

F-22 Fighter Performance

How does the F-22 compare
a quarter century later?

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Sponsored by
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Center for Defense Information

Great fighter characteristics

- Obtain the first sighting
- Outnumber the enemy in the air
- Outmaneuver to gain firing position
- Achieve split second quick kills

F-22A replaces F-15



Why question Air Force?

- Sprey's summary is inconsistent with what the senior Air Force management says we need
- After all ...

Generals know best



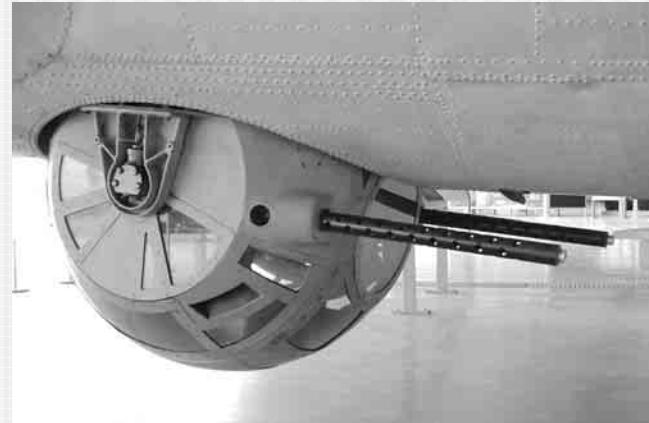
Air Force planning prior to Pearl Harbor



So heavily armored ...



and so heavily armed ...



...fighters not needed...



... that bombers could
fly with impunity...



... reach their targets...



- Such as the August 17, 1943 raid on Schweinfurt, Germany

...and destroy German war-making capabilities



But anti-aircraft was
harsh,



Reality was harsher



The promised “so heavily armed and armored”



Air Force offered the P-47



REPUBLIC P-47 THUNDERBOLTS

- Compared to the P-51, the P-47
 - Weighed twice as much
 - Cost twice as much
 - Could not fly with bombers to their targets

P-51 required FDR directive



As for destroying the war-making capabilities



us: No need to re- attack

- "All five of the works at Schweinfurt were either completely or almost completely wiped out. Our attack was the most perfect example in history of accurate distribution of bombs over a target. It was an attack that will not have to be repeated for a very long time if at all."

Reality: raids continued



- For another 20 months with 22 bombing raids, 2,285 bombers, dropping 592,598 bombs until 10 April 1945
- Ball bearing plants were the only targets, but Air Force destroyed 50% of homes

■ Questioning senior
Air Force

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Obtain first sighting

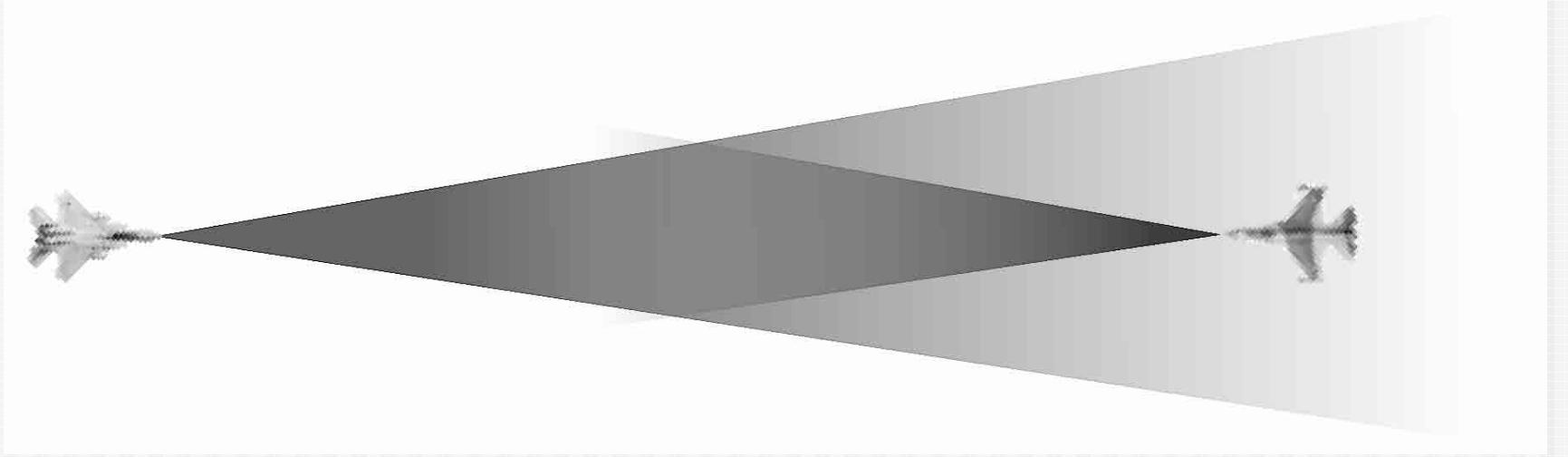
■ Topgun survey

- What single advantage would you like
 - Longer range missile
 - Longer range radar, etc.

■ Air Force position

- “First look, first shoot, first kill.”

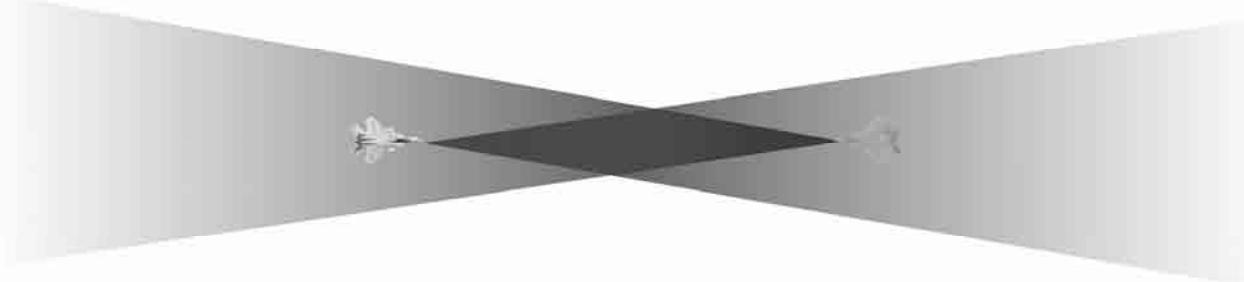
The first sighting, electronically



F-4B: Guns not required



Radars ~ equal range



F-22 invisible to radars

- "And [the F-22's] biggest distinctive advantage over the F-15 or any other airplane in the inventory today is that it cannot be seen by the radars, either the ground-to-air defense system or the radars that drive the air-to-air missiles."

F-117 “invisible”

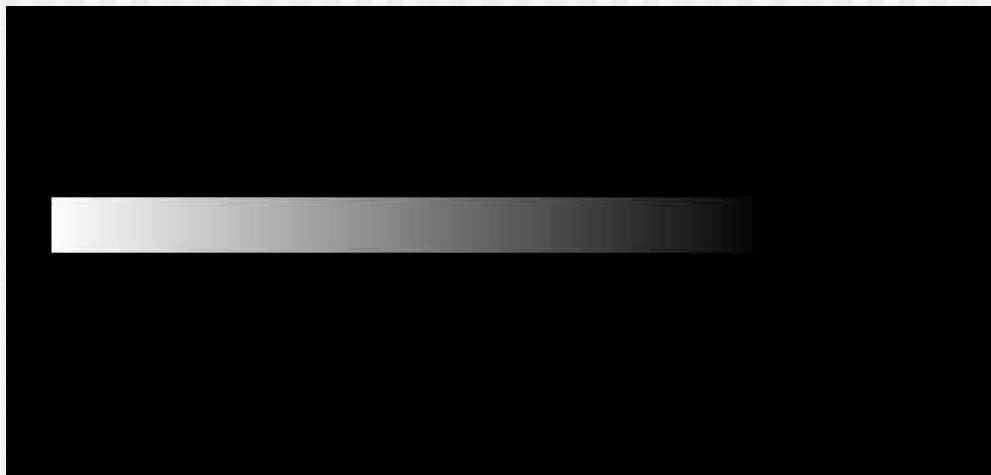
- Secretary of Defense Perry made similar remarks about the F-117 as being invisible to radar



Stealth in combat

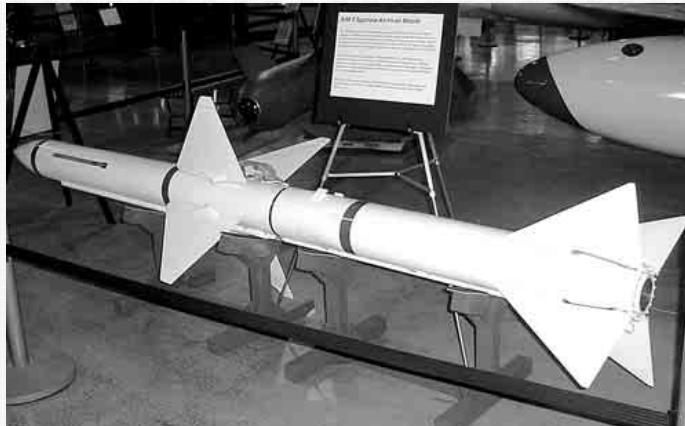
- F-117 had higher loss rate than F-16 in Serbian air war
- Lost 2 F-117s to 1950s technology
- However advanced, “stealth” aircraft have to emit radar if enemy

Who do you want to be
in a dark alley...



- ... the cop with the flashlight
or
- the crook with a gun that
fires light-homing bullets?

Radar-homing missile

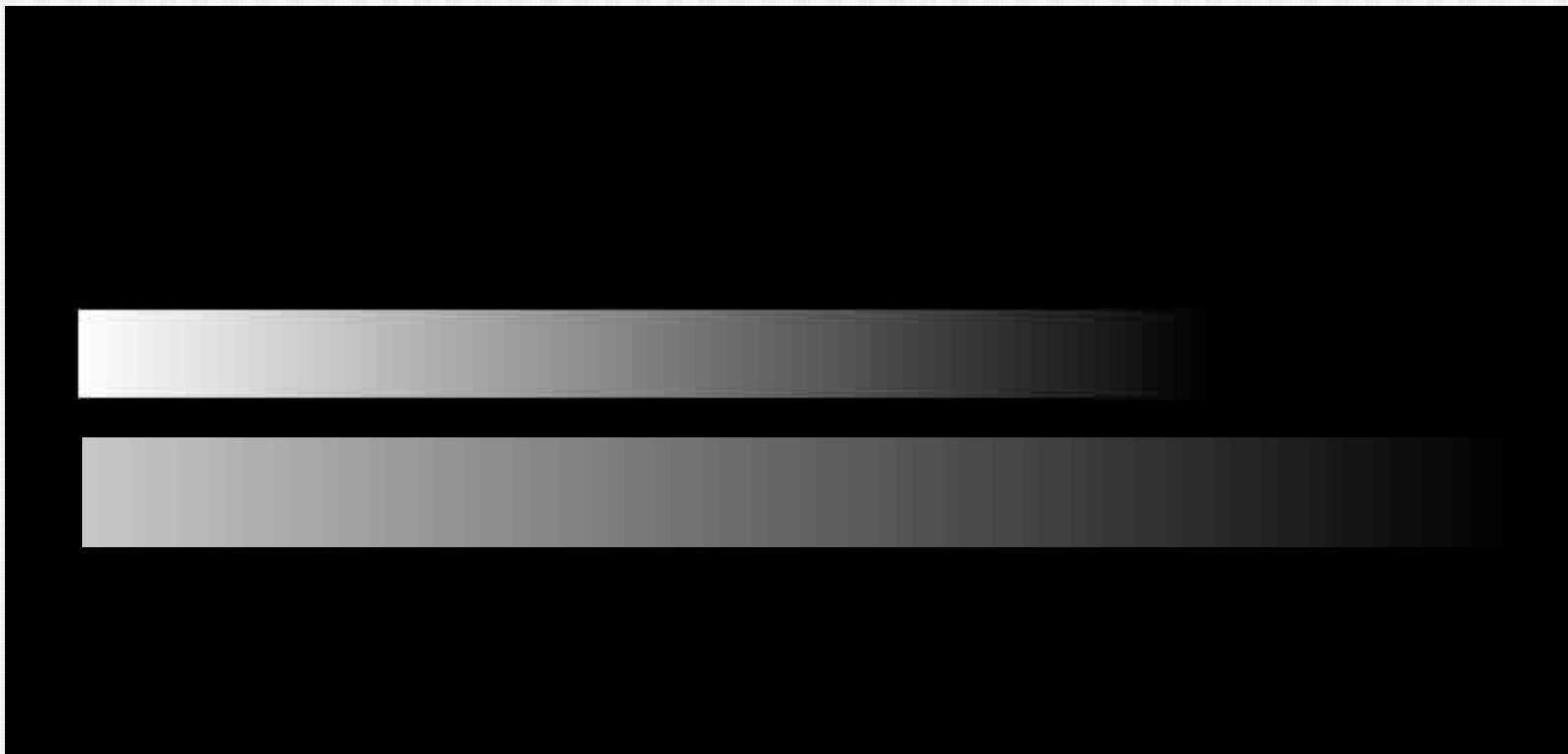


- AIM-7N anti-radiation missile used in Desert Storm
- Russian's have the R-27P, the newer R-77P, and a rumored R-77T anti-radiation missile

Russian R-27P for sale



F-22 rebuttal: Frequency hopping



Radars on or off?

- Some assert that in the next air war, all the radars will be off and the air war will merge to air combat maneuvering
- This is what has happened in all previous wars

The return of the dogfight



First sight wins the fight

F-16



F-35 CTOL



F-22

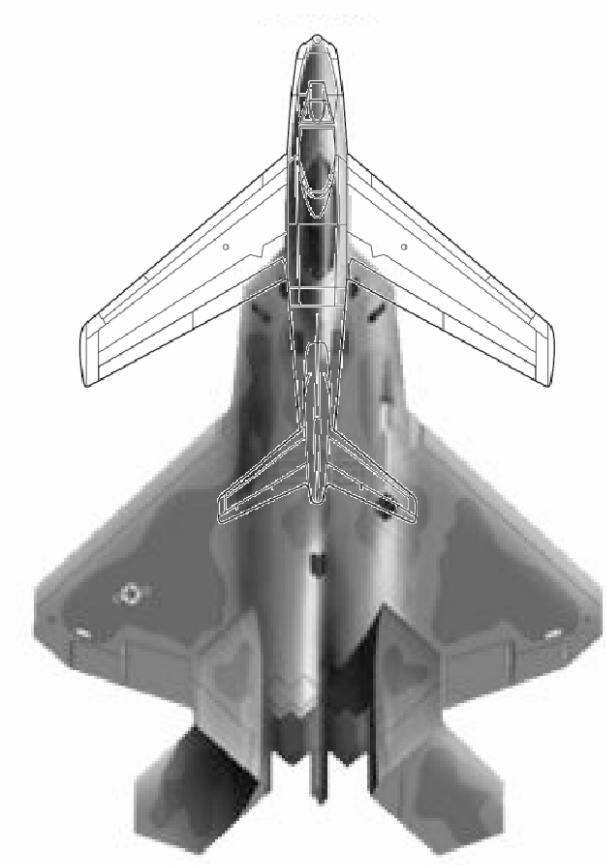


Length	49.7 ft
Span	31 ft
Wing Area	300 ft ²

Length	51.1 ft
Span	35 ft
Wing Area	460 ft ²

Length	62.1 ft
Span	44.5 ft
Wing Area	840 ft ²

"The biggest target in the sky, is always the first to die."



F-22s are seen first



You didn't see that?



Not invisible but not the first to be seen

Rearward visibility

- In all air wars, 65-95% of pilots never saw who shot them
- Is the F-22 a step forward?
 - (What about the F-35 Joint Strike Fighter?)

Rearward visibility pre-World War 2



REPUBLIC P-47 THUNDERBOLTS

Visibility after combat



Forgotten lessons



- Dogfights a thing of the past
- Smooth canopy to help top speed

F-22: a step forward?



Technology vs visibility



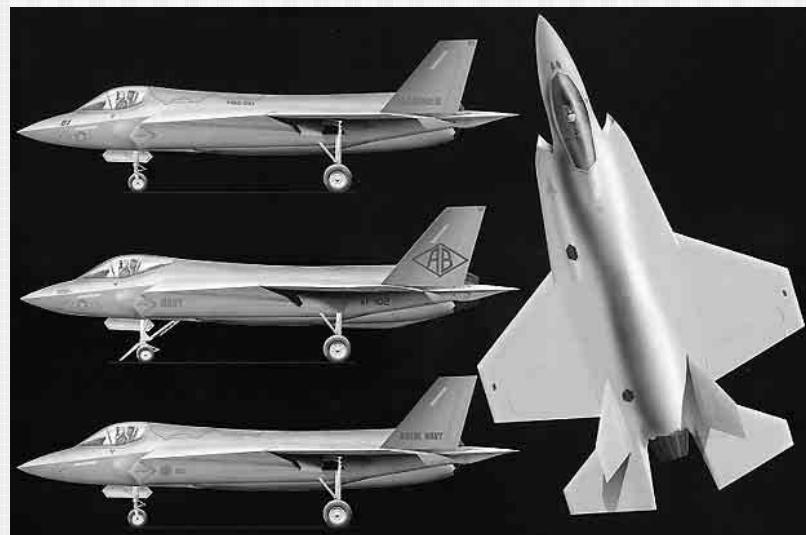
■ Rearward visibility sacrificed for stealth



F-16 cockpit visibility



Rearward visibility trend



- Rearward visibility sacrificed for technology

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Analysis without numbers



The effect of numbers

- An increase in the total number of aircraft in aerial combat drives the exchange ratio toward parity
- AIMVAL experience
 - 1 v 1 (2 airplanes in the sky)
 - 3.8-to-1
 - 4 v 4 (8 airplanes in the sky)
 - ~ 1-to-1

Aircraft enemy sees for equal cost

	Aircraft for equal cost	X	Sortie Rate	=	Available Aircraft for Equal Cost
F-22A	1		0.7		0.7
F-15C	3.4		1		3.4
F-16C	9.7		1.2		11.7

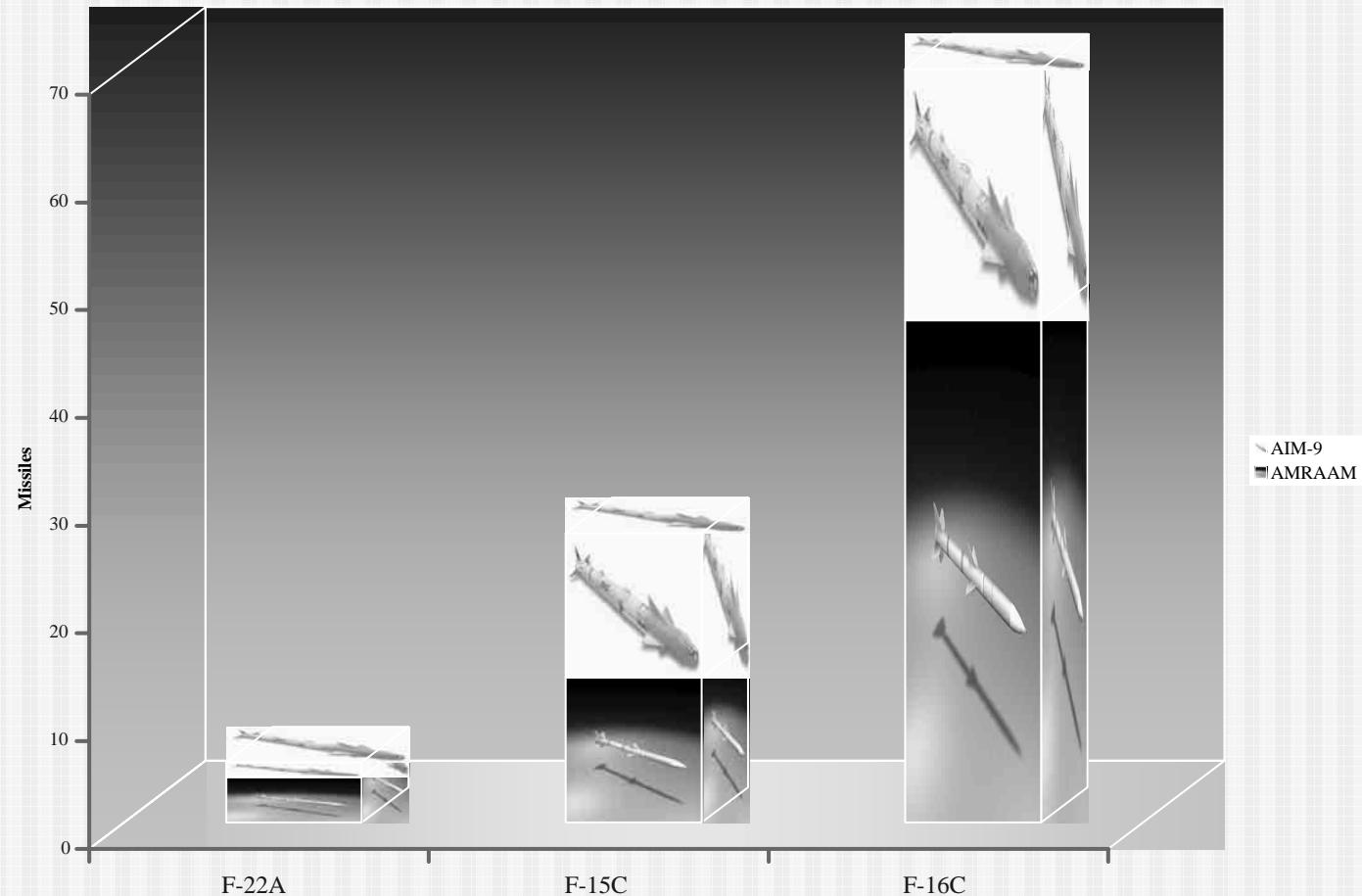
Source: Sorties rates come from Operation Desert Storm: Evaluation of the Air Campaign (GAO/NSIAD-97-134 (Washington, D.C.: General Accounting Office, June 1997) pp. 166, 169. Aircraft costs for F-22A come from December Selected Acquisition Reports.

Effect of numbers



- Me 262 had 100 knots advantage in cruise speed over P-51
- P-51 numbers overcame technology
- Numbers increase probability of getting the first shot

Missiles for equal cost



Vietnam AIM-7 promise

- AIM-7 promised Probability of Kill (P_K)
 - 80-90 percent
- ~ 8-9 out of 10
- Vietnam actual kill rate
 - 9.6 percent
 - ~ 1 out of 10

F-22 claimed probability of kill

- The recent tests between F-15s and F-22s used a 0.65 probability of kill (P_K) for the AMRAAM missile kills
 - Justification based on 1991 Iraqi combat
- However, radar missile kills were AIM-7Ms, not AMRAAMs.
- P_v was .34 against non-

Friend from Foe

- IFF has always been the weak link
 - In every war since WWII, we've been told the IFF would work
 - But forces turned them off to avoid being tracked
- Assertion today is that it is fixed
 - Evidence that F-15s in 1991 Iraq war had autonomous right to fire beyond visual range (BVR) from own electronics

Within visual range

AIM-9X



What about the AIM-82?

- The AIM-9X of its day
- Claimed: 955-to-1 kill-loss ratio
 - Used to sell the F-15
- Reality: cancelled due to total failure
- The IR missile may be improved but Air Force has screwed up the gun by requiring a trap door to open

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Fighter characteristics

- Acceleration, maneuverability, and persistence are fundamental characteristics to gaining a firing solution

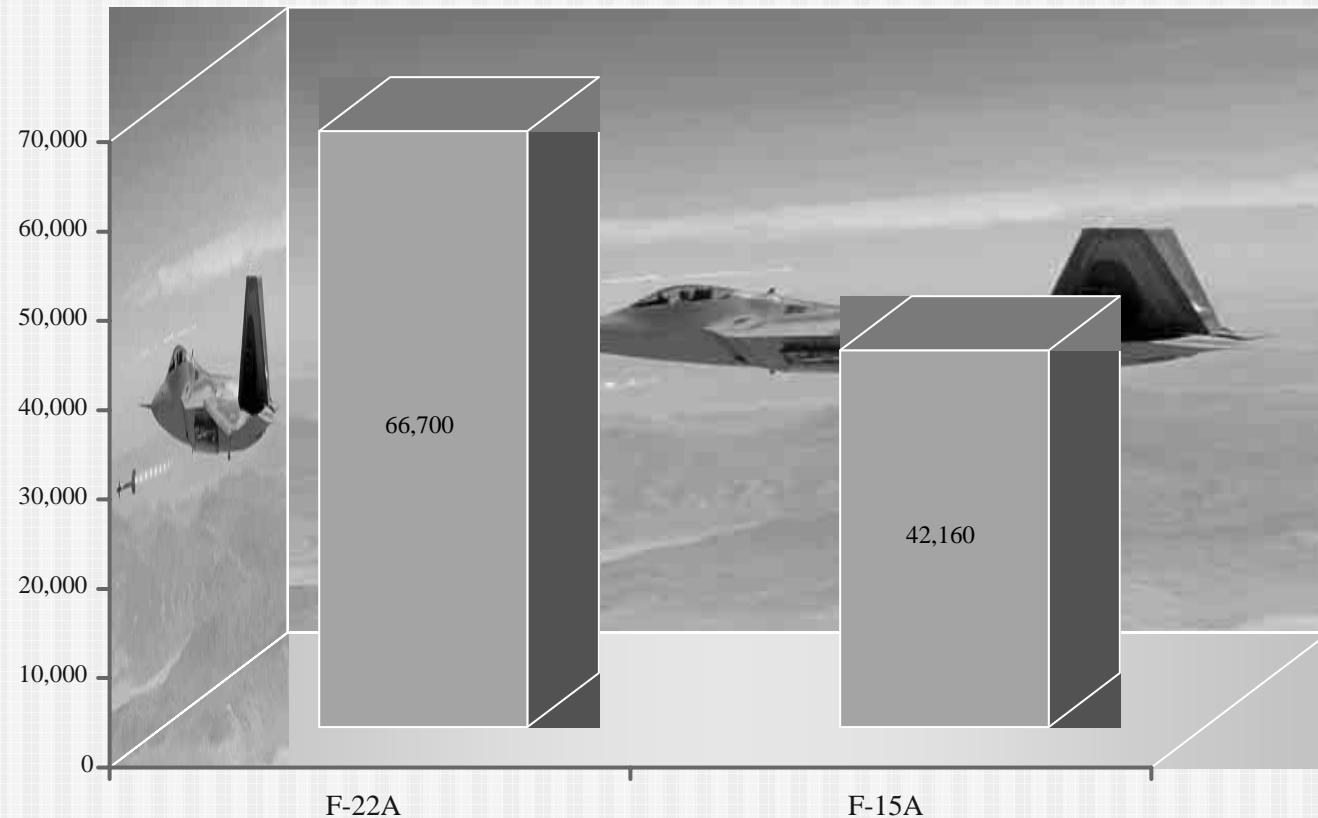
Input to acceleration

$\frac{\text{Thrust (in pounds)}}{\text{Weight (in pounds)}} = \text{Thrust-to-weight ratio}$

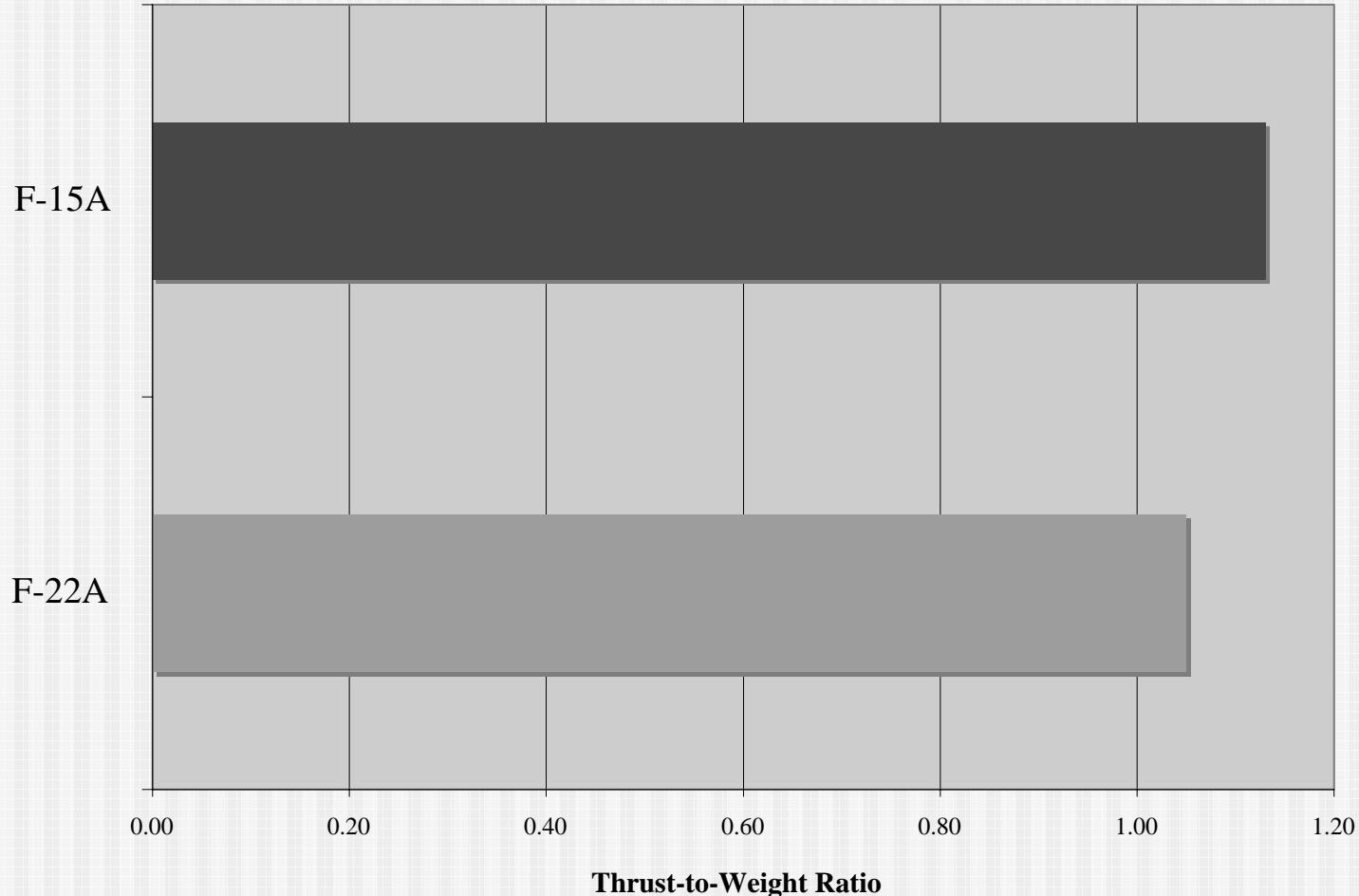
- Higher thrust-to-weight ratio, better acceleration

F-22A and F-15A weights

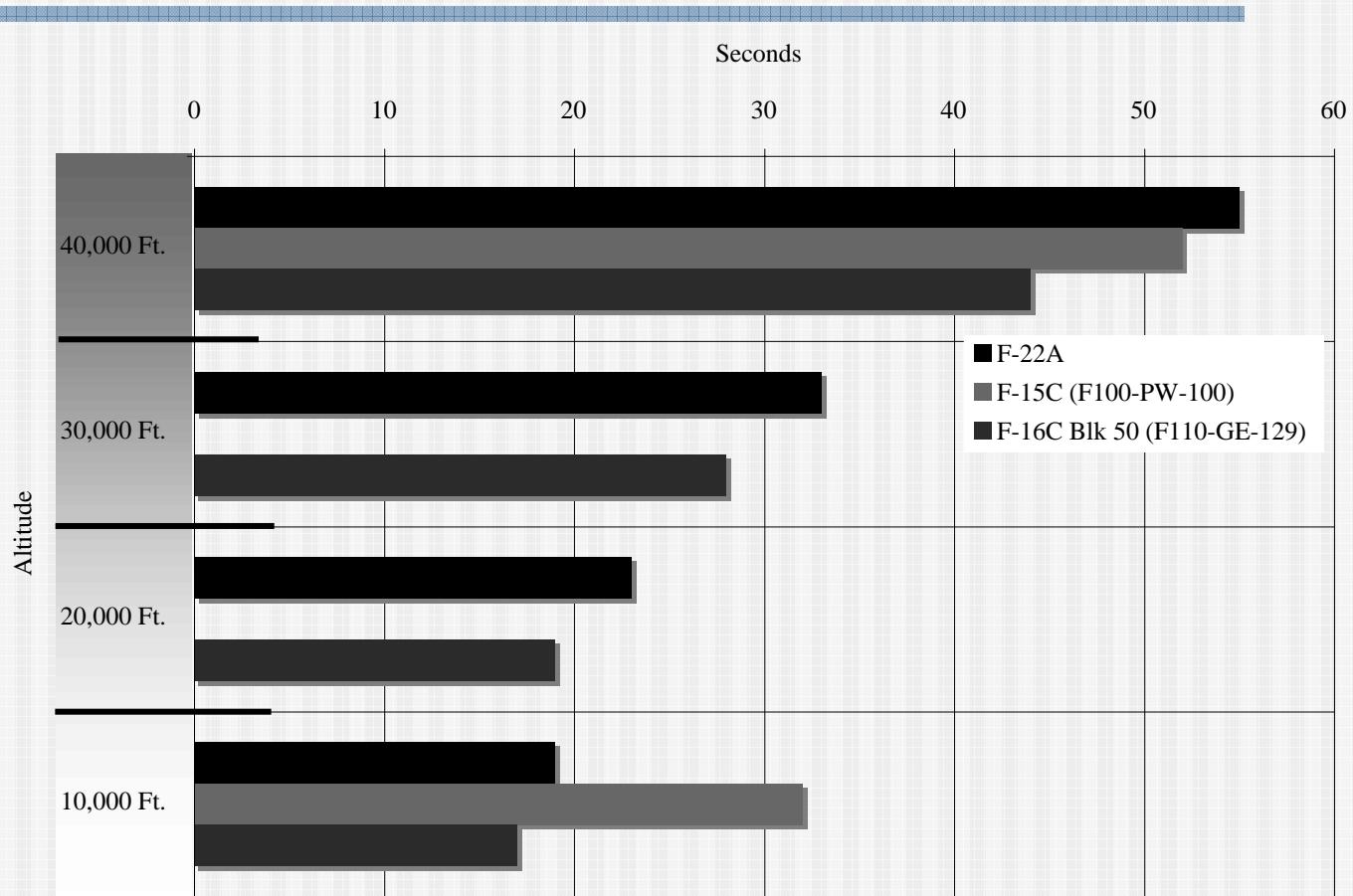
Weight Comparison of F-22A with F-15A



Thrust-to-weight compared



Acceleration time 0.8- 1.2

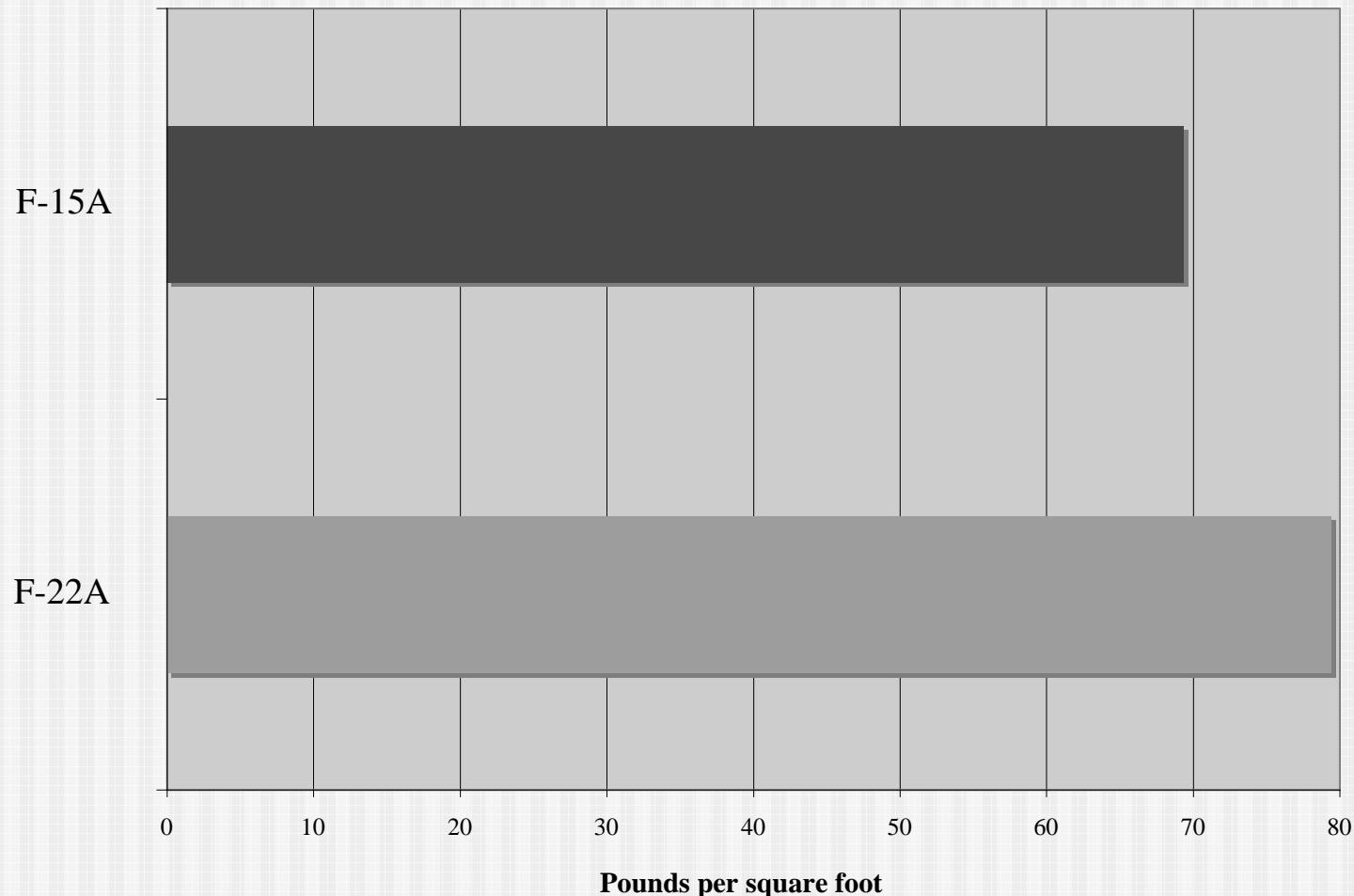


Input to maneuverability

$$\frac{\text{Weight (in pounds)}}{\text{Wing Area (sq. ft.)}} = \text{Wing Loading}$$

- Lower wing loading, better maneuverability

Wing loadings compared

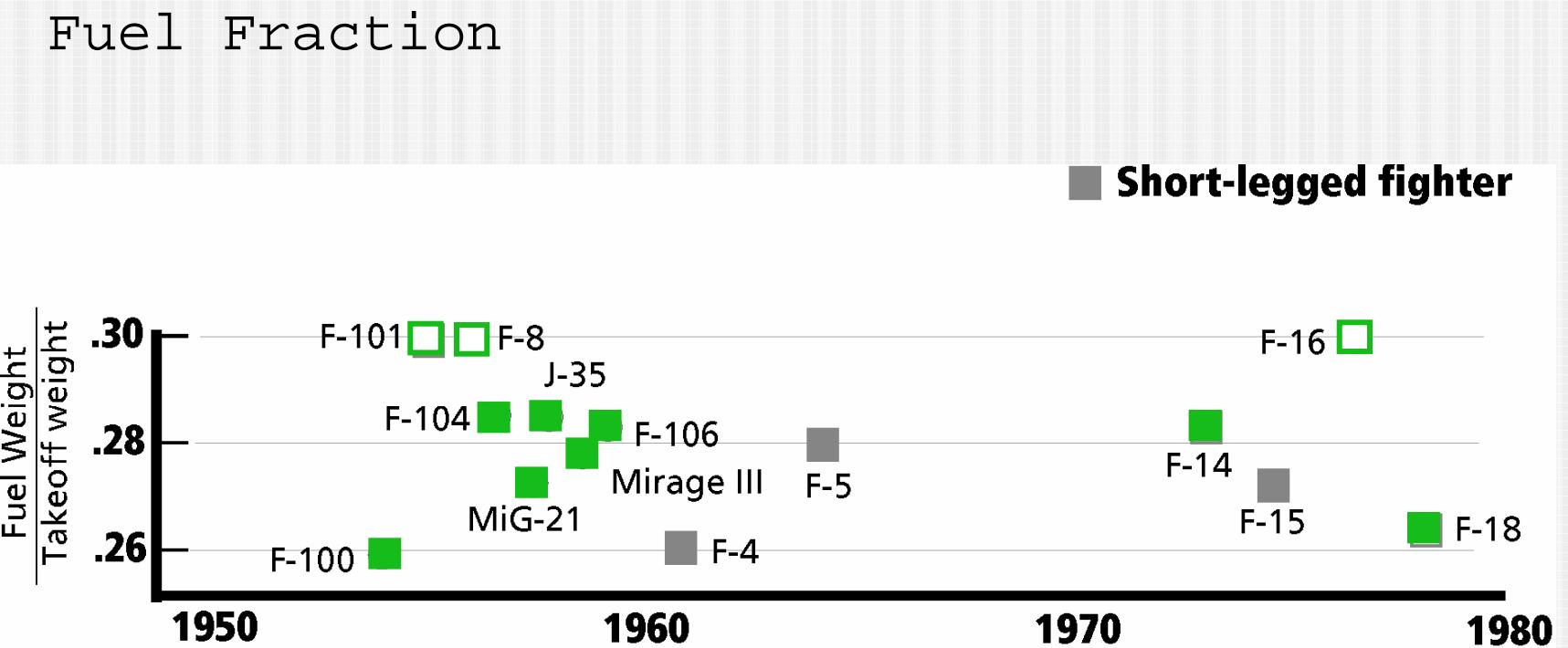


Input to persistence

Weight of fuel (pounds) = **fuel fraction**
Wt. of aircraft +
wt. of fuel (pounds)

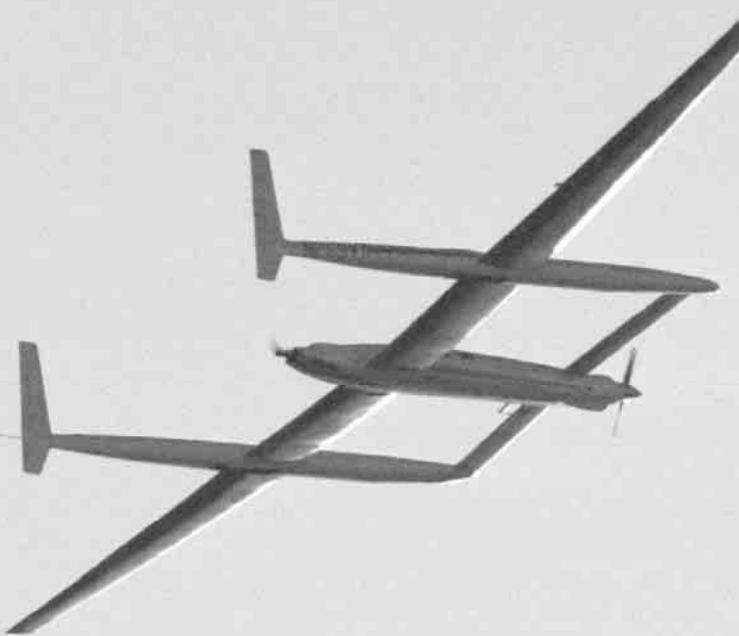
- Higher fuel fraction, greater persistence and/or range

contributes to range
and persistence



Fuel fraction 0.72

Voyager around-the-world non-stop



NASA Dryden Flight Research Center Photo Collection
<http://www.dfdc.nasa.gov/gallery/photo/index.html>
NASA Photo: EC87-0029-02 Date: 23 Dec 1986 Photo by: NASA /Harrop

Voyager aircraft return from non-stop trip around the world

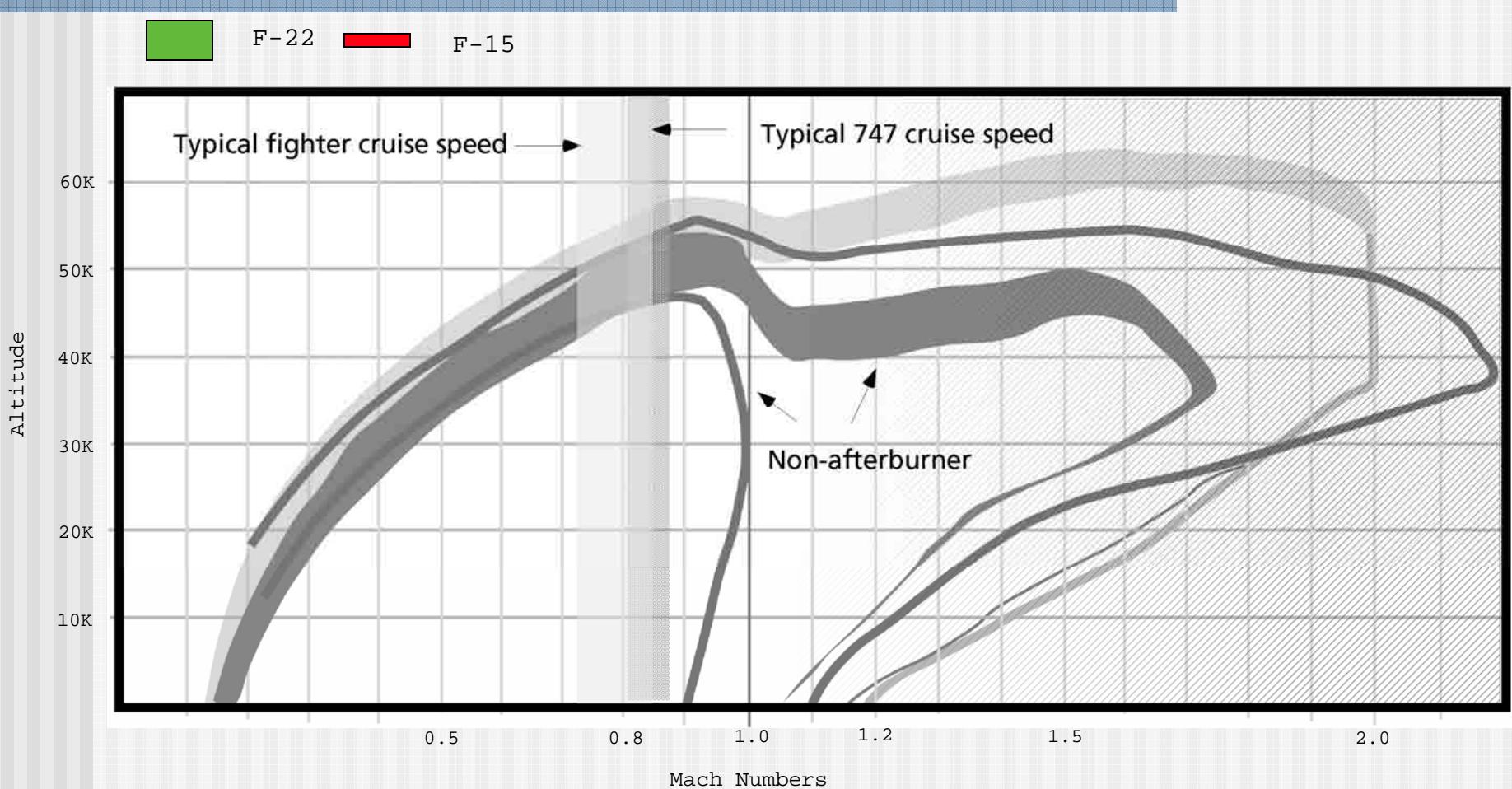
1955 F-8 fuel fraction
0.30



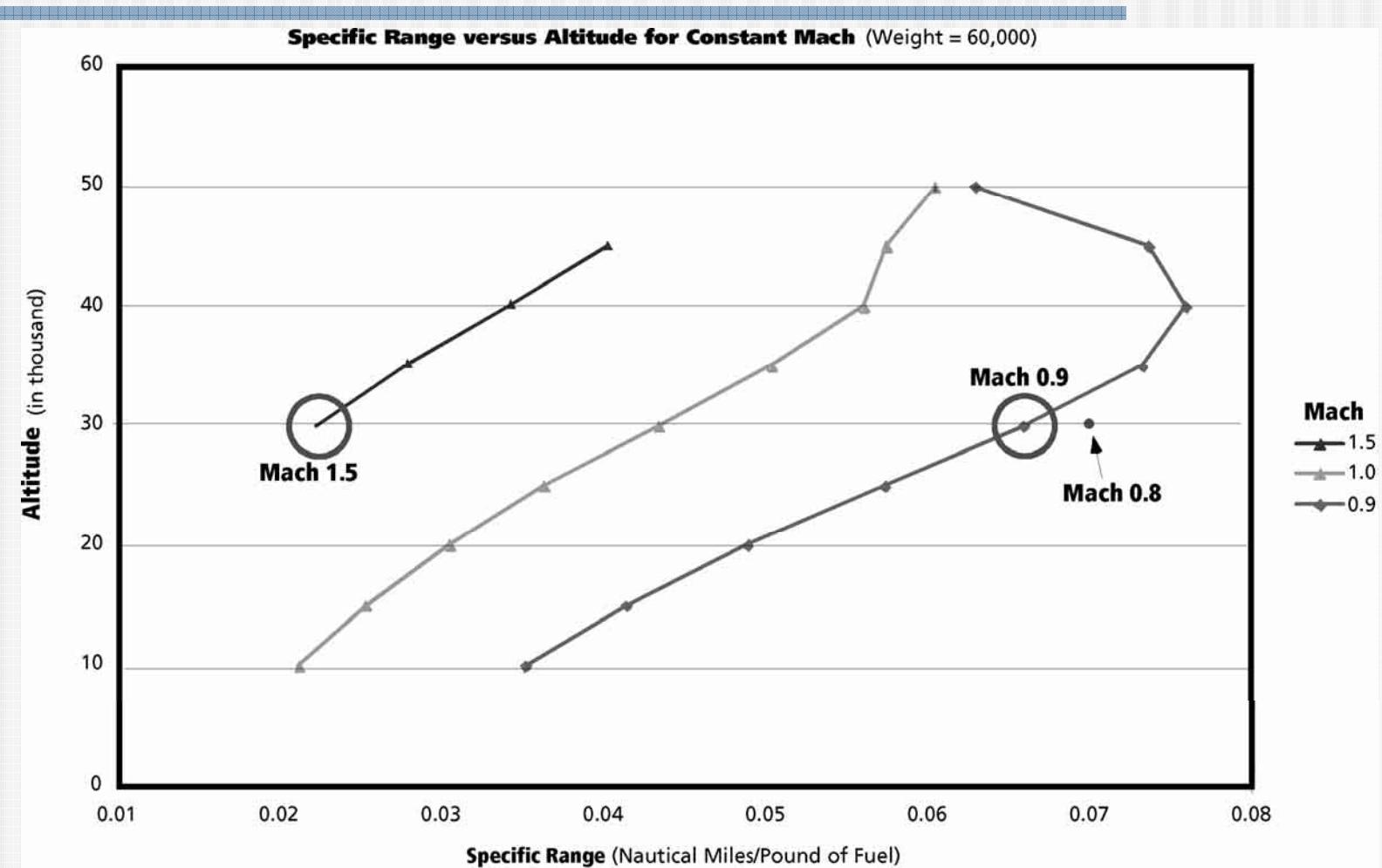
2006 F-22 fuel fraction
0.275



F-22 and F-15 cruise and maximum speed



F-22 miles per pound of fuel



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Split-second kills



P-51 .50 caliber gun and 400 rounds

- .50 caliber of World War II had quicker:
 - Time to first shot
 - Time of flight
 - Cumulative lethality
- Today's 20mm has
 - Longer start up time
 - Less range
 - Longer time to target than 20mm of World War II

Split-second kills



- F-22 requires gun door to open
- M61A2 requires $\frac{1}{2}$ second start up time
- Missiles require 10-15 seconds electronic acquisition time for cooperative threat
- After acquired, missile launch requires opening missile bay doors

F-22 Summary

- Radar missile P_K used to justify F-22 requires leap of faith
 - That combat P_K will equal predictions
 - It never has
 - That IFF will work
 - It never has (even AWACS can't tell a Hind from a Blackhawk)
 - That enemy will not fire an anti-radiation missiles
 - Russians are not selling anti-radiation missiles to our allies

F-22 Summary

- F-22 costs prevent the purchase of adequate numbers
 - Original requirement was for 750 but increasing program acquisition unit cost of 3 for \$1 billion, reduces quantity below 190
- F-22 does not have rearward visibility, acceleration, maneuverability, or persistence of previous era fighters

Questions?

