Paul Brodeur, Director of Vessel Maintenance, Preservation and Engineering
Jonathan Olds, Environmental Program Manager
Presentation Outline

• Background Information on WSF
  ▪ Vessels and Routes
  ▪ Fuel Facts and Prices

• WSF Clean Fuel & Fuel Conservation Initiatives

• ULSD and WSF’s First Biodiesel Pilot Project

• Washington State Biodiesel Legislation

• Biodiesel Research and Demonstration Project
• The largest ferry system in the United States
  ▪ 28 vessels, 10 vessel classes
• Operating on 10 routes through 20 terminals
• Each year, WSF carries on average
  ▪ 24+ million passengers
  ▪ 11+ million vehicles
Vary by:

- Transit time
- Passengers & vehicles carried
- Navigational challenges
- Proximity to population centers
- Emergency response capabilities
Vessel Class

Mark II

Mark I or Jumbo

Super

Issaquah
Vessel Class

Evergreen State

Steel Electric

Rhododendron
WSF Fuel Facts

- 2007 Fuel Consumption
- 2007 Fuel Costs
- FY’07 – FY ’09 Fuel Budget
- Use of Low-Sulfur Diesel
- Use of Ultra-low Sulfur Diesel
- Use of Biodiesel
Price per US gallon *

- **Low Sulfur** $3.76
  - Low Sulfur $2.09 (6/1/07)
  - Low Sulfur $2.41 (5/16/06)
  - Low Sulfur $1.72 (5/16/05)

- **Ultra Low Sulfur** $3.78
  - Ultra Low Sulfur $2.10 (6/1/07)
  - Ultra Low Sulfur $2.46 (5/16/06)
  - Low Sulfur $1.75 (5/16/05)

* As of June 4, 2008
Prices are before all taxes
WSF Fuel & Emissions Management Initiatives

- Exhaust Emissions Study
- Clean Fuel Initiative
- Machinery Upgrades
- Fuel Conservation Initiative
- Biodiesel Testing
WSF Exhaust Emission Study

Test Fuels

• High sulfur diesel fuel (HSD)
• Low sulfur diesel fuel (LSD)
• Ultra-low sulfur diesel fuel (ULSD)
• Blend of low sulfur diesel fuel with 20% biodiesel (B20 – LSD)
Clean Fuel Initiatives

• New engine installations
• Conversion of fleet to Low Sulfur Diesel
• Pilot test of Ultra-low Sulfur Diesel
• Pilot test of Biodiesel
• Diesel fuel conservation
Machinery Upgrades

• Engine Modifications
• Fuel Injector Upgrades
• Main Propulsion Engine Replacements
• Ships Service Generator Prime Mover Engine Replacements
Fuel Conservation Initiatives in Progress

• Run vessels on fewer engines
• Reduce fuel margin carried
• Positive restraint system

• Waste heat recovery
Why Biodiesel at WSF?

- Governor’s executive order
- WSF fuel initiatives
- Experience
2004-05 Biodiesel Pilot Tests
Usage / Costs

- 100% Virgin Soy was specified
- 843,157 gallons B-20
- Costs
- Seattle City Light Partnership
Issues

MV Issaquah
Fuel Oil Purifier disk stack

Purifier disk stack with B-20
Purifier disk stack with LSD
2004-05 Biodiesel Pilot Test

Issues

MV Issaquah
Fuel Oil Purifier bowl
The mysterious “Butterscotch Mousse”
Biodiesel Legislation

• 2006 Legislation - ESSB 6508 Renewable Fuel Standard

• 2% of annual diesel fuel sales will be biodiesel sales
  ▪ 2% requirement must be met with feedstocks grown in WA
  ▪ On or before November 30, 2008

• Increases to 5%
  ▪ In-state oil seed crushing capacity and feedstock grown in WA can satisfy 3% of total annual diesel fuel sales
2007 Legislation ESS HB 1303

• June 1, 2009 – State agencies required to use a minimum 20% biodiesel in diesel powered vessels and vehicles

• June 1, 2015 – State agencies must satisfy 100% of their fuel usage in vessels and vehicles from bio-fuel or electricity if practical
Statewide Biodiesel Working Groups

- Department of Agriculture lead Agency
- Two groups working in parallel
  - Bio-fuels Advisory Committee which is charged with advising the Director or Agriculture on implementing the minimum renewable fuel content requirements
  - Bio-fuels Technical Working Group which is developing statewide labeling, sampling and testing standards
Biodiesel Research and Demonstration Project

Partnership Opportunity

- Senator Cantwell’s Office
- Department of Energy
- Puget Sound Clean Air Agency
- Seattle City Light
- Washington State Ferries
Biodiesel Research and Demonstration Project

Project Steering Committee Members

- Seattle City Light
- Puget Sound Clean Air Agency
- Clean Cities Puget Sound Clean Cities Coalition
- Washington State Ferries
Biodiesel Research and Demonstration Project

Project Steering Committee Responsibilities

- Drafting of RFPs
- RFP evaluations
- Contract award recommendations
- Project management
- Committee oversight and input
Biodiesel Research and Demonstration Project

Project Team Members
Biodiesel Research and Demonstration Project

OBJECTIVES

- Controlled, scientific research study
- Identify sources of quality problems
- Marine and land based consumers
- Develop fuel quality assurance testing system
- Develop a product handling guidance document
Biodiesel Research and Demonstration Project

Project Organization

- Phase I developed research sampling and test procedures.
- Phase II implemented the new quality assurance test procedures derived from research in phase I.
- Phase III involves controlled research tests under actual ferry operating conditions.
Biodiesel Research and Demonstration Project

Contracting

• Phases 1 and 2: PSCAA has let a contract for the research efforts
  Washington State University
  University of Idaho
  Imperium Renewables

• Phase 3: PSCAA has contracted with The Glosten Associates
  Assist the project team in the implementation and demonstration phase of the project
Biodiesel Research and Demonstration Project

Phase 1

Washington State University

- Assess previous WSF experience
- Develop fuel specifications for various feedstocks
- Design test procedures and sampling protocols for fuel quality
Biodiesel Research and Demonstration Project

Phase 1 Cont.

Fuel quality looked at throughout the supply chain

- Production
- B-100 transport
- Storage
- Blending
- Blended transport
- On board storage tanks
Biodiesel Research and Demonstration Project

Phase 2

• Trial of Phase 1 sampling protocols and test procedures and fuel specifications
• Use existing “real world” biodiesel transport, fuel storage, fuel blending and blended fuel transport systems
• Parallel controlled laboratory experiments simulating marine environment
Biodiesel Research and Demonstration Project

Phase 3

- Implement phase 2 testing procedures and sampling protocols
- Controlled demonstration project on WSF vessels
- Incorporating research results including use of recommended biodiesel blended fuels
- Bio-fuels from different feedstocks and different blend ratios
Biodiesel Research and Demonstration Project

Final Report

- Identify the sources / conditions that contribute to biodiesel blended fuel contamination and filter clogging
- Document best practices to protect fuel quality
- Address environmental conditions for biodiesel application in the marine industry
Biodiesel Research and Demonstration Project

Final Report Cont.

Document all research with a focus on marine and land based applications:

- Recommended fuel quality specifications
- Fuel test procedures
- Sampling protocols
## Biodiesel Pilot Test Implementation Schedule

<table>
<thead>
<tr>
<th>DATE</th>
<th>VESSEL</th>
<th>FUEL TYPE</th>
<th>PERCENTAGES</th>
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<tbody>
<tr>
<td>March 2008</td>
<td>MV Issaquah</td>
<td>Soy</td>
<td>B5 first 30 days, B10 next 30 days, B20 there after</td>
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<tr>
<td>April 2008</td>
<td>MV Tillikum</td>
<td>Canola</td>
<td>B5 first 30 days, B10 next 30 days, B20 there after</td>
</tr>
<tr>
<td>July 2008</td>
<td>MV Klahowya</td>
<td>High Cloud Point - Tallow</td>
<td>B5 first 30 days, B10 next 30 days, B20 there after</td>
</tr>
</tbody>
</table>
Biodiesel Research and Demonstration Project

Testing to date

- Issaquah is burning B20 Soy
- Tillikum is burning B5 Canola
- Klahowya has not begun biodiesel test
### Fuel Costs

**As of June 4, 2008**

*Before all taxes*

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>ULSD / US Gallon</td>
<td>$3.78</td>
</tr>
<tr>
<td>Soy Biodiesel / US Gallon</td>
<td>$5.75</td>
</tr>
<tr>
<td>80% ULSD</td>
<td>$3.03</td>
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<tr>
<td>20% Biodiesel</td>
<td>+$1.15</td>
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<tr>
<td>B20 Blend</td>
<td>$4.18</td>
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<tr>
<td>ULSD</td>
<td>- $3.78</td>
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<tr>
<td>Premium</td>
<td>$0.40</td>
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</table>
B100 Biodiesel vs. ULSD Diesel Fuel Price per US Gallon on State Contract
Fuel System Modifications
Fuel System Modifications
Fuel System Modifications
Vessel Tank Cleaning
MV Issaquah

Prior to tank cleaning
Vessel Tank Cleaning
MV Issaquah

During tank cleaning
Vessel Tank Cleaning
MV Issaquah

After tank cleaning with biodiesel wipe down
Fuel Purifier Cleaning
MV Issaquah burning B5 Soy

Fuel Purifier

Fuel Purifier Lid Removed
Fuel Purifier Cleaning
MV Issaquah burning B5 Soy

Fuel Purifier Spindle

Fuel Purifier Disk Stack
Fuel Purifier Cleaning
MV Issaquah burning B5 Soy

Fuel Purifier Spindle

Fuel Purifier Bowl
Fuel Purifier Sludging
MV Tillikum burning B5 Canola
Fuel Purifier Sludging
MV Tillikum burning B5 Canola
Fuel Purifier Sludging
MV Tillikum burning B5 Canola
Questions