



**pennsylvania**  
DEPARTMENT OF ENVIRONMENTAL  
PROTECTION

January 14, 2020

Mr. Adam McMurray  
Royal Hydraulic  
2 Washington Street  
Cokeburg, PA 15324

Re: **ITEM:** Diesel Engine Package  
**MODEL:** RDSC370; **SERIAL NO.:** N/A; **VOLTAGE:** 12/VDC; **HP:** 173  
**APSID NO:** 1007131  
**APPROVAL NO. BOTE-DEES 2-20**

Dear Mr. McMurray:

Chapter 4 of the "Bituminous Coal Mine Safety Act" (the Act) provides for the use of diesel-powered equipment in underground bituminous coal mines. Section 424 of the act created a Technical Advisory Committee ("TAC") for the purpose of advising the Department regarding implementation of Chapter 4 and evaluation of alternative technology or methods for meeting the requirements of Chapter 4.

On December 4, 2019, Royal Hydraulic submitted a request to the Technical Advisory Committee ("TAC") and Bureau of Mine Safety to have this piece of equipment inspected. On December 4, 2019, The DEP Bureau Director requested the TAC review and comment on this request.

On December 11, 2019, the DEP traveled to Royal Hydraulic to conduct their investigation and subsequently issued their report recommending approval to the TAC. The TAC recommended approval on December 27, 2019. Permanent approval was recommended at the TAC meeting on January 8, 2020.

Based on the recommendation of the TAC and the equipment approval staff, your request for approval is granted.

If you have any questions on this request, please contact me at either [rwagner@pa.gov](mailto:rwagner@pa.gov) or at 724.404.31544.

Sincerely,

Richard A. Wagner, P.E.  
Director  
Bureau of Mine Safety

cc: Art Brower  
Chas Washlack  
James Ross

**Pennsylvania Technical Advisory Committee  
On Diesel Powered Equipment**

**Paul Borchick**

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December 27, 2019

Richard Wagner, PE  
Director  
Bureau of Mine Safety  
PO Box 133  
New Stanton, PA 15672

RE: Royal Hydraulics Model RDSC370 Diesel Powered Source Car utilizing a Deutz 1013FC diesel engine (MSHA ID 07-ENA-040007-1) 173 HP@ 2300 RPM with an Airflow Catalyst Systems, Inc ACSMNC Model M15S15 oxidation catalyst and an Airflow Catalyst Systems, Inc Model ACSMNC-M15S15 silicon carbide filter system (87% efficient) and a Royal Exhaust Cooler Model REC-200 exhaust cooler.

Dear Mr. Wagner:

Chapter 4 of the "Bituminous Coal Mine Safety Act" (the Act) provides for the use of diesel-powered equipment in underground bituminous coal mines. Section 424 of the act created a Technical Advisory Committee ("TAC") for the purpose of advising the Department regarding implementation of Chapter 4 and evaluation of alternative technology or methods for meeting the requirements of Chapter 4.

**Background**

On October 25, 2019 Royal Hydraulics submitted a request to the Bureau of Mine Safety (BMS) for approval for a Royal Hydraulics Model RDSC370 Diesel Powered Source Car utilizing a Deutz 1013FC diesel engine (MSHA ID 07-ENA-040007-1) 173 HP@ 2300 RPM with an Airflow Catalyst Systems, Inc ACSMNC Model M15S15 oxidation catalyst and an Airflow Catalyst Systems, Inc Model ACSMNC-M15S15 silicon carbide filter system (87% efficient) and a Royal Exhaust Cooler Model REC-200 exhaust cooler.



On December 4, 2019 the Director of BMS requested the TAC to evaluate the Model RDSC370 Diesel Powered Source Car and to advise the Department regarding the TAC's recommendation as to whether the referenced equipment meets requirements of Section 403 of the Act.

The diesel power package includes the following items:

- Deutz 1013FC diesel engine (MSHA ID 07-ENA-040007-1) 173 HP@ 2300 RPM
- Airflow Catalyst Systems, Inc Management System
  - Airflow Catalyst Systems, Inc ACSMNC Model M15S15 oxidation catalyst
  - Airflow Catalyst Systems, Inc Model ACSMNC-M15S15 silicon carbide filter system (87% efficient)
  - Royal Exhaust Cooler Model REC-200 exhaust cooler

More detailed information on the specifications of the diesel power package is included on the General Specification Sheet which is attached as Attachment 1.

### **Investigation**

On December 11, 2019 the DEP traveled to Royal Hydraulics to inspect the equipment when it became available. The TAC evaluated the engine and exhaust emissions package data provided.

Emissions testing of the engine and after-treatment system were performed, as well as exhaust gas temperature monitoring and stall test procedure. Since this diesel unit is not capable of inducing an engine stall the same as a wheeled transportation unit, an alternate method was needed. Royal Hydraulics established an Emissions Test Procedure (Attachment 2) that achieves the desired repeatable test parameters. This test procedure will be used when conducting emissions testing on this Model RDSC370 Diesel Source Car.

The results of the emission tests showed the engine was performing within MSHA's approval specifications.

The exhaust was cooled by a Royal Exhaust Cooler Model REC-200 exhaust cooler. Monitoring of the exhaust gas temperature produced a high exhaust gas temperature reading well below the 302° F as required by Section 403 (b)(4) of the Act. The maximum surface temperature observed was 175° F after conducting all CO testing. The maximum engine oil temperature was 160° F and the maximum engine coolant temperature was 200° F.

The after-treatment system is fitted with an Airflow Catalyst Systems, Inc Model ACSMNC-M15S15 silicon carbide filter system (87% efficient). The engine and filter extrapolations show that the diesel power package will result in an average ambient concentration of 0.065 mg/m<sup>3</sup> of diesel particulate matter when diluted by 100% of the MSHA approval plate ventilation rate for this engine, which is well below the .12 mg/m<sup>3</sup> requirement of Section 403 (a)(1) the Act. (Attachment 3)

In addition to the testing that was conducted, our investigation and our observations confirmed that the diesel power package is capable of meeting all the requirements of Section 403 of the Act.


## Recommendation

Our recommendation is based upon the data supplied by Royal Hydraulics, the results of the tests conducted on December 11, 2019, as well as the data acquired and provided for our investigation. The TAC has determined that the Royal Hydraulics Model RDSC370 Diesel Powered Source Car utilizing a Deutz 1013FC diesel engine (MSHA ID 07-ENA-040007-1) 173 HP@ 2300 RPM with an Airflow Catalyst Systems, Inc ACSMNC Model M15S15 oxidation catalyst and an Airflow Catalyst Systems, Inc Model ACSMNC-M15S15 silicon carbide filter system (87% efficient) and a Royal Exhaust Cooler Model REC-200 exhaust cooler meets all requirements of Section 403 of Chapter 4 of the Pennsylvania Bituminous Coal Mine Safety Act. As such, we are recommending approval of the above described diesel power package. This recommendation is provided with the understanding that the General Specification Sheet (Attachment 1) be strictly adhered to.

The TAC acknowledges that since this particular unit is not a typical wheeled transportation unit there are certain specifications of the Act that must be complied with:

- The Royal Hydraulics Emission Test Procedure (Attachment 2) used to induce the stall during the 100 hour tests (Section 418) should be part of the diesel mechanic's training.
- The unit must be attended during operation as required in Section 401(b) of the Act.
- Face plate ventilation must be maintained at all times while the unit is in operation as required in Section 404.

Should the Director receive a request for temporary approval for use prior to the next TAC meeting, the TAC will recommend temporary approval until the next scheduled TAC meeting on January 8, 2020 at which time permanent approval will be recommended.

  
Paul Borchick

  
Ron Bowersox



# General Specification Sheet

## I. Engine

<b>Manufacturer</b>	<b>Deutz</b>	<b>High Idle (RPM)</b>	<b>2530</b>
<b>Manufacturer Address</b>	<b>3883 Steve Reynolds Blvd. Norcross, Ga. 30093</b>	<b>Particulate Index (PI)</b>	<b>4000</b>
		<b>Backpressure</b>	<b>40" wg</b>
<b>Model Number</b>	<b>1013FC</b>	<b>Gaseous Ventilation Rate (CFM)</b>	<b>7000 cfm</b>
<b>Serial Number</b>	<b>12367327</b>	<b>Raw DPM (gr/hp)</b>	<b>6.197 g/hr</b>
<b>Horse Power</b>	<b>173hp@2300RPM</b>	<b>MSHA 7E Approval Number</b>	<b>07-ENA-040007-1</b>
<b>Max. dirty Intake Air Restriction (H<sup>2</sup>O)</b>	<b>26" wg</b>	<b>Type of Aspiration</b>	<b>Turbo</b>
<b>Max. Allowed Clean intake Restriction (H<sup>2</sup>O)</b>	<b>20" wg</b>	<b>Fuel Delivery System</b>	<b>Mechanical Injection</b>
<b>Turbocharger Boost Pressure</b>	<b>21.8 psi</b>	<b>Low Idle (RPM)</b>	<b>900</b>

ATTACHMENT 1-1

## II. Filter System

<b>Manufacturer</b>	<b>Airflow Catalyst Systems inc.</b>
<b>Manufacturer Address</b>	<b>2640 State Route 21 Wayland, NY. 14572</b>
<b>Model Number</b>	<b>ACSMNC M15S15</b>
<b>System Type</b>	<b>Passive, Ceramic</b>
<b>System Composition</b>	<b>Silicone Carbide (SIC)</b>
<b>Efficiency Rating</b>	<b>87%</b>
<b>Type of Regeneration</b>	<b>Passive</b>

## III. Catalyst

<b>Manufacturer</b>	<b>Airflow Catalyst Systems inc.</b>
<b>Manufacturer Address</b>	<b>2640 State Route 21 Wayland, NY. 14572</b>
<b>System Name</b>	<b>ACSMNC</b>
<b>Model Number</b>	<b>M15S15</b>

## IV. Exhaust Cooler

<b>Manufacturer</b>	<b>Royal Hydraulics Manufacturing and Service</b>
<b>Manufacturer Address</b>	<b>2 Washington St Cokeburg, PA. 15324</b>
<b>System Name</b>	<b>Royal Exhaust Cooler (REC)</b>
<b>Model No.</b>	<b>REC 200</b>

# Emissions Test Procedure

1. Place the equipment into an intake entry. Make sure no personnel are in front of or behind the equipment during test.
2. **Chock the wheels or be sure the car is secure from movement.**
3. Start the diesel engine. **Be sure that the engine is at operating temperature prior to conducting the emissions test. Once this has been achieved.**
4. **Open 2 inch Air Supply Valve.**
5. **Engage Compressors 1&2, by turning the switches located on the control panel**
6. Perform the required emissions tests.
7. After testing is complete.
8. **Switch off Compressors 1&2 by returning the switches to the off position.**
9. **Close the 2 inch Air Supply Valve.**
10. **Allow the engine to operator in low idle until Turbocharger has cooled sufficiently prior to shut down.**
11. Comply with record-keeping requirements pursuant to Section 414.

# DPM Calculation Sheet

Engine Model	Deutz 1013 FC
MSHA Number	07-ENA040007-1
Ventilation Rate	7000 cfm
Filter Type	Silicone Carbide (SIC)
Filter Efficiency	87%

**Convert DPM From (grams/hr) to (mg/min)**

$$(6.197\text{g/hr.}) \text{ :- } (1\text{hr./}60\text{min}) \times (1000\text{mg/g}) = 100.28 \text{ mg/min}$$

**Convert Ventilation Rate from cfm to m<sup>3</sup>/min.**

$$(7000 \text{ ft}^3/\text{min}) \times (.028315 \text{ m}^3/\text{ft}^3) = 198.2 \text{ m}^3/\text{min.}$$

**Divide DPM (mg/min) by Ventilation Rate (m<sup>3</sup>/min.)**

$$(100.28 \text{ mg/min}) \text{ :- } (198.2 \text{ m}^3/\text{min.}) = .50 \text{ mg/m}^3.$$

**Solve for Ambient DPM Level AT 87% Filter Efficiency**

$$.50 \text{ m}^3/\text{min} \times (100 - 87\% \text{ Filter Efficiency}) = .065 \text{ mg/m}^3$$