

**COMBUSTION SYSTEM IMPROVEMENT  
STANDARD 372**

**DOCUMENTATION EXAMPLE  
JULY, 2012**

Replacement diesel engine for an existing sprinkler irrigation system.

500 gpm  
20 ft pumping lift  
70 psi pump discharge pressure  
Direct drive

Resource Concern: Air Quality

Existing Engine: Caterpillar, 1987  
75 hp  
From farmer unit consumes 8 gal/hr of operation

Minimum BHP Required for replacement:

$TH = \text{Pumping Lift (ft)} + \text{Discharge Pressure (ft)}$

$TH = 20 \text{ ft} + (70\text{psi} \times 2.31) \text{ ft} = 182 \text{ ft}$

$WHP = (GPM \times TH) / 3960$

$WHP = (500 \times 182) / 3960 = 23 \text{ hp}$

$BHP = WHP / (E_p \times E_d)$

$BHP = 23 / (.75 \times 1.0) = 31 \text{ hp}$

Adjustment for cooling system @ 5%:  $31 / 0.95 = 33 \text{ hp}$

Adjustment for continuous operation @ 20%:  $33 / 0.8 = 41 \text{ hp}$

Selected Power Unit: John Deere 4024H, Tier 3 (See attached)  
41 hp @ 2800 rpm, 2.6 gal/hr fuel consumption

**Emission Calculations:**

Existing Engine: Emissions tons/yr =  $\frac{EF \times BHP \times \text{annual operating hrs} \times \text{load factor}}{907,200}$

Emissions Factor, EF from Job Sheet, Table 1

Annual operating hours from farmer, 1200

Load factor from Job Sheet Table 3

$$NO_x = (12.09 \times 75 \times 1200 \times 0.51) / 907,200 = 0.61 \text{ tons/yr}$$

$$VOC = (1.73 \times 75 \times 1200 \times 0.51) / 907,200 = 0.09 \text{ tons/yr}$$

$$PM_{10} = (0.547 \times 75 \times 1200 \times 0.51) / 907,200 = 0.03 \text{ tons/yr}$$

Replacement: Emissions Factor, EF from Job Sheet Table 2

Annual operating hours assume at 1200

Load factor from Job Sheet Table 3

$$NO_x = (2.74 \times 41 \times 1200 \times 0.51) / 907,200 = 0.076 \text{ tons/yr}$$

$$VOC = (0.12 \times 41 \times 1200 \times 0.51) / 907,200 = 0.003 \text{ tons/yr}$$

$$PM_{10} = (0.160 \times 41 \times 1200 \times 0.51) / 907,200 = 0.004 \text{ tons/yr}$$

**Efficiency Calculations:** NOTE: Since the Resource Concern is Air Quality, this is not required.  
Required only when the Resource Concern is Energy

$$\text{Power Unit Performance} = BHP \times (\text{hrs/gal of fuel})$$

$$EFF = (\text{Power Unit Performance} \times 100\%) / \text{Power Unit Performance Standard, Table 2}$$

Existing: Power Unit Performance =  $75 \times (1/8) = 9.4$

$$EFF = 9.4 \times 100 / 14.75 = 64\%$$

Replacement: Power Unit Performance =  $(41 \times 0.8) \times (1/2.6) = 12.6$   
(Note: Table 2 Perf. Std. not under continuous operation  
So BHP must be adjusted.)

$$EFF = 12.6 \times 100 / 14.75 = 86\%$$

(Note: If resource concern was energy, replacement engine would be 20% more efficient as required by Standard 372.)

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Tier 3/Stage III A PowerTech™ M Engines

2-Valve Mechanical

| Engine Model | Rated Speed rpm | Continuous kW | Continuous hp | Fuel Data gal/hr | rpm  | Continuous kW | Continuous hp | Fuel Data gal/hr |
|--------------|-----------------|---------------|---------------|------------------|------|---------------|---------------|------------------|
| 4024H        | 2800            | 31            | 41            | 2.6              | 1800 | 27            | 35            | 1.9              |
| 4045T        | 2400            | 54            | 72            | 4.4              | 1800 | 48            | 64            | 3.6              |
| 4045H        | 2400            | 67            | 90            | 5.0              | 1800 | 61            | 82            | 4.2              |

Tier 3/Stage III A PowerTech E Engines

2-Valve Electronic

| Engine Model | Rated Speed rpm | Continuous kW | Continuous hp | Fuel Data gal/hr | rpm  | Continuous kW | Continuous hp | Fuel Data gal/hr |
|--------------|-----------------|---------------|---------------|------------------|------|---------------|---------------|------------------|
| 4045H        | 2400            | 86            | 115           | 6.4              | 1800 | 78            | 105           | 5.6              |
| 6068H        | 2400            | 116           | 156           | 8.6              | 1800 | 105           | 141           | 7.4              |

Tier 3/Stage III A PowerTech Plus Engines

4-Valve Electronic

| Engine Model | Rated Speed rpm | Continuous kW | Continuous hp | Fuel Data gal/hr | rpm  | Continuous kW | Continuous hp | Fuel Data gal/hr |
|--------------|-----------------|---------------|---------------|------------------|------|---------------|---------------|------------------|
| 6068H        | 2400            | 168           | 225           | 11.0             | 1800 | 151           | 203           | 9.8              |
| 6090H        | 2200            | 224           | 300           | 14.4             | 1800 | 224           | 300           | 14.3             |
| 6135H        | 2100            | 373           | 500           | 25.4             | 1800 | 373           | 500           | 25.4             |

Tier 2/Stage II PowerTech Engines

2-Valve Mechanical

Continuous rpm Continuous

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## Combustion System Improvement (372) Engine Replacement Implementation Record

Name VEGGIE FARM County SALEM  
 Location MANNINGTON

Planned By ABC Date 3/12  
 Plan Checked DEF Date 3/12  
 Plan Approved GHI Date 3/12

Purpose:  Improve air quality by reducing emissions  Improve energy efficiency

### Existing Engine Information and Decommissioning

| Existing Engine | Purpose / Location on Farm | Fuel Type | Make/Model | Model Year | Serial No. | Rated BHP | Annual Hours Used | Decommissioning |      |
|-----------------|----------------------------|-----------|------------|------------|------------|-----------|-------------------|-----------------|------|
|                 |                            |           |            |            |            |           |                   | Method          | Date |
| 1               | IRRIGATION/POND            | DIESEL    | CAT        | 1987       | XXXXXX     | 75        | 1200              | 1               | 4/12 |
| 2               |                            |           |            |            |            |           |                   |                 |      |
| 3               |                            |           |            |            |            |           |                   |                 |      |

After being repaired, the existing engine must be rendered inoperable by one of the following methods:

1. Dismantling for scrap metal. A dated receipt is required, identifying the engine and certifying that no parts or components were or will be parted-out, used or sold as parts, or used to rebuild an engine intended for destruction.
2. Creating a permanent hole at least six inches in diameter to include a portion of the oil pan rail (sealing surface), or by cutting the engine block into multiple pieces. The disabled engine (or written, signed and dated certification that the engine has been disabled as required) must be kept on-farm for inspection.

3. Other \_\_\_\_\_

### Replacement Engine Information

| New Engine | Purpose / Location on Farm | Fuel Type | Make/Model  | Model Year | Serial No. | Rated BHP | Minimum BHP | Date Installed |
|------------|----------------------------|-----------|-------------|------------|------------|-----------|-------------|----------------|
| 1          | IRRIGATION/POND            | DIESEL    | DEERE/4024H | 2011       | XXXXXX     | 41        | 41          | 5/12           |
| 2          |                            |           |             |            |            |           |             |                |
| 3          |                            |           |             |            |            |           |             |                |

### Emissions and Efficiency Information (Emissions in Tons/Yr; Efficiency in %)

| Engine 1        | Existing | Replacement | Improvement | Engine 2        | Existing | Replacement | Improvement | Engine 3        | Existing | Replacement | Improvement |
|-----------------|----------|-------------|-------------|-----------------|----------|-------------|-------------|-----------------|----------|-------------|-------------|
| NO <sub>x</sub> | 0.61     | 0.076       | 0.534       | NO <sub>x</sub> |          |             |             | NO <sub>x</sub> |          |             |             |
| VOC             | 0.09     | 0.003       | 0.087       | VOC             |          |             |             | VOC             |          |             |             |
| PM10            | 0.03     | 0.004       | 0.026       | PM10            |          |             |             | PM10            |          |             |             |
| Eff. %          |          |             |             | Eff. %          |          |             |             | Eff. %          |          |             |             |

### USDA Program Participant Certification:

To the best of my knowledge these records accurately reflect the actual combustion system improvement(s) implemented.

5/12  
Date

\_\_\_\_\_  
USDA Program Participant Signature

NRCS Acceptance:  
Completed practice meets NRCS standards and specifications.

5/12  
Date

\_\_\_\_\_  
NRCS Representative Signature