Aerodynamics of Magnetic Levitation (MAGLEV) Trains

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Engineering Design for the Future

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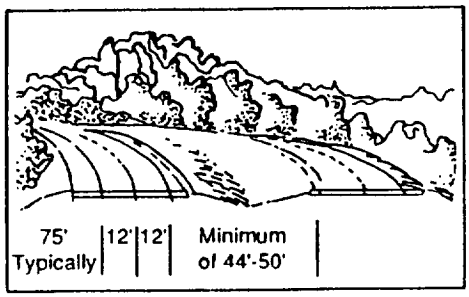
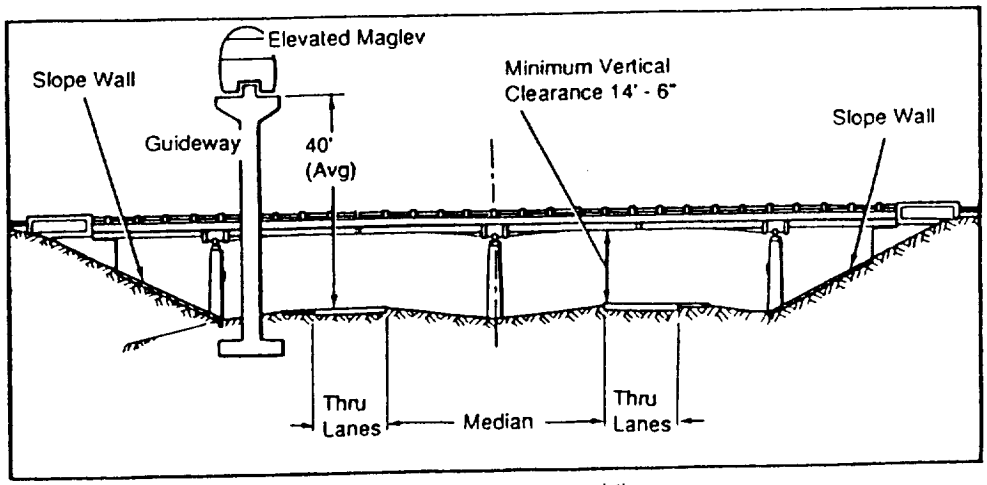
Track Arrangement

The track arrangement that is receiving the most consideration in the US is elevated as shown.



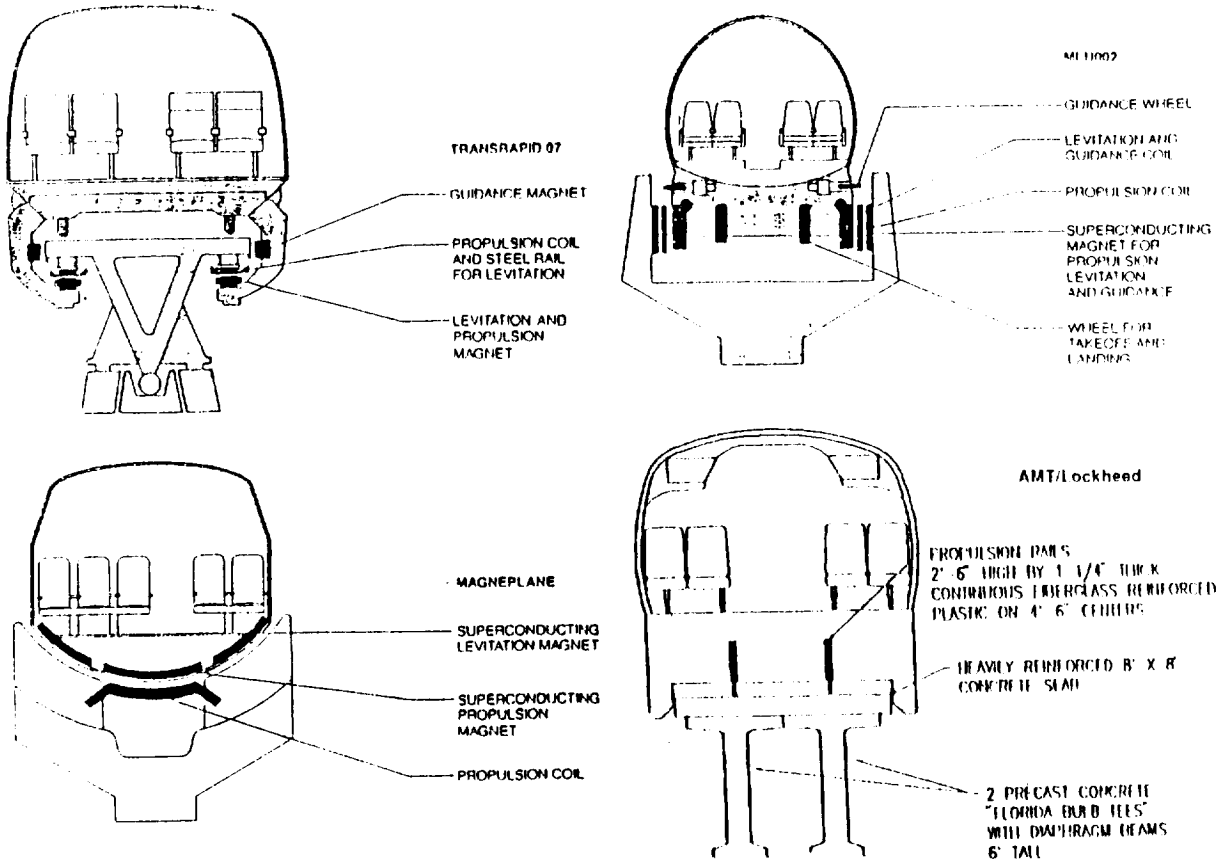
There's ample clearance on rural Interstates for Maglev construction along the median or the right of way.



Elevating the Maglev guideway provides adequate clearance over existing Interstate bridges and other structures.

Magnetic Suspension Systems

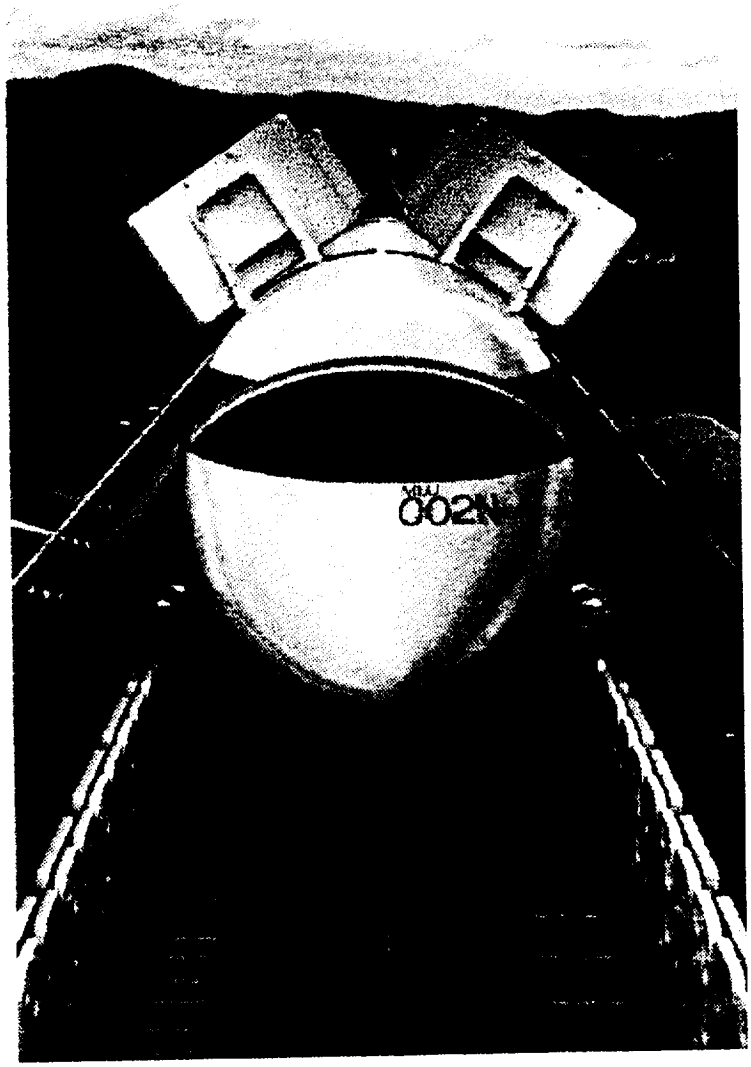
The different systems that have been proposed have a large influence on vehicle configuration design.



German Test Vehicle

There are ongoing test vehicle programs in Germany and Japan.

Japanese Test Vehicle

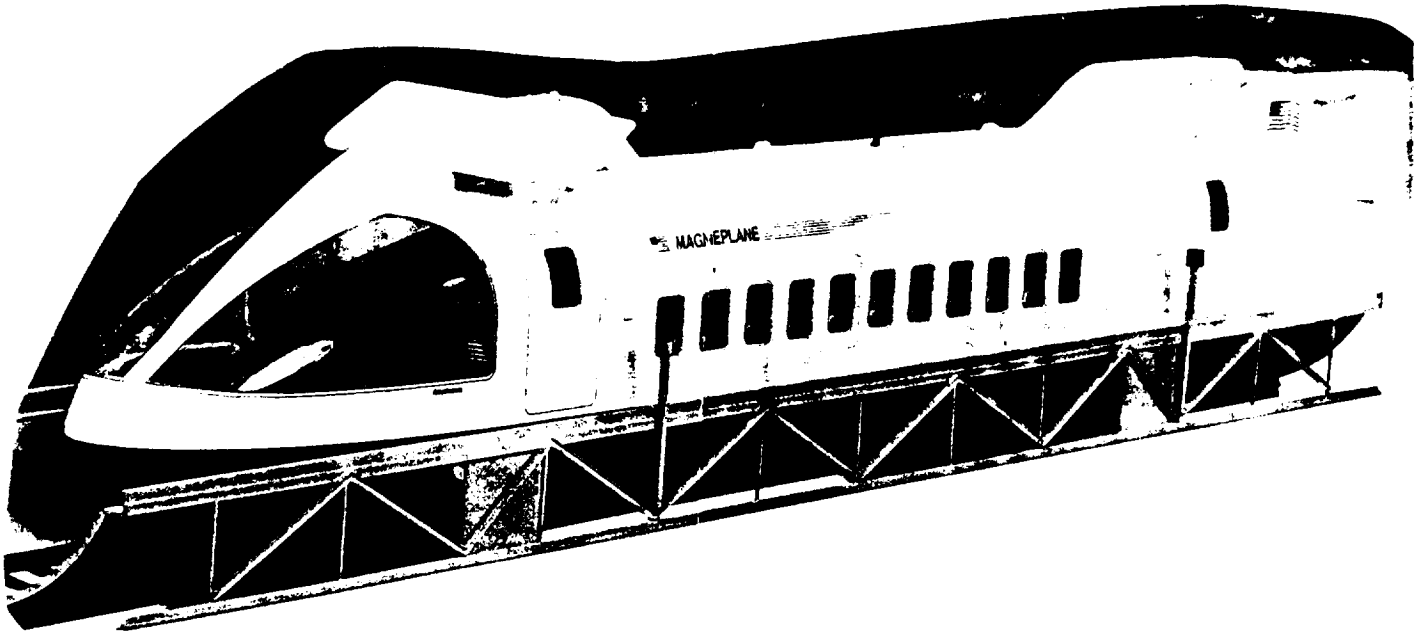


Proposed Japanese Designs

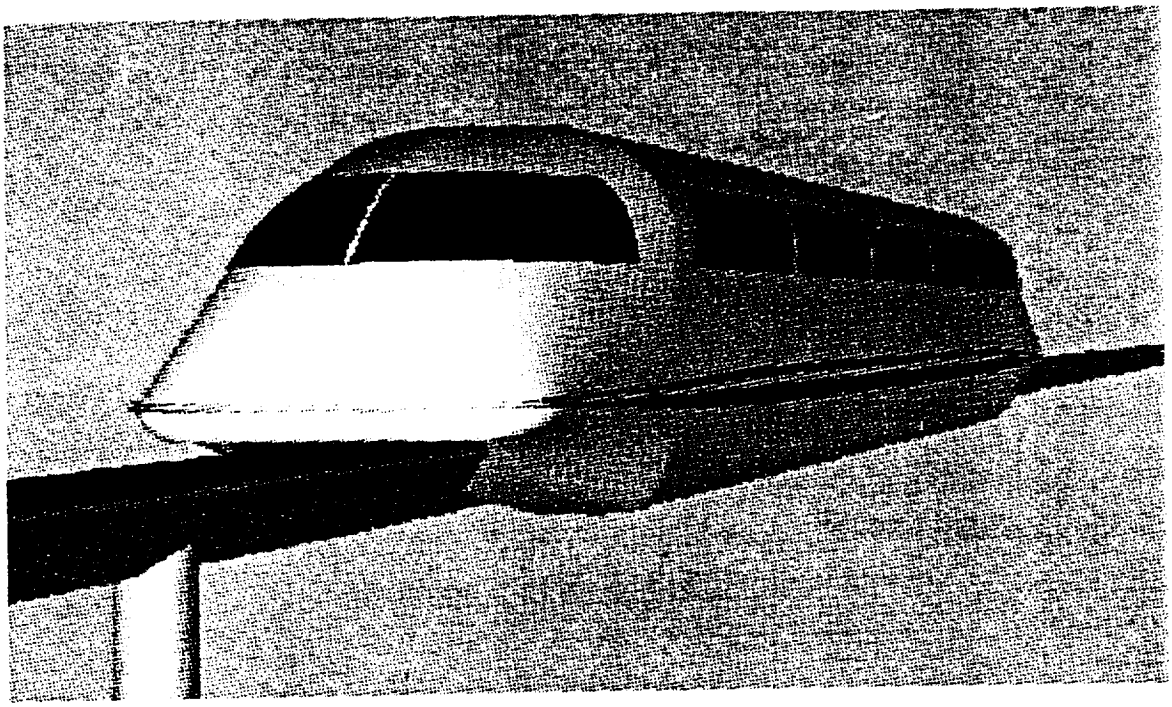
The Japanese have developed new designs to minimize aerodynamic forces, noise and tunnel entry/exit problems.

Proposed US Designs

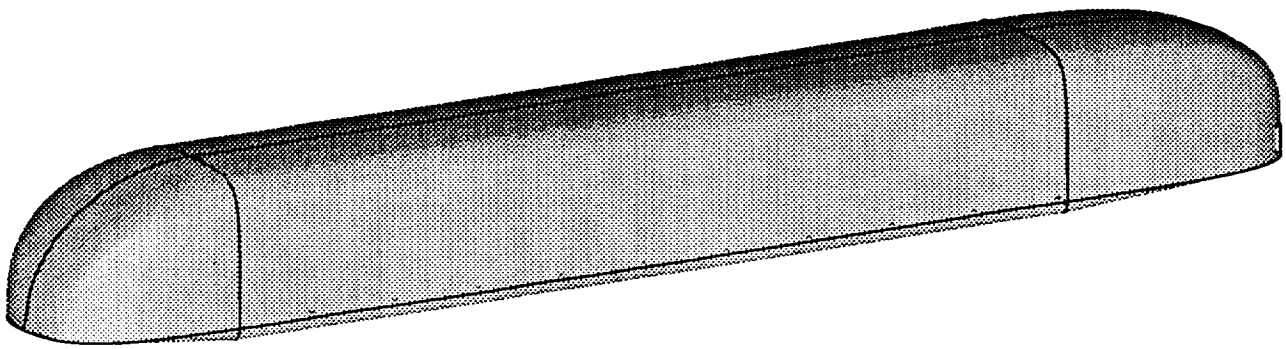
There are several US designs that have been proposed.



Grumman Designs



Lockheed Design for AMT



Need for Wind Tunnel Studies

+ There is little relevant data in the literature

+ The analytical estimates for drag vary widely

+ CFD is unreliable and very expensive for 3D flows with separated regions

Wind Tunnel Tests of Maglev Vehicles

+ Model ground effect of track with a moving belt

+ Model clearance between elevated track and ground (approx. 3 diam.)

+ Parallel, uniform incoming flow to model accomplished with proper shrouding

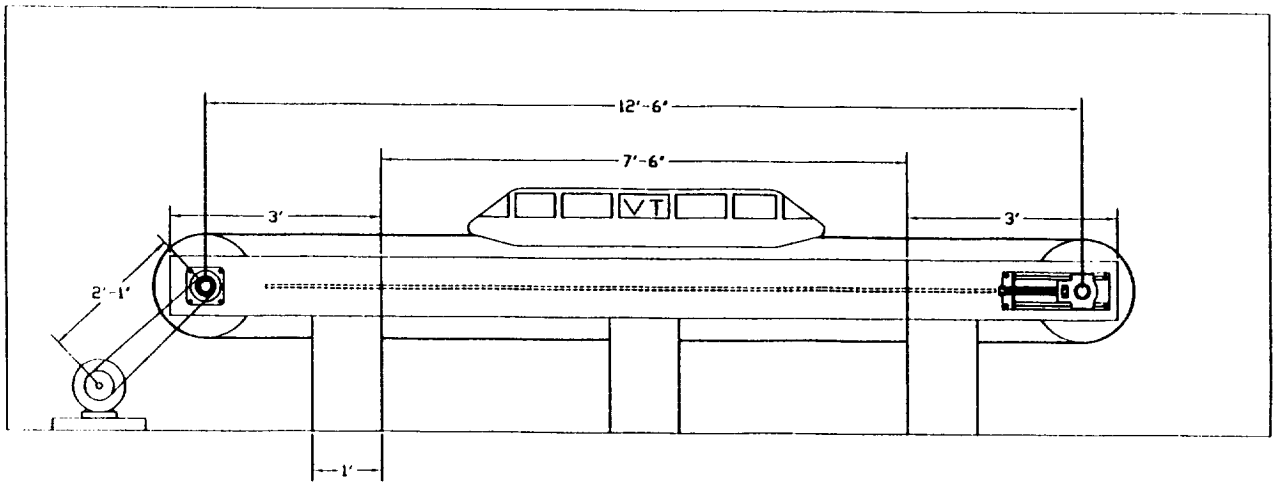
+ Reynolds number simulation with a "trip" strip

Moving Belt System

+ Use in *VT* 6 ft. X 6 ft. Wind Tunnel

+ Accommodate 6 ft.(long) X 1 ft.(diam.) model

+ Maximum belt speed

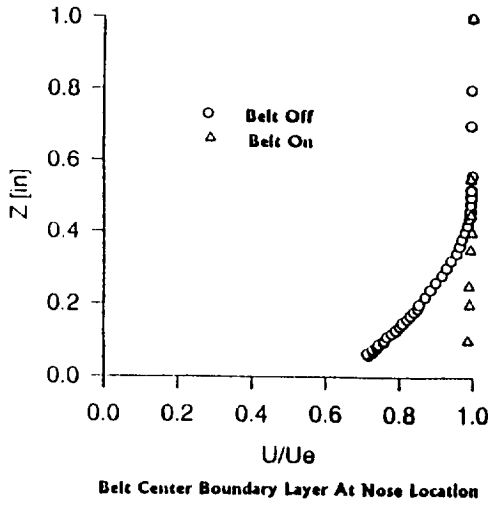


SHROUDING NOT SHOWN

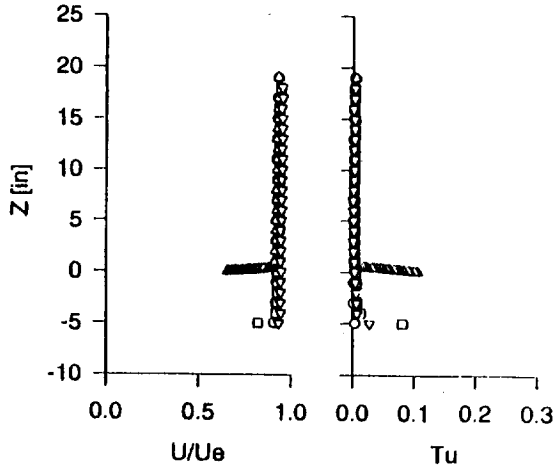
Incoming Flowfield Verification

+ Hot-wire measurements at various locations above and around the belt

+ Mean-flow and turbulence profiles

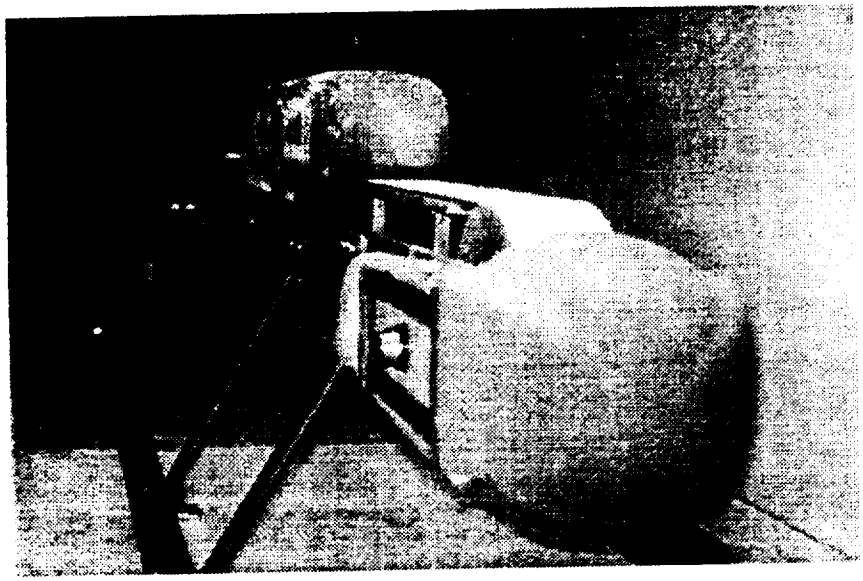


Belt Center Boundary Layer At Nose Location



Nose Location, Stationary Belt Region Velocity And Turbulence Profiles

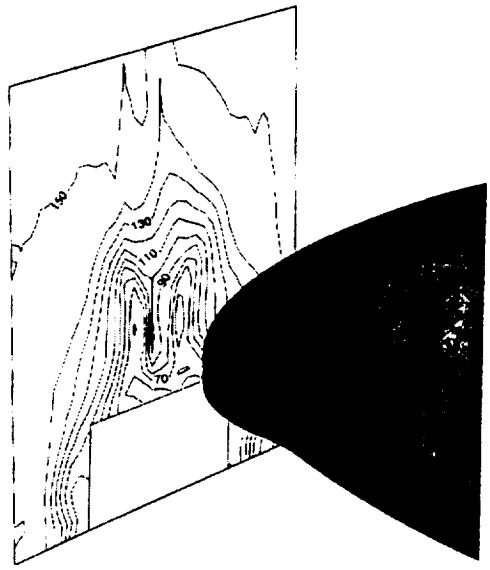
Northrop/Grumman Model in the Wind Tunnel with Moving Track



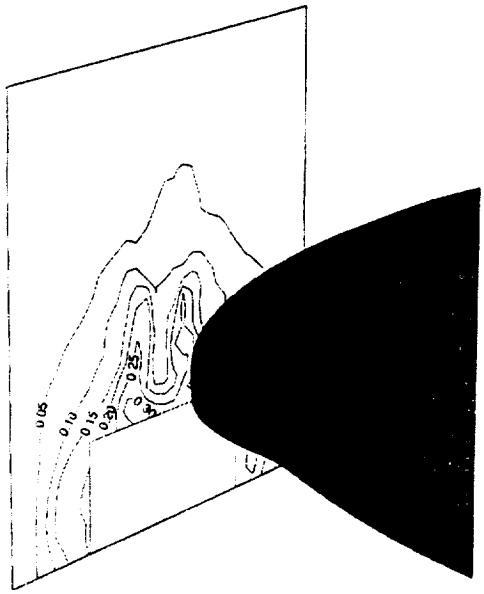
Experimental Methods

+ Force and Moment balance
+ Tuft surface flow observations
+ Hot-wire flowfield surveys
+ Surface pressure distributions
+ Skin friction gages

Typical Flowfield Surveys

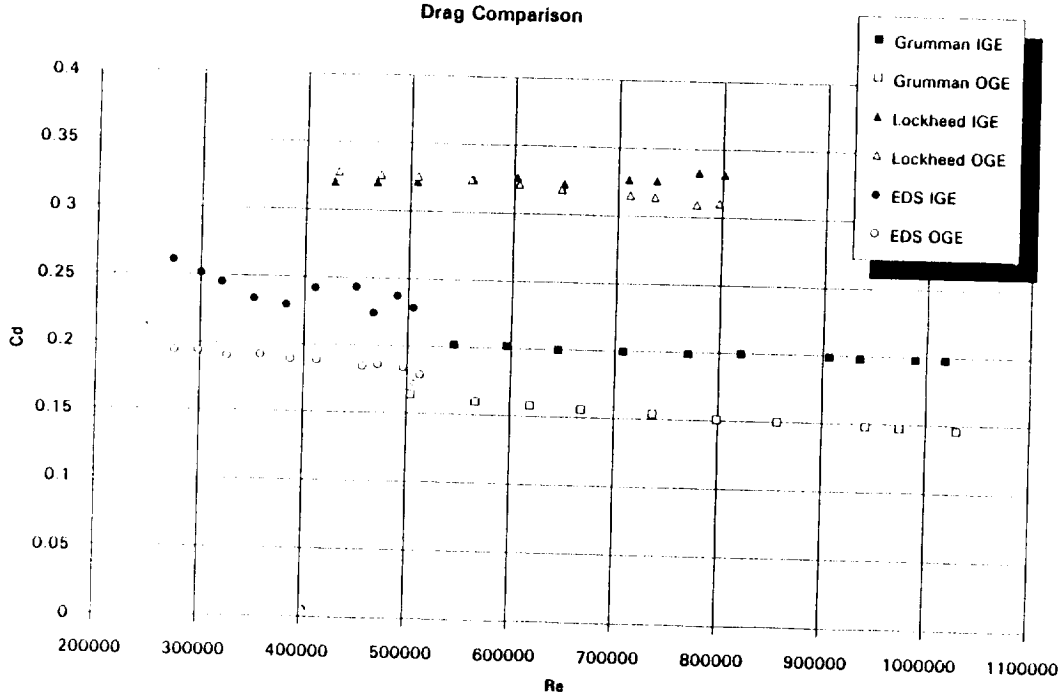


Velocity Contours Aft Of Tail

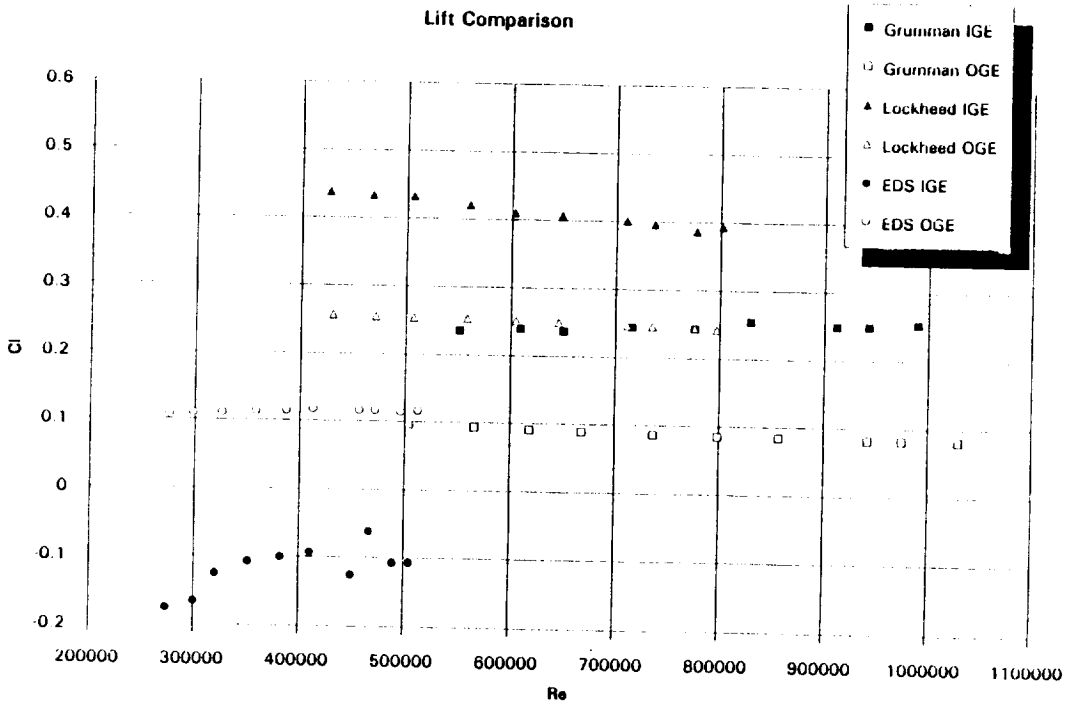


Turbulence Contours Aft Of Tail

Wind Tunnel Data



Wind Tunnel Data



MultiDisciplinary Design

Design Considerations

- Aerodynamics
- Structures
- Control
- Propulsion
- Cost
- Transportation utility

MultiDisciplinary Design

Aerodynamics

- Low Drag, Lift and Moment
- Low noise
- Cross winds
- Passing
- Tunnel entry/exit

Structures

- Load-bearing skin (like an airplane, not like a train)
- Weight
- Construction/materials
- Impact loads
- Unsteady aero loads

Cost/Shape

- Weight
- Shape complexity and tolerances
- Construction/materials
- Conventional rail cost info NG
- Some MAGLEV cost info available
- Use small transport plane cost info