Safer Alternatives to VOC-Emitting Lubricants, Vanishing Oils and Rust Inhibitors

October 23, 2008

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• NONPROFIT ORGANIZATION ESTABLISHED IN 1989
• IDENTIFIES, TESTS, DEVELOPS, DEMONSTRATES SAFER ALTERNATIVES
• HEAVY FOCUS ON SOLVENTS
  – CLEANING
  – DRY CLEANING
  – PAINT STRIPPING
  – ADHESIVES
  – COATINGS
  – LUBRICANTS
BACKGROUND

• THOUSANDS OF MANUFACTURERS USE METAL WORKING FLUIDS AS PART OF THEIR OPERATIONS
  – MACHINE SHOPS
  – MANUFACTURERS, ASSEMBLERS

• MANY PROCESSES USE METAL WORKING FLUIDS
  – STAMPING
  – CUTTING
  – FORMING
  – HONING
  – COLD HEADING
  – TUBE BENDING
  – DRAWING
MANY METAL WORKING FLUIDS ARE BASED ON PETROLEUM PRODUCTS
- MAY THEMSELVES BE VOCS
- MAY BE DILUTED WITH MINERAL SPIRITS OR KEROSENE

OTHER METAL WORKING FLUIDS ARE SYNTHETICS, SEMI-SYNTHETICS, VEGETABLE OR WATER-BASED
- OFTEN HAVE LOW-VOC CONTENT
ALTERNATIVES PROJECTS

• EPA PROJECT
  – FOCUSED ON ALTERNATIVE LUBRICANTS

• EPA/SCAQMD PROJECT
  – FOCUSED ON ALTERNATIVES TO VOC VANISHING OILS AND RUST INHIBITORS

• IRTA WORKED WITH VARIETY OF COMPANIES WITH RANGE OF OPERATIONS
  – 12 COMPANIES AND 15 OPERATIONS
## COMPANIES AND TYPES OF OPERATIONS

<table>
<thead>
<tr>
<th>Company</th>
<th>Metal Working Fluid Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;H Machine</td>
<td>Lubricant -- Machines</td>
</tr>
<tr>
<td>Nelson Nameplate</td>
<td>Lubricant -- Stamping</td>
</tr>
<tr>
<td></td>
<td>Vanishing Oil -- Stamping</td>
</tr>
<tr>
<td></td>
<td>Vanishing Oil -- Cutting</td>
</tr>
<tr>
<td>Fortner Engineering</td>
<td>Lubricant -- Honing</td>
</tr>
<tr>
<td>Hydro-Aire</td>
<td>Lubricant -- Honing</td>
</tr>
<tr>
<td>Weldcraft</td>
<td>Lubricant -- Machines</td>
</tr>
<tr>
<td>Fred Rippey</td>
<td>Vanishing Oil -- Stamping</td>
</tr>
<tr>
<td>Winders &amp; LeBlanc</td>
<td>Vanishing Oil -- Forming</td>
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<tr>
<td>B&amp;B Specialties</td>
<td>Vanishing Oil -- Machines</td>
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<tr>
<td>Dynaflex Products</td>
<td>Rust Inhibitor</td>
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<tr>
<td>Deltronic</td>
<td>Rust Inhibitor</td>
</tr>
<tr>
<td>Tracy Industries</td>
<td>Rust Inhibitor</td>
</tr>
<tr>
<td>Robinson Helicopter</td>
<td>Lubricant -- Testing</td>
</tr>
<tr>
<td></td>
<td>Rust and Corrosion Inhibitor</td>
</tr>
</tbody>
</table>
PROJECT APPROACH

• VISIT FACILITIES
• SELECT OPERATIONS FOR TESTING
• IDENTIFY / DEVELOP POTENTIAL LOW-VOC ALTERNATIVES
• CONDUCT INITIAL TESTS
• CONDUCT SCALED-UP TESTING
• ANALYZE / COMPARE COSTS
  – INCLUDED CHANGES IN RELATED PROCESSES
• ASSIST COMPANIES IN CONVERTING
  – FIVE COMPANIES ADOPTED ALTERNATIVES
S&H MACHINE

- SMALL FAMILY OWNED MACHINE SHOP
- MACHINES PARTS FOR AEROSPACE INDUSTRY
  - ALUMINUM
  - STAINLESS STEEL
- SHOP HAS 21 MACHINE STATIONS
  - INCLUDES CNC LATHES AND MILLS
- CONVERTED FROM MINERAL SPIRITS TO WATER-BASED CLEANERS FOR PARTS CLEANING
- CONVERTED FROM PETROLEUM LUBRICANT TO A WATER MISCIBLE CUTTING/GRINDING LUBRICANT
- LATER CONVERTED TO SYNTHETIC VEGETABLE ESTER LUBRICANT
## Annualized Cost Comparison for S&H Machine

<table>
<thead>
<tr>
<th></th>
<th>Petroleum Lubricant</th>
<th>Water Miscible Lubricant</th>
<th>Ester Lubricant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annualized Capital Cost</strong></td>
<td>-</td>
<td>$1,079</td>
<td>$1,079</td>
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<tr>
<td><strong>Lubricant Cost</strong></td>
<td>$1,584</td>
<td>$3,500</td>
<td>$3,402</td>
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<tr>
<td><strong>Maintenance Labor Cost</strong></td>
<td>-</td>
<td>$3,720</td>
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<tr>
<td><strong>Machining Labor Cost</strong></td>
<td>$249,600</td>
<td>$224,640</td>
<td>$224,640</td>
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<tr>
<td><strong>Disposal Cost</strong></td>
<td>$360</td>
<td>$1,025</td>
<td>$1,025</td>
</tr>
<tr>
<td><strong>Cleaning Cost Change</strong></td>
<td>$11,534</td>
<td>-</td>
<td>-</td>
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<tr>
<td><strong>Mineral Spirits Oil Distribution Cost</strong></td>
<td>$594</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td>$263,672</td>
<td>$233,964</td>
<td>$233,866</td>
</tr>
</tbody>
</table>
HYDRO-AIRE

- MANUFACTURERS BRAKING SYSTEMS, PUMPS AND AIR LOCKING DEVICES FOR MILITARY AND COMMERCIAL AIRCRAFT
- USED PETROLEUM BASED LUBRICANT FOR HONING OPERATIONS
  - ALUMINUM / STAINLESS STEEL
- CONVERTED TO VEGETABLE ESTER BUT EMPLOYEES DIDN’T LIKE ODOR
- TESTED TWO VEGETABLE ESTER PRODUCTS ON ALUMINUM
- CLEANING A PROBLEM WITH ONE VEGETABLE ESTER LUBRICANT
- TESTED WATER DILUTABLE VEGETABLE ESTER SUCCESSFULLY
  - CLEANING EASIER
  - VARIED CONCENTRATION TO FIND OPTIMAL BLEND
HYDRO-AIRE CONT’D

• ALTERNATIVE LUBRICANT PERFORMED WELL AT 33 PERCENT
• TESTED ALTERNATIVE FOR THREE MONTHS
• CONVERTED TO ALTERNATIVE FOR ALUMINUM
• FOR STAINLESS STEEL, OPTIMAL LUBRICANT CONCENTRATION WAS 75 PERCENT
• CONVERTED TO ALTERNATIVE FOR STAINLESS STEEL
• CLEANING OF ALL PARTS EASIER AFTER CONVERSION
### ANNUALIZED COST COMPARISON FOR HYDRO-AIRE -- ALUMINUM HONING

<table>
<thead>
<tr>
<th></th>
<th>Petroleum Lubricant</th>
<th>Vegetable Ester Lubricant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lubricant Cost</td>
<td>$366</td>
<td>$240</td>
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<tr>
<td>Cleaning Cost</td>
<td>$9,100</td>
<td>$4,550</td>
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<tr>
<td>Total Cost</td>
<td>$9,466</td>
<td>$4,790</td>
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</tbody>
</table>

### ANNUALIZED COST COMPARISON FOR HYDRO-AIRE -- STAINLESS STEEL HONING

<table>
<thead>
<tr>
<th></th>
<th>Petroleum Lubricant</th>
<th>Vegetable Ester Lubricant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lubricant Cost</td>
<td>$732</td>
<td>$855</td>
</tr>
<tr>
<td>Cleaning Cost</td>
<td>$18,200</td>
<td>$9,100</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$18,932</td>
<td>$9,955</td>
</tr>
</tbody>
</table>
FRED R. RIPPY INC.

- SMALL COMPANY WITH 45 EMPLOYEES
- MANUFACTURES MOTOR AND HEAD LAMINATIONS USED IN ELECTRONICS APPLICATIONS
- PROCESSES 5 MILLION PARTS ANNUALLY
- STAMPS OUT PARTS FROM FERROUS METAL
  - SOME SILICON STEEL
  - SOME HIGH COBALT
  - ALL RUST EASILY
- USES VANISHING OIL IN STAMPING OPERATION
  - RESIDUE REMAINS ON PARTS DURING FURTHER MACHINING / PROCESSING
USES AUTOMATED MAGNETIC SYSTEMS
SOME OF PARTS SENT FOR HEAT TREATING AND CURRENT OIL LEAVES NO ASH ON PART
IRTA TESTED VARIETY OF ALTERNATIVES
- VEGETABLE AND WATER-BASED ALTERNATIVES LEFT PARTS STICKY
- MANY OF WATER-BASED ALTERNATIVES INTERFERED WITH MAGNETIC SYSTEM
TWO ALTERNATIVES WORKED WELL
- VEGETABLE BASED REQUIRED CLEANING
- WATER SOLUBLE LUBRICANT LEFT LOW RESIDUE
# Annualized Cost Comparison

## For Fred R. Rippy

<table>
<thead>
<tr>
<th></th>
<th>Vanishing Oil</th>
<th>Vegetable Lubricant</th>
<th>Water Soluble Lubricant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capital Cost</strong></td>
<td>-</td>
<td>$3,467</td>
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<tr>
<td><strong>Lubricant Cost</strong></td>
<td>$2,850</td>
<td>$1,275</td>
<td>$239</td>
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<tr>
<td><strong>Electricity Cost</strong></td>
<td>-</td>
<td>$22,604</td>
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<tr>
<td><strong>Water-Based Cleaner Cost</strong></td>
<td>-</td>
<td>$1,200</td>
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<tr>
<td><strong>Disposal Cost</strong></td>
<td>-</td>
<td>$2,400</td>
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<tr>
<td><strong>Total Cost</strong></td>
<td>$2,850</td>
<td>$30,946</td>
<td>$239</td>
</tr>
</tbody>
</table>
WINDERS & LE BLANC INC.

- SMALL COMPANY
- PROVIDES METAL STAMPING AND WIRE FORMING SERVICES
- FEEDS STEEL, GALVANIZED STEEL AND ALUMINUM WIRE TO MACHINES AND IS FORMED INTO PARTS
- USES VANISHING OIL FOR LUBRICITY AND TO PREVENT RUSTING
- WORKED ON FENCE TIE MACHINE
- WIRE IS LUBRICATED WITH CLOTH IMMERSED IN SMALL CONTAINER
WINDERS CONT’D

• TESTED VARIETY OF ALTERNATIVES
  – VEGETABLE BASED
  – ACETONE / MINERAL SPIRITS
  – WATER-BASED LUBRICANTS

• COMPARED WITH BASELINE AND SET OUTSIDE UNDER EAVES
  – CHECKED RUSTING

• VEGETABLE BASED PRODUCTS “SLIPPED,” ACETONE BLENDS AND MOST WATER-BASED PRODUCTS DID NOT PROVIDE SUFFICIENT RUST PROTECTION

• ONE WATER-BASED PRODUCT PERFORMED WELL
  – SCALED-UP TESTING
  – OPTIMAL CONCENTRATION OF 5 TO 10 PERCENT
## ANNUALIZED COST COMPARISON FOR WINDERS & LE BLANC

<table>
<thead>
<tr>
<th></th>
<th>Vanishing Oil</th>
<th>Water Soluble Lubricant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lubricant Cost</td>
<td>$3,082</td>
<td>$874</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$3,082</td>
<td>$874</td>
</tr>
</tbody>
</table>
DYNAFLEX PRODUCTS

• MANUFACTURES FLEXIBLE EXHAUST CONNECTORS
  – CHROME STACKS FOR TRUCK MARKET
  – BELLOWS TYPE EXPANSION JOINTS FOR COMMERCIAL AND MILITARY EQUIPMENT AND ENGINES

• PERFORMS MANY OPERATIONS INCLUDING BENDING, EXPANDING, FLANGING, HYDRAULIC FORMING, CONVOLUTING AND WELDING

• TUBE SIZE FROM ONE-HALF TO 12 INCHES DIAMETER

• USES HIGH VOC RUST INHIBITOR TO PROTECT STORED TUBES FROM CORROSION

• TESTED SEVERAL ALTERNATIVES AND LEFT THEM ON PANELS OUTSIDE
DYNAFLEX CONT’D

• TWO VEGETABLE BASED PRODUCTS PERFORMED WELL
• TESTED ALTERNATIVES FOR WELDING
  – NO POROSITY
  – DID NOT REQUIRE CLEANING
• DYNAFLEX CITED SEVERAL BENEFITS OF USING ALTERNATIVES
  – LESS R.I. WOULD BE REQUIRED
  – COULD AVOID CLEANING BEFORE AND AFTER WELDING
  – REDUCED SHIPPING COSTS
## ANNUALIZED COST COMPARISON FOR DYNAFLEX

<table>
<thead>
<tr>
<th></th>
<th>Current Rust Inhibitor</th>
<th>Low-VOC Rust Inhibitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rust Inhibitor</td>
<td>$2,303</td>
<td>$2,729</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$2,303</td>
<td>$2,729</td>
</tr>
</tbody>
</table>
DELTRONIC

• MANUFACTURES THREAD AND PLUG GAGES, OPTICAL COMPARATORS AND VIDEO INSPECTION SYSTEMS

• PROVIDES CENTERLESS GRINDING AND LAPPING TO MEDICAL, ELECTRICAL, AEROSPACE AND COMPUTER INDUSTRIES

• PRODUCES 20,000 TO 30,000 PARTS PER MONTH
  – COMMON METALS INCLUDE STEEL, HIGH STRENGTH ALLOYS AND EXOTIC STAINLESS STEEL

• MACHINES STEEL GAGES AND USED MINERAL SPIRITS FOR RUST PROTECTION DURING SUBSEQUENT PROCESSING AND STORAGE
  – NEED SIX MONTHS TO 1 YEAR PROTECTION
DELTRONIC CONT’D

- TESTED WATER-BASED AND VEGETABLE BASED ALTERNATIVES
  - HUMIDITY CHAMBER TESTING
  - ALSO PUT ON SHELF
- COMPANY HAD CONVERTED TO WATER-BASED PRODUCT THAT DID WELL IN SHELF TESTING
  - COMPANY DISCONTINUED PRODUCT
  - PROVIDED ANOTHER PRODUCT THAT WAS TESTED
- COMPANY CONVERTED TO PRODUCT
## ANNUALIZED COST COMPARISON FOR DELTRONIC

<table>
<thead>
<tr>
<th></th>
<th>Mineral Spirits</th>
<th>Nocor E12</th>
<th>Nocor E6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rust Inhibitor Cost</td>
<td>$364</td>
<td>$244</td>
<td>$254</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$364</td>
<td>$244</td>
<td>$254</td>
</tr>
</tbody>
</table>
ROBINSON HELICOPTER COMPANY

• WORLD’S LEADING PRODUCER OF CIVIL HELICOPTERS
• WORKED ON THREE OPERATIONS
• SPRING / COIL LUBRICATION
  – USES AEROSOL VANISHING OIL
  – TESTED ALTERNATIVE VEGETABLE BASED LUBRICANT
  – WORKED EFFECTIVELY
• GENERAL RUST INHIBITION FOR STEEL
  – TOOLS
  – USES AEROSOL VANISHING OIL
  – COVERED PANELS WITH BASELINE OIL AND ALTERNATIVES
  – WATER-BASED RUST INHIBITOR PERFORMED WELL IN SCALED-UP TESTING
CORROSION INHIBITION OF ALUMINUM CONTACTS IN WIRING SYSTEM

- Uses aerosol vanishing oil
- Tested aluminum panels
- All showed evidence of corrosion except one of baseline products
- Only mild corrosion found with water-based material
- Conducted salt spray tests with baseline and alternative at two concentrations
- All performed well
### ANNUALIZED COST COMPARISON FOR ROBINSON HELICOPTER SPRING COIL OPERATION

<table>
<thead>
<tr>
<th></th>
<th>Vanishing Oil</th>
<th>Vegetable Lubricant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lubricant Cost</td>
<td>$4.66</td>
<td>$1.56</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$4.66</td>
<td>$1.56</td>
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</tbody>
</table>

### ANNUALIZED COST COMPARISON FOR ROBINSON HELICOPTER STEEL TOOLING MAINTENANCE

<table>
<thead>
<tr>
<th></th>
<th>High-VOC Product</th>
<th>Low-VOC Product</th>
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</thead>
<tbody>
<tr>
<td>Rust Inhibitor Cost</td>
<td>$1,929</td>
<td>$355</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$1,929</td>
<td>$355</td>
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</table>
# Annualized Cost Comparison for Robinson Helicopter Aluminum Wiring Corrosion Protection

<table>
<thead>
<tr>
<th></th>
<th>High-VOC Product</th>
<th>Low-VOC Product 100%</th>
<th>Low-VOC Product 50%</th>
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</thead>
<tbody>
<tr>
<td>Rust Inhibitor Cost</td>
<td>$1,090</td>
<td>$310</td>
<td>$155</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$1,090</td>
<td>$310</td>
<td>$155</td>
</tr>
</tbody>
</table>
REGULATIONS ON METAL WORKING FLUIDS

• SCAQMD DEVELOPING REGULATION
  − RULE 1144 “LUBRICANTS, METAL WORKING FLUIDS AND RUST INHIBITORS”
• ESTIMATING INVENTORY IN SOUTH COAST BASIN
  − ANNUALLY 4.2 to 8.1 MILLION GALLONS
• VOC EMISSIONS 4.3 TPD
  − VANISHING OILS
  − RUST PREVENTATIVES
  − STRAIGHT SOLVENT
  − SOME LUBRICANTS
• UNCERTAINTY IN VOC CONTENT
  − EPA 24
  − GC/FID (313L)
REGULATIONS CONT’D

• PROPOSING VOC LIMIT OF 50 GRAMS PER LITER
  – AFTER DILUTION
  – VOC EMISSION REDUCTION OF 3.5 TPD

• CONTAINERS MUST HAVE VOC CONTENT INFORMATION

• PROHIBITION OF SALE
  – SIX MONTH YEAR SELL THROUGH
  – DOES NOT APPLY TO CARB REGULATED PRODUCTS

• REDUCED RECORD KEEPING FOR “SUPER COMPLIANT” MATERIALS

• FINAL HEARING DECEMBER 5
CONCLUSIONS

- LOW-VOC LUBRICANTS, RUST INHIBITORS AVAILABLE FOR ALL APPLICATIONS
- ALTERNATIVES ARE GENERALLY SAFER
- ALTERNATIVES INCLUDE
  - WATER-BASED PRODUCTS WHICH ARE GENERALLY DILUTED
  - VEGETABLE BASED PRODUCTS, SOME OF WHICH ARE WATER DILUTABLE
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