

# “Engines of Change”<sup>SM</sup>

## DEPLOYMENT OF THE WORLD’S CLEANEST LOCOMOTIVE TECHNOLOGIES

Lanny A. Schmid ~ Union Pacific Railroad Company  
Faster Freight Cleaner Air 2006 Conference  
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Union Pacific

## Environmental Policy



*Union Pacific Railroad is committed to protecting the environment for our customers, our employees, and the communities in which we live. We strive to meet the highest principles of environmental responsibility in our role as a leader in transportation.*

**“Environmental protection is the responsibility of every UP employee.”**

Jim Young, Chairman, President & CEO



*Union Pacific employees accomplish this through:*

### Stewardship

- ☑ Protecting the natural resources where we operate
- ☑ Promoting the efficient use of energy
- ☑ Conserving resources through waste minimization, recycling and reuse of materials

### Relationships

- ☑ Building relationships based on common safety and environmental goals
- ☑ Openly communicating with government agencies and communities

### Process

- ☑ Assessing our environmental performance using measurable business objectives
- ☑ Using assessment results to guide environmental management improvement strategies

### Results

- ☑ Meeting and exceeding compliance standards of environmental laws and regulations
- ☑ Supporting development of effective and balanced environmental laws and regulations
- ☑ Practicing and continually improving healthy work activities



## LOCOMOTIVE TECHNOLOGIES

### →EPA Tier Requirements Apply

- ✦ Standards for new Tiers 0, 1, and 2
- ✦ Include in-use testing, rebuilds, and retrofits

### →EPA Tier 3/4 Rulemaking

- ✦ NPRM (new standards) to be published 1Q07
- ✦ Likely to include aggressive rebuild/retrofit requirements
- ✦ Anticipate technology forcing elements Includes in-use testing, rebuilds, and retrofits

### →Underlying Principles

- ✦ Frugal use reduces both consumption & emissions
- ✦ Most older units retired when replaced



## LOCOMOTIVE TECHNOLOGIES

### →Acquisitions of New Locomotives

### →Retrofit Existing Equipment

### →Operational Aspects

### → Innovative Concepts



# LOCOMOTIVE TECHNOLOGIES

- **Acquisitions of New Locomotives**
- Retrofit Existing Equipment
- Operational Aspects
- Innovative Concepts



# ACQUISITIONS

- **Road - Line Haul - High Horsepower**
  - ✓ Produced by GE and EMD
  - ✓ Current fleet of 6500+ locomotives
  - ✓ Over 2400 are Tier 0, 1 or 2
  - ✓ Acquire 200-300 per year on average
- **Switch - Yard Job - Low Horsepower**
  - ✓ Produced by EMD, NRE, RailPower, MPI, others
  - ✓ Current fleet of 1700+ locomotives
  - ✓ Most are 20+ year old locomotives
  - ✓ Acquire 160 by 7/2007 (all ULEL's)



## ACQUISITIONS - GE ROAD LOCOMOTIVE



*UP C45ACCTE Tier 2*

*300+ GE Tier 2 units delivered to  
UP since January 2005*

**Built by GE Rail**

**EPA Tier 2 certified (<5.5 gr/BHp-Hr NOx & 0.20 PM)**

**4400 HP16-cylinder diesel engine w/ EFI**

**Equipped with Automatic Engine Stop-Start (“AESS”)**



## ACQUISITIONS - EMD ROAD LOCOMOTIVE



*UP SD70ACe Tier 2*

*150+ EMD Tier 2 units delivered  
to UP since January 2005*

**Built by Electro-Motive Diesel (“EMD”)**

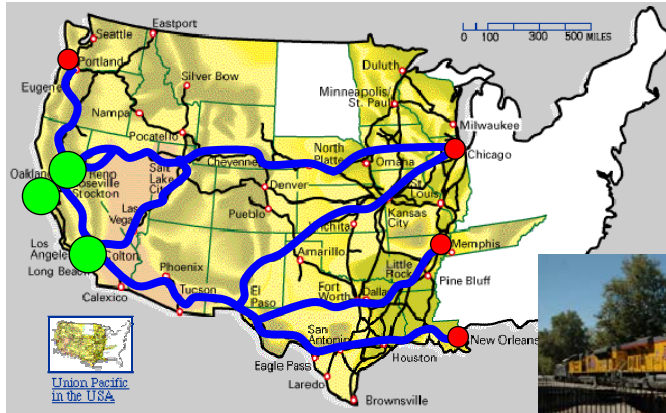
**EPA Tier 2 certified**

**4400 HP16-cylinder diesel engine w/ EFI**

**Equipped with Automatic Engine Stop-Start (“AESS”)**



## ACQUISITIONS - ROAD UNITS for CA



UP has acquired 440 EPA Tier 2 line-haul locomotives in 2005 & 2006



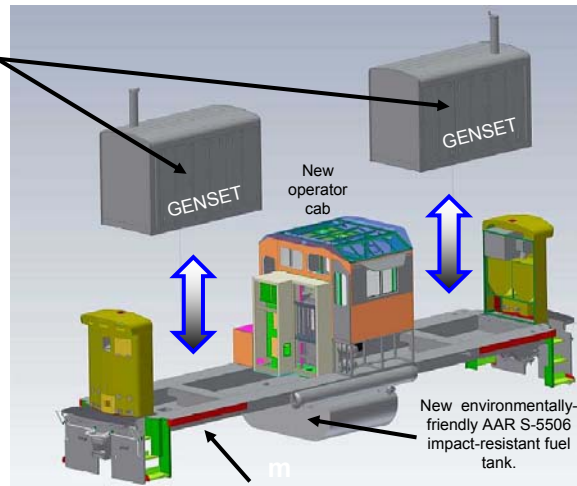
UP's EPA Tier 2 line-haul freight locomotives are used on trains to~from California (Roseville, Oakland & Los Angeles/Long Beach areas)



## ACQUISITIONS - GENSET CONCEPT

Each genset is a modular self-contained package:

- low-emissions EPA Tier 3 nonroad diesel engine
- electrical generator
- cooling system with antifreeze (automatic idle-elimination by shutting-down to 20F)
- replaceable as a complete package ("plug and play") when engine requires major repairs/overhaul



Basic locomotive platform can be remanufactured.




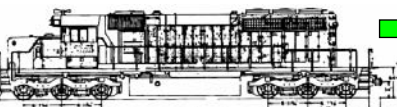
## ACQUISITIONS - GENSET LOCOMOTIVES


1400 HP genset prototype unit UPY 2005 (\*) ...  
(2) 700 HP Tier 3 nonroad gensets in modular packages



  
2000 HP EMD GP38-2 Los Angeles switcher  
with (1) large diesel engine on 4-motors

  
2100 HP genset Los Angeles switcher  
with (3) 700 HP gensets on 4-motors (\*\*)

  
2000 HP EMD GP38-2 Roseville hump unit  
with (1) large diesel engine on 6-motors

  
2100 HP genset Roseville hump unit  
with (3) 700 HP gensets on 6-motors (\*\*\*)

(\*) UP funded construction of the genset prototype UPY 2005.

(\*\*) UP is reviewing bids to acquire (60) of these units for service in the Los Angeles area.

(\*\*\*) Sac Metro & Placer County APCDs providing incentive funds for building 4 hump units.



## ACQUISITIONS - GENSET ATTRIBUTES

### → Quantum improvement over existing units

- ✓ Up to 80% reduction in NOx & PM compared to existing yard units (using EPA's test protocol)
- ✓ Minimum 15 to 20% reduction in diesel fuel use
- ✓ Reduction in lineside noise due to engines
- ✓ Emissions @ switch duty cycle (grams/brake hp-hr) for a genset are <3.0 for NOx, 0.05 for PM & 1.51 for CO

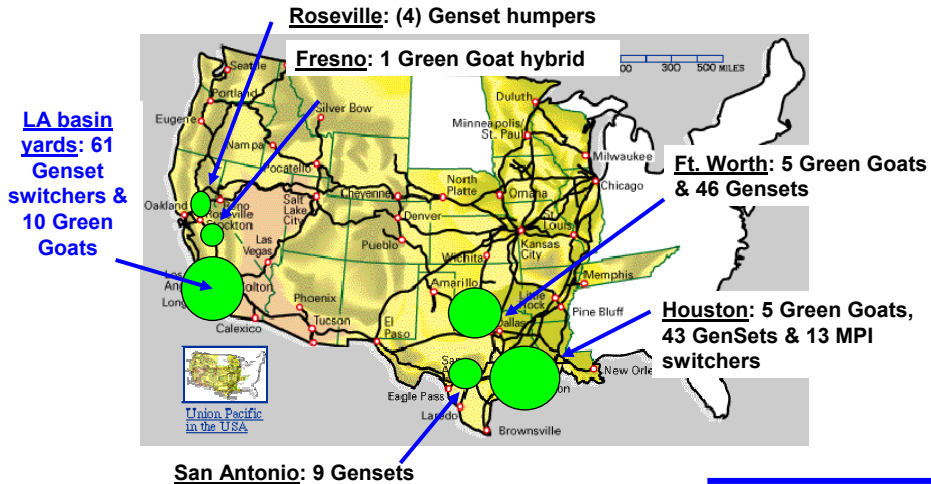


☞ CARB Ultra-Low Emitting Locomotive ("ULEL") status

☞ EPA Tier 2 locomotive certified



## ACQUISITIONS – GENSET & ULEL DEPLOYMENT ON UPRR SYSTEM



## LOCOMOTIVE TECHNOLOGIES

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## RETROFIT

- Shutdown Devices (ICD's)
- Diesel Particulate Filters (DPF's)
- Diesel Oxidation Catalysts (DOC's)
- Selective Catalytic Reduction (SCR)



## RETROFITS - SHUTDOWN DEVICES

- Function - designed to maintain 'vital signs'
  - ✓ Air, battery charge, and fluids
  - ✓ Typically achieves 1.5 - 2.5 ton/year NOx reduction
- Supplied by ZTR, Kim Hot Start, EcoTrans, others
  - ✓ Current fleet of 8500+ locomotives
  - ✓ Over 2900 equipped (either OEM or retrofits)
  - ✓ Retrofit ~100 a year with ZTR controls





## RETROFIT - DPF RESEARCH/DEVELOPMENT



*Two UP 1500 horsepower switchers were equipped with DPF technology in 4Q '06; now being tested for maintainability, durability and emissions performance in California*

UP & BNSF co-funded a \$5 million R&D project (CY 2000 start) to develop & evaluate DPF's on older switching locomotives

R&D work performed by *Southwest Research Institute* ("SWRI") through Association of American Railroads ("AAR")

No technical precedent ...*European locomotives have NO in-service testing due to type of locomotives equipped*



## RETROFIT - DOC RESEARCH/DEVELOPMENT



*One 3800 HP road unit has been fitted with a DOC and is being tested in Commerce CA to evaluate ops performance, maintainability, durability and emissions reductions*

EPA & UP co-funded an R&D project to install & evaluate a DOC on an older road locomotive

R&D work performed by *Southwest Research Institute* ("SWRI")

One year test planned w/ possible additional retrofits to accelerate the data gathering process



## RETROFIT - SCR RESEARCH/DEVELOPMENT

- ➔ No known locomotives now equipped in the world
- ➔ R&D is being pursued by major locomotive manufacturers
- ➔ Challenges that must be overcome
  - ✦ Safety concerns & hazmat issues
  - ✦ Space constraints & physical clearance



## ACQUISITIONS vs. RETROFIT



UP 7606 & UP 7605



UPY 2701



UPY 1378



UP 2368

	<u>UP 7606 &amp; UP 7605</u>	<u>UPY 2701</u>	<u>UPY 1378</u>	<u>UP 2368</u>
Model	"Evolution"	"Genset"	"MP15"	"SD60M"
Builder	GE	National Rwy.	GM-EMD	GM-EMD
Type	Road service	Yard switching	Yard switching	Road service
Status	In-use	In-use	Experimental	Experimental
Service	Transcontinental	LA rail yards	Oakland rail yard	LA basin
Build date	Feb. '07	Jan. '07	Jun. '80	Oct. 89
Horsepower	4400 HP	2100 HP	1500 HP	3800 HP
EPA certification	Tier 2	Tier 2 & Ca ULEL	Tier 0	Tier 0
Engine status	New	New (3 engines)	Overhauled '06	Overhauled '06
Aftertreatment?	None	None	Particulate filter	Oxidation catalyst
NOx cert. limit*	5.5	5.5 (ULEL=4.0)	14.0	9.5
EPA NOx actual w/o Aft.*	5.3	2.8	11.4	8.4
EPA NOx actual w/ Aft.*	n/a	n/a	11.1	8.1
EPA PM limit*	0.20	0.20	0.72	0.60
EPA PM actual w/o Aft.*	0.10	0.05	0.50	0.39
EPA PM actual* w/ Aft.*	n/a	n/a	0.08	0.17



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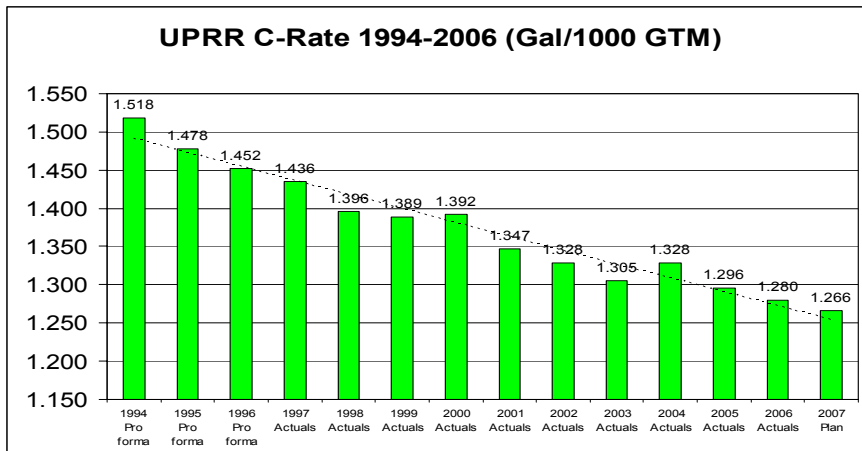
## OPERATIONAL - CONTINUING EFFORTS

- **Shutdown Training**
  - ✓ Updated program materials and process
  - ✓ Trained 3600+ employees in CA since Jan '06
- **Fuels**
  - ✓ Dispensing 99+% ultra low sulfur diesel in CA
  - ✓ Closely monitoring all fuels research efforts
- **Train Operations**
  - ✓ Scheduling/building trains & managing car inventory
  - ✓ Aggressive locomotive engineer training, testing and monitoring



## OPERATIONAL - CONTINUING EFFORTS

Resulting 12% reduction in usage since 1995 (thru 2006)



## OPERATIONAL - NEW PROGRAMS

### → Fuel Masters

- ✓ Incentives for engineers to conserve fuel
- ✓ Significant reductions on selected routes
- ✓ Reduced consumption by >60 MM gal since 2005
- ✓ Full text of release is at  
[http://www.uprr.com/newsinfo/releases/environment/2006/0428\\_fuel\\_economy.shtml](http://www.uprr.com/newsinfo/releases/environment/2006/0428_fuel_economy.shtml)

### → Communications Based Train Control (CBTC)

- ✓ Significant initiative announced January, 2007
- ✓ Ultimately 5 yr \$1 billion revolutionary demonstration



## OPERATIONAL – CBTC DETAILS

- Locomotive control & operations technology
- Testing in 3Q07 thru mid 2009
- Spokane and South Morrill subdivisions
- Initial \$20 million project
- Several major benefits
  - ✓ Enhanced safety, fewer hazmat releases/derails
  - ✓ Monitors compliance & automatically intervenes
  - ✓ Significant environmental implications

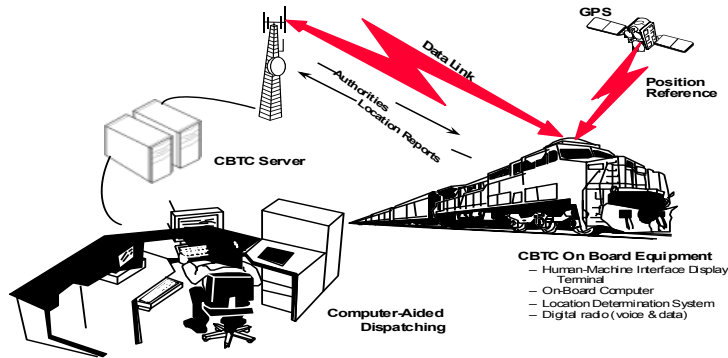


## OPERATIONAL – CBTC & EMISSIONS

- Local energy model in on-board computer
- Projected 6-8 % fuel savings
- Increased rail system fluidity & efficiency
- Reduced crossing delays
  - ✓ Corollary reduction in motor vehicle idling
- Greater predictive & analytical capabilities



## OPERATIONAL – CBTC CONCEPT



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## INNOVATIONS

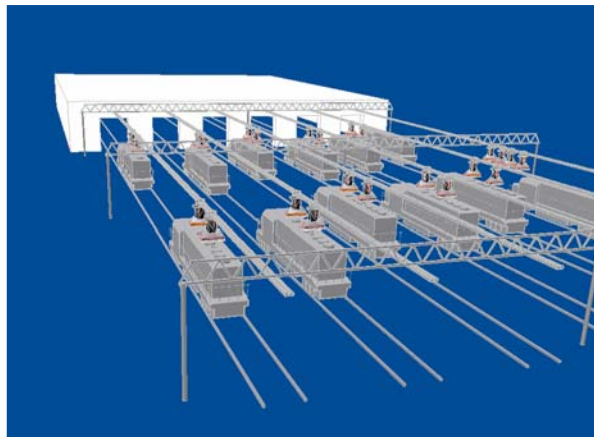
### → Advanced Locomotive Emissions Control Systems (ALEC's)

- ✓ 'Proof of Concept' demonstration at Roseville 3Q06
- ✓ Capture emissions in yards/around shops
- ✓ Evaluated collector, scrubber, cost and cost effectiveness
- ✓ Final report in March, 2007 will identify next steps, provide empirical data on life cycle costs, and summarize the scrubbers removal efficiency



## INNOVATIONS – ALECS

**Maintenance  
Yard and/or  
Test Facilities**



## Questions & comments

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