

Diesel Pumping Efficiency Program

A Multi-Purpose Resource Management Program



- Helping California to...
- Clean the Air
 - Conserve Water
 - Conserve Energy
 - Protect Water Quality



DPEP – How does it do this?...

1. Improving the overall pumping plant efficiency
2. Improving management of the plant

In other words...

- Get more water production for every gallon of diesel burned and...
- Thus, decrease emissions per unit water produced, while...
- Minimizing the amount of water pumped



DPEP – The Foundation Thesis...

The pumping plant is a SYSTEM of 3 mechanical components and one human component...

1. The engine itself (up to ~30 – 35% efficient)
2. Power transmission - driveshaft, v-belts, right-angle drives, etc. (up to ~95 – 97% efficient)
3. The pump itself (up to ~75 – 85% efficient)
4. Management
 - Specification/design of the pumping plant
 - Maintenance of the pumping plant
 - Operation of the pumping plant



DPEP Foundation Thesis...

To the extent that there are **INEFFICIENCIES** in any one of these components then emissions are increased...

1. Emissions per unit water are increased – inefficient hardware
2. Pumping time is increased – inefficient management



DPEP Focus – the PUMP itself...

- ❑ An efficient pump will produce more water per gallon of diesel consumed than an inefficient pump
- ❑ Thus, an efficient pump results in less emissions per unit water produced
- ❑ An efficient pump is like an efficient engine – no matter how long it is run, emissions are reduced



DPEP – Analogy to automobiles

- ❑ Programs like Moyer basically “install a catalytic converter” (Tier III and IV engines) in that they reduce the emissions per gallon fuel consumed.
- ❑ Programs like DPEP basically “improve fuel economy” (higher pumping plant efficiency) and reduce emissions by reducing the total amount of fuel consumed.



DPEP Implemented on Pilot Basis...

- Funding:
 - West Coast Collaborative
 - Valley CAN

- Total Goals (all goals exceeded!):
 - 62 pump efficiency tests
 - 11 pump retrofit projects

- Geographic Area:
 - Central and Southern San Joaquin Valley



DPEP Results...

- ❑ 67 Pump Efficiency Tests total, 58 were before retrofits (57 wells, 1 booster) w/ 17.1% average OPE (22-24% attainable)
- ❑ 20 wells and 1 booster committed to repairs
- ❑ 11 well pump retrofit projects completed with 11 post-tests

	Before	After
OPE	13.5%	23.2%
GPM	754	1010
Brake HPinput	80	86
Engine RPM	1734	1696
Input HP-hrs per ac-ft	2237	1319

- ❑ Implied emissions reduction – average pump repair 3.6 tons NOx and 0.16 tons PM10
- ❑ Average direct cost per project (two tests plus rebate) - \$3,800



DPEP – Phase II Just Completed...

- ❑ Help develop pump test infrastructure

- ❑ Components:
 - Complete pump test calculation/report/databasing software
 - Instructions for fuel flow device construction and operation
 - On-site visits to transfer knowledge

- ❑ Funding: Valley CAN



Verification of Emissions Reduction...

Moyer:

- Keys on emissions/hour
- Per unit reduction verified by engine manufacturers
 - is engine kept in tune, run at correct rpm and load?
 - persistence of engine performance?
- total emissions determined based on hour meter – self-reported unless inspected

DPEP:

- Keys on emissions/Ac-Ft
- Per unit reduction verified by in-field pump test
 - test at normal operating conditions?
 - persistence of pump performance?
- Total units determined based on flow meter – self-reported unless inspected



Verification of Emissions Reduction...

- Verification for DPEP can be achieved to same level of confidence as current Moyer
 - Per unit reduction by accepted measurements - standard pump efficiency test vs. manufacturer's data
 - Same types of variances apply - manufacturing tolerances, tune of engine, management of engine, persistence
 - Total emissions based on an accepted (and self-reported meter) – hour meter for current Moyer, flowmeter for DPEP

- Current Moyer guidelines allow for non-engine measures



Next Step...

Full-scale Diesel Pumping Efficiency Program for 3-5 years

- ~ 800 pump tests/year
 - ~ 100-125 pump retrofit/rebuild projects/year
 - ~ 10 educational seminars in field/year + educational materials
- Numbers based on current census of engines and “what market will bear”



Diesel Pumping Efficiency Program...

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Also – see www.pumpefficiency.org for information on the Ag Pumping Efficiency Program (the model for DPEP)



Peter Canessa – Program Manager...

- ❑ M.S. Irrigation and Drainage
- ❑ Registered Agricultural Engineer in California
- ❑ 30 Years in Ag Water and Energy Management
 - Teaching at Cal Poly – SLO & CSU Fresno
 - 10 yrs consulting in Ag energy efficiency programs for PG&E
 - Irrigation scheduling and system design software
 - Non-point source pollution reduction/control programs
 - Water conservation program design and implementation
 - Consultant to San Diego County Water Authority in IID-SDCWA water transfer
 - NSW, Australia – on-farm and irrigation district-level water management improvements
 - Program Manager – Ag Peak Load Reduction Program
 - Program Manager – Ag Pumping Efficiency Program



Today's discussion...

1. Thesis Supporting the Diesel Pumping Efficiency Program
2. Design and Implementation of the DPEP
3. Results from the Pilot-Level DPEP
4. Verification of Emissions Reductions



Center for Irrigation Technology...

- Hydraulic Laboratory Testing
- Applied Research
- Special Projects
- Education
- A part of:

College of Agricultural Sciences and Technology,
California State University at Fresno



Diesel Pumping Efficiency Program...

A multi-purpose resource management program for:

1. Air Quality
2. Energy Conservation
3. Water Conservation
4. Water Quality



Current pilot-level DPEP...

- Components:
 - 62 pump efficiency tests
 - 11 pump retrofit projects

- Funding:
 - Region 9 Federal EPA
 - Valley CAN

- Geographic Area:
 - Central and Southern San Joaquin Valley

- Timing:
 - Initiated June, 2005--final reports due Fall, 2006



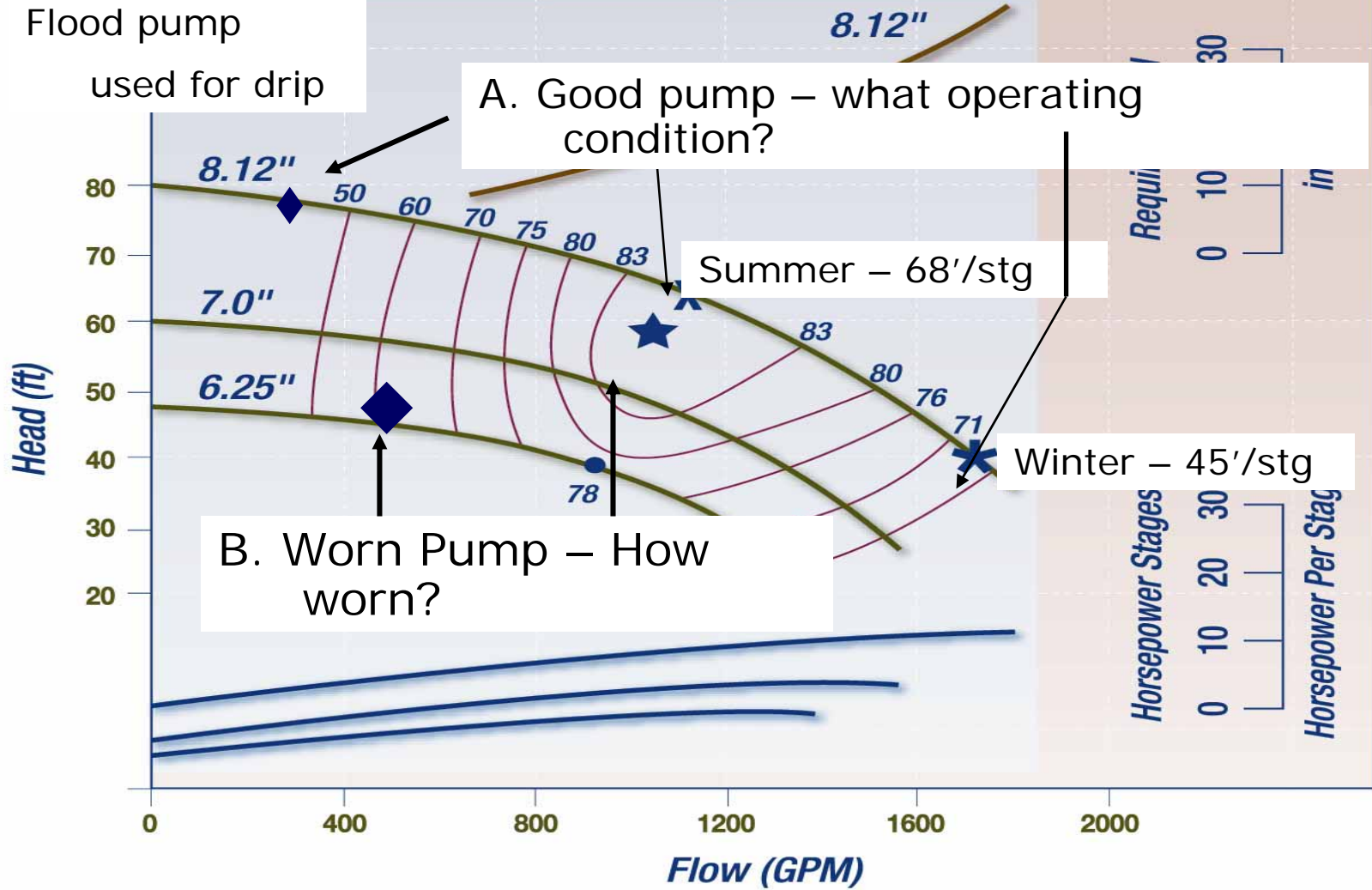
Why does a pump become inefficient?

If OPE is poor, or the flow/head is not sufficient:

- The pump may be physically deteriorated
- The required “operating condition” has changed
 1. Well has deteriorated
 2. Change in irrigation system
 3. Systemic change in water table



Variable Operating Condition



DPEP Components...

Currently, the pilot-level DPEP provides...

1. Subsidized pump efficiency tests
2. Incentive rebates for a pump retrofit

A full-scale DPEP would add...

3. Education to improve management
(see www.pumpefficiency.org for a model of the educational effort)



The Pump Efficiency Test...

OPE – Overall Pumping Plant Efficiency

- ❑ OPE tells you how much usable energy you get from the energy you buy -
 - If the overall OPE is 20%, the other 80% of energy you paid for is wasted.
- ❑ We know achievable levels of OPE –
 - Thus, knowing OPE leads to an estimate of the benefit/cost of a pump retrofit.



The Pump Test reveals cost/benefits...

Estimates of before and after retrofit pumping cost are on the report...

	Retrofitted Conditions	Original Conditions	Savings
7. Diesel Gallons per Acre-foot:	25.2	37	11.3
8. Estimated Gallons per year:	8192	11899	3707.2
9. Average Cost per Gallon:	\$2.50	\$2.50	
10. Average Cost per hour:	\$9.74	\$11.17	\$1.43
11. Average Cost per acre-foot:	\$62.99	\$91.27	\$28.28
12. Estimated acre-feet per year:	325	326	
13. Operating hours per year:	2412	3000	588
14. NOx tons/year	1.17	1.63	0.46
15. PM tons/year	0.06	0.08	0.02
16. Overall Plant Efficiency:	22.3%	15.1%	
=====			
17. <i>Estimated Total Annual Cost</i>	<u>\$23,494</u>	<u>\$33,497</u>	<u>\$10,003</u>

– But since the cost of the repair is not known, no ability to do payback, rate of return, etc. on the report – but the owner can!



DPEP Incentive Rebate...

- ❑ Designed to affect the perceived benefit/cost ratio of retrofitting the pump
- ❑ Intended to have the same effect as current Moyer program but on the PUMP, not the ENGINE
- ❑ Grants currently capped at 35% of project cost up to \$3,500 maximum



Participation – Pump Efficiency Test...

- ❑ DPEP qualifies “participating pump testers” that agree to DPEP procedures
- ❑ Client either calls DPEP to obtain the list of Testers or Testers actively market the test
- ❑ Test arranged between the Client and the Tester (note: Client chooses which Tester to use)
- ❑ Tester prepares and delivers report
- ❑ Tester takes care of paperwork with DPEP and DPEP pays subsidy to Tester directly



Participation – DPEP Incentive Rebate...

DPEP – A “programmatic” response to the air quality problem

- Simplified participation
- Minimized administrative costs

1. Fill out application and submit with:
 - i. Copy of pump test before the project
2. We review and issue Letter of Approval
3. When project is complete you send:
 - i. Copy of an invoice marked PAID
 - ii. Copy of the after-project pump test
4. We send you the check



Verification of Emissions Reduction...

- A key issue in funding this Program at full scale is verification of emissions reductions – that is...

Can DPEP verify emissions reductions at same level of confidence as current Moyer Program?



Non-Engine Projects...

- As per Part I, page II-31...

“...if low emissions technology is not certified it may be approved on a case-by-case basis by ARB...”

- As per Part II, page X-10, potential non-engine projects...

“...Another potential project is the evaluation of irrigation pump efficiency. Improvement in pump efficiency through parts replacement and repair has the potential for emission reductions of NO_x, ROG, and PM by reduced work by the engine or motor for water output.”



Non-Engine Projects...

As per Part II, pages X-7 and X-8, Non-Engine Projects evaluation criteria:

1. Provide real, quantifiable, and enforceable emissions reductions (DPEP = HP-hrs/ac-ft pumped)
2. Have standardized testing procedures to quantify emissions (DPEP = pump efficiency test)
3. Have available baseline emission factors (DPEP = pre- and post-test requirements)
4. Potential multi-media issues(?)



Why a DPEP “on top of” ARBs?

- Programmatic response through DPEP most efficient and effective use of Moyer/Ag Assistance Program funds to achieve emissions reductions through pump efficiency improvements
 - CIT/APEP in field for 5 years – established communication links, grower trust
 - Easy application, quick turnaround
 - Cost-effective administration
 - Fully-integrated program (education -> pump test -> pump retrofit)
 - We know agriculture, pumps, and irrigation



DPEP - Education...

The Mobile Education Centers are self-contained pumping plants that travel to the farmer. We would add this component for a full-scale DPEP. They can...

- Perform real-time pump efficiency test with computerized displays of performance
- Show correct flow meter use
- Synthesize diesel operations using Variable Frequency Drives
- Calculate cost of inefficient pumping



In Summary...

- ❑ DPEP sees the pumping plant as a system of four components – inefficiencies in any of them increase emissions
- ❑ As current Carl Moyer addresses the power source, DPEP addresses the pump itself and management of the plant
- ❑ An efficient pump results in less emissions per unit water produced, just as a Tier III engine



In Summary...

- A pilot-level DPEP with pump efficiency tests and retrofit incentives essentially complete:
 - 58 pre-retrofit pump efficiency tests – average 17.1% OPE (22 – 24% attainable)
 - 11 completed retrofit projects all water wells
 - Showing average pre-retrofit 13.5% OPE and post-retrofit 23.2% OPE, deep wells
 - Showing implied 40% first year emissions reduction (2237 HP-hours/AF -> 1319 HP-hrs/AF)
 - Lifetime total 3.6 tons NO_x and .16 tons PM₁₀ emissions reduction (20,000 hours)
 - Average \$3,800 program costs/retrofit (incentive and 2 pump tests) - \$560/weighted ton emissions reduction (neglecting ROG, PM₁₀ x 20)



In Summary...

- ❑ Phase II starting up, to be complete 12/31/06
- ❑ It will provide essential infrastructure for improving diesel-powered pumping plant efficiency – pump efficiency testers
(NO ONE makes a multi-thousand dollar decision to retrofit a pump without objective information)

