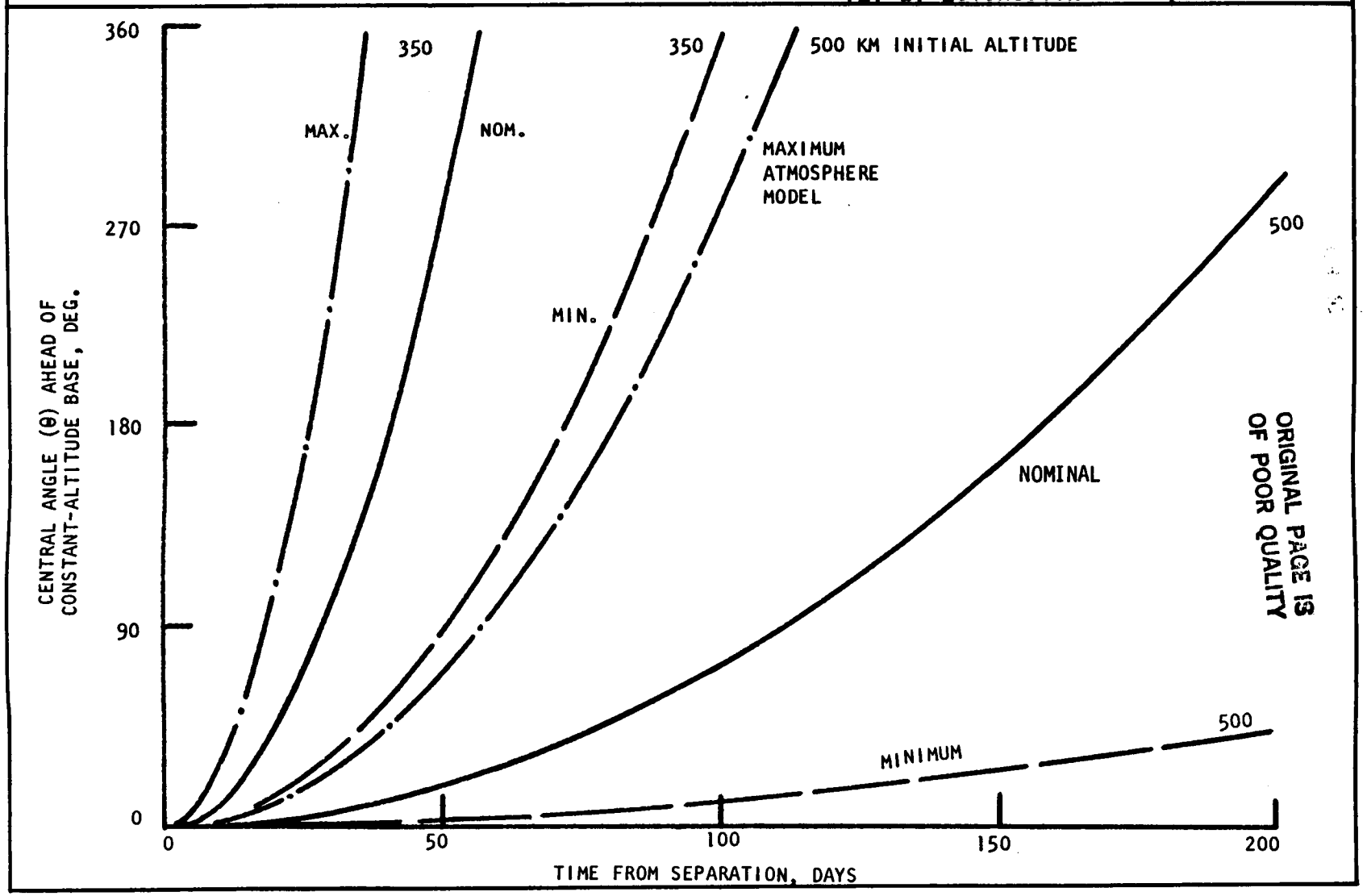

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TIME FOR ONE REVOLUTION RELATIVE TO BASE

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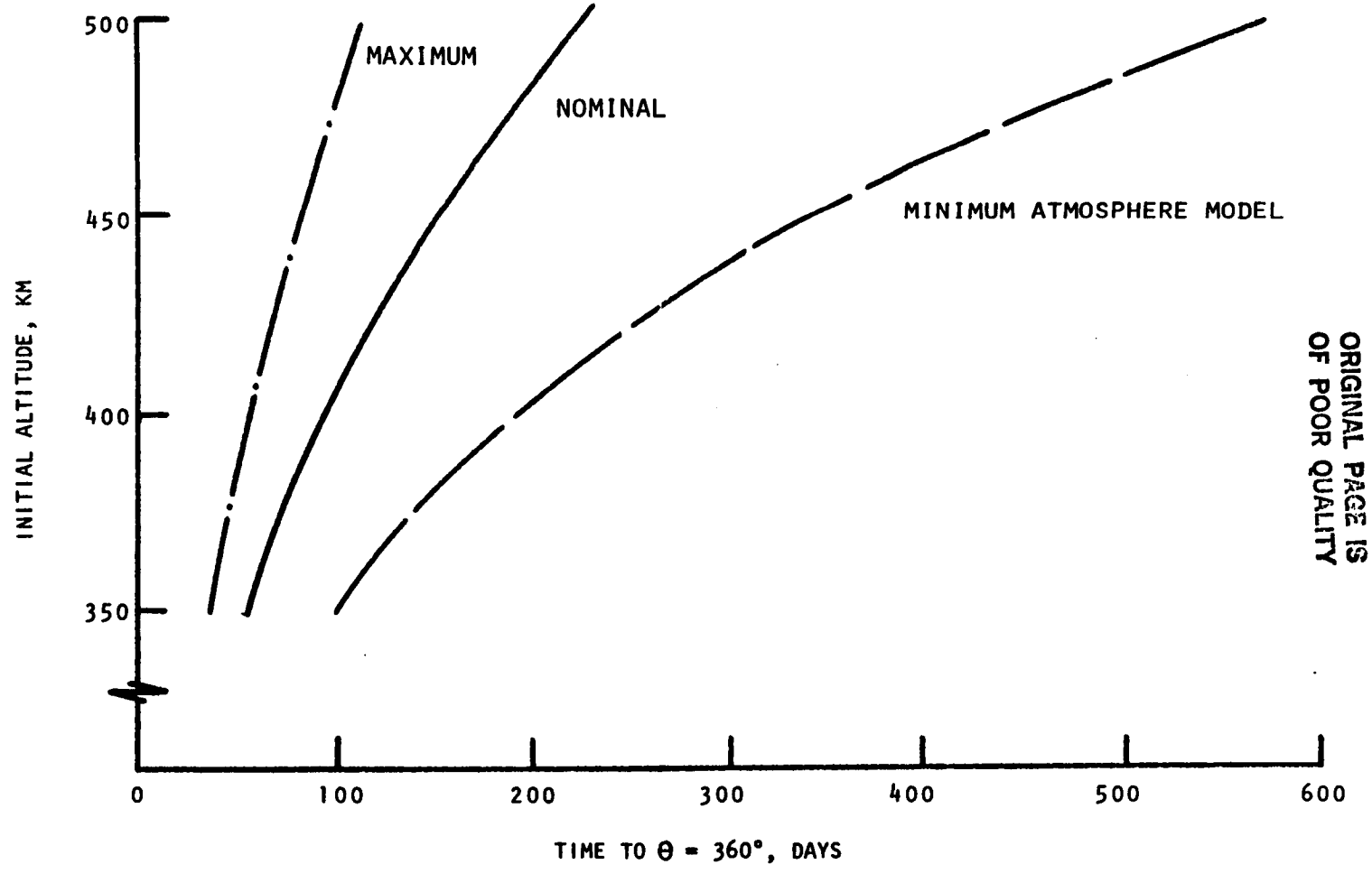

ALTITUDE DIFFERENTIAL

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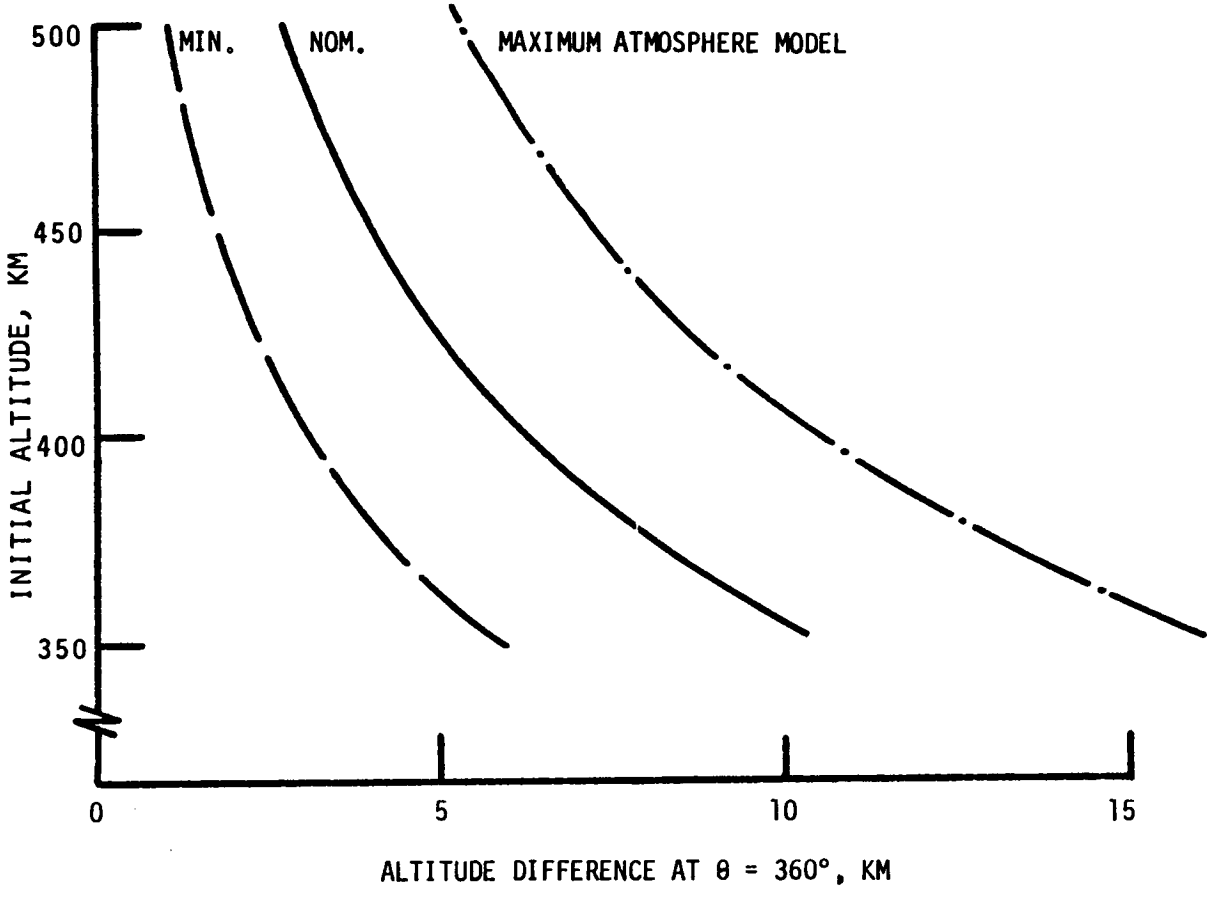

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RETURN AT ARBITRARY TIME

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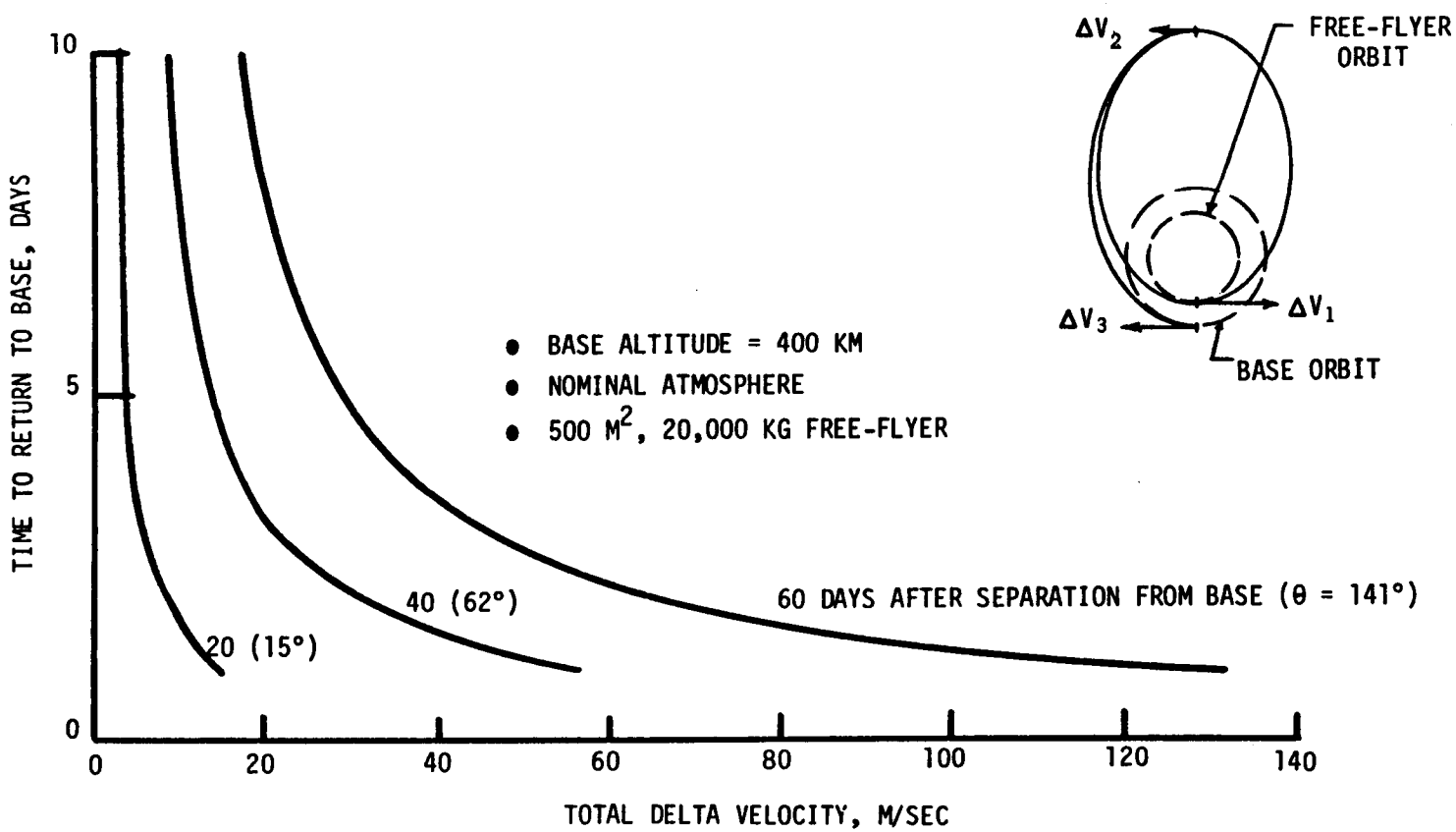

DIFFERENTIAL NODAL REGRESSION

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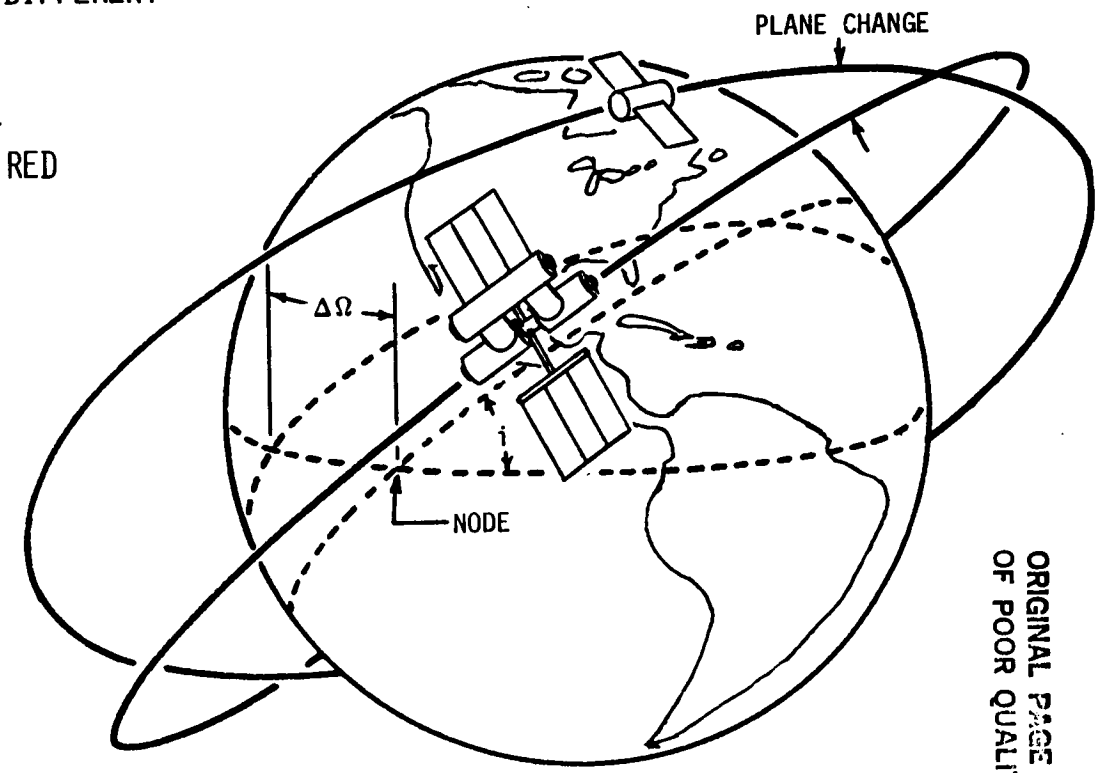
- EARTH'S OBLATENESS CAUSE NODE TO MOVE ALONG EQUATOR.
- RATE DEPENDS ON ALTITUDE AND INCLINATION.
- FREE-FLYER REGRESSES AT DIFFERENT RATE FROM BASE.
- PLANE CHANGE GREATLY INCREASES PROPELLANT REQUIRED FOR TRANSFER.



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DIFFERENTIAL NODAL REGRESSION

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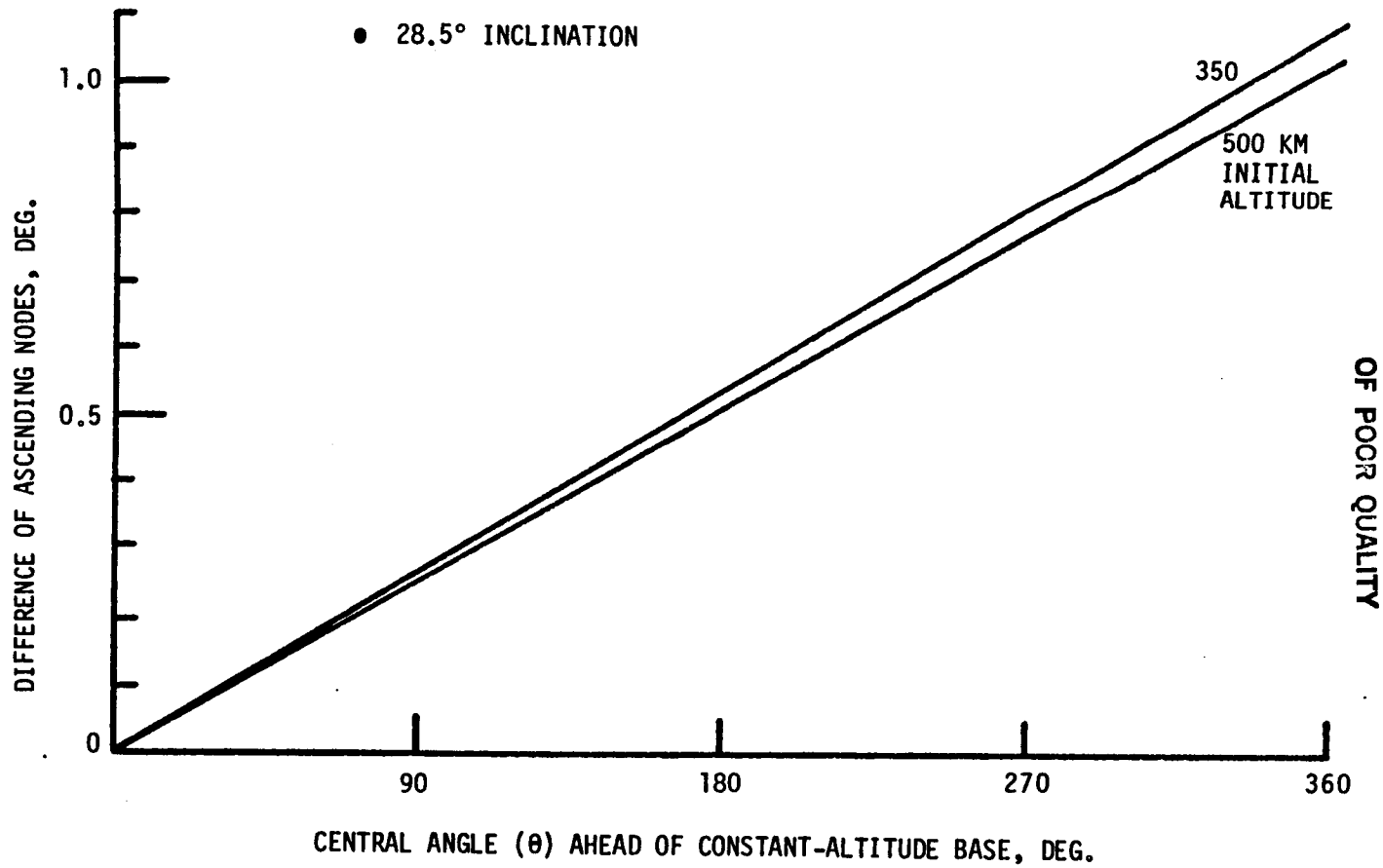

DIFFERENTIAL NODAL REGRESSION

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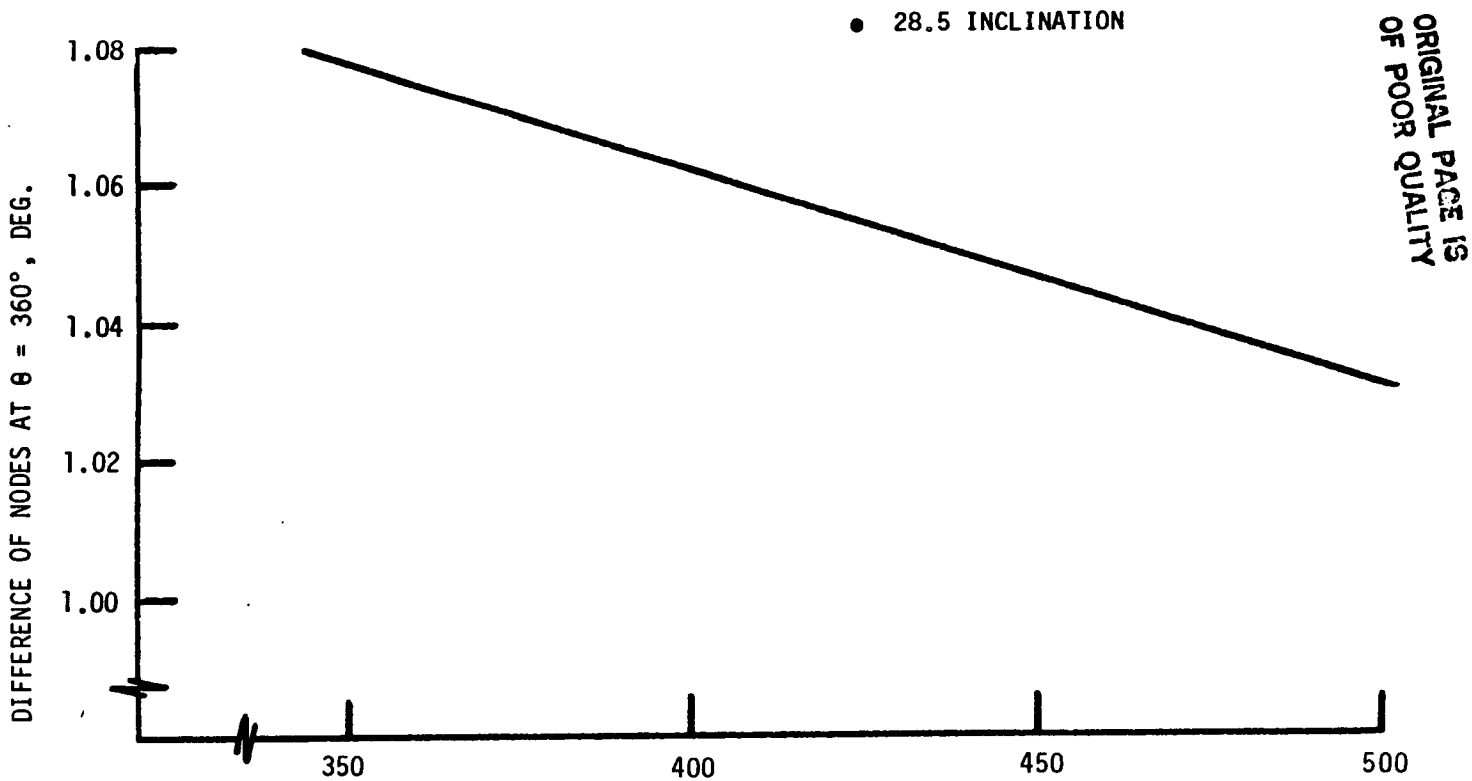

RETURN AFTER ONE REVOLUTION RELATIVE TO BASE

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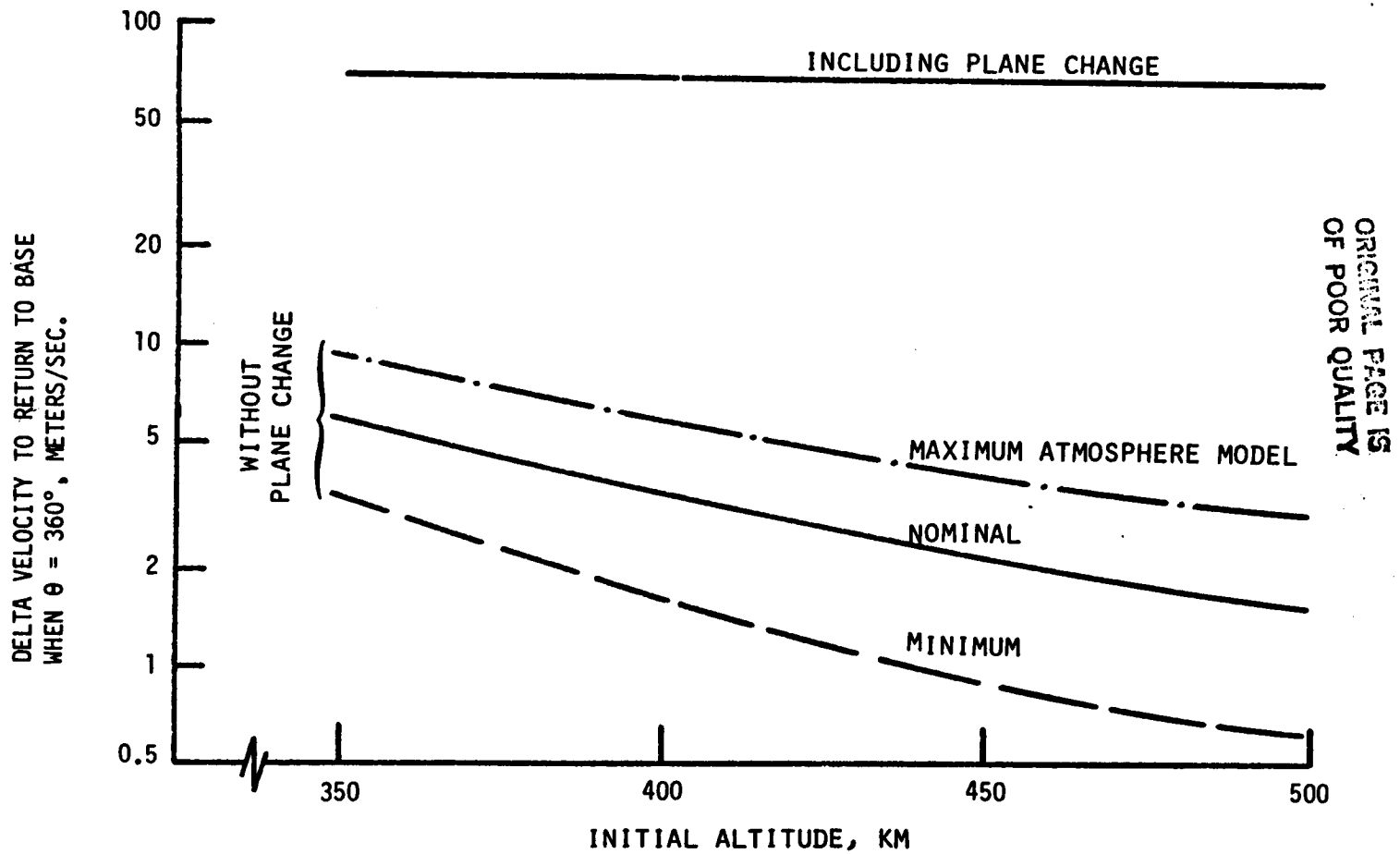

"BOOMERANG" CONCEPT

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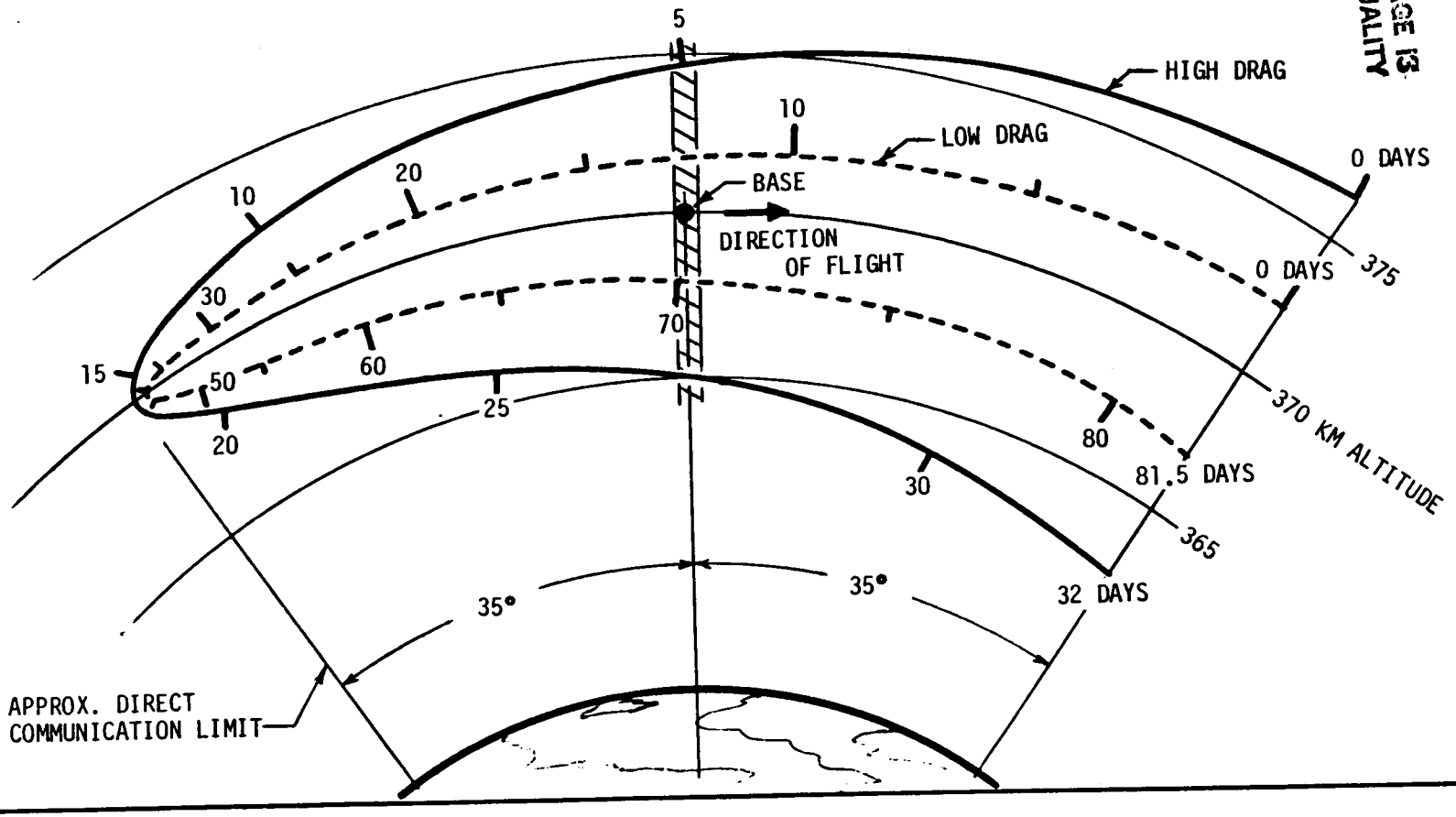
- BASE MAINTAINS CONSTANT 370 KM ALTITUDE
- FREE-FLYERS PERFORM NO ORBIT MAINTENANCE
- HIGH-DRAG FREE-FLYER - 10,000 KG, 100 M^2 (————)
- LOW-DRAG FREE-FLYER - 25,000 KG, 35M^2 (– – – – –)



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"BOOMERANG" CONCEPT

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- SEPARATION OF NODES FROM DIFFERENTIAL REGRESSION IS PROPORTIONAL TO ANGULAR SEPARATION FROM BASE, AND RETURNS TO ZERO WHEN FREE-FLYER IS BENEATH INITIAL POSITION RELATIVE TO BASE.

- LOW ΔV REQUIRED FOR REBOOST (EXAMPLES FROM PRECEDING CHART)
  - LOW DRAG: 2.2 M/SEC AT BASE
    3.1 M/SEC AT COMMUNICATIONS LIMIT
  - HIGH DRAG: 5.6 M/SEC AT BASE
    8.0 M/SEC AT COMMUNICATIONS LIMIT

- EASY ACCESS FROM BASE AT FREQUENT INTERVALS.

PERIODIC CO-PLANARITY

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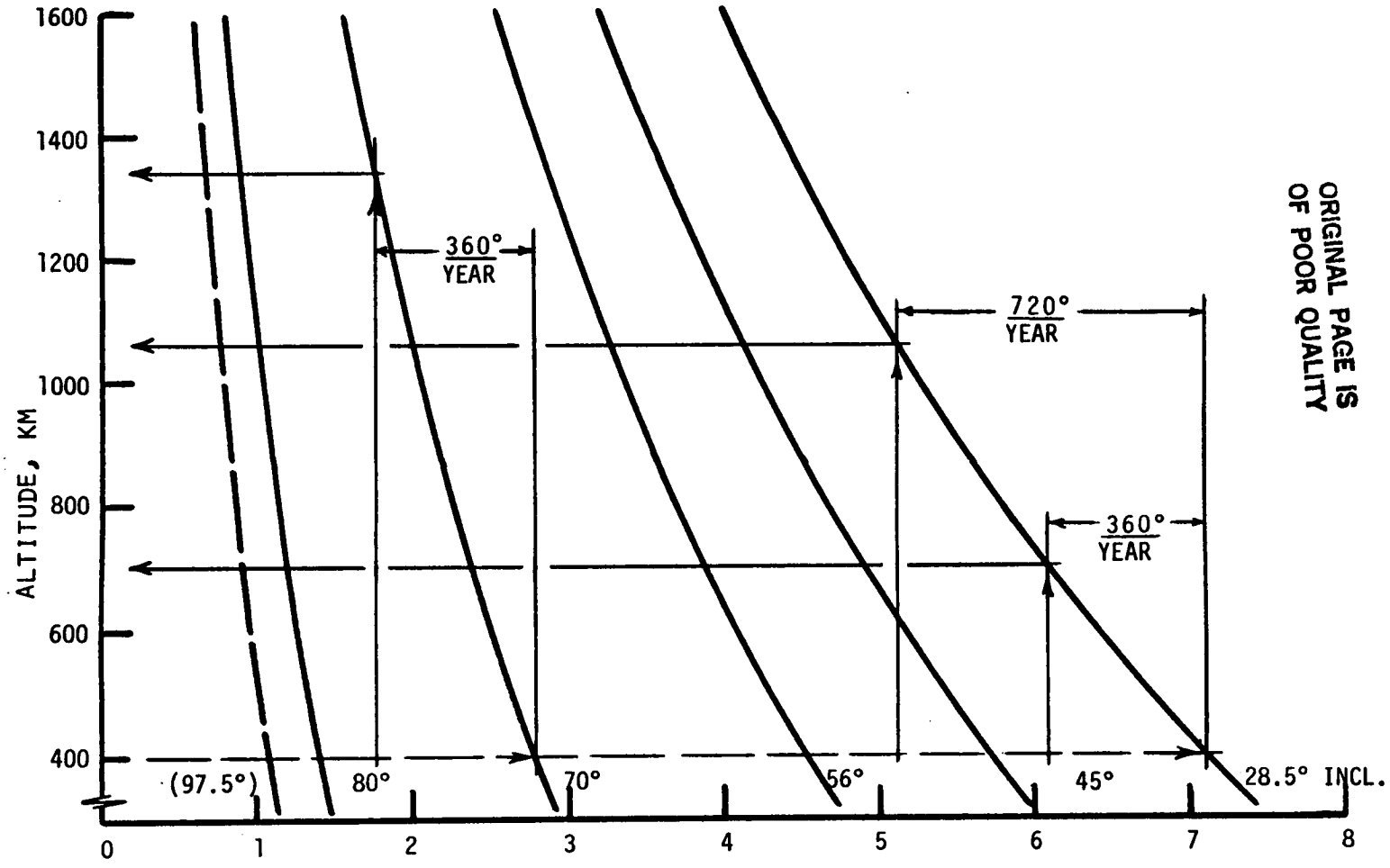

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PERIODIC CO-PLANARITY

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