

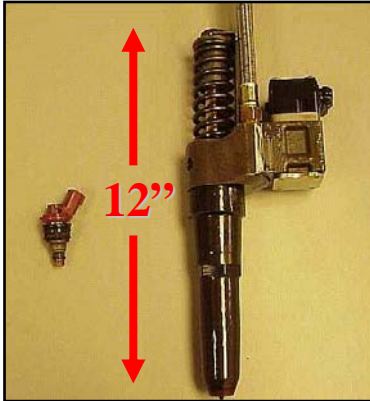


# **Locomotive Idle Reduction: Technology Issues**

**Union Pacific Railroad Company**

**National Idling Reduction Planning Conference  
Albany, NY ~ May 17-19, 2004**

# Diesel engines in perspective



**(L) Typical auto injector**

**(R) Typical locomotive injector**

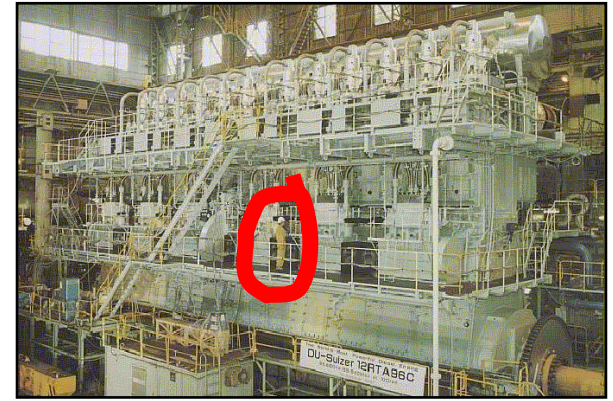


**Typical Loco. diesel engine ... 1500-to-4400 HP  
125-367 HP/cylinder**

**Weight 20+ tons**

**668 in<sup>3</sup> per cylinder**

**9" bore x 10.5" stroke**



**World's largest diesel engine ... 89,640 HP marine engine  
7,470 HP/cylinder**

**Weight 2,000 tons**

**111,144 in<sup>3</sup> per cylinder**

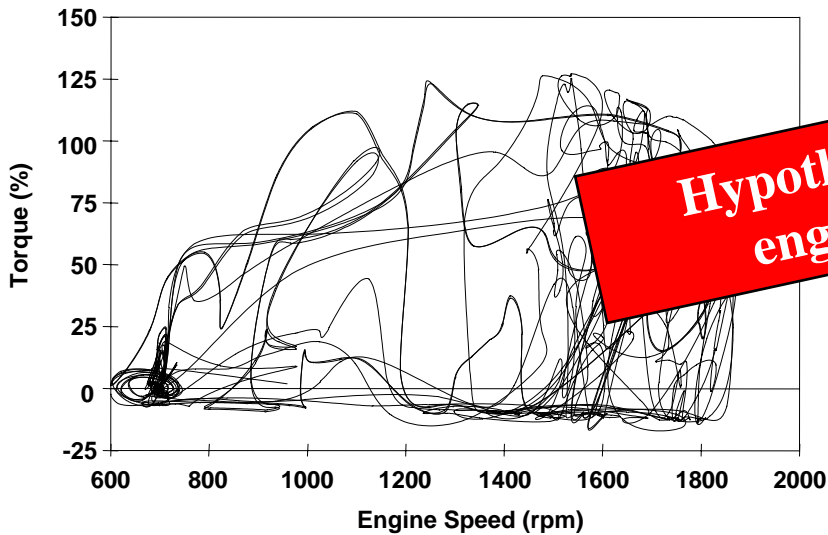
**38" bore x 98" stroke**

# What a loco. diesel engine does

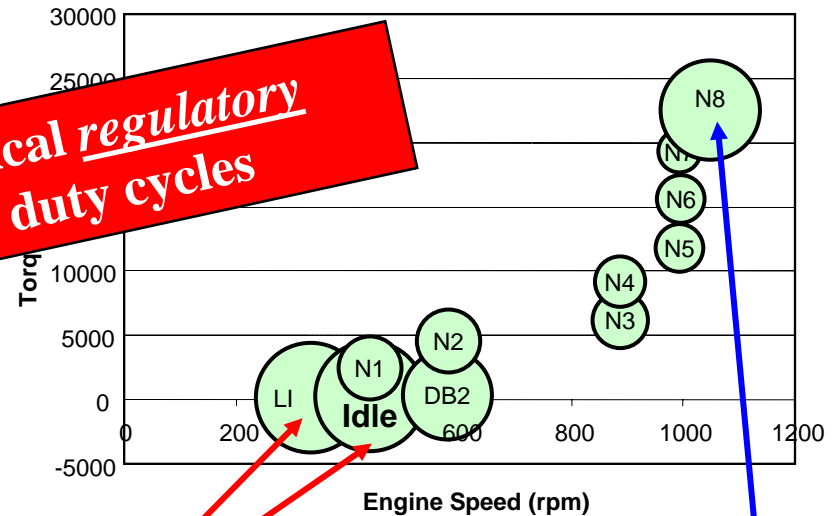
- ✓ Provides power for traction motors (ex: 4400 HP)
  - ⚡ Propulsion of train
- ✓ Provides auxiliary power (ex: ~110 additional HP)
  - ⚡ Cooling fans, blowers, controls, HVAC, etc.
- ✓ Enables use of “dynamic braking”
  - ⚡ Traction motors become generators
  - ⚡ DB energy dissipated thru resistance grids (not regen.)
  - ⚡ “Electric brake” to supplement train air brakes

# Truck v Locomotive operation

EPA Heavy Duty Truck Transient Cycle



EPA Loco Line-Haul Throttle weighting points



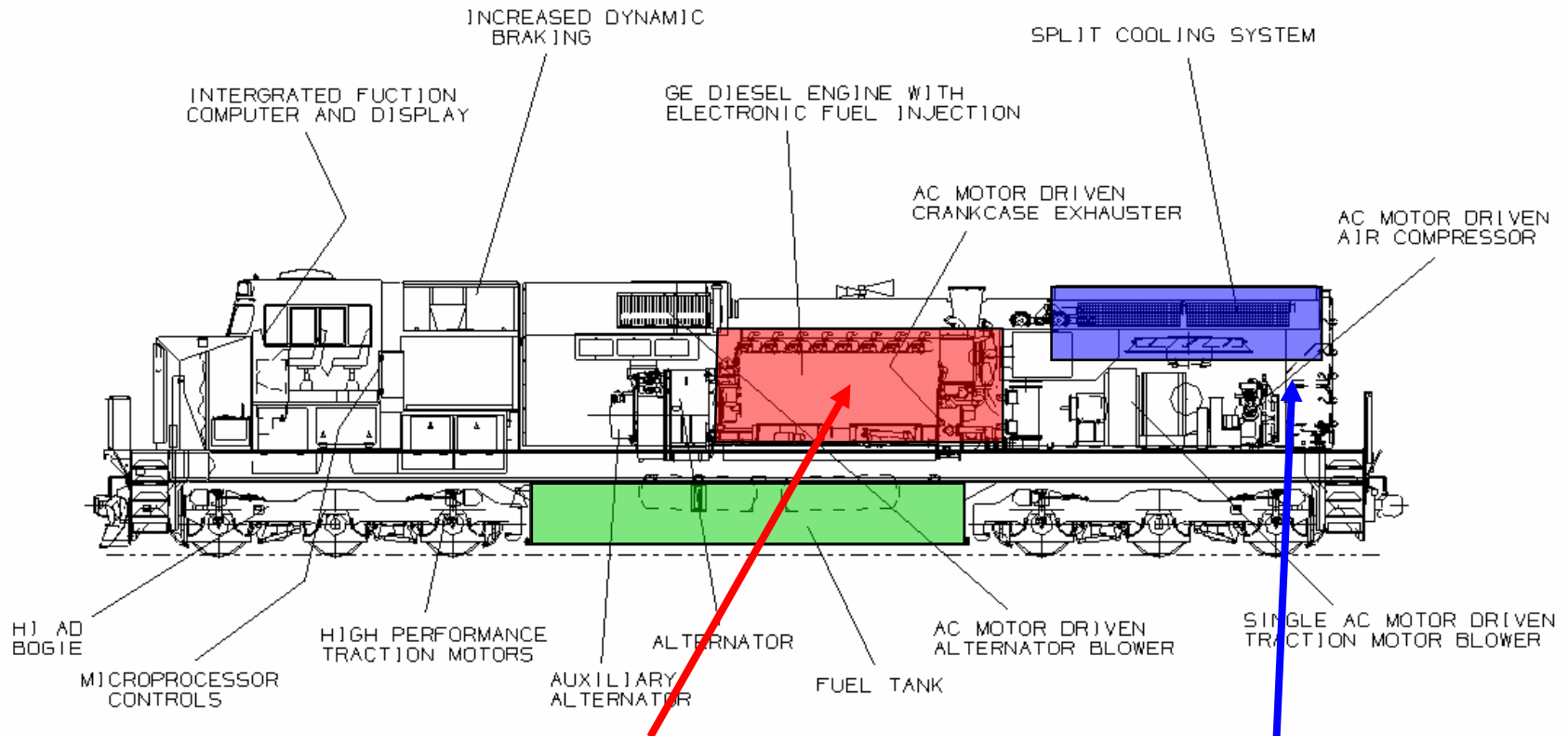
**% run time at idle  
& low-idle (typ. 4  
& <4 gal/hr)**

**% run time at full load  
(typ. 180-200 gal/hr)**

# Key Loco. Issues: idling v shut-down

- ✗ No antifreeze used (only corrosion inhibitors)
- ✗ Evolutionary design of locos 1939-present
- ✗ Fixed infrastructure: tunnel clearances, etc.
- ✗ No volume onboard for larger glycol radiators
- ✗ “Onboard attendant”: Trucks 1:1, Locos. 1:3+  
(and *sometimes unattended* rear- or mid-train)
- ✗ Large mass of engines, typ. 40K# 12~16 cyl.
- ✗ Extensive interchange of locos between RRs

# 4400 HP “AC” road locomotive



**12~16 cylinder diesel engine weighs 40,000#**

**0-75 MPH capability**

**Can haul 3,300 tons up 2.2% grade at 10 MPH**

**Measures 76' long x 10' wide x 16.3' high**

**Weighs 425,000 pounds**

**Carries 5,000 gallons fuel & 425 gallons coolant**

# N. American railroads & locomotives

- ✓ **Class I RRs: 5 US, 2 Canada, 2 Mexico; Amtrak passenger; x00s “short lines” & commuter operators**
- ✓ **26,000 locomotives in service today**
  - ⚡ **2 OEMs ... *GM Electro-Motive Division & GE Rail***
  - ⚡ **Union Pacific RR: 5,000 road + 2,000 yard = 7,000 total**
- ✓ **1972-2002 US production:**
  - ⚡ **435,197,000+ automobiles (gasoline)**
  - ⚡ **11,295,000+ heavy trucks (small-bore high-speed diesel)**
  - ⚡ **22,089 locomotives (large-bore medium-speed diesel)**

# **Diesel engine R&D funding**

- ✓ **\$300+ million in *federal* funds for truck engine research past 5 years**
- ✓ **\$225+ million in *railroad industry* funds (OEMs and railroad customers) for locomotive diesel research in past 5 years**



# Fuel efficiency factors ~ Railroads

## ✓ Technology

- ✦ Locomotives: diesel engines & transmission (AC v DC)
- ✦ Idle reduction procedures & technologies
- ✦ Other

## ✓ Human factors

- ✓ Train handling practices
- ✓ Train dispatching practices

## ✓ Geography (fixed) & weather (variable)

# Locomotive idle reduction

- ✓ Reduces overall fuel consumption
- ✓ Reduces air emissions
- ✓ Idle time affected by operating parameters ...  
train type, geographical area (west, midwest, east), weather
- ✓ Is one technology in a complex set of tools  
for fuel management

# Loco fuel consumption rates

- ✓ Idling: ~4 US gallons/hour
- ✓ Full throttle: 180-200 US gallons/hour
  
- ✓ Estimated UP fuel consumption:
- ✓ 95% over-the-road (low idle time potential)
- ✓ 5% in-yard (moderate idle time potential)
  
- ✓ **UP: 14% improvement in fuel efficiency since 1999 due to all combined initiatives**



**(left) Typical 3-unit consist, crew on 1st unit**



**(right) single yard unit (with remote-control car)**

**135-car unit coal train (20,000 tons) with 2+2+2 locomotive configuration (below):**



**2 Distributed Power units on rear-end (unmanned)**



**2 Distributed Power units at mid-train (unmanned)**



**2 primary units on head-end of train (lead unit manned)**

**67 cars (3,571') apart**

**68 cars (3,625') apart**

# UP locomotive fleet

✓ 5,000 road units (3000-4000-4400-6000 HP/unit)

✦ 35% acquired new since EPA loco regulations 1-1-2000

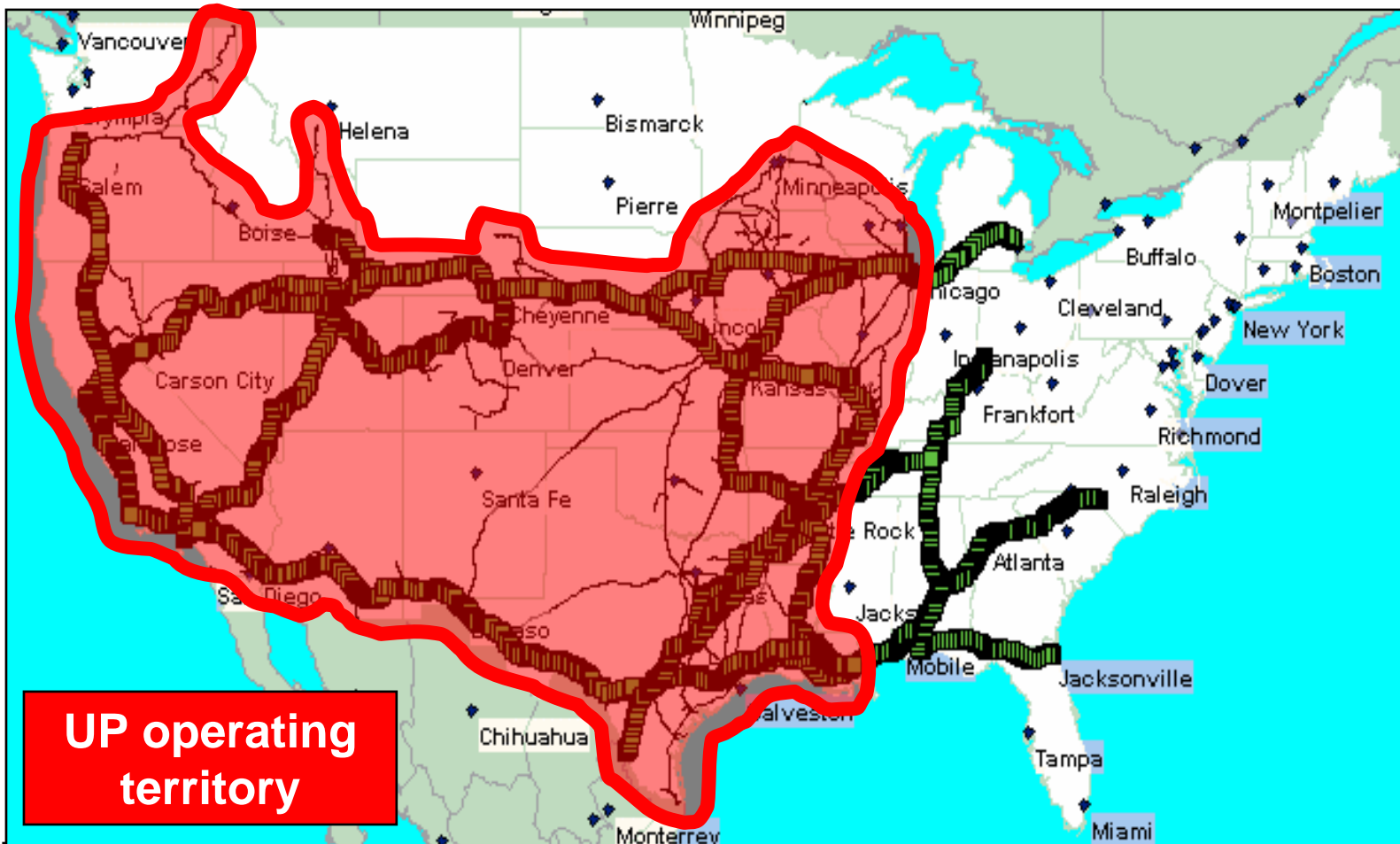
✦ Auto stop-start on 500+ GM-EMD and 300+ GE (OEMs)

✓ 2,000 yard+switch units (1500-2300 HP/unit)

✦ Auto stop-start on 600+ low-HP units (retrofit)

✓ About 1,400 UP locos (*20% of total fleet*) now equipped with auto engine stop-start idle-reduction technology

# Transcontinental & International operation of locomotives

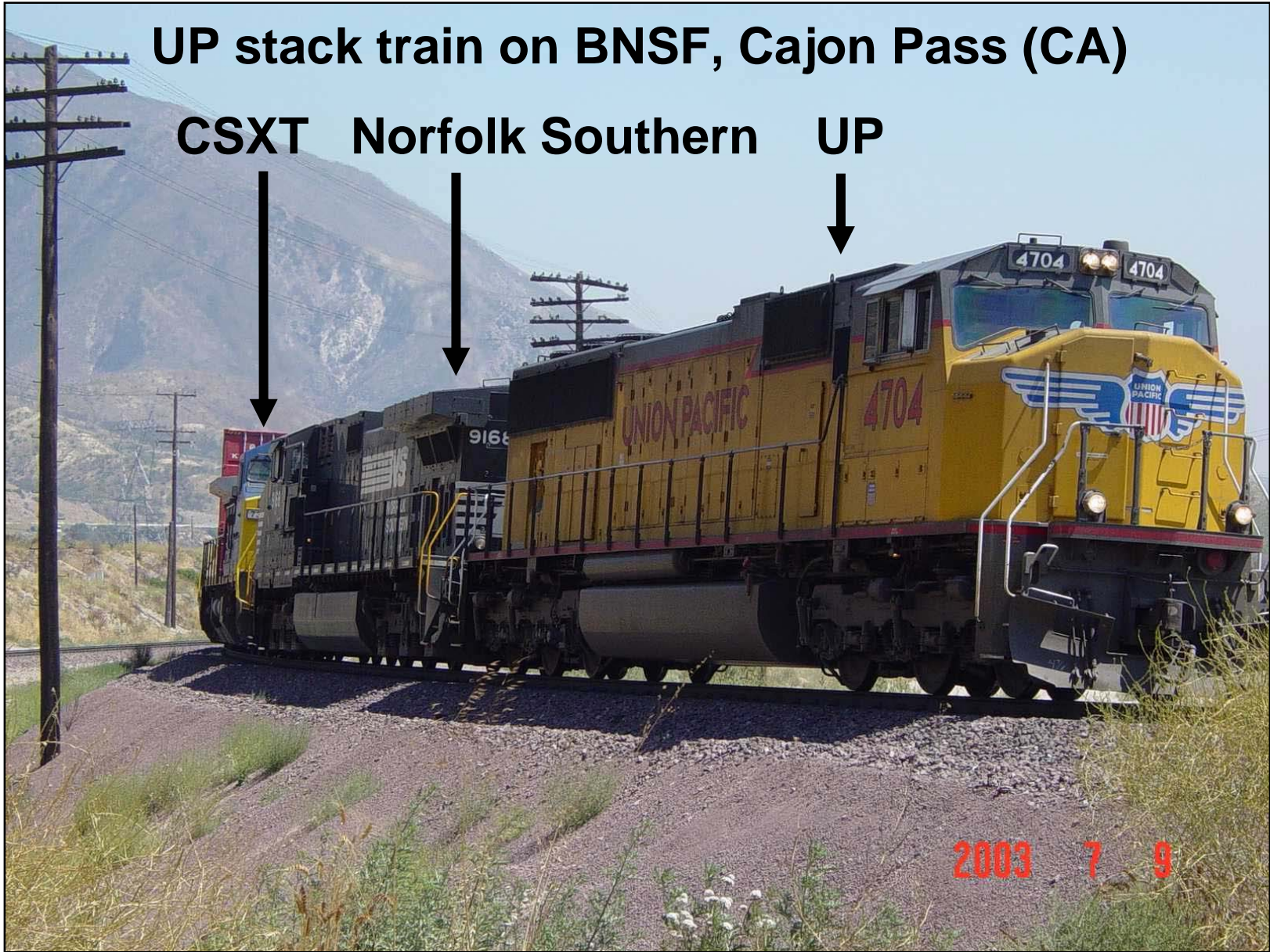


**UP operating territory**

**60-day GPS movement track: UP road locomotive**

# UP stack train on BNSF, Cajon Pass (CA)

CSXT   Norfolk Southern   UP



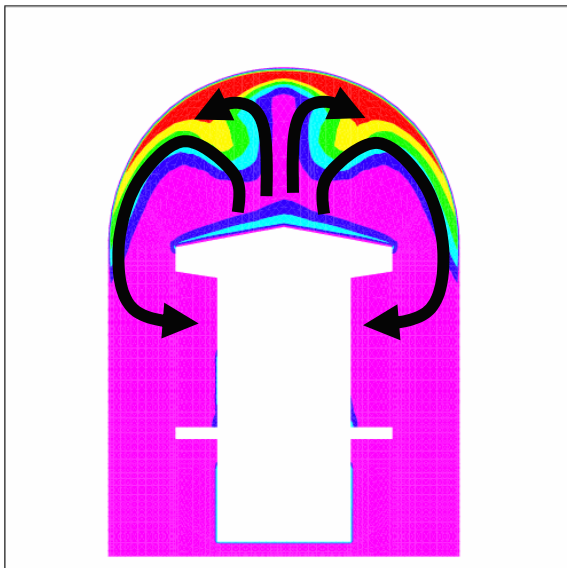
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# **Auto engine stop-start technologies**

- ✓ **OEM auto stop-start on high-HP locomotives**
- ✓ **Retrofit stop-start for older low-HP locos**
- ✓ **“Plug-in” heaters used on Chicago commuter locos (owned by Reg. Transp. Authority)**
  - ✦ **Locos stay overnight at same location repeatedly**
- ✓ **Have reviewed APU (auxiliary power unit)**
  - ✦ **Could power auxiliaries such as cab air conditioning**
  - ✦ **Declining need: air conditioning on remote yard units**



# Loco operation in tunnels ... technical challenge re radiator design



# Locos cannot get higher or wider ... nor much longer!

Maximum  
freight car  
height on  
special  
designated  
routes  
20'3"



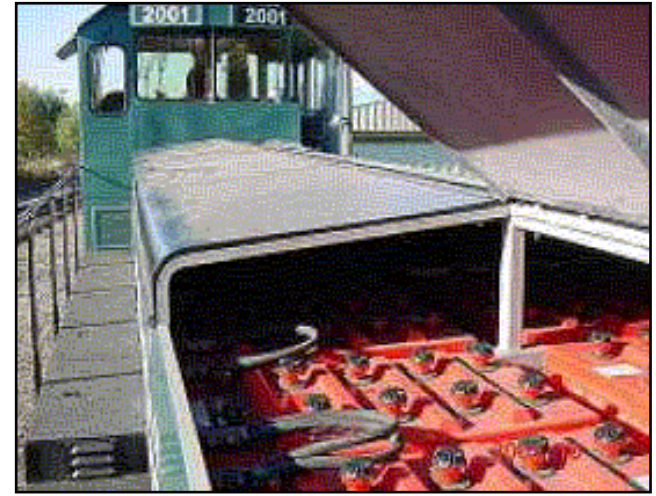
Unrestricted  
locomotive  
height on  
any AAR-  
member  
railroad  
16'3"

10'3"  
wide

# Yard loco technology under review

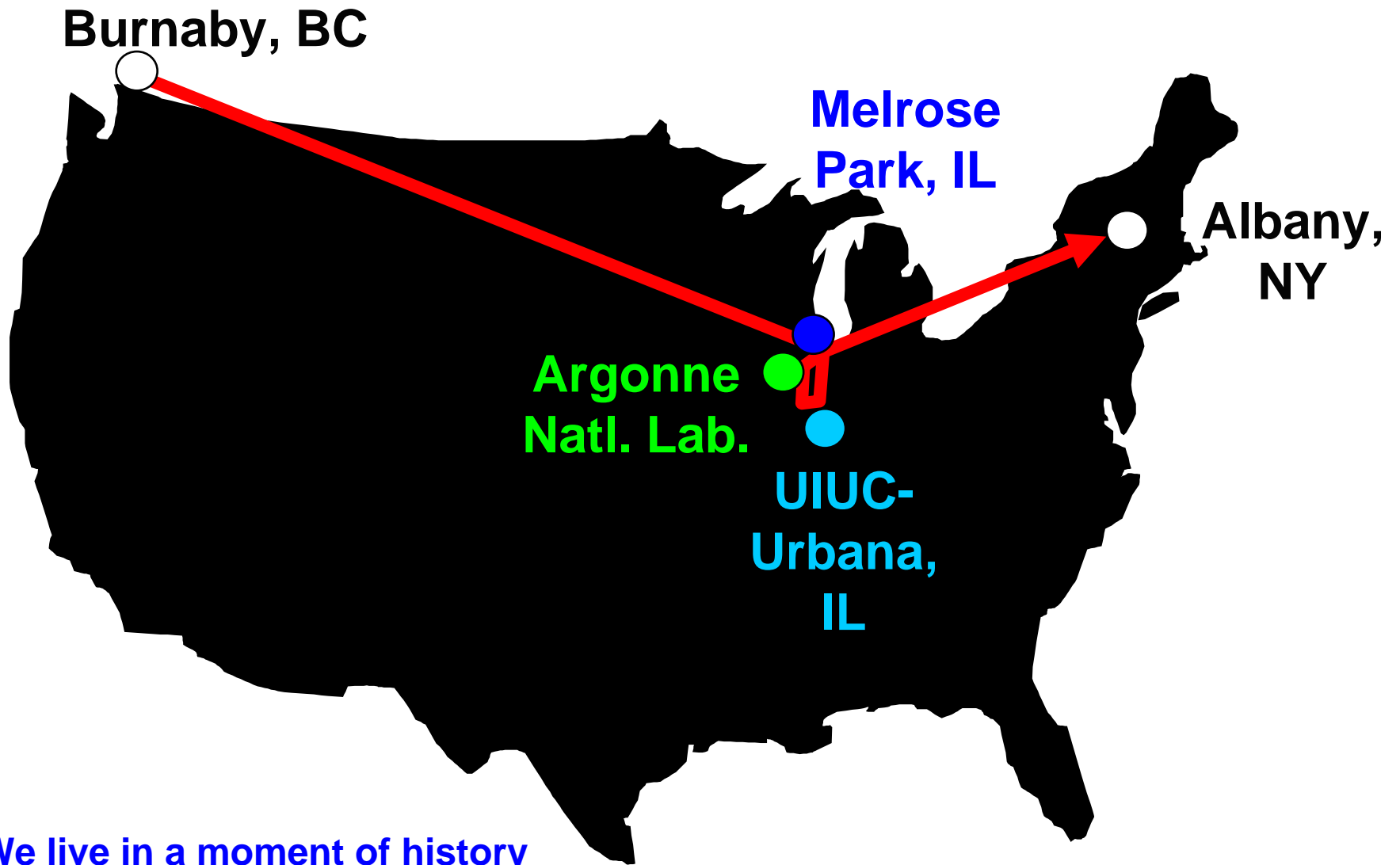
## ✓ Hybrid yard switcher

- ✦ *Battery bank powers traction motors, truck-engine alternator recharges batteries*
- ✦ **Glycol+Water coolant (improved shut-down capability)**



## ✓ Truck-engine yard switcher

- ✦ *Truck-engine gen sets replace large-bore loco engine*
- ✦ **Glycol+Water coolant (improved shut-down capability)**



"We live in a moment of history where change is so speeded up that we begin to see the present only when it is already disappearing."

R. D. Laing, *"The Politics of Experience"*



# Questions & Comments