AIGA 2008 MEETING

Product Vehicle Safety & Accident Prevention

AIGA

Asia Industrial Gases Association

FMM MIGMA

Co-organiser:

FMM Malaysian Industrial Gases Manufacturers Group

Vehicle Rollover Prevention

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Ease of Rolling Over

Type of Vehicle	"Gs" Required to Cause a Rollover Accident
Cars 	1.2 - 1.3
Sport Utility Vehicle (SUV) 	1
Pickup or Jeep 	.8
Fully loaded trailer 	.4
Fully loaded tanker 	**.23**

Risk Factors That Cause Rollovers

- Vehicle design – controllable
- Vehicle operation/driver behaviors – controllable
- Selection of Routes – controllable
- Road design – not controllable

Factors to Help Avoid Rollovers

- Vehicle design
- **Driver training**
- Selection of Routes for Large Vehicles

Vehicle Rollover Prevention

Vehicle Design

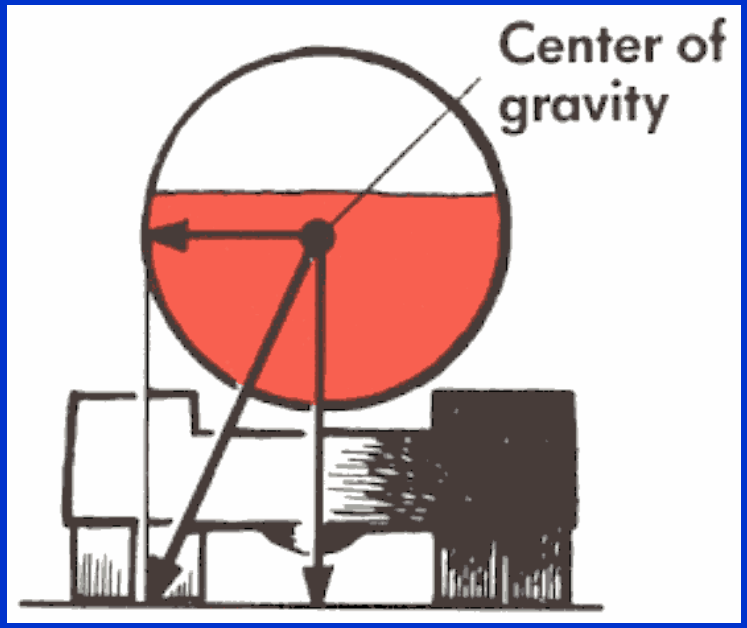
Vehicle Design

Resistance to overturning is dependent on:

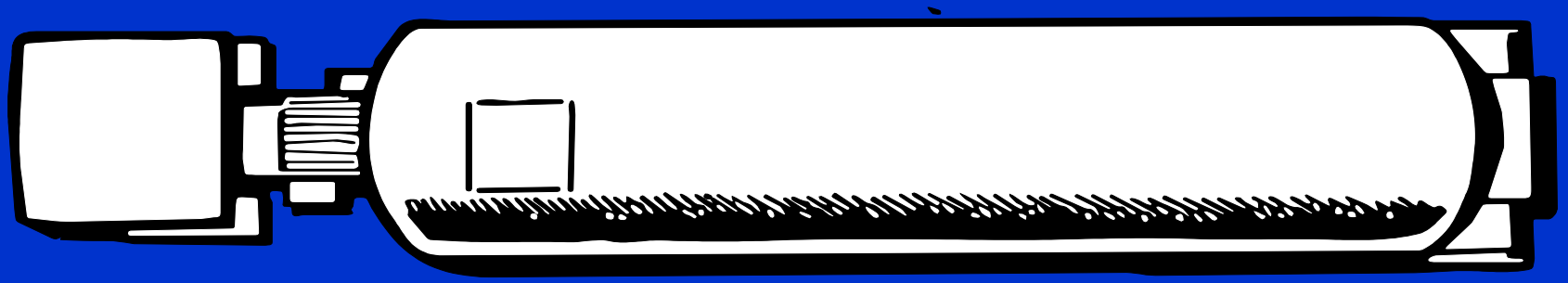
- **Vehicle's center of gravity**
- **Stability of the vehicle**
- **The stability of its cargo**
- **Type of truck (Articulated v. straight truck)**

Center of Gravity

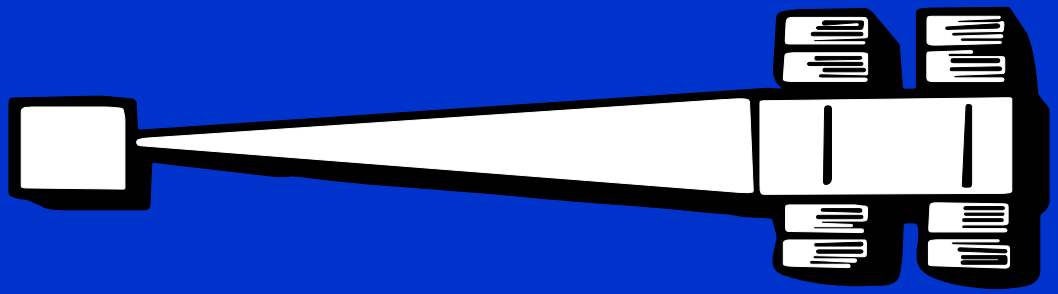
- The higher the center of gravity, the easier to overturn the vehicle



Vehicle Stability

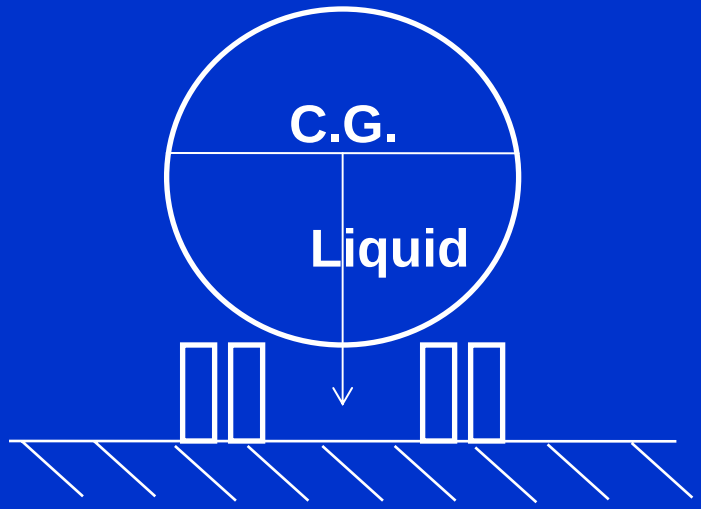


- The stability of a trailer can be compared to that of a three-wheeled vehicle such as a motorcycle with side car or a lift truck.



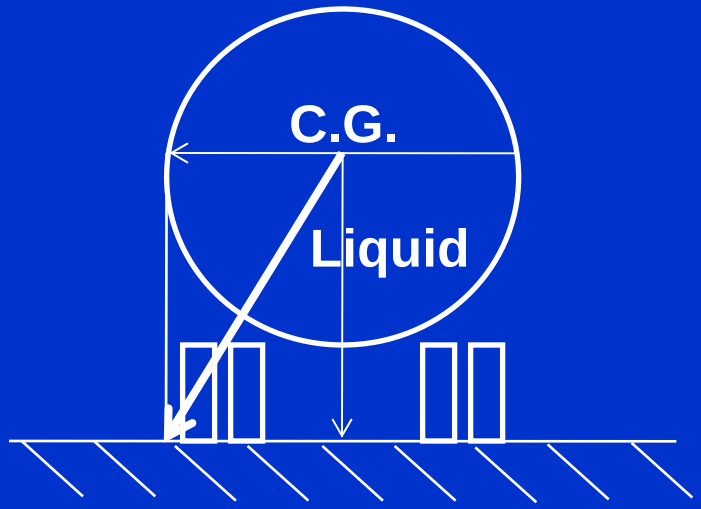
Stable Vehicle

- A vehicle is stable as long as the vertical force (center of gravity) passes between the supporting points (in this case the wheels thru the axles and suspension hangers).



Unstable Vehicle

- A rollover (overturn) occurs when the vertical line passes outside the supports (wheels). But the center of gravity is still in the same position.
- The liquid in the tank moves sideways when vehicle goes through a curve or surges forward when vehicle brakes are applied



Vehicle Design to Reduce Overturning

- Minimize vehicle's center of gravity
- Maximize the width of the axles
- Provide cargo tanks with barriers against surge
- Equip lorries and trailers with designs to improve vehicle stability and technology to prevent overturns

Vehicle Rollover Prevention

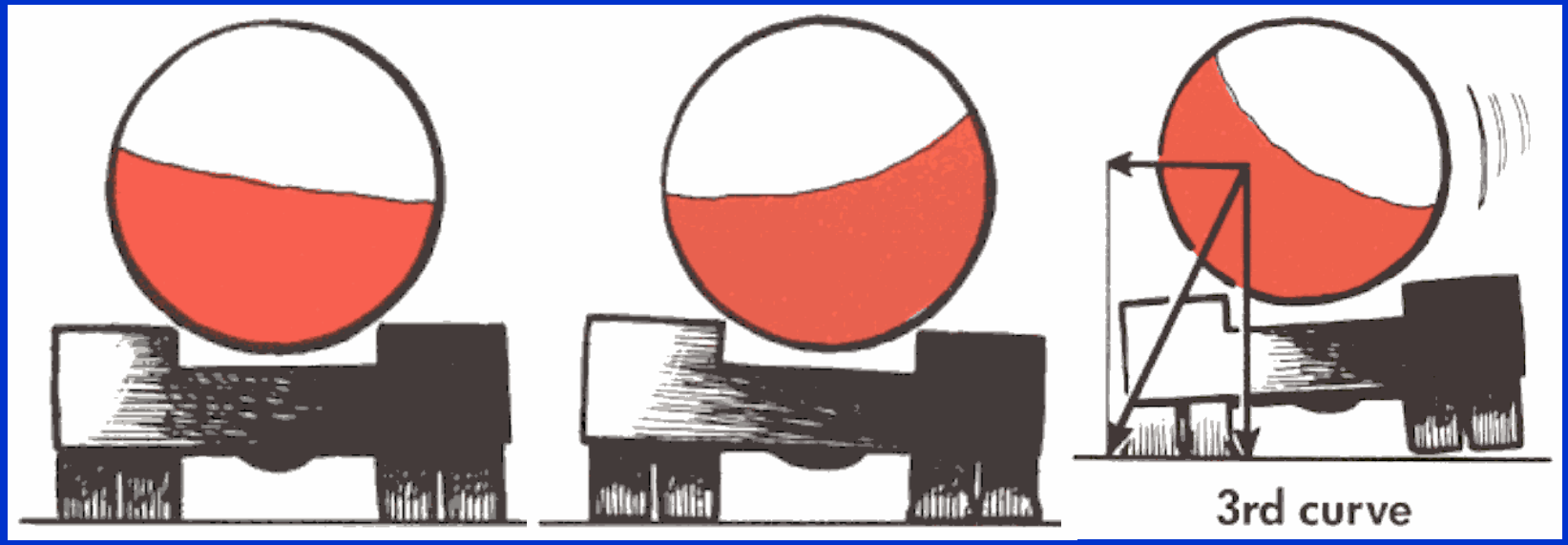
Driver Training

Operating Variables & Stability

- **Liquid Slosh & Surge Resulting from:**
  - ✓ **Speed**
  - ✓ **Turning radius**
  - ✓ **Braking**
  - ✓ **Sudden maneuvers**

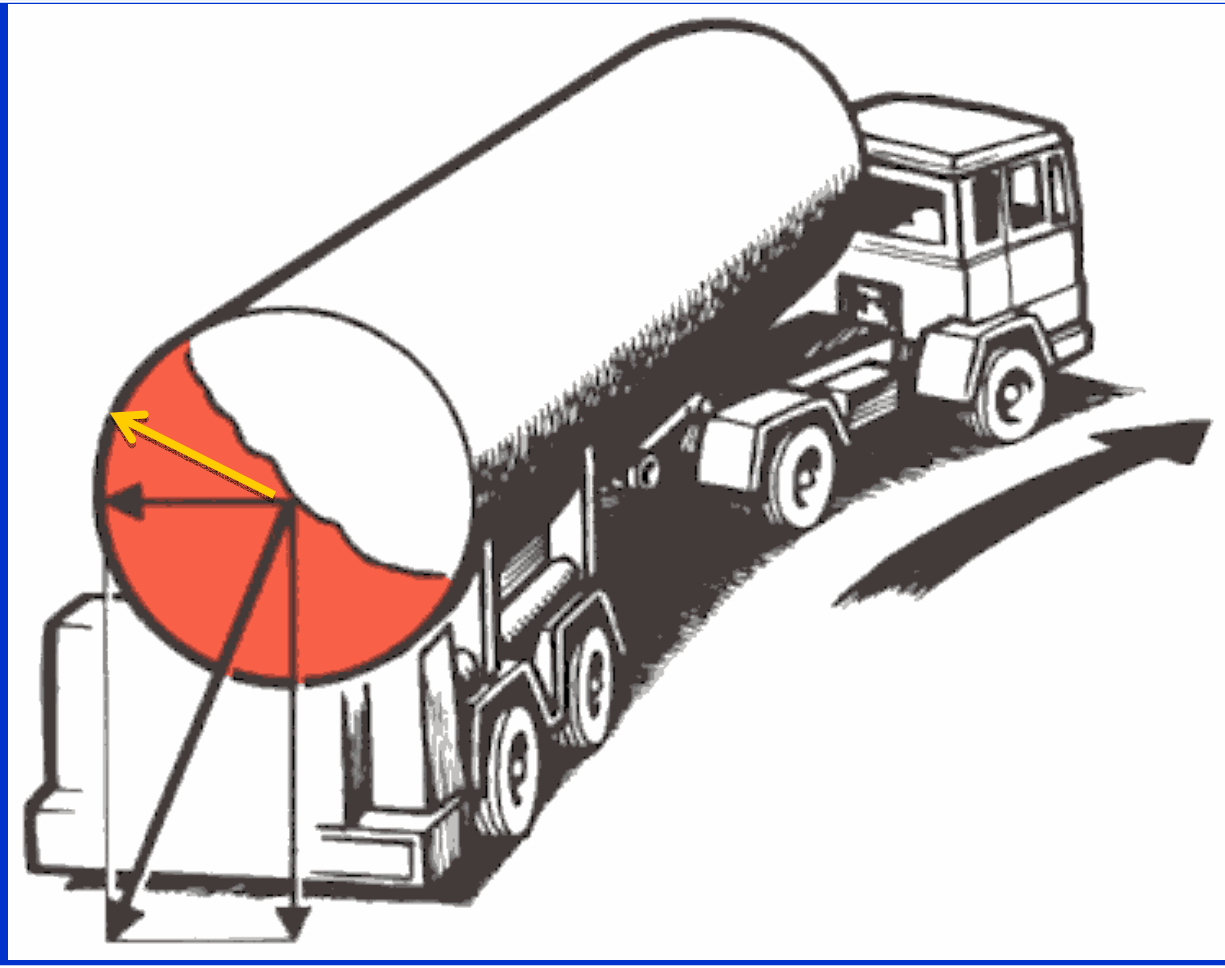
Liquid Slosh

- Liquid slosh is the movement of liquid from one side of a tank to another

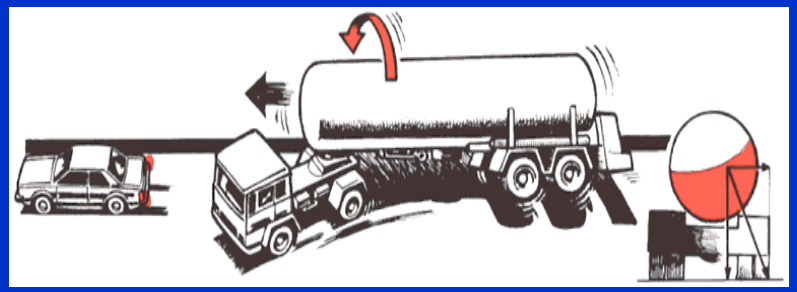


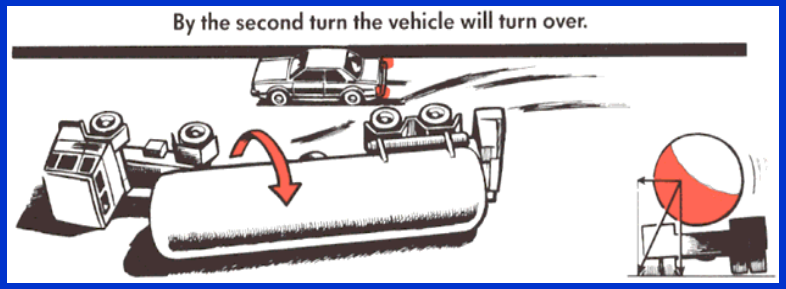
Vehicle Speed

- If the speed is too high the moving liquid will cause a turnover.



Turning

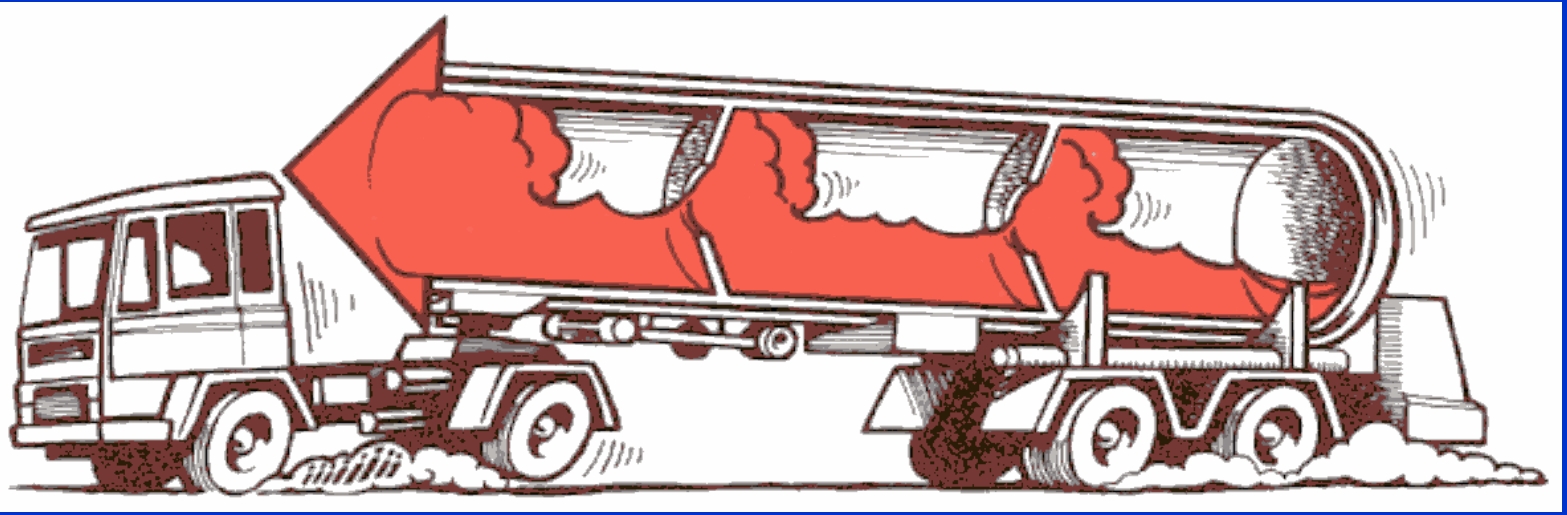




- Surging liquid, will create a sideways force which lifts the semi-trailer from the road and can easily turn it over
- In a series of turns, by the third turn or curve the liquid will move back to the first side, and can now be in phase with the vehicle's movement so that its weight can be sufficient to cause a turnover (if the speed is sufficient).

Braking

- When applying the brakes and turning, the liquid surges to the front and to the outside of the turn, actually forcing the rear of the tractor in a straight line

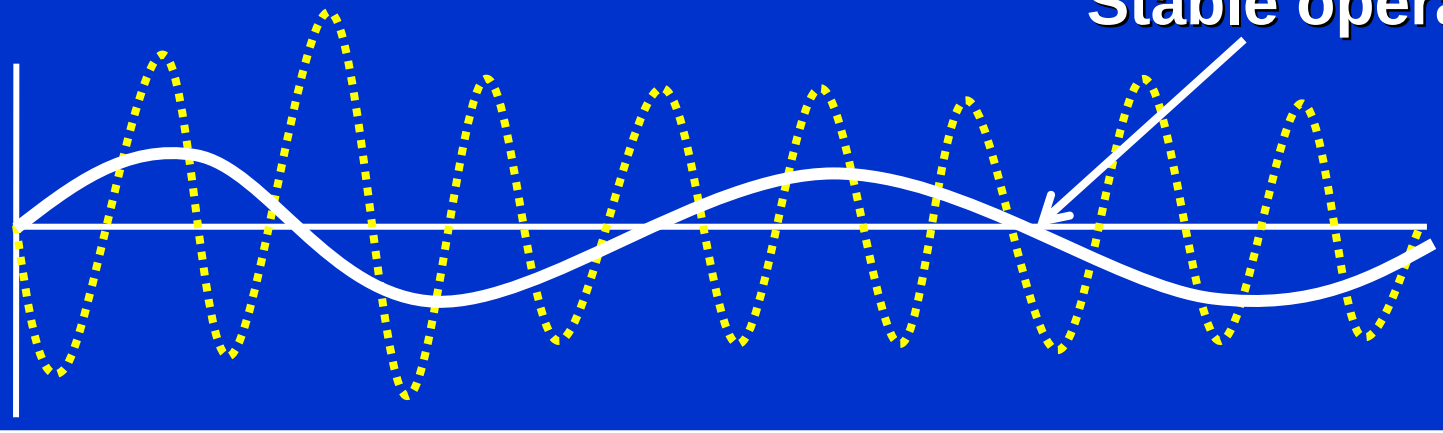


Sudden Maneuvers

- Surge occurs in a tanker following a sudden maneuver :
  - ✓Driver is forced to brake and suddenly turn
  - ✓Driver attempts to return to the road after drifting off of the pavement
  - ✓Sudden stopping while turning to avoid contact

Control Vehicle to Avoid Sloshing

- Speed
- Braking
- Maneuvers
- Turning techniques
- Apply technology



Driver's Are the Key!

- Drivers control vehicle speed
- Driver anticipation minimizes need for sudden braking
- Anticipation reduces the needs for sudden maneuvers
- Drivers control turning techniques

Driver's Are Still the Key!

- **Roll Stability systems are supplemental**
  - Operators should drive normally / prudently
  - Electronics can identify / react to certain situations faster than typical human reaction times
- **System educates the driver**
  - Notify the driver - buzzer / light / brake application / other
    - Teaches the limitations of the vehicle
      - Constant change of tractors, trucks, trailers, loads, etc.
    - Discourage drivers that "push the envelope"
    - Speed reduction beyond stability as a warning

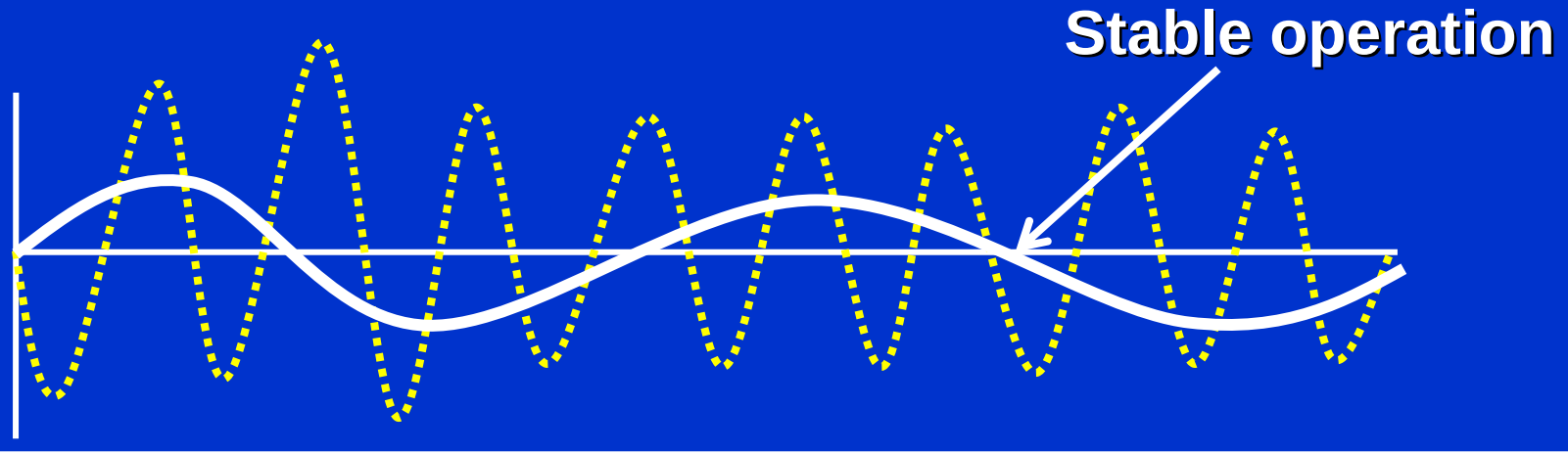
Rollover Forces are Large

Vehicle Rollover Prevention

Summary

Controls to Avoid Vehicle Overturning

- Vehicle design
- **Driver training**
- Selection of routes



Summary

- Drivers hold the key to preventing overturns
- Vehicle design can maximize the stability of cargo tank
- Technology can supplement driver training and vehicle designs to prevent:
  - ✓ Overturns in higher speed turns
  - ✓ Sudden maneuvers

Questions ?