THE COMPLETE NAV GOUGE

"The only one you need"

3 types of Navigation:

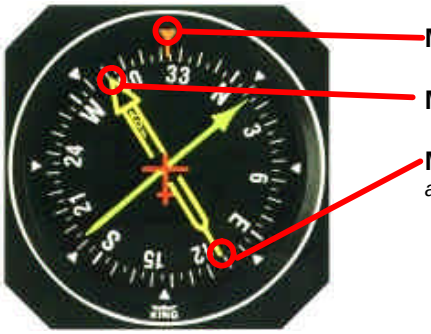
1. Dead Reckoning
2. Visual Navigation
3. Electronic Navigation

} Backups for Dead Reckoning

Dead Reckoning – 3 Primary instruments:

1. Compass	Direction	Speed = Distance/Time Knots = Nautical Miles/Hour
2. Clock	Time	
3. Airspeed Indicator	Speed	
4. Altimeter		Secondary: For air density
5. OAT (Outside Air Temp)		

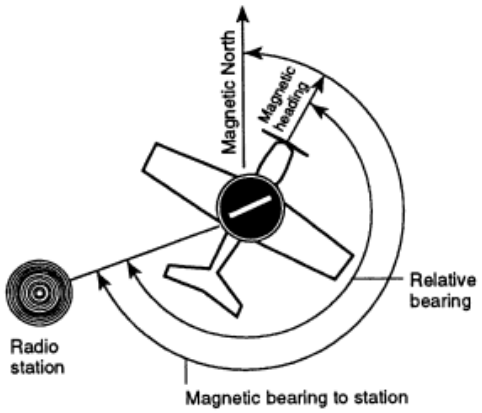
- **Parallels:** Lines of Latitude = horizontal / left-right, measured along longitude, 0-90°
- **Meridians:** Lines of Longitude = vertical / up-down, measured along latitude (Prime Meridian
- **Position:** Graphic point defined by coordinates. Change indicates *Direction (degrees*°) and *Distance (NM)*
- **Direction:** Angular distance from the reference.
- **Magnetic North:** Point from which all of the earth's magnetic lines of force emanate.
- **Remote Gyro Vertical Compass Card/BDHI (Bearing Distance Heading Indicator):** Primary instrument for determining direction. Uses a remotely located detection element (flux detector) to sense magnetic field at a min. interference point (wing tip). Magnetic energy → electric voltage → turns compass card → gives heading
- **Standby/WET Compass:** Backup to BDHI/RGVCC. Magnetic Needle in fluid. UNSTABLE in maneuvering, but reliable and independent of the aircraft's electrical system.
- **Visual Navigation:** Direct visual contact with the surface. High Speed/Low level flight
- **Electronic Navigation:**
  - **Ground Stations:** VOR, ADF, OMEGA/VLF and **TACAN**
    - **TACAN**: Provides distance (NM) & bearing *FROM* (radial) from station. Transmitted at frequencies 962-1213 MHz UHF, #1-126, there are 360 signals in circular direction. Positions "fix". Bearings MAGNETIC. Information provided is indicated on the BDHI on the #2 needle.
  - **Transmission** (send & receive): RADAR, DOPPLER
  - **Starting location:** INERTIAL NAV SYSTEM or INS



MAG heading (Airplane nose)

MAG bearing TO station

MAG bearing FROM station
a.k.a. "You're on the x Radial"



- **Chart:** 2-dimensional. Earth: 3-dimensional, an undevelopable surface.
- **Constant scale:** if 1" on a chart = 100 real miles exactly in every direction.
- **Great Circle:** shortest distance between 2 points on a sphere, plane intersects center of the earth. All meridians are great circles; equator is the only parallel that is also a great circle.
- **Lambert Conformal:** CONIC projection developed using secant cone over earth intersecting standard parallels.
  - Characteristics of Lambert Conformal projection:
    - **Parallels –** equally spaced concentric circles (10°/latitude)
    - **Meridians –** straight lines converging at poles
    - **Scale –** constant distance scale
    - **Great circle –** straight line
  - Types of Lambert Conformal Charts (legend on left, oriented to TRUE north):
    - ONC: Operational Navigation Chart, 1:1mil scale, Long range planning
    - TPC: Tactical Pilotage Chart, 1:500k (larger ratio, larger scale), more detailed, low-level radar/visual, route/checkpoint navigation
  - Measuring distances: One Nautical Miles = 1 minute of arc along any great circle

- **Course:** (future) intended path on Lambert Conformal oriented TRUE on great circle line.
- **Heading:** (direction nose is pointed) angular distance of aircraft's longitudinal axis from a reference. Measured clockwise from 0° MAG *or* TRUE.
- **Track:** (Actual path/history) aircraft's actual flight path *OVER GROUND*.
- **Magnetic North:** Located somewhere near HUDSON BAY in northern Canada. Cockpit compass systems are referenced to magnetic lines of force (MAG north)
- **Variation:** Angular difference from TRUE north to MAGNETIC north from surface position. Expressed in the direction MAG is taking you to.
    - o True → Mag, east is least, west is best. (subtract easterly variation, add westerly variation)
    - o Mag → True (add easterly variation, subtract westerly variation)
- **Isogonic line:** connects points of equal variation, appear as dashed blue lines, variation in deg°
- **Time:** Measured according to the rotation of the earth. 360° / 24 hours = 15° = LMT (Local mean time). Prime Meridian is Z (ZULU) = GMT (Greenwich Mean Time). ZD (Zone Description) indicates difference vs. GMT

TIME BRIDGE

Landing

(ZD) _____: Zulu
_____: Local

(ZD-ZD=zone steps)
(ZD-ZD=Hours difference)

Take-off

(ZD) _____: Zulu
_____: Local

- **Altitudes:** Temperature (3°C / 1,000') and Pressure (1" Hg / 1,000').
    - o Use L.A.G.S. to correct Indicated Altitude into Pressure altitude (Indicated pressure **L**ESS than Std. day, 29.92"Hg? then **A**DD; indicated pressure **G**REATER than Std. day, 29.92"Hg? then **S**UBTRACT. Remember "Low to High, Plenty of Sky and High to low, look out below" for horizontal change.
    - o Use 11°C/4% rule for IAT to OAT. For every 11°C Variation from Std. Lapse, there is a 4% altimeter error.
- **Airspeed:** TAS = CAS corrected for altitude & temperature. CAS = IAS corrected for instrument / form error.

COMPUTER / WHIZ-WHEEL STEPS

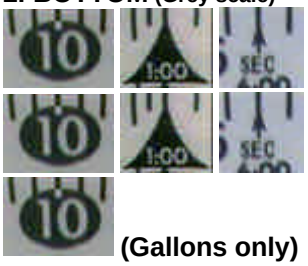
1. TOP (Outer Scale)

SPEED (Knots)

Fuel Flow (FF)

Weight Modifier

2. BOTTOM (Grey scale)



(Gallons only)

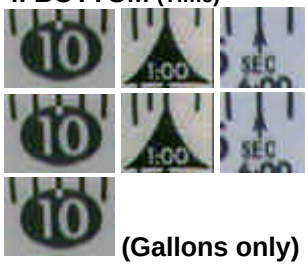
3. TOP (Outer scale)

Distance (NM)

Pounds (lbs.)

Pounds (lbs.)

4. BOTTOM (Time)



(Gallons only)

S = D / T
Knots = NM/Hr.

Consumption= PPH (lbs./Hr.)

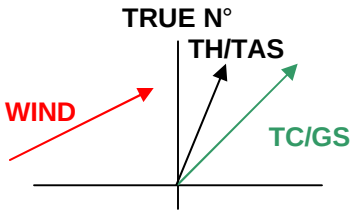
Fuel weight= (lbs./gal.)

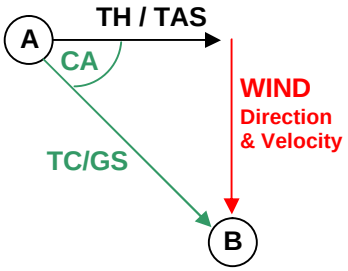
WINDS

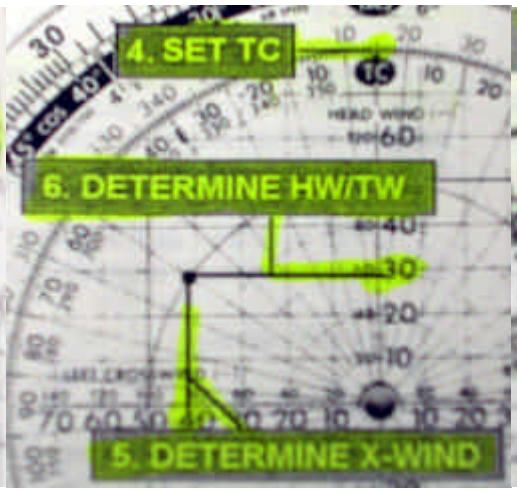
- **Wind:** Movement of air mass across the earth's surface, expressed in direction FROM.
- **True Wind:** Enroute winds from forecaster are TRUE from Winds-Aloft charts and Teletype Winds-Aloft Forecasts.
- **Magnetic Winds:** Surface winds from Airport Traffic Control and Approach/Departure Control are MAG winds, and coincide with MAG direction of runways.
- **Ground speed:** GS = TAS corrected for winds. (GS=TAS+TW, GS=TAS-HW)

PREFLIGHT WINDS

1. Estimate.
   a. Map out TC on True North graph.
   b. Map out estimated winds.
   c. Deduce effects visually.
   "…In this case, LTW, so TH<TC, TAS<GS"
2. Plot on Whiz Wheel.
3. Check answers against estimations.

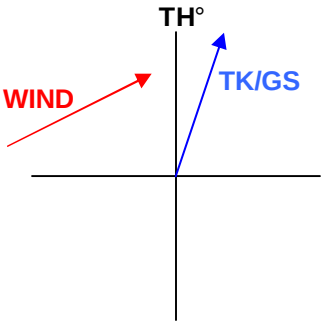


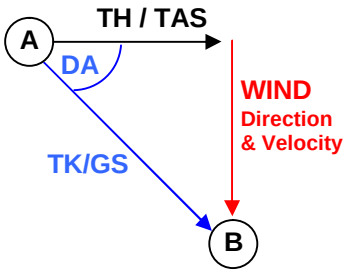


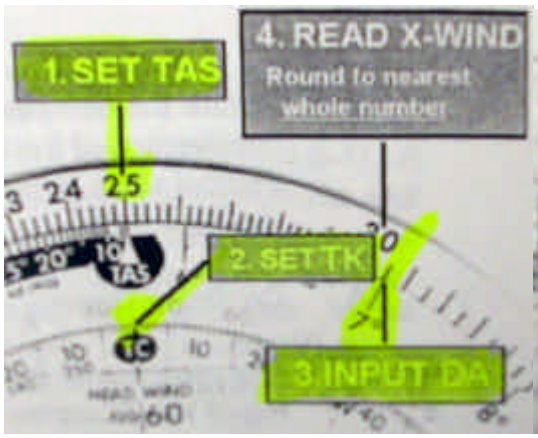


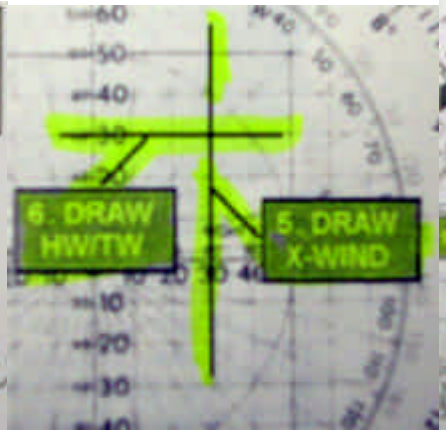
IN-FLIGHT WINDS

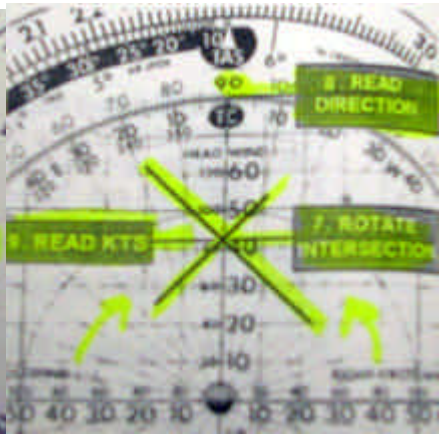
1. Estimate.
   a. Use Top (North) of cross as TH.
   b. Draw out the track.
   c. Write out the Drift angle.
   d. Estimate winds
   (winds in addition to CA calculation)
2. Plot on Whiz Wheel.
3. Check answers against estimations.











JETLOG

ROUTE TO	IDENT / CHAN	CUS	DIST	ETE	ETA / ATA	LEG FUEL	EFR / AFR	NOTES

JETLOG STEPS