Fuel Conservation
Airframe Maintenance for Environmental Performance

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Maintenance Personnel

Opportunities For Fuel Conservation

- Empty weight control
- Airframe maintenance
- Systems maintenance

Reducing Aircraft Weight Reduces Fuel Burned

Approximate %Block Fuel Savings Per 453 kg (1000 lb) ZFW Reduction

717-200	737-3/4/500	737-6/7/8/900	757-200/300	767-2/3/400	777-200/300	747-400
.9%	.7%	.6%	.5%	.3%	.2%	.2%

Reducing OEW Reduces ZFW

Items To Consider

- Passenger service items
- Passenger entertainment items
- Empty Cargo and baggage containers
- Unneeded Emergency equipment
- Excess Potable water

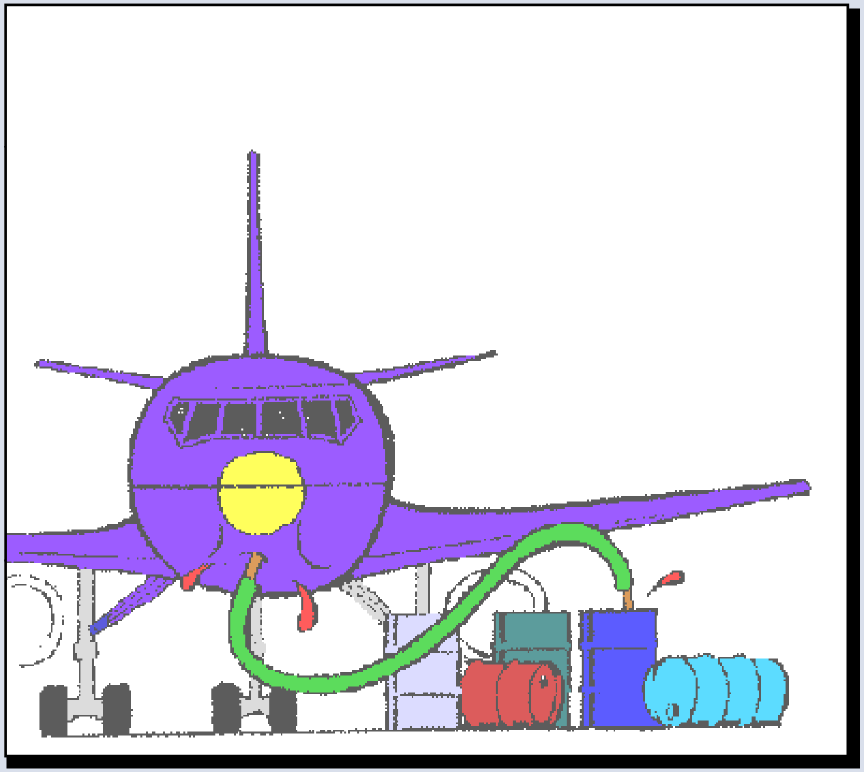
Reducing OEW Reduces ZFW

- Operating empty weight (OEW) increases on average 0.1% to 0.2% per year, leveling off around 1% after 5 to 10 years
- Most OEW growth is mainly due to moisture and dirt

Reducing Aircraft Drag Reduces Fuel Burned

Effect of a 1% Drag Increase In Terms Of Gallons Per Year

- 747 ≈ 100,000
- 777 ≈ 70,000
- 767 ≈ 30,000
- 757 ≈ 25,000
- 737 ≈ 15,000
- 727 ≈ 30,000



(Assumes typical aircraft utilization rates)

Total Drag Is Composed Of:

Compressible drag ≈ drag due to high Mach

- Shock waves, separated flow

Induced (vortex) drag ≈ drag due to lift

- Downwash behind wing, trim drag

Parasite drag ≈ drag **not** due to lift

- Shape of the body, skin friction, leakage, interference between components
- Parasite drag **includes** **excrescence** drag

Contributors To Total Airplane Drag

(For a new airplane at cruise conditions)

Pressure, trim and interference drag (optimized in the wind tunnel)

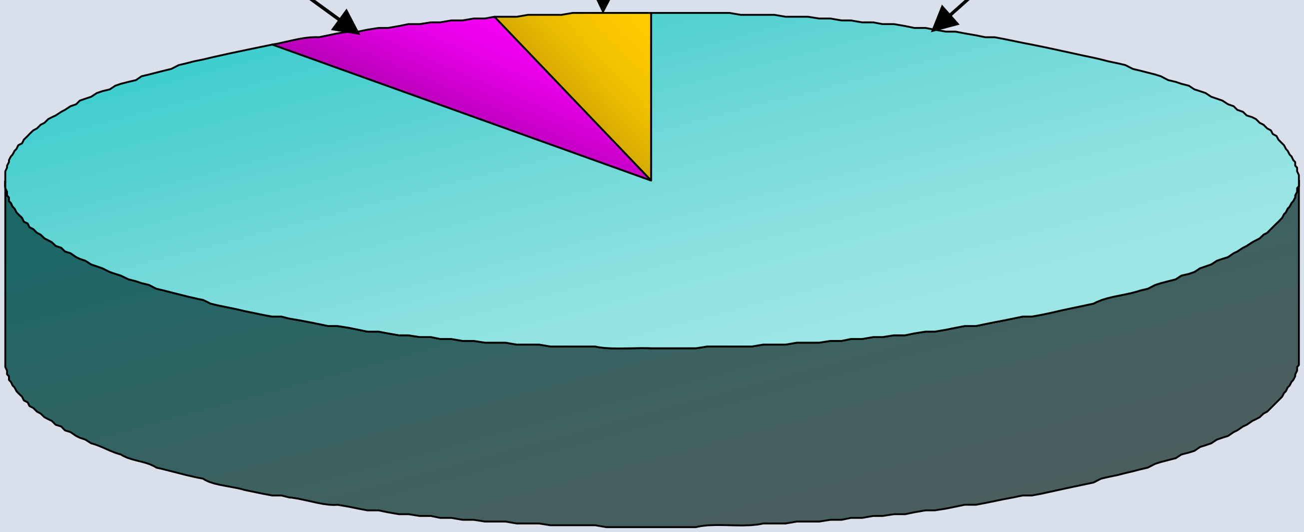
~ 6%

Excrescence drag (this can increase)

~ 4%

Drag due to airplane size and weight (unavoidable)

~ 90%



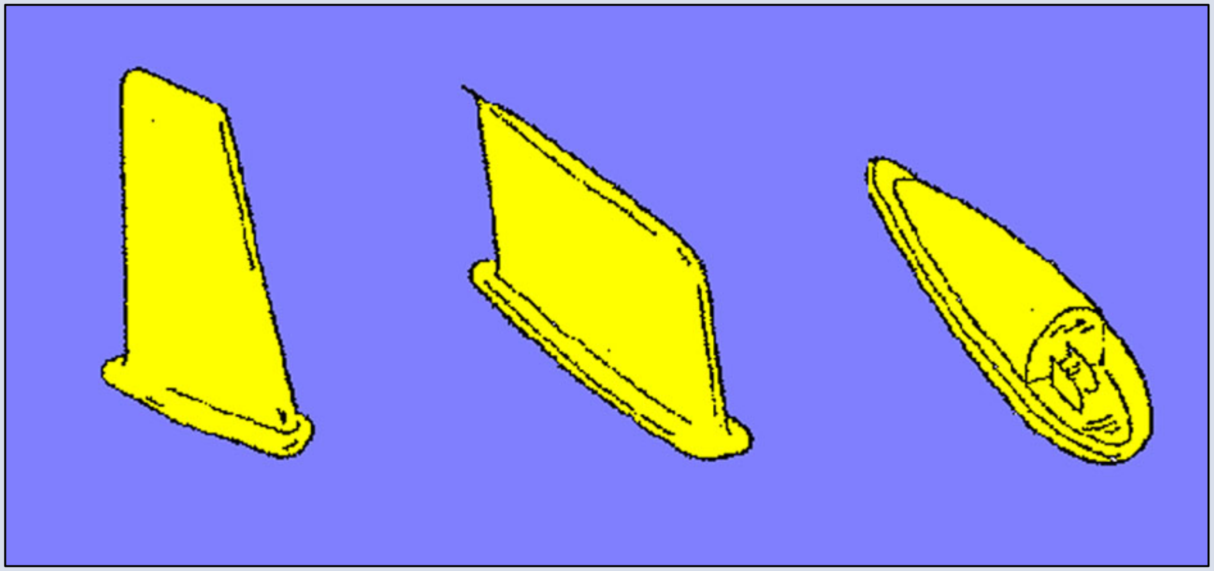
What Is Excrescence Drag?

The additional drag on the airplane due to the sum of all deviations from a smooth sealed external surface

Proper maintenance can prevent an increase in excrescence drag

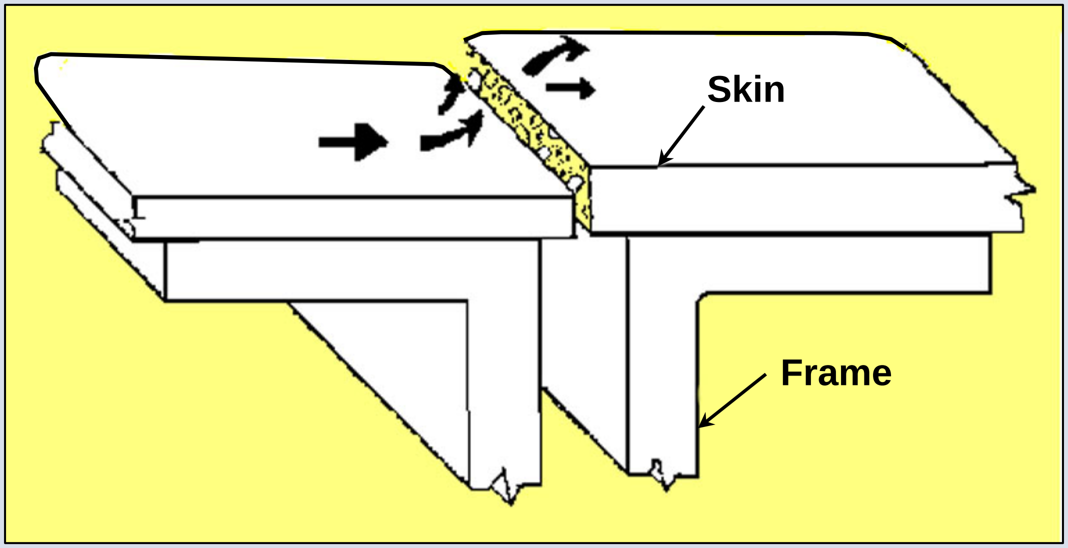
Discrete Items

- Antennas, masts, lights
- Drag is a function of design, size, position

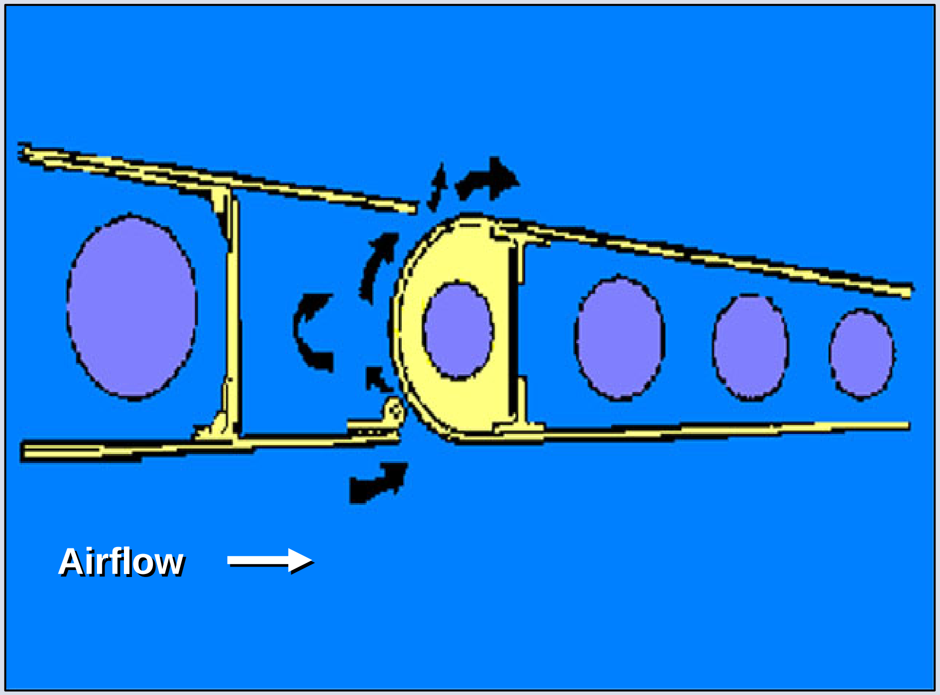


Mismatched Surfaces and Gaps

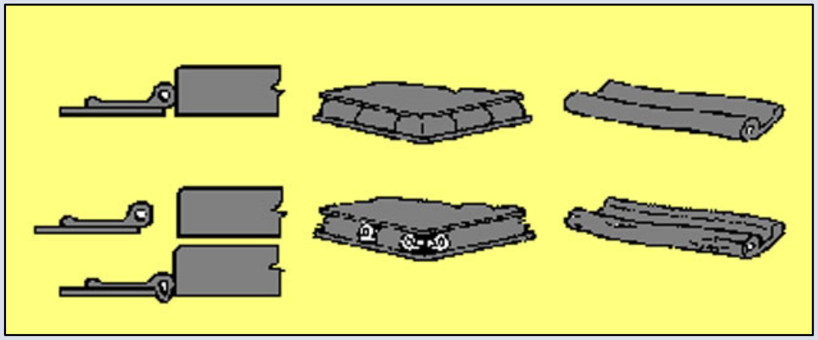
Steps at skin joints, around windows, doors, control surfaces, and access panels



Internal Airflow

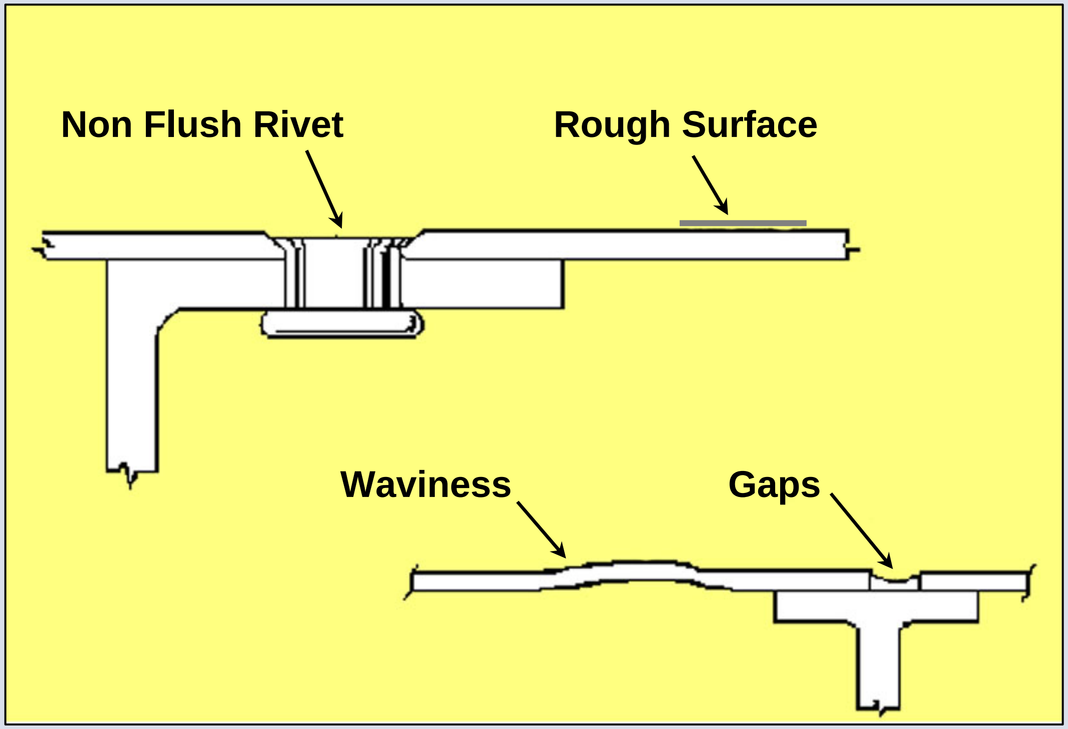


Leaks through gaps, holes, and aerodynamic seals



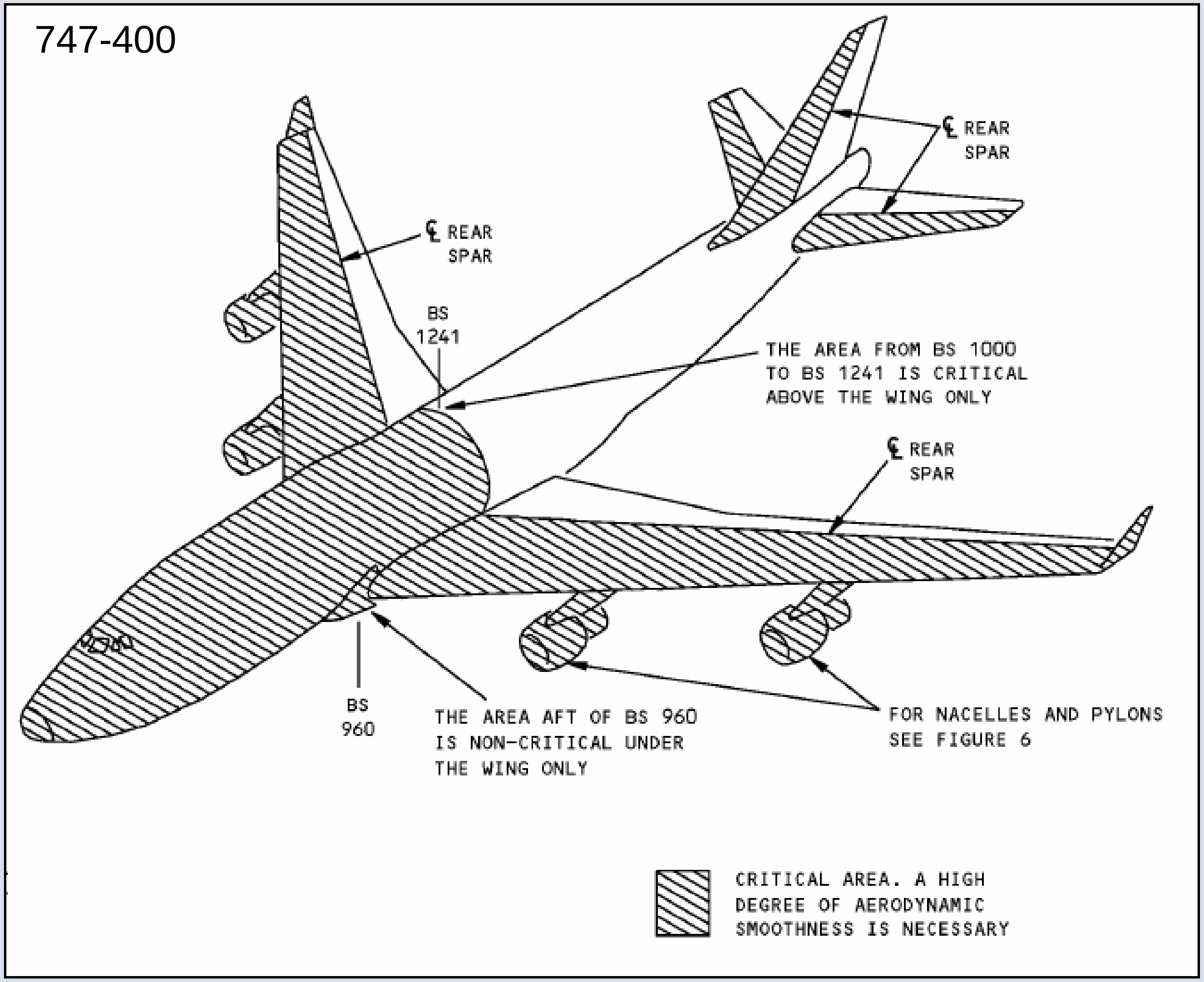
Roughness
(Particularly Bad Near Static Sources)

- Non-flush fasteners, rough surface
- Waviness, gaps



Most Important in Critical Areas

- Structural Repair Manuals Identifies Critical Areas



Average Results Of In-service Drag Inspections

Average total airframe drag deterioration ~ 0.65%, composed mainly of:

- Control Surface Rigging ≈ 0.25%
- Deteriorated Seals ≈ 0.20%
- Misfairs ≈ 0.1%
- Roughness ≈ 0.05%
- Other ≈ 0.05%

A well-maintained airplane should not exceed 0.5% drag increase from its new airplane level

Regular Maintenance Minimizes Airframe Deterioration

- Flight control rigging
- Misalignments, mismatches and gaps
- Aerodynamic seals
- Empty weight control
- Exterior surface finish
- Instrument calibration/maintenance

Maintain a Clean Airplane

- Maintain surface finish
- Fluid leaks contribute to drag
- Periodic washing of exterior is beneficial
  - 0.1% drag reduction if excessively dirty
  - Minimizes metal corrosion and paint damage
  - Location of leaks and local damage
- Customer aesthetics

Instrument Calibration/Maintenance

- Speed measuring equipment has a large impact on fuel mileage - keep airspeed system maintained
- If speed is not accurate then aircraft is flying faster or slower than intended - airspeed reads 1% low, aircraft flying 1% fast
- On the 747-400, flying 0.01M faster then intended can increase fuel burn by over 1%

Proper and Continuous Airframe and Engine Maintenance Will Keep Aircraft Performing at Their Best!

Conclusions

It Takes the Whole Team to Win

- Large fuel (and emissions) savings results from the accumulation many smaller fuel-saving actions and policies
- Dispatch, flight operations, flight crews, **maintenance**, management, all need to contribute

Thank You!

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