SO, YOU WANT TO BUILD A RAILROAD?

A CASE STUDY OF TWO PROJECTS
UNIVERSITY OF ILLINOIS
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Today, Building A New Railroad is Tough

- NIMBY (Not in my back yard!) issues
- Environmental issues
- Regulatory hurdles
- Physical space/geographical limitations
- Public/private benefit issues
- Competitive issues
- Political issues

Building A New Railroad is Tough

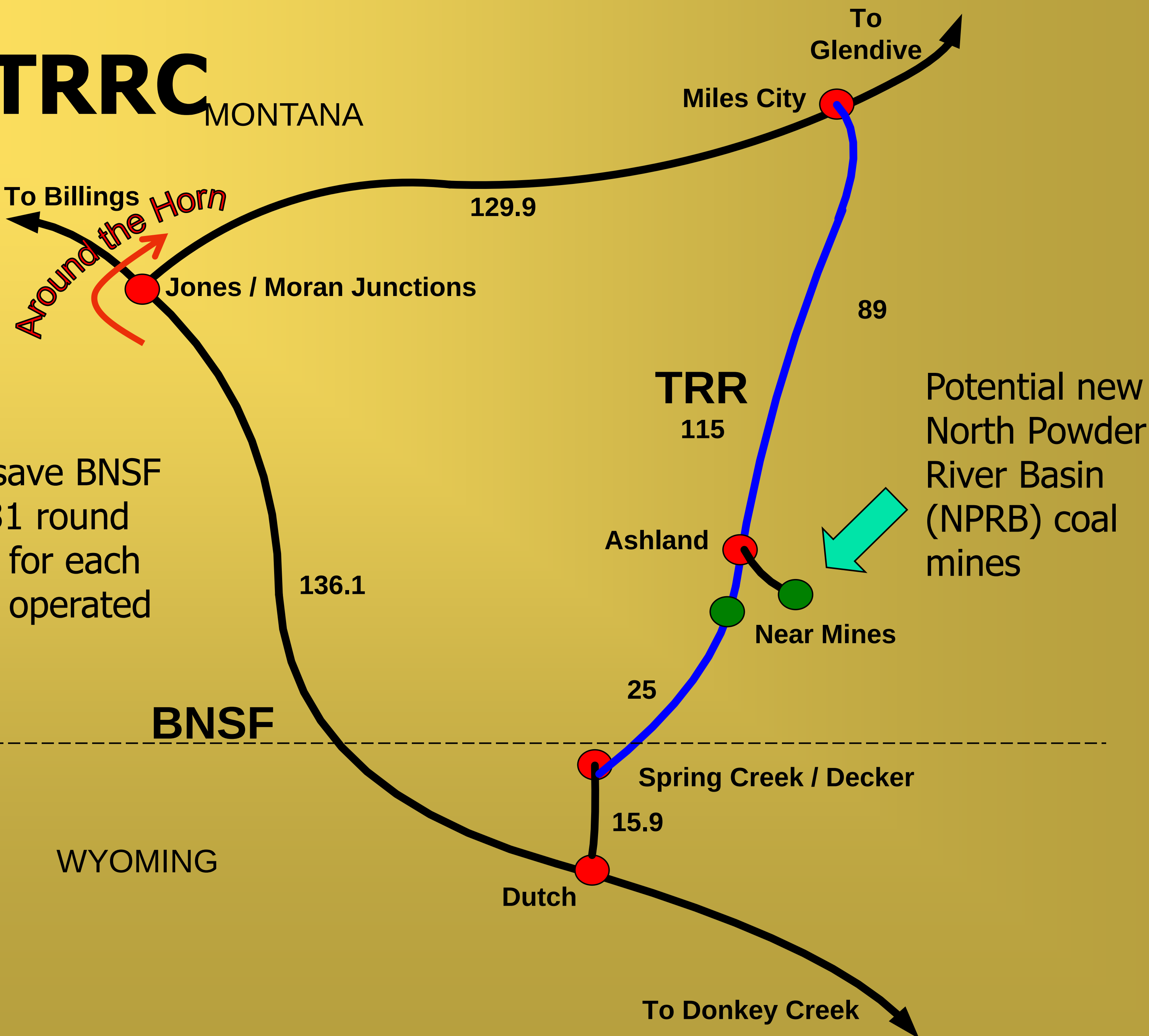
Though not a scientific finding, it now appears to take roughly 10 – 15 years to build a 150 mile railroad – roughly 12 miles a year!

At that rate, it would take over 200 years to build a transcontinental railroad compared to the 41 years it actually took to connect both coasts (from the time the B&O started construction in 1828 until the last spike was driven at Promontory Point in 1869).

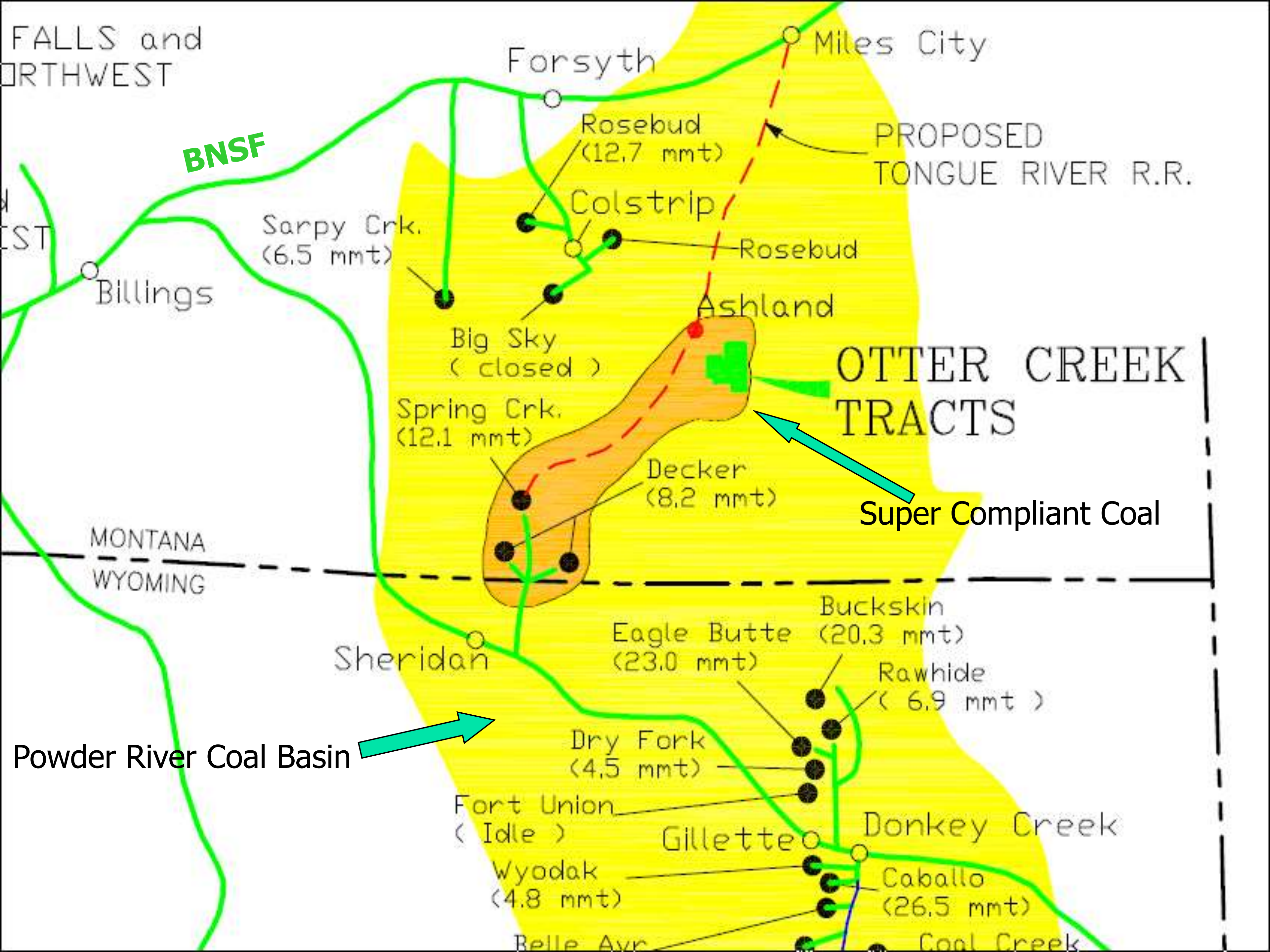
A Study of Two Examples

- Tongue River Railroad Corp. (TRRC) – Montana
  - Shortcut for BNSF coal traffic
  - Open new mines in North Powder River Coal Basin
  - Studies began in 1978
- I-70 Corridor Railroad – Denver Airport to Glenwood Springs
  - Relieve congestion on I-70
  - Add capacity
  - Studies beginning in 2007

The TRRC



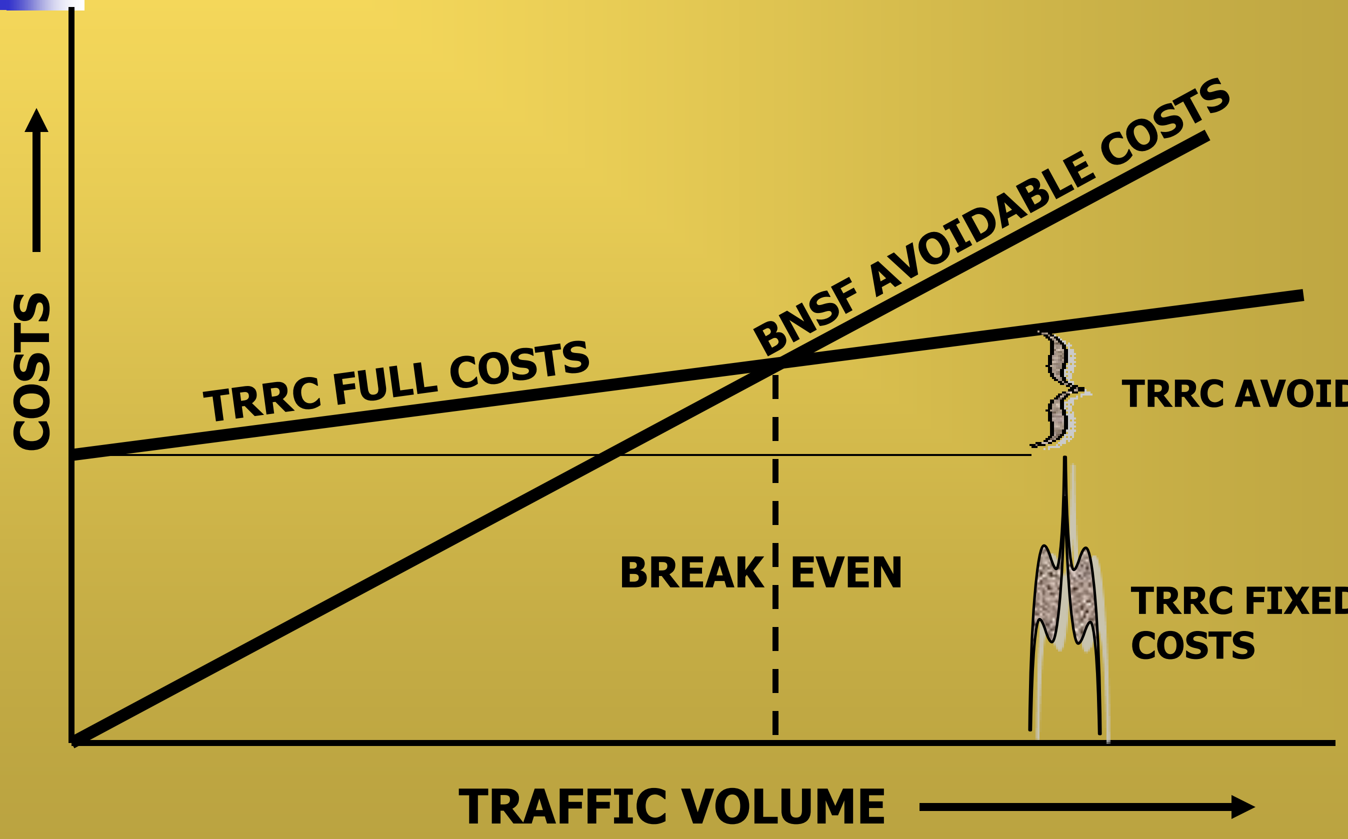
TRR will save BNSF 268 to 331 round trip miles for each coal train operated


FALLS and
Forsyth
Miles City
BNSF
Rosebud
(12.7 mmt)
PROPOSED
TONGUE RIVER R.R.
Colstrip
Sarpy Crk.
(6.5 mmt)
Rosebud
Billings
Ashland
Big Sky
(closed)
OTTER CREEK
TRACTS
Spring Crk.
(12.1 mmt)
Decker
(8.2 mmt)
Super Compliant Coal
MONTANA
WYOMING
Buckskin
(20.3 mmt)
Eagle Butte
(23.0 mmt)
Sheridan
Rawhide
(6.9 mmt)
Powder River Coal Basin
Dry Fork
(4.5 mmt)
Fort Union
(Idle)
Gillette
Donkey Creek
Wyodak
(4.8 mmt)
Caballo
(26.5 mmt)
Belle Ayr
Coal Creek

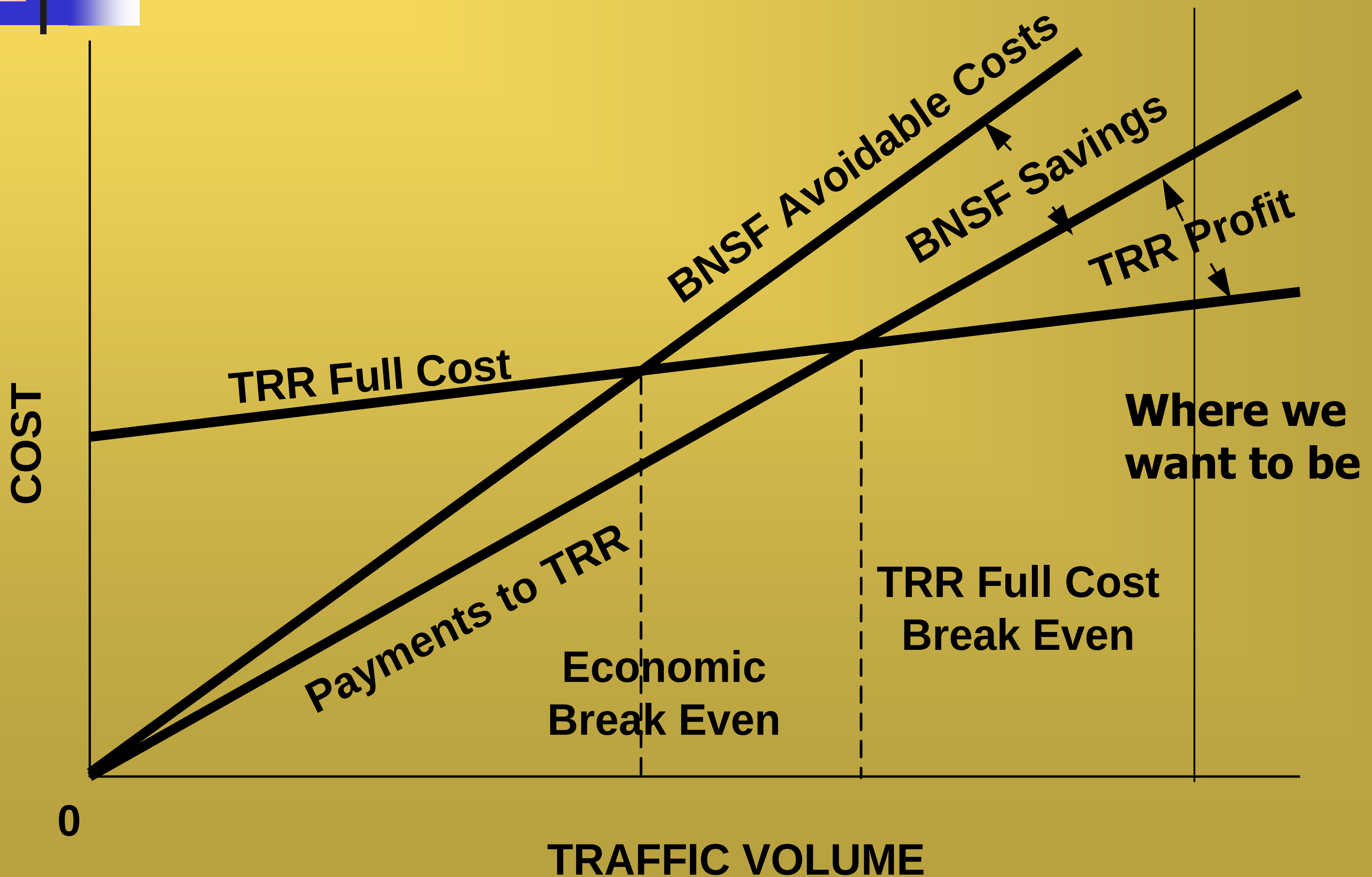
29-Years in Development

- Many obstacles to overcome
  - BNSF (& former BN) initially not convinced of economics or benefits
  - Environmental issues
  - Legal issues
  - Cyclical changes in the coal market
  - Aggregating checkerboard coal lease rights
  - Financing

BNSF AND TRRC COST RELATIONSHIPS VERSUS VOLUME ARE VERY DIFFERENT



TO BE ADVANTAGEOUS TO TRRC AND BNSF, BOTH MUST BENEFIT



A Look at Cost Assumptions

PROJECTED TRAFFIC, MILLIONS OF TONS

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WY Origin	13.6	14.7	14.8	14.8	15.0	14.8	14.8	14.8	14.5	14.4
MT Origin	15.4	15.6	15.7	15.8	16.0	15.9	15.9	15.6	15.6	15.6
New Mines	7.0	11.9	13.8	14.2	14.4	16.9	16.9	17.0	16.8	16.9
Total	**36.0**	**42.2**	**44.3**	**44.8**	**45.4**	**47.6**	**47.6**	**47.4**	**46.9**	**46.9**

Selected Revenue / Cost Factors

- **TRRC Rate Inflation**
- **PV Discount Rate**
- **BNSF Cost Inflation (Except Fuel)**
- **BNSF Fuel Price and Escalation Rate**

Cost Assumptions, Continued

Operating Factors x Avoidable Costs per Unit = Avoidable Costs (Existing Route & Via TRRC)

Operating Factors	Avoidable Cost
Train Performance Calculator →	Fuel
↓ Train-Hours, Locomotive Unit-Hours & Car-Days →	Labor, Capital, Maintenance
Train Miles, Railroad Owned Car-Miles →	Maintenance
Gross Ton-Miles →	Maintenance

TRR Costs

- Capital (construction) costs split between capital and equity portion
- Debt amortized over 20 years
- TRRC maintains right of way (track, signals, road crossings, structures)
- BNSF dispatches and operates trains
- Minimum TRRC admin expense

Findings

- Net BNSF avoidable cost savings exceed TRR full costs and debt service for total predicted traffic expectations
- TRRC can be justified to serve only BNSF traffic or local NPRB mines – best benefit if both are served
- Aggregating coal leases required in order to develop local mines
- TRRC and BNSF need to negotiate splitting of savings so both benefit

Benefits to Investor

Highly influenced/affected by:

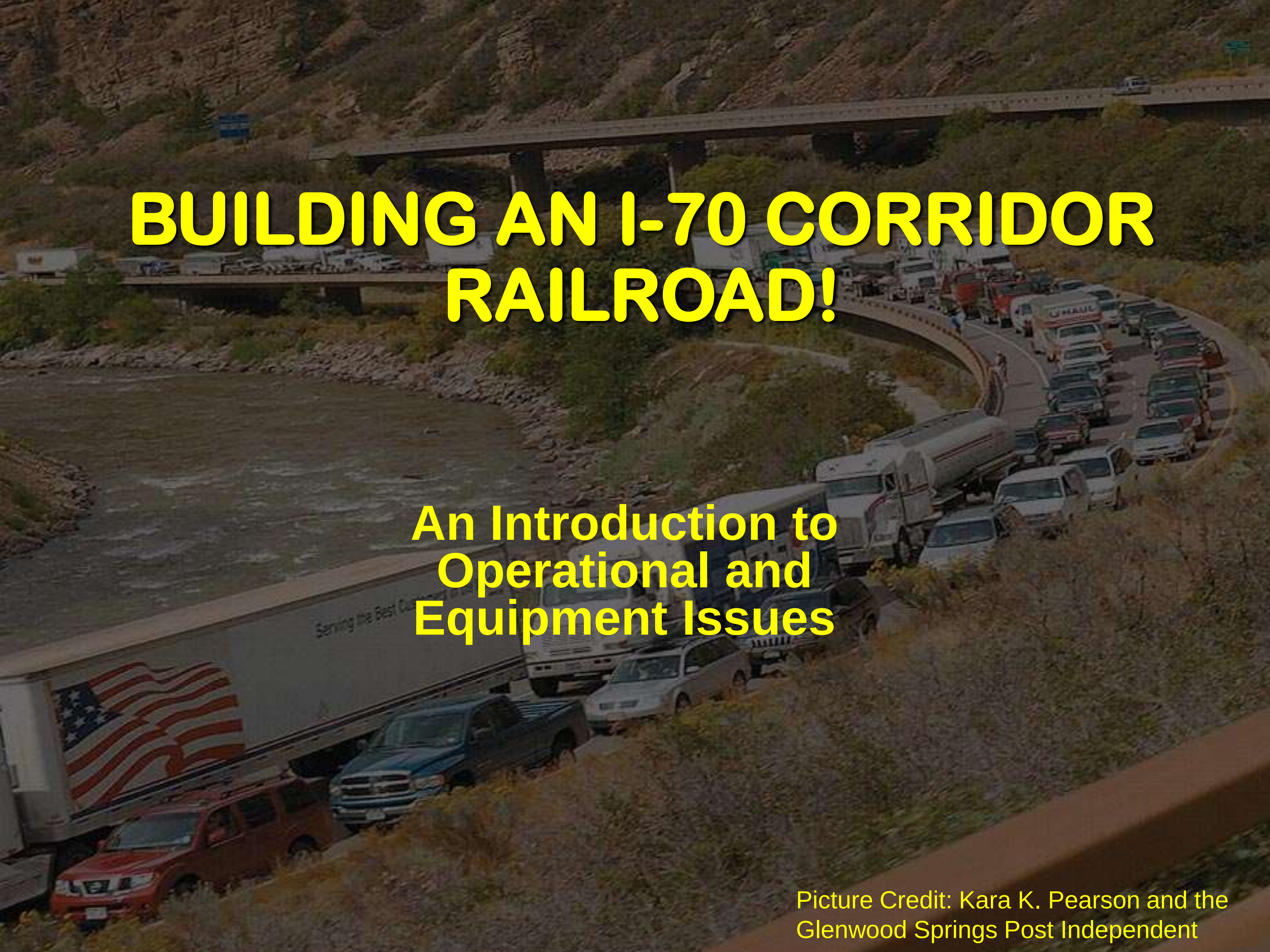
- **debt/equity ratio**
- **Interest rate on debt**
- **Traffic volume**
- **Inflation rate (TRRC largely fixed costs, not subject to inflation; all BNSF costs subject to inflation)**
- **BNSF captured share of savings**

Maybe, Just Maybe

Construction might start in 2007 or 2008!

BUILDING AN I-70 CORRIDOR RAILROAD!

An Introduction to Operational and Equipment Issues



Picture Credit: Kara K. Pearson and the Glenwood Springs Post Independent

The Problem

- Traffic on the already congested I-70 Corridor between Denver Airport – Denver – Glenwood Springs is expected to increase by 50+ percent between 2000 and 2025.
- Many severe physical constraints make adding lanes to I-70 prohibitively expensive
- Highway expansion poses many negative environmental, safety, construction, and weather reliability concerns

Proposed Solutions

- Rail, in one of several forms
  - Maglev – a “dream” (naïve?) solution
  - High Speed Rail – á la European TGV
  - Conventional (Heavy) Rail – passenger and freight (intermodal)
  - Light rail – cheaper but may not meet demand or all needs
- Bite the bullet – call in the bulldozers and concrete mixers
- Do nothing

I-70 Coalition Faces Similar Problems as TRRC

- NIMBY (Not in my back yard!) issues
- Environmental issues
- Regulatory hurdles
- Physical space/geographical limitations
- Public/private interests, costs and benefits
- Competitive issues (public and private)
- Political
- Education

Proposed Study

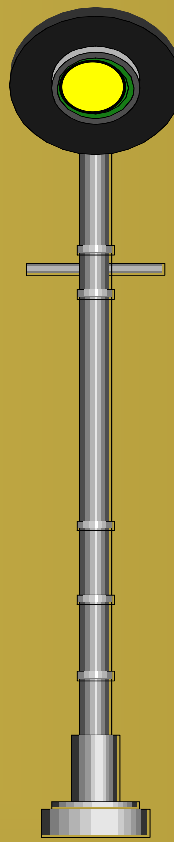
- 26 local towns and cities and 10 counties formed the I-70 Coalition in 2004 in order to identify, evaluate, and select the best capacity improving alternatives
- Coalition wants to counter established bias for highway expansion
  - Federal funding is highway oriented
  - Strong highway lobbies
  - American love of cars and independence
  - Colorado DOT performed a PEIS that appears to favor highway
- Educate public on benefits of rail

Background – Commuter / Regional Rail

- One of the fastest-growing segments of the passenger business
- Over 213 million trips were recorded in the first six months of 2006 – up over 3.4 percent from the same period in 2005
- Growing competition for limited Federal funding

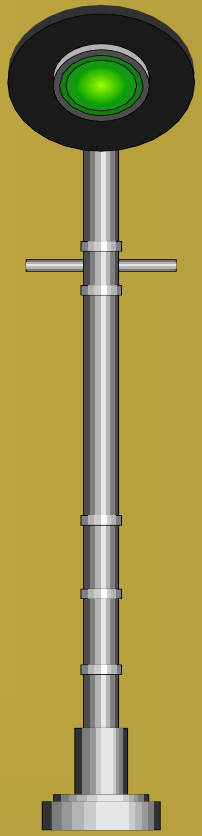
Difficult Hurdles Ahead

- High capital costs create a lower benefit / cost ratio, making it more difficult to compete for Federal Funding
- Consensus has not yet been reached that rail is the best solution
- Many competing and independent political interests and government agencies
- The proposed railroad is unique and the first of its kind in the U.S.



Political, Marketing, Financial, and Technical Knowledge is Required

- The I-70 Coalition is off to a great start on perhaps the most difficult challenge – the political aspect of building project momentum
- This presentation is an introduction to some technical and operational aspects of the proposed railroad.



The Proposed Railroad Must Be Designed As A System

- **Start with defining the mission**
  - **Long distance passenger**
  - **Local passenger**
  - **Commuter**
  - **Intermodal**
  - **Freight**
  - **A combination of the above**
- **Markets served**
  - **Desired routing(s)**
  - **Stations and other facilities**

Defining the Mission Sets Key Design Parameters

- Quantify Expected Traffic
  - Passenger
  - Freight
- Evaluate Equipment Alternatives
  - Locomotive powered trains
  - Self propelled Multiple Units
  - Tilt or non-tilt
  - Cars and interior and capacity specifications
  - FRA safety compliance requirements

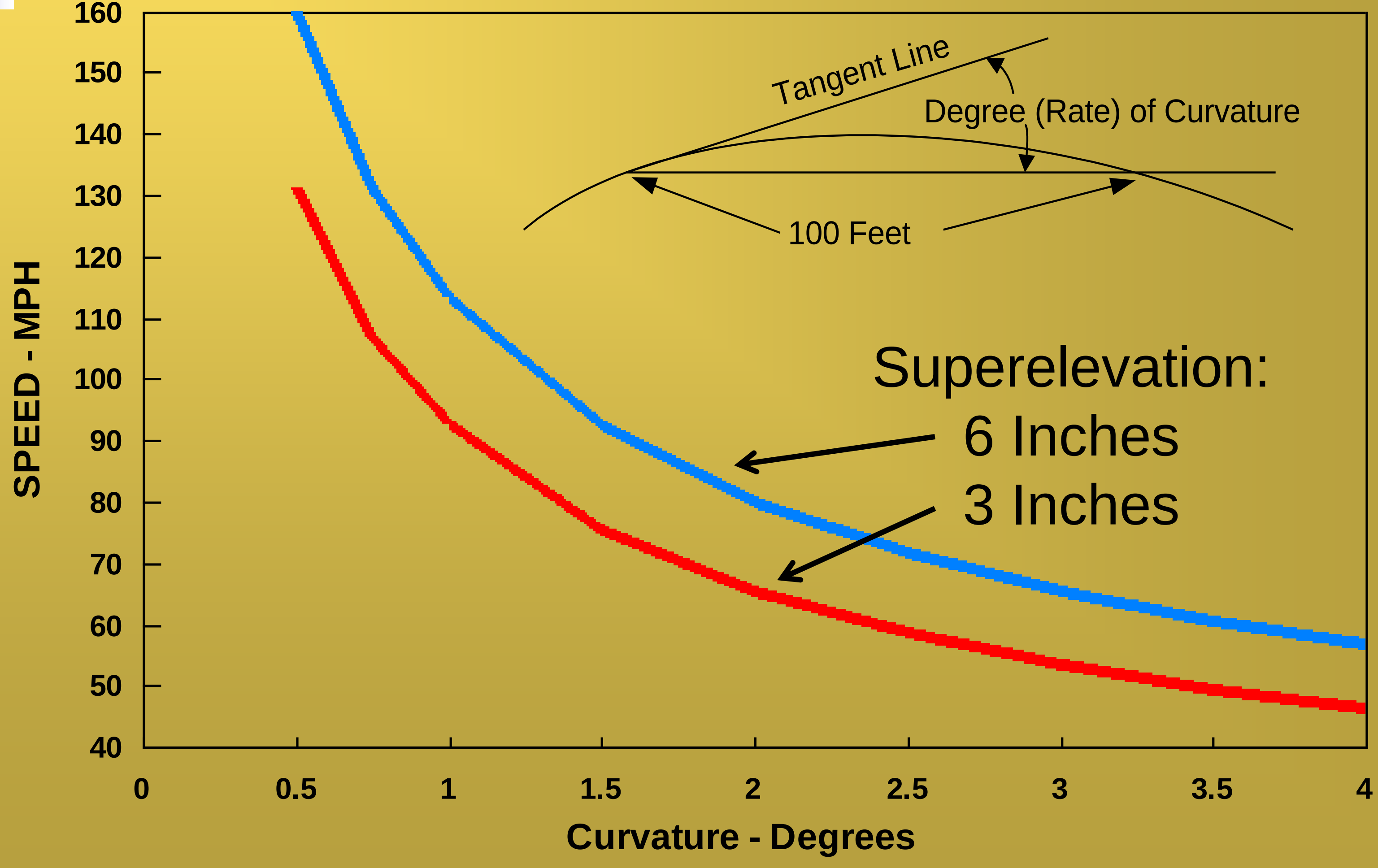
Key Design Parameters

- Propulsion Selection
  - Diesel
  - Electric
- Select Route
  - Engineering design constraints
    - Maximum gradient
    - Speed limits
    - Curvature
    - Environmental considerations
  - Single track with sidings or multiple tracks
  - Trade-off analysis (initial capital versus long-run operating costs, other)
- Select train control system(s) (signaling)

A Few Rules of Thumb…

- 1 - 1.5 HP per ton per one percent gradient – freight train
- 4 - 8+ HP per ton per one percent gradient – passenger train
- Maximum comfort speed on curves – 3 inch imbalance
- Maximum comfort acceleration and deceleration rates – 3 feet per second per second.
- Maximum superelevation on curves – three inches for freight trains, six inches for passenger trains only

Speed vs Curvature With 3 Inch Imbalance



A Few More Rules of Thumb

Practical gradient limits for:

- freight trains – 2 percent (4% under very special circumstances)
- passenger trains – 4 percent (7% under very special circumstances)

(Interstate Highways are usually limited to a maximum of 6 percent)

A Few Safety Considerations

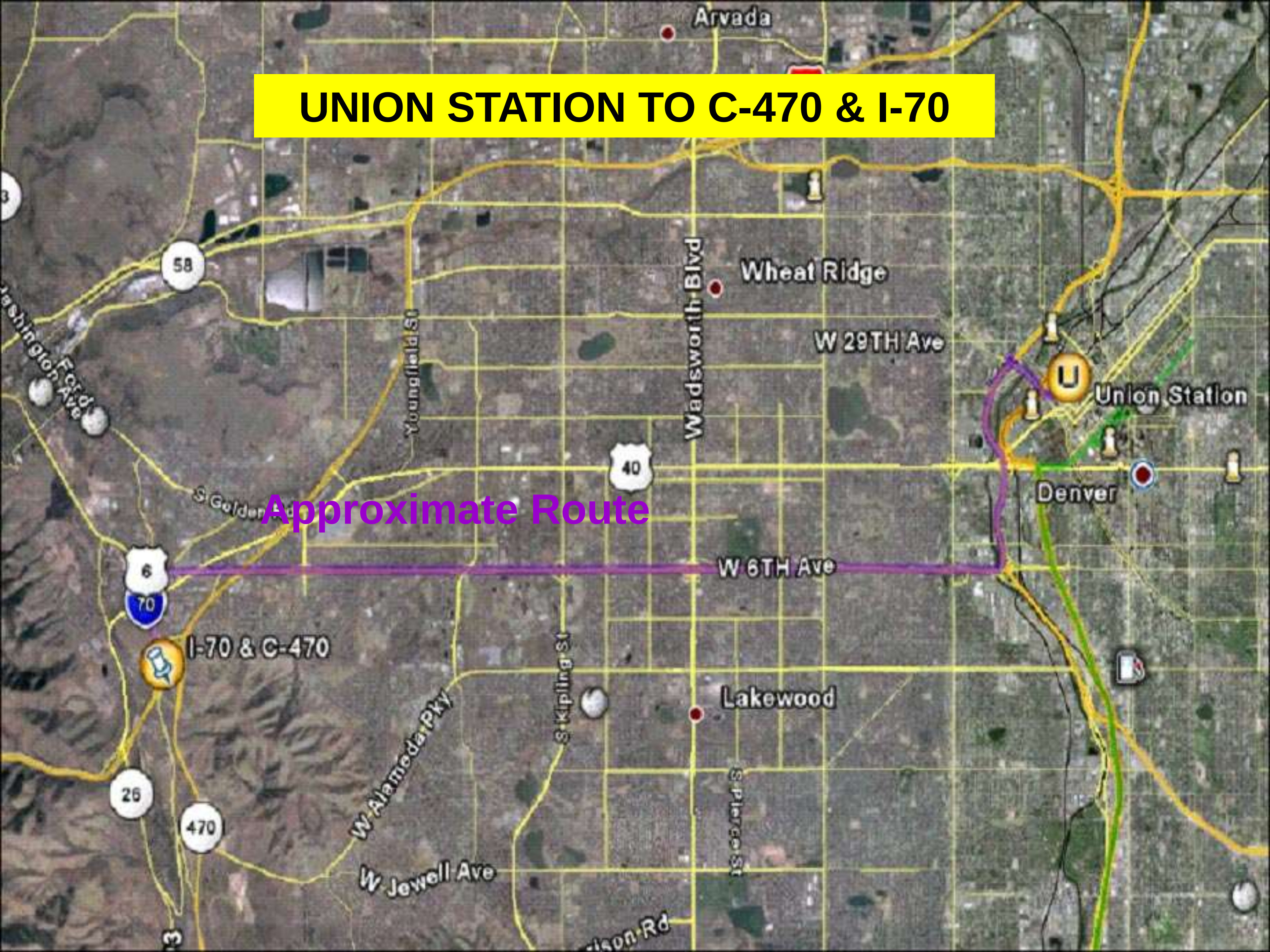
- Maximum design speed
  - Class 4 track – 80 MPH – most Amtrak routes
  - Class 5 track – 90 MPH – Automatic Train Stop or Cab Signals required
  - Class 6 track – 110 MPH – Special restrictions on grade crossings
  - Class 7 track – 125 MPH – Requires total right-of-way protection
- Braking on descending gradients – requires reduced speeds or external (non-adhesion dependent) braking

A First "Armchair" Look at a Potentially Feasible Operation

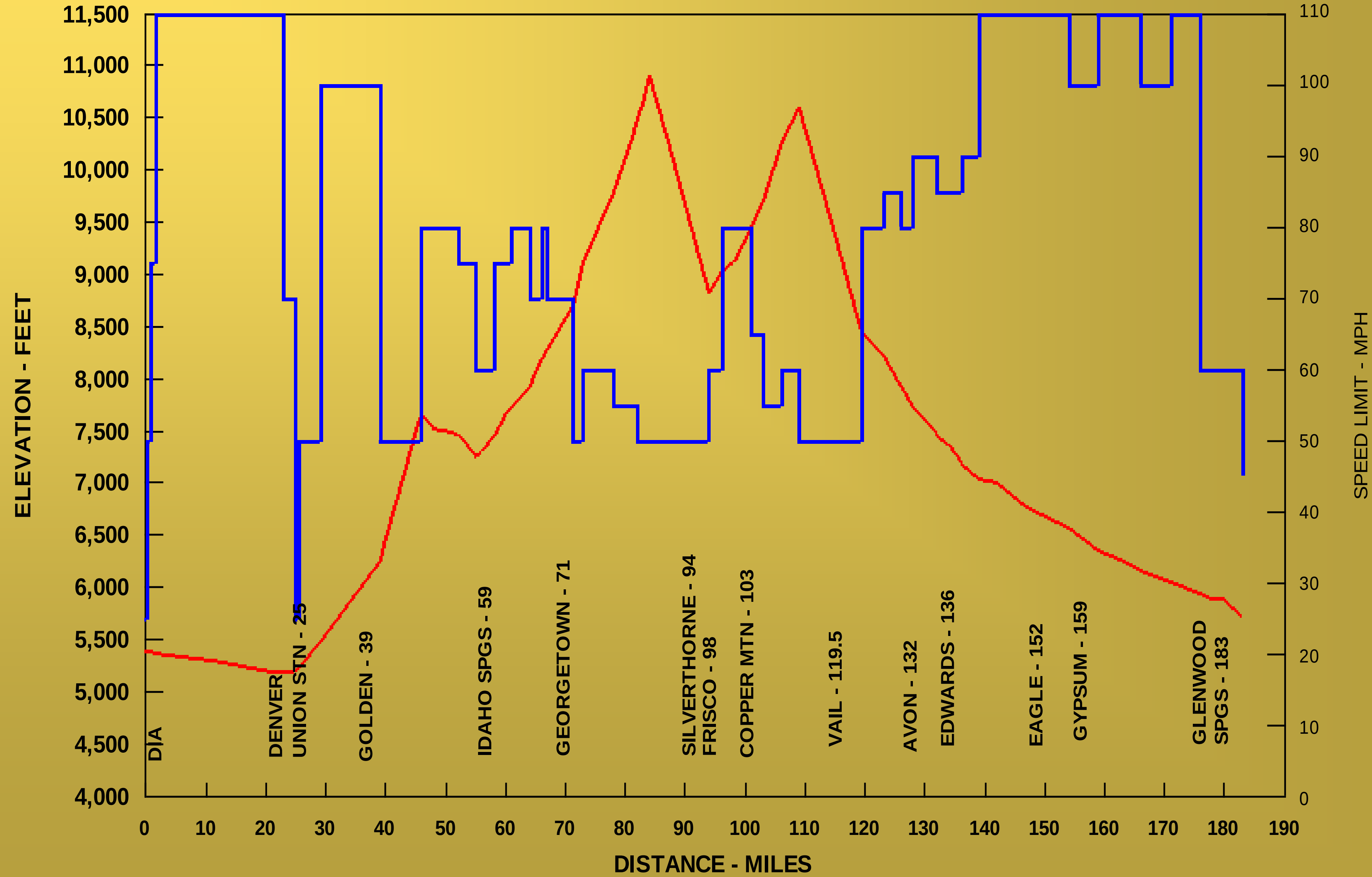
- 110MPH maximum operating speed where safety and equipment permits
- Maximum gradient of 4 percent to enable handling intermodal freight traffic off-peak
- Speed limits on selected gradients
- Service to all local I-70 communities
- Electric propulsion
  - Reduces weight by omitting diesel prime mover
  - Regenerative braking
  - Alternate energy sources

DIA TO UNION STATION

UNION STATION TO C-470 & I-70



ROUGH I-70 PROFILE AND RAIL SPEED LIMITS
DENVER AIRPORT TO GLENWOOD SPRINGS



Station Stops

Station	Miles from DIA	Stop Duration (Mins)
Denver Airport (DIA)	0	- -
Denver Union Sta	29	3
Golden	39	2
Idaho Springs	59	1
Georgetown	71	2
Silverthorne	94	2
Frisco	98	2
Copper Mountain	103	2
Vail	119.5	2
Avon	132	1
Edwards	136	1
Eagle	152	1
Gypsum	159	1
Glenwood Springs	183	- -

Equipment Simulated

Equipment Type*	Propulsion	Cars Per Train	Max Speed, MPH	Seats Per Train
Adtranz Flexliner	Diesel (DMU)	3	75	180
X2000	Electric	3	110	180
AMD103 / Talgo	Diesel Electric	12	103	312
Colorado Railcar	Diesel Electric DMU	3	90	180
Stadler FLIRT	Electric (EMU)	3	100	154
*Bombardier equipment candidates submitted too late for analysis.				



FLIRT (Fast, Light, Innovative Trains) – 2 to 6 car trains

Matching floor / platform
Height is a must for fast
ingress and egress,
especially with luggage,
skis, and bikes

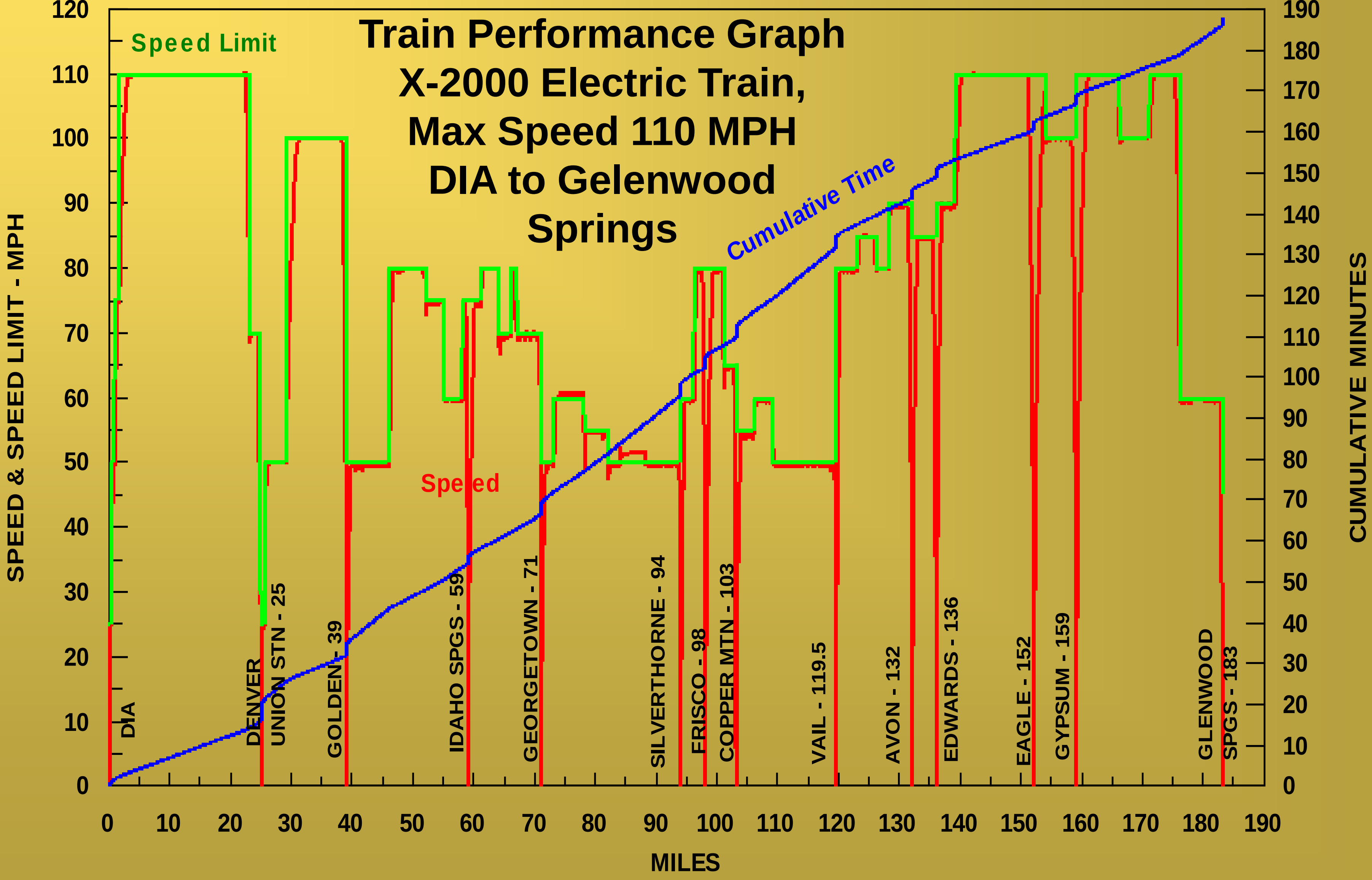
Bombardier Regina – 2 & 3 car EMU’s are sinews of Sweden’s intercity and interregional services at speeds up to 250 km/h (150 mph).

Bombardier Electrostar trains are designed to operate at speeds of up to 160 km/h (100 mph).

Bombardier Merdian family of DMU’s – up to 200 km/h (120 mph), tilt and non-tilt versions.

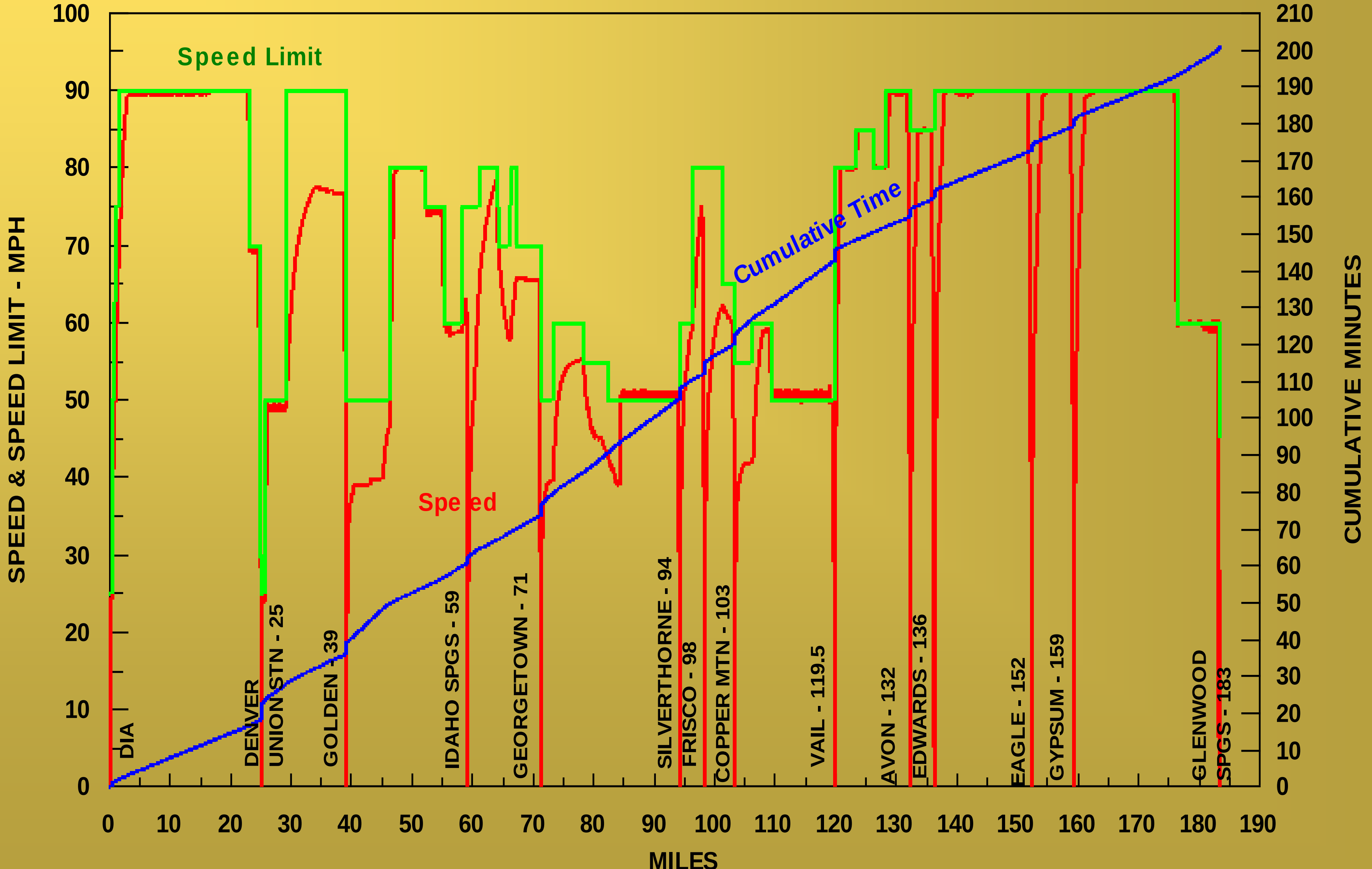
Bombardier Talent DMU’s (2, 3, or 4-car configurations) operate at speeds up to 140 km/h (85 mph).

Let's Look at Some Sample Operating Characteristics



COLORADO RAILCAR 5-CAR DMU

DENVER AIRPORT TO GLENWOOD SPRINGS



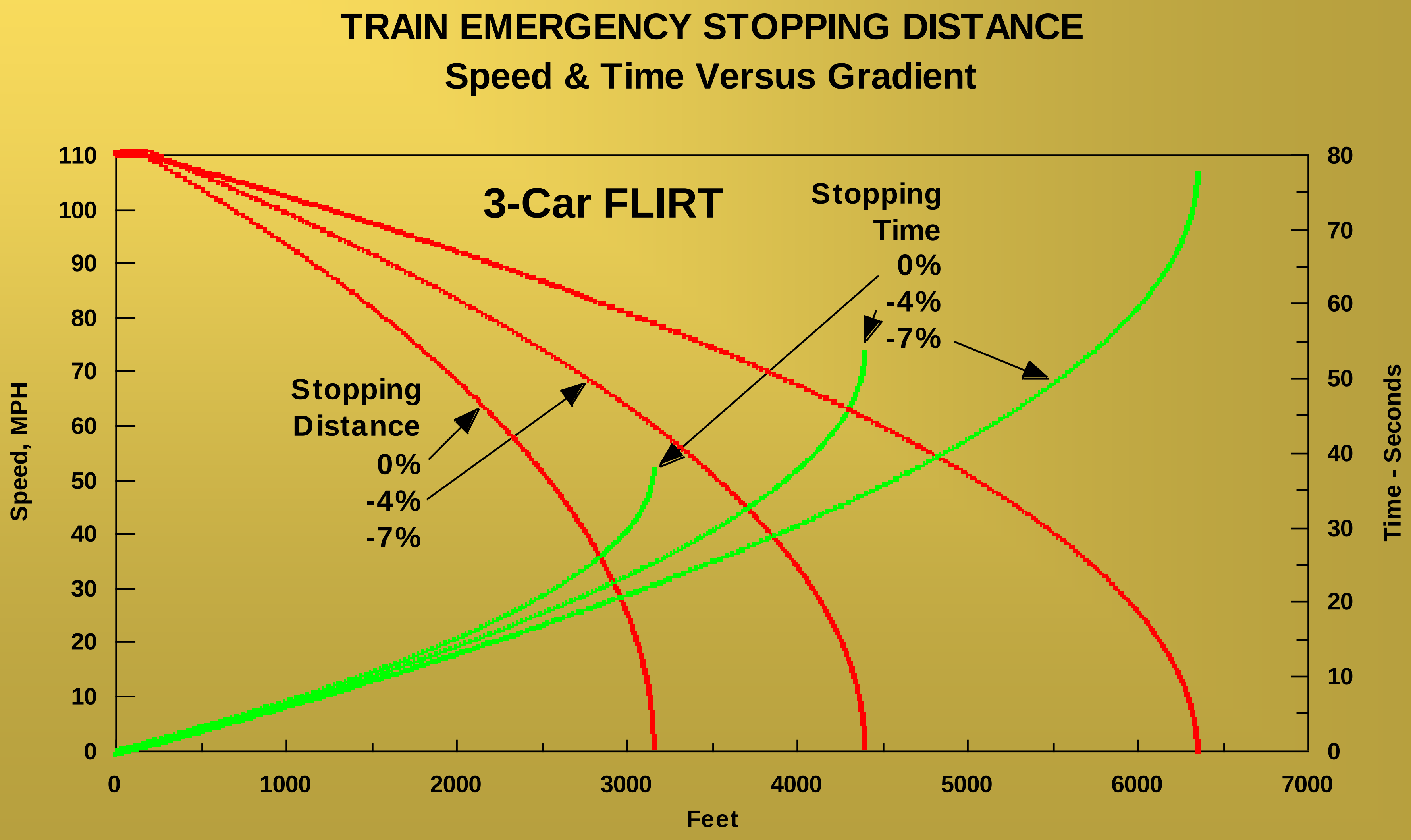
Simulation Operating Results

EQUIPMENT TYPE	FLEXLINER	X2000	AMD103 Talgo	COLORADO RAILCAR	FLIRT 3-CAR
Power	Diesel	Electric	Diesel	Diesel	Electric
Cars in Train	1	3	12	5	3
Seats (Nominal)	60	180	312	300	154
Eqpt Max Spd (As Configured)	75	125	103	90	100
WESTBOUND					
Running Time (Hours)	3.5	3.1	3.2	3.4	3.1
Energy (Gal/KWH)	252	4302	355	537	3219
Seat Miles per Gal or KWH	44	8	161	102	9
EASTBOUND					
Running Time (Hours)	3.5	3.1	3.3	3.4	3.1
Energy (Gal/KWH)	269	4519	369	567	3234
Seat Miles per Gal or KWH	41	7	155	97	9

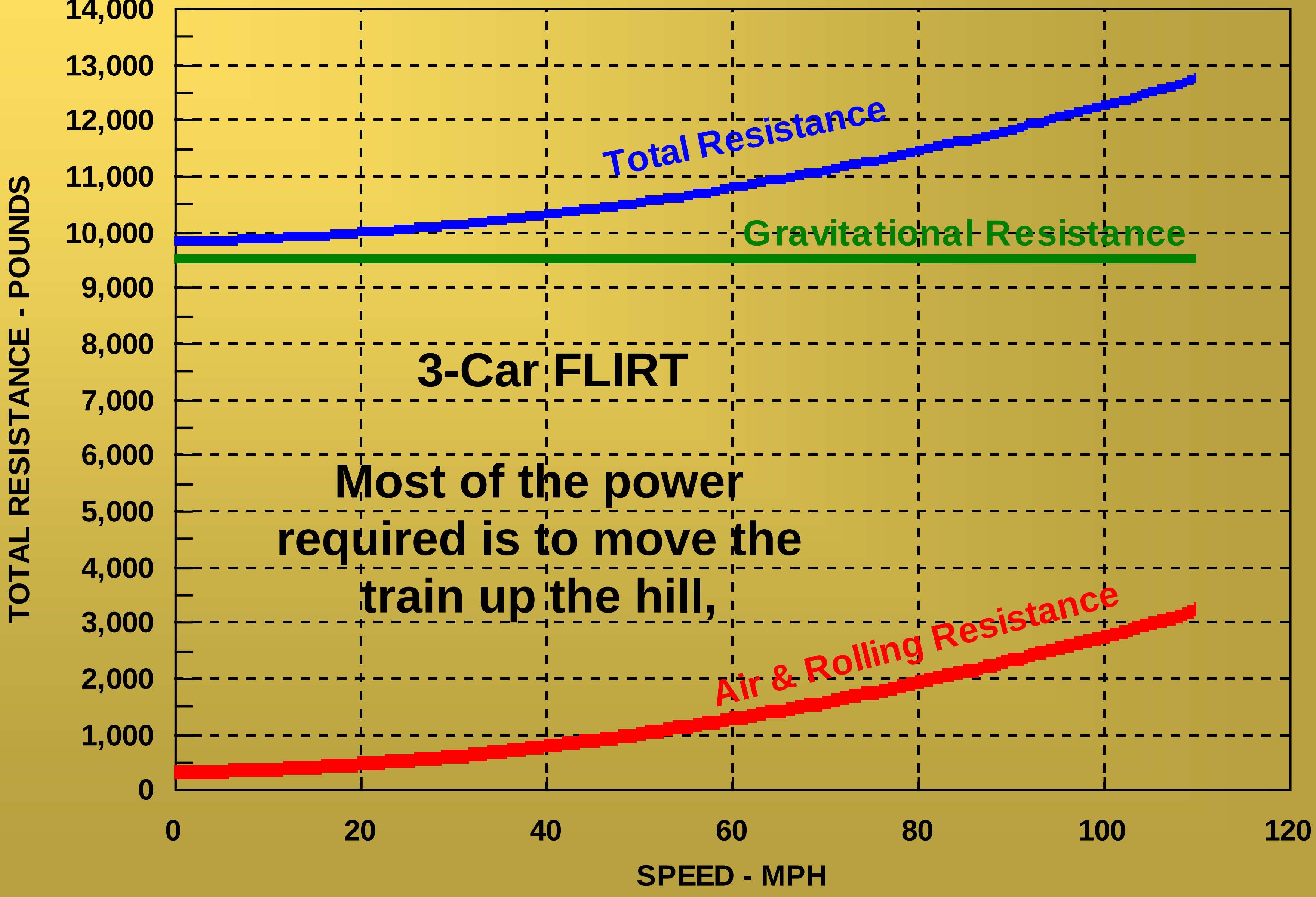
So What Do These Results Mean?

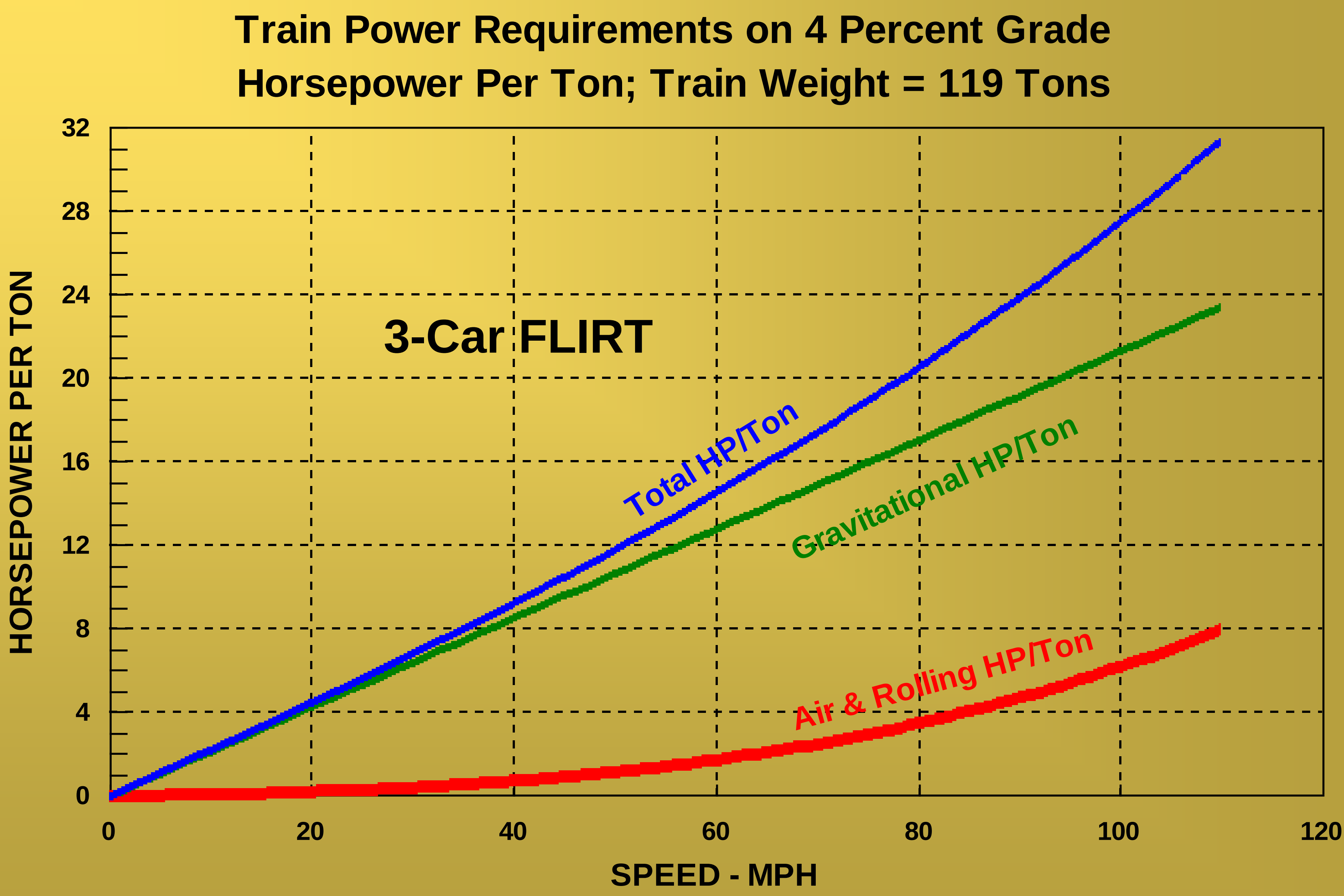
- Total times in either direction range from 3.1 to 3.5 hours – about a 25 minutes difference
- A speed limit of 110 is not as important as maintaining a high average speed
- Electric trains, with less weight (no heavy diesel engine) and with short term overload power draw offer superior performance in mountainous territory
- Carefully matching equipment, profile (grades, curves, mileage), limiting number of stops and duration suggest that total running time could be designed to be less than three hours

Emergency Stopping on Grades is a Critical Issue



Train Resistance on 4 Percent Grade
Total Train Weight = 119 Tons





Train Power Requirements on 4 Percent Grade
Horsepower Per Ton; Train Weight = 119 Tons
3-Car FLIRT
Total HP/Ton
Gravitational HP/Ton
Air & Rolling HP/Ton
HORSEPOWER PER TON
SPEED - MPH
0
4
8
12
16
20
24
28
32
0
20
40
60
80
100
120

The Proposed I-70 Corridor Railroad is Unique

- Line gradients (ruling grade) is critical in determining equipment requirements, safe speeds, and operating and maintenance costs
- Train weight is very important
- Required power to weight ratios are high, and increase as speed limits, weight and gradients increase (more power adds weight)
- FRA crash worthiness requirements (weight) need to be modified to focus more on accident avoidance and prevention

The Opportunity is Here…

- Needed technology is proven, off the shelf
- Highway alternatives are more expensive, less environmentally sound, less safe, and will incur years of construction related congestion
- A single track has more than twice the passenger carrying capacity of a single lane of highway

RAIL IS THE BEST SOLUTION TO ALLEVIATE I-70 CONGESTION AND PROVIDE CAPACITY FOR THE FUTURE

A Final Note…

California high-speed rail plan back on track for 700-mile route

Harrison Sheppard and Sue Doyle, Los Angeles Daily News Staff Writers. Wednesday, April 11,2007

SACRAMENTO -- Supporters of a $40 billion high-speed rail line in California are revitalizing their **decade-long battle for a 700-mile route**...

The plan for the transit corridor has languished for years, unable to overcome weak political support and strong criticism of its hefty pricetag.

…[A] record-breaking run by a French TGV train …has revived interest …[to] whisk passengers between Los Angeles and San Francisco in less than three hours.

"**<u>I think this is the future</u>** for California," said Assemblywoman Fiona Ma, D-San Francisco, …one of several state lawmakers who … witness[ed] the speed record.

"I think people are sick and tired of long commutes, tired of not knowing whether their plane is going to come in on time, tired of the high cost of gas and airline tickets," Ma said….

Still, the plan faces significant challenges.

"I think **it's a ridiculous boondoggle**," said Robert Poole, director of transportation studies at the Reason Foundation in Los Angeles….. "**Californians prefer driving their cars regardless of traffic**, and airlines already offer quick north-south routes at a reasonable price"

[Norm] King [director of the Leonard Transportation Center at Cal State San Bernardino] said **money would be better invested in highway projects because roads would create more congestion relief…**

The road ahead for the I-70 Coalition is not easy – it must stay focused and on track. (Pun intended.)