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## **Compliance Test Report**

**EUENGINE1, EUENGINE2, EUENGINE3 &  
EUENGINE4**

**White Pigeon Compressor Station  
68536 A Road, Route 1  
White Pigeon, Michigan 49099**

**Test Dates: March 2-5, 2015**

**Report Submitted:  
April 28, 2015**

**Work Order No. 24068842  
Report Revision 0**

**Test Performed by the Consumers Energy Company  
Regulatory Compliance Testing Section  
Laboratory Services Department**

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## 1.0 INTRODUCTION

### *Identification, location and dates of tests*

This report summarizes the results of testing conducted on March 3-5, 2015 at Consumers Energy Company's (CEC) White Pigeon Compressor Station. CEC's Regulatory Compliance Testing Section (RCTS) conducted performance tests on four (4) 4-stroke lean burn (4SLB) natural gas-fired, reciprocating internal combustion engines (RICE), identified as EUENGINE1, EUENGINE2, EUENGINE3 and EUENGINE4. The engines are located and operating at the White Pigeon Compressor Station in White Pigeon, Michigan. Please note that reproducing portions of this test report may omit critical substantiating documentation or cause information to be taken out of context. If any portion of this report is reproduced, please exercise due care in this regard.

### *Purpose of testing*

The purpose of the testing was to evaluate compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) for RICE, 40 CFR Part 63, Subpart ZZZZ, and the Standards of Performance for Stationary Spark Ignition (SI) Internal Combustion Engines (ICE), 40 CFR Part 60, Subpart JJJJ, as well as to demonstrate compliance with the facility's current ROP (No. MI-ROP-N5573-2013) emissions limits, as cited in Table I of FGENGINES Flexible Group Conditions. The following table describes the applicable regulations and test parameters for each RICE unit:

**Table 1**  
**Summary of Test Parameters**

Source	Test Parameters	Underlying Regulation
EUENGINE1 EUENGINE2 EUENGINE3	Carbon Monoxide (CO) & diluent gas (Oxygen (O <sub>2</sub> ) or Carbon Dioxide (CO <sub>2</sub> )) both upstream and downstream from the oxidation catalyst (% reduction)	Subpart ZZZZ
EUENGINE4	Nitrogen Oxides (NO <sub>x</sub> ), CO <sup>1</sup> & Volatile Organic Compound (VOC) emissions at the engine exhaust (outlet)	Subpart JJJJ

<sup>1</sup> Please note in 40 CFR Part 60, Subpart JJJJ, Table 1, footnote (b) indicates a new or reconstructed non-emergency lean burn SI ICE greater than or equal to 250 brake horsepower meeting 40 CFR Part 63, Subpart ZZZZ requirements are not required to comply with the CO emission standards in Subpart JJJJ.

### *Brief description of source*

The White Pigeon Compressor Station is a natural gas compressor station. The purpose of the facility is to compress and maintain natural gas pipeline system pressure along the pipeline system. Each RICE is of a 4SLB design and is exclusively fired with pipeline quality natural

gas. EUENGINE1 is a Caterpillar Model G3608 engine, while EUENGINE2, EUENGINE3 and EUENGINE4 are Caterpillar Model G3616 engines. Each of these engines is equipped with oxidation catalysts to reduce CO and VOC emissions.

*Names, addresses, and telephone numbers of the contacts for information regarding the test and the test report, and names and affiliation of all personnel involved in conducting the testing*

A Test Protocol, dated December 15, 2014, was submitted and subsequently approved by the MDEQ in their letter dated December 29, 2014. RCTS Technical Analysts Gregg Koteskey, Brian Miska and Joe Mason performed the tests on March 3 through March 5, 2015. CEC Senior Engineer Ms. Amy Kapuga was onsite to coordinate the collection of process data. White Pigeon Field Leader, Mr. Timothy Wolf, coordinated the test and CEC Senior Technician, Craig Jaeger, collected operating data. MDEQ representative Mr. Dennis Dunlap was on site on March 3, 2015 to witness a portion of this test event.

**Table 2  
Test Program Participants**

<b>Responsible Party</b>	<b>Address</b>	<b>Contact</b>
Test Facility	White Pigeon Compressor Station 68536 A Road White Pigeon, Michigan 49099	Mr. Timothy Wolf 269-483-2902 timothy.wolf@cmsenergy.com
Corporate Air Quality Contact	Consumers Energy Company Environmental Services Department 1945 West Parnall Road Jackson, Michigan 49201	Ms. Amy Kapuga 517-788-2201 amy.kapuga@cmsenergy.com
Test Representative	Consumers Energy Company Regulatory Compliance Testing Section 17010 Croswell Street West Olive, Michigan 49460	Mr. Joe Mason, QSTI 231-720-4856 joe.mason@cmsenergy.com
State Representative	Michigan Department of Environmental Quality 7953 Adobe Rd. Kalamazoo, Michigan 49009	Mr. Dennis Dunlap 269-567-3553 dunlapd@michigan.gov

**2.0 SUMMARY OF RESULTS**

***Operating Data***

Operating data collected during each test run included catalyst inlet temperature, pressure drop across catalyst, engine load, ambient temperature, barometric pressure, humidity, fuel flow rate, suction pressure, discharge pressure, and horsepower. The purpose of documenting engine horsepower is to verify engine load during the performance test, as Subpart ZZZZ § 63.6620 (b) states *the test must be conducted at any load condition within plus or minus 10 percent of 100 percent load*. Engine load was obtained by dividing the recorded horsepower value observed during each test run by the rated engine horse power.

***Applicable Permit Number***

The White Pigeon Compressor Station is currently operating pursuant to the terms and conditions of Renewable Operating Permit (ROP) No. MI-ROP- N5573-2013. Performance tests were conducted, as required, on four (4) 4SLB natural gas-fired RICE, identified as EUENGINE1, EUENGINE2, EUENGINE3 and EUENGINE4.

***Results***

The purpose of the testing was to evaluate compliance with both (a) the National Emission Standards for Hazardous Air Pollutants (NESHAP) for RICE, 40 CFR Part 63, Subpart ZZZZ, and (b) Standards of Performance for Stationary Spark Ignition (SI) Internal Combustion Engines (ICE), 40 CFR Part 60, Subpart JJJJ. A summary of the test results are presented below.

**Table 3  
Summary of 40 CFR 63 Subpart ZZZZ RICE  
Carbon Monoxide Reduction, Catalyst Pressure Drop &  
Catalyst Inlet Temperature Results**

<b>Source</b>	<b>CO Reduction Efficiency (%) [ZZZZ Limit = ≥93%]</b>	<b>Catalyst Pressure Drop (Inches Water Gauge)</b>	<b>Catalyst Inlet Temperature (°F)</b>
EUENGINE1	97.1	3.36	786.8
EUENGINE2	99.6	2.60	764.2
EUENGINE3	98.9	2.40	749.1
EUENGINE4	99.4	2.47	772.3

Based on the dry CO concentrations measured at the oxidation catalyst inlet and outlet corrected to 15% O<sub>2</sub>, the above results indicate the oxidation catalysts are operating at a CO reduction efficiency greater than the 93 percentage requirement in Subpart ZZZZ.

In addition, NO<sub>x</sub>, CO and VOC emission rates were verified for the natural gas-fired RICE pursuant to MI-ROP-N5573-2013, FGEngines, Conditions I.1, I.2 and IX.2.

**Table 4**  
**Summary of 40 CFR 60 Subpart JJJJ**  
**NO<sub>x</sub>, CO and VOC Emission Rates**

Source	NO <sub>x</sub> Emission Rate (g/hp-hr) [ROP Limit = 0.5; JJJJ Limit = 2.0]	CO Emission Rate (g/hp-hr) [ROP Limit = 0.2 <sup>1</sup> ; JJJJ Limit = 4.0]	VOC Emission Rate, Expressed as NMOC (g/hp-hr) [JJJJ Limit = 1.0]
EUENGINE1	0.44	0.016	0.006
EUENGINE2	0.47	0.003	0.005
EUENGINE3	0.43	0.008	0.005
EUENGINE4	0.49	0.005	0.004

The NO<sub>x</sub>, CO and VOC engine emission rates shown above all fall within the permit requirements, as well as the applicable emission limits within 40 CFR Part 60, Subpart JJJJ in cases where the permit does not contain an explicit emission limit (i.e., VOCs).

### **3.0 SOURCE DESCRIPTION**

#### ***Description of Process***

The White Pigeon Compressor Station is a natural gas compressor station. The purpose of the facility is to maintain pressure of natural gas in order to move it along the pipeline system. Four (4) natural gas-fired reciprocating engine driven compressor units, designated at EUENGINE1, EUENGINE2, EUENGINE3 and EUENGINE4, were installed in 2010 to maintain station reliability, working in conjunction with several other grandfathered RICE located at the facility.

The NO<sub>x</sub> emissions from each of the engines are minimized through the use of lean-burn combustion technology. Lean-burn combustion refers to a high level of excess air (generally 50% to 100% relative to the stoichiometric amount) in the combustion chamber. The excess air absorbs heat during the combustion process, thereby reducing the combustion temperature and pressure and resulting in lower NO<sub>x</sub> emissions.

Each of the engines is also equipped with oxidation catalysts. The catalysts are designed in a modular manner, and each Caterpillar Model G3616 engine is equipped with four catalyst modules, while the Caterpillar Model G3608 engine is equipped with two catalyst modules. The catalysts use proprietary materials in order to lower the temperature at which the oxidation process occurs for CO and other organic compounds. As a result, the oxidation process will occur at the exhaust gas temperatures generated by the engines. The catalyst vendor has guaranteed a minimum CO destruction efficiency of 93%. The estimated formaldehyde and non-methane, non-ethane hydrocarbon (NMNEHC) destruction efficiencies are 85% and 75%, respectively.

#### ***Process Flow Sheet or Diagram***

NA

#### ***Type and Quantity of Raw Material Processed During the Tests***

NA

#### ***Maximum and Normal Rated Capacity of the Process***

The White Pigeon Compressor Station operates four natural gas fired, 4SLB Caterpillar engines equipped with oxidation catalysts for CO and formaldehyde reduction. The three Model 3616's and one Model 3608 are operated to maintain natural gas main pipeline transport pressure to various storage facilities located in Michigan and/or local distribution companies. The following table contains pertinent engine specifications.

Table 5

Summary of Specifications for EUENGINE1 – EUENGINE4

Parameter <sup>1</sup>	EUENGINE1	EUENGINE2 -4
Make	Caterpillar	Caterpillar
Model	G3608	G3616
Output (brake-horsepower)	2,370	4,735
Heat Input, LHV (mmBtu/hour)	16.1	32.0
Exhaust Gas Temp. (°F)	857	856

<sup>1</sup> All engine specifications are based upon vendor data for operation at 100% of rated engine capacity.

***Description of Process Instrumentation Monitored During the Test***

Engine process data collected included catalyst inlet temperature, pressure drop across the catalyst, engine load, horsepower, ambient temperature, barometric pressure, humidity, fuel flow rate, suction pressure and discharge pressure. Emergency engine process data collected included torque, rpm, engine load, fuel flow rate, ambient temperature, barometric pressure and humidity. The preceding data was logged at least once every clock minute and then averaged to determine the per-test run values.

## 4.0 SAMPLING AND ANALYTICAL PROCEDURES

### *Description of sampling train(s) and field procedures*

Triplicate one-hour runs were performed on each engine to determine CO reduction efficiency by concurrently measuring O<sub>2</sub>, CO<sub>2</sub> and CO concentrations at the oxidation catalyst inlet and outlet (engine exhaust). NO<sub>x</sub> and VOC concentrations were also measured, in conjunction with, CO at the engine exhausts. The U.S. EPA Test Methods described within the test protocol were used throughout the test, without deviation. The CO reduction efficiency test methods and calculations were consistent with those specified in 40 CFR Part 63, Subpart ZZZZ §63.6620 Equation 1 and Table 4. The NO<sub>x</sub>, CO and VOC emission rates were measured and calculated using Equations 1-3 in 40 CFR Part 60, Subpart JJJJ §60.4244 and Table 2.

Please note that RCTS measured O<sub>2</sub> and CO<sub>2</sub> diluent concentrations, which affords the use of either to satisfy Subpart ZZZZ requirements for correcting CO concentrations to 15% O<sub>2</sub> prior to determining percent CO reduction. The CO<sub>2</sub> correction factor is based on O<sub>2</sub> to CO<sub>2</sub> fuel factor ratios as described in §63.6620 (e)(2)(ii)(Eq.3), which allows the CO concentrations to be corrected to 15% O<sub>2</sub> based on dry basis CO<sub>2</sub> concentrations as described in Equation 4, § 63.6620 (e)(2)(iii). The F<sub>c</sub> and F<sub>d</sub> fuel factors used to derive the CO<sub>2</sub> correction factors were based on the daily natural gas fuel samples and analyses.

The sampling locations at EUENGINES2-4 are a-typical (relative to U.S. EPA Method 1 "Sample and Velocity Traverses for Stationary Sources" criteria) at the oxidation catalyst inlet, due to the proprietary nature and design of that abatement equipment. Figure 3 of this report illustrates the path of engine effluent as it enters and exits the oxidation catalyst. In an attempt to meet the gas stratification requirements of U.S. EPA Method 7E, measurements at each engine catalyst inlet were performed by selecting and traversing 2 points within each of the two catalyst inlet "ducts". The design and dimension of these ducts precluded the use of more than 2 traverse points. Conversely, the engine exhaust traverse points were typical from a U.S. EPA Method 1 perspective. Traverse points on the engine exhaust stack were located at 16.7, 50.0, and 83.3% of the stack diameter in a line through the centroidal area as described in Method 7E.

All components of the CO<sub>2</sub>, O<sub>2</sub>, NO<sub>x</sub>, CO and VOC extractive sample systems in contact with flue gas were constructed of Type 316 stainless steel and/or Teflon. The CO<sub>2</sub>, O<sub>2</sub>, NO<sub>x</sub> and CO samples were routed to a sample conditioner to remove moisture from the gas prior to injection into the respective analyzer, while the VOC sample was injected directly into the analyzer from the heated sample line as the VOC instrument measures gas on a wet basis. The output signal from each analyzer was connected to a computerized data acquisition system (DAS).

The CO<sub>2</sub>, O<sub>2</sub>, NO<sub>x</sub>, and CO analyzers were calibrated with U.S. EPA Protocol calibration gases at a minimum of three points: low (0-20% of calibration span), mid-level (40-60% of calibration span) and high-level gas (equal to the calibration span) following specifications in U.S. EPA Method 7E. The VOC instrument was calibrated with four propane in nitrogen gases following U.S. EPA Method 25A specifications at the zero level, low (25 to 35 percent of calibration span), mid (45 to 55 percent of calibration span) and high (equivalent to instrument span). All instruments were operated thereafter to insure that zero drift, calibration gas drift, bias and calibration error met the specified method requirements. The extractive sample system apparatus diagram is shown in Figure 1.

The data measured from the pollutant and diluent analyzers was averaged for each run and corrected for drift and bias. The inlet and outlet CO concentrations in part per million by volume (ppmv) used for determining CO reduction efficiency were also corrected to 15 percent O<sub>2</sub> using the CO<sub>2</sub> correction factor ratio equation in 40 CFR Part 63, Subpart ZZZZ, § 63.6620 (e)(2)(ii). Both CO<sub>2</sub> and O<sub>2</sub>, concentrations were measured as percent by volume, dry basis, while NO<sub>x</sub> concentrations were measured as ppmv, dry basis.

CO<sub>2</sub> and O<sub>2</sub>, diluent concentrations were monitored using a non-dispersive infrared (NDIR) and paramagnetic analyzer, respectively, following the guidelines of U.S. EPA Method 3A, *Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from a Stationary Source (Instrumental Analyzer Procedure)*.

NO<sub>x</sub> concentrations were monitored using a chemiluminescence analyzer following the guidelines of U.S. EPA Method 7E, *Determination of Nitrogen Oxides from Stationary Sources (Instrumental Analyzer Procedure)*.

The CO concentrations were measured using an NDIR analyzer following the guidelines of U.S. EPA Reference Method 10, *Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)*.

VOC concentrations were monitored using a Thermo Model 55i Direct Methane and Non-methane Analyzer following the guidelines of U.S. EPA Method 25A, *Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer (FIA)* using the drift and bias corrections specified in U.S. EPA Method 7E, *Determination of Nitrogen Oxides from Stationary Sources (Instrumental Analyzer Procedure)*. This instrument is similar to a Method 25A analyzer with methane cutter in that it employs a flame ionization detector (FID) analytical principal and is capable of providing a total hydrocarbon concentration, minus methane. However, with the Thermo 55i analyzer, the method of determining the methane and non-methane organic concentrations is slightly different. Specifically, while the Thermo 55i does rely upon a FID to determine the concentration of organic compounds, it also contains a gas chromatographic column which is used to separate methane from the other organic

compounds. It works by first injecting the sample gas into the column, after which the methane fraction of the sample gas moves through the column more quickly than the other organic compounds (due to its low molecular weight and high volatility). The methane then exits the column and is analyzed in the FID. After the methane has been analyzed, the column is flushed with inert carrier gas and the remaining non-methane organic compounds are then analyzed in the FID. The preceding analytical technique results in separate measurements for methane and non-methane organic compounds via the use of a single FID, and these measurements are recorded by a data acquisition system. Compared to more conventional Method 25A analyzers with methane cutters, the Thermo 55i is believed to yield more accurate low-level non-methane hydrocarbon measurements, even in the presence of high levels of methane. It should be noted that for purposes of this test program, RCTS did not quality assure the methane channel on the Thermo Model 55i analyzer.

#### Quality Assurance Procedures

Each U.S. EPA reference method performed during this test contains specific language stating that to obtain reliable results, persons using these methods should have a thorough knowledge of the techniques associated with each method. To that end, CEC RCTS attempts to minimize any factors which could cause sampling errors by implementing a quality assurance (QA) program into every component of field testing, including the following information.

U.S. EPA Protocol gas standards certified according to the U.S. EPA Traceability Protocol for Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997 or May, 2012 version and certified to have a total relative uncertainty of  $\pm 1$  percent were used to calibrate the analyzers during the test program. Although not required in the context of this Parts 60 and 63 test program, the vendors providing the calibration gases also participate in the Protocol Gas Verification Program (PGVP), an EPA audited program developed for 40 CFR Part 75.

The extractive sample system instruments were calibrated and operated following the appropriate method guidelines, based on specifications contained in Method 7E (as referenced in Methods 3A and 10). Before daily testing began, an Analyzer Calibration Error (ACE) test was conducted by introducing the calibration gases directly into each analyzer. If the measured response didn't meet the  $\pm 2$  percent of instrument span specification, or within 0.5 ppmv absolute difference to pass the ACE check, appropriate action was taken and the ACE was repeated. Prior to beginning the first run, an initial system bias check was conducted by introducing the low and upscale calibration gases into the sampling system at the probe outlet and drawing them through the sample conditioning system in the same manner as the exhaust gas sample, while measuring the instrument response. Each instrument response must meet a specification of  $\leq 5.0$  percent of instrument span.

Low and upscale bias calibrations were performed after each run thereafter to quantify system calibration drift and bias. During the initial system bias tests, system response time was measured and the sample flow rate throughout the remainder of the test was monitored to maintain the sample flow rate within 10 percent of the average flow rate observed during the response time test. Sampling for each run was started after twice the system response time had elapsed.

*Description of recovery and analytical procedures*

NA

*Dimensioned sketch showing all sampling ports in relation to breeching and to upstream and downstream disturbances or obstructions of gas flow and a sketch of cross-sectional view of stack indicating traverse point locations and exact stack dimensions*

The exhaust stack configuration for the Caterpillar Model G3608 engine (i.e., EUENGINE1) is shown in Figure 2, while Figure 3 shows the Caterpillar Model G3616 engine (i.e., EUENGINE2, EUENGINE3 and EUENGINE4) exhaust stack configuration, including hand markups which are intended to provide an illustration of the flue gas path through the stack.

## **5.0 TEST RESULTS AND DISCUSSION**

### ***Detailed tabulation of results, including process operating conditions and exhaust gas conditions***

Tables 1 through 4 contain a summary of the CO percent reductions and emission rates, NO<sub>x</sub> emissions rates, and VOC emissions rates, observed for each of the units during testing conducted between March 3 and March 6, 2015. Comprehensive RICE operating data, individual run concentrations and emissions, calculation spreadsheets, field data sheets, calibration information, fuel analyses and analytical data are contained in Attachments 1 - 6.

### ***Discussion of significance of results relative to operating parameters and emission regulations***

#### **40 CFR 63 Subpart ZZZZ**

The average percent reduction of CO for each of the four engines was greater than the minimum required destruction efficiency. Thus, EUENGINE1, EUENGINE2, EUENGINE3, and EUENGINE4 are in compliance with the CO percent reduction across the catalyst.

#### **40 CFR 60 Subpart JJJJ**

The NO<sub>x</sub>, CO and VOC emission rates are within the MDEQ ROP and 40 CFR 60 Subpart JJJJ emission limits for each of the four engines.

### ***Discussion of any variations from normal sampling procedures or operating conditions, which could have affected the results***

Although differential pressure ( $\Delta P$ ) drop across the catalyst was monitored continuously throughout the testing on EUENGINE1; this was not the case during testing on EUENGINE2 through EUENGINE4. As a practice, the facility leaves the pressure lines slightly open during the winter months to prevent water freezing in the lines. To comply with the  $\Delta P$  monitoring requirement in the ROP, the facility periodically closes these valves to accurately measure the pressure drop. The pressure lines were not closed during testing of EUENGINE2 through EUENGINE4. Differential pressures for these units were approximated from facility engine operating data obtained prior to and just after the test event. These values were then averaged to provide the  $\Delta P$  for the actual test day(s). This data is included in Attachment 1.

### ***Documentation of any process or control equipment upset condition which occurred during the testing***

NA

### ***Description of any major maintenance performed on the air pollution control device(s) during the three month period prior to testing***

NA

*In the event of a re-test, a description of any changes made to the process or air pollution control device(s)*

NA

*Results of any quality assurance audit sample analyses required by the reference method*

NA

*Calibration sheets for the dry gas meter, orifice meter, pitot tube, and any other equipment or analytical procedures which require calibration*

Attachment 4 contains the analyzer calibration data, response time test results, NO<sub>2</sub> to NO converter efficiency check and calibration gas Certificates of Analysis.

*Sample calculations of all the formulas used to calculate the results*

Sample calculations for all formulas used in the test report are contained in Attachment 8.

*Copies of all field data sheets, including any pre-testing, aborted tests, and/or repeat attempts*

Please refer to Attachment 1 for process data collected during the test runs; Attachment 2 for calculation spreadsheets for each of the test runs; and Attachment 3 for data sheets with the measured concentrations for each test run.

*Copies of all laboratory data including QA/QC*

For this testing event, laboratory data includes the results of the natural gas fuel analyses which are presented in Attachment 5. The information in Attachment 5 also includes a calculation spreadsheet for each natural gas fuel analysis for purposes of calculating the  $F_d$ ,  $F_c$  and  $F_w$  fuel factors.

**TABLE 6**  
**SUMMARY OF RICE EFFICIENCY AND EMISSIONS**  
**WHITE PIGEON COMPRESSOR STATION**  
**EUENGINE1**  
**March 5, 2015**

Time Period	Run 1	Run 2	Run 3	Averages
	1335-1435	1453-1553	1602-1702	
<b>Process Conditions</b>				
Engine Speed, Revolutions Per Minute:	996	989	983	989
Brake Horsepower:	2273	2275	2275	2274
Load, Percent:	95.9	96.0	96.0	96.0
Fuel Flow, SCFM	283.2	283.0	282.7	283.0
Suction Pressure, PSIG:	602.6	608.4	613.1	608.0
Catalyst Delta P, Inches of Water:	3.37	3.37	3.35	3.36
Catalyst Inlet Temperature, degrees F:	789.2	787.9	783.4	786.8
<b>Inlet Gas Conditions</b>				
Drift Corrected Oxygen Concentration, Dry (Percent):	12.04	11.99	11.97	11.98
Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):	394.92	393.87	397.8	395.53
Corrected Carbon Monoxide Concentration (ppmdv @ 15% O <sub>2</sub> ):	263.05	260.93	262.83	262.27
<b>Outlet Gas Conditions</b>				
Drift Corrected Oxygen Concentration, Dry (Percent):	12.11	11.95	11.91	11.99
Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):	11.50	11.35	11.52	11.45
Drift Corrected Carbon Monoxide Concentration (ppmdv @ 15% O <sub>2</sub> ):	7.72	7.48	7.56	7.59
CO Percent Reduction Efficiency (≥ 93% Per 40 CFR Part 63, Subpart ZZZZ):	97.06	97.13	97.12	97.11
Emission Rate, Grams Per Brake Horsepower:	0.017	0.016	0.016	0.016
ROP Emission Limit, Grams Per Brake Horsepower <sup>2</sup> :	0.2	0.2	0.2	0.2
Drift Corrected Nitrogen Oxides Concentration, Dry (ppmdv):	51.63	52.71	52.86	52.4
Emission Rate, Grams Per Brake Horsepower:	0.44	0.44	0.44	0.44
ROP Emission Limit, Grams Per Brake Horsepower <sup>1</sup> :	0.5	0.5	0.5	0.5
Drift Corrected Volatile Organic Compounds (as NMOC) Concentration, Dry (ppmdv):	0.77	0.65	0.66	0.69
VOC (as NMOC) Emission Rate, Grams Per Brake Horsepower:	0.006	0.005	0.005	0.006
40 CFR Part 60, Subpart JJJJ Emission Limit, Grams Per Brake Horsepower:	1.0	1.0	1.0	1.0

<sup>1</sup> The ROP CO and NO<sub>x</sub> emission limits are more stringent than the applicable limits in 40 CFR Part 60, Subpart JJJJ, which are as follows: CO = 4.0 grams/HP-hour; NO<sub>x</sub> = 2.0 grams/HP-hour.

**TABLE 7**  
**SUMMARY OF RICE EFFICIENCY AND EMISSIONS**  
**WHITE PIGEON COMPRESSOR STATION**  
**EUENGINE2**  
**March 4, 2015**

Time Period	Run 1	Run 2	Run 3	Averages
	0957-1057	1123-1223	1249-1349	
<b>Process Conditions</b>				
Engine Speed, Revolutions Per Minute:	997	1000	1000	1000
Brake Horsepower:	4544	4573	4584	4567
Load, Percent:	96.0	96.6	96.8	96.5
Fuel Flow, SCFM	571.5	570.7	572.8	571.7
Suction Pressure, PSIG:	599.6	597.0	595.5	597.3
Catalyst Delta P, Inches of Water:	2.60	2.60	2.60	2.60
Catalyst Inlet Temperature, degrees F:	767.5	763.2	762.0	764.2
<b>Inlet Gas Conditions</b>				
Drift Corrected Oxygen Concentration, Dry (Percent):	15.06	15.45	15.63	15.38
Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):	329.95	314.35	303.59	316.0
Corrected Carbon Monoxide Concentration (ppmdv @ 15% O <sub>2</sub> ):	333.18	340.22	340.09	337.8
<b>Outlet Gas Conditions</b>				
Drift Corrected Oxygen Concentration, Dry (Percent):	11.47	11.85	11.91	11.75
Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):	2.04	2.03	2.07	2.0
Drift Corrected Carbon Monoxide Concentration (ppmdv @ 15% O <sub>2</sub> ):	1.28	1.33	1.36	1.3
CO Percent Reduction Efficiency (≥ 93% Per 40 CFR Part 63, Subpart ZZZZ):	99.6	99.6	99.6	99.6
Emission Rate, Grams Per Brake Horsepower:	0.003	0.003	0.003	0.003
ROP Emission Limit, Grams Per Brake Horsepower <sup>1</sup> :	0.2	0.2	0.2	0.2
Drift Corrected Nitrogen Oxides Concentration, Dry (ppmdv):	57.9	57.1	57.1	57.3
Emission Rate, Grams Per Brake Horsepower:	0.46	0.47	0.47	0.47
ROP Emission Limit, Grams Per Brake Horsepower <sup>1</sup> :	0.5	0.5	0.5	0.5
Volatile Organic Compounds (as NMOC) Concentration, Dry (ppmdv):	0.65	0.64	0.66	0.65
VOC (as NMOC) Emission Rate, Grams Per Brake Horsepower:	0.005	0.005	0.005	0.005
40 CFR Part 60, Subpart JJJJ Emission Limit, Grams Per Brake Horsepower:	1.0	1.0	1.0	1.0

<sup>1</sup> The ROP CO and NO<sub>x</sub> emission limits are more stringent than the applicable limits in 40 CFR Part 60, Subpart JJJJ, which are as follows: CO = 4.0 grams/HP-hour; NO<sub>x</sub> = 2.0 grams/HP-hour.

**TABLE 8**  
**SUMMARY OF RICE EFFICIENCY AND EMISSIONS**  
**WHITE PIGEON COMPRESSOR STATION**  
**EUENGINE3**  
**March 3, 2015**

Time Period	Run 1	Run 2	Run 3	Averages
	1414-1514	1532-1632	1645-1745	
<b>Process Conditions</b>				
Engine Speed, Revolutions Per Minute:	997	996	997	<b>996</b>
Brake Horsepower:	4594	4722	4707	<b>4675</b>
Load, Percent:	97.0	99.7	99.4	<b>98.7</b>
Fuel Flow, SCFM	565.7	579.8	578.0	<b>574.5</b>
Suction Pressure, PSIG:	569.0	576.5	586.8	<b>577.5</b>
Catalyst Delta P, Inches of Water:	2.40	2.40	2.40	<b>2.40</b>
Catalyst Inlet Temperature, degrees F:	756.5	748.6	742.3	<b>749.1</b>
<b>Inlet Gas Conditions</b>				
Drift Corrected Oxygen Concentration, Dry (Percent):	14.92	14.94	14.68	<b>14.85</b>
Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):	309.95	325.44	336.85	<b>324.08</b>
Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):	305.64	322.24	319.37	<b>315.75</b>
<b>Outlet Gas Conditions</b>				
Drift Corrected Oxygen Concentration, Dry (Percent):	11.79	11.80	11.87	<b>11.82</b>
Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):	5.47	5.50	5.64	<b>5.53</b>
Drift Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):	3.54	3.56	3.68	<b>3.59</b>
CO Percent Reduction Efficiency ( $\geq$ 93% Per 40 CFR Part 63, Subpart ZZZZ):	98.8	98.9	98.9	<b>98.9</b>
Emission Rate, Grams Per Brake Horsepower:	0.008	0.008	0.008	<b>0.008</b>
ROP Emission Limit, Grams Per Brake Horsepower <sup>1</sup> :	0.2	0.2	0.2	<b>0.2</b>
<b>NO<sub>x</sub> Emissions</b>				
Drift Corrected Nitrogen Oxides Concentration, Dry (ppmdv):	54.2	53.0	53.1	<b>53.5</b>
Emission Rate, Grams Per Brake Horsepower:	0.44	0.43	0.43	<b>0.43</b>
ROP Emission Limit, Grams Per Brake Horsepower <sup>1</sup> :	0.5	0.5	0.5	<b>0.5</b>
<b>Volatile Organic Compounds (as NMOC) Emissions</b>				
Volatile Organic Compounds (as NMOC) Concentration, Dry (ppmdv):	0.64	0.59	0.77	<b>0.67</b>
VOC (as NMOC) Emission Rate, Grams Per Brake Horsepower:	0.005	0.005	0.006	<b>0.005</b>
40 CFR Part 60, Subpart JJJ Emission Limit, Grams Per Brake Horsepower:	1.0	1.0	1.0	<b>1.0</b>

<sup>1</sup> The ROP CO and NO<sub>x</sub> emission limits are more stringent than the applicable limits in 40 CFR Part 60, Subpart JJJ, which are as follows: CO = 4.0 grams/HP-hour; NO<sub>x</sub> = 2.0 grams/HP-hour.

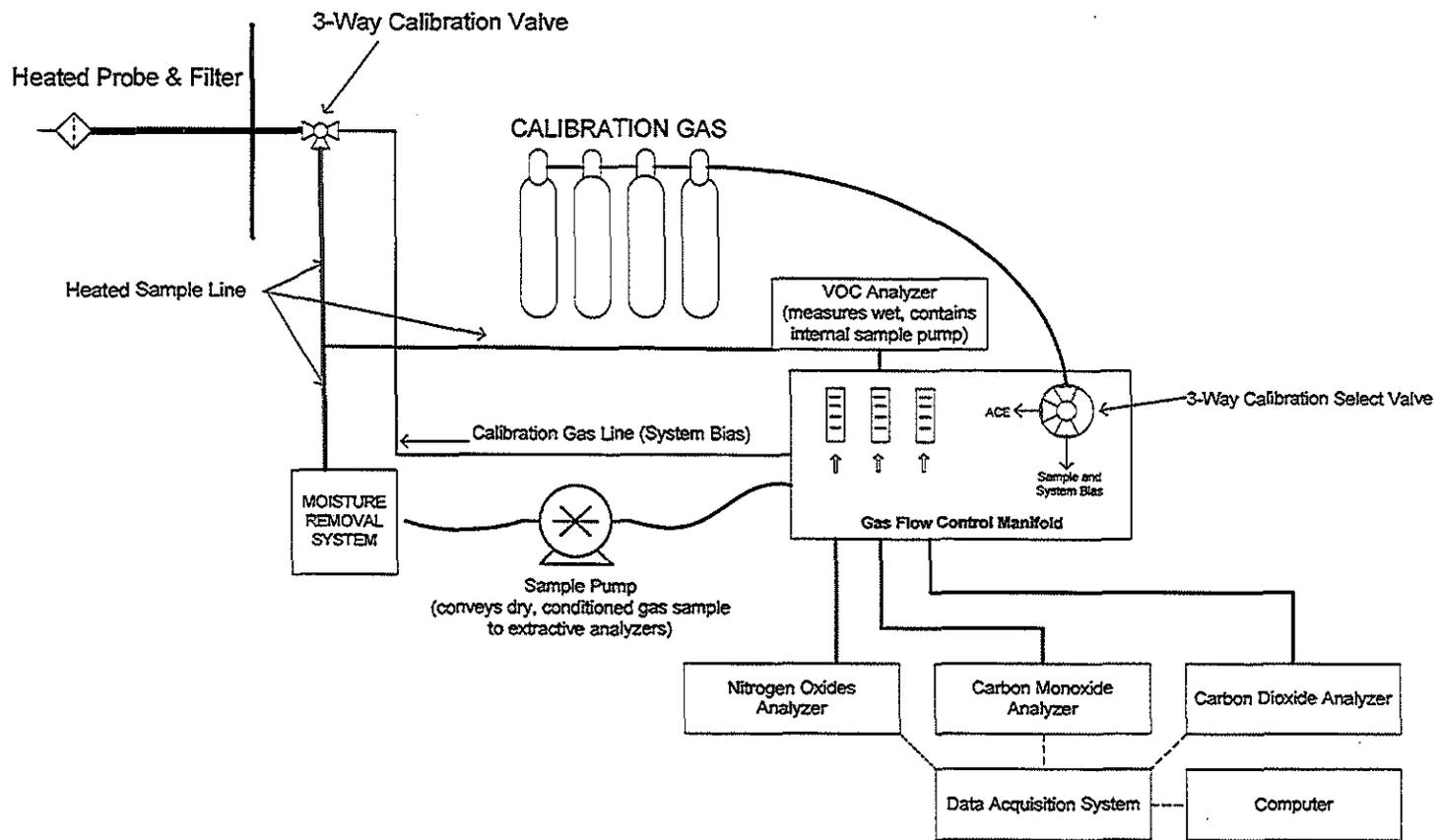
**TABLE 9**  
**SUMMARY OF RICE EFFICIENCY AND EMISSIONS**  
**WHITE PIGEON COMPRESSOR STATION**  
**EUENGINE4**  
**March 3, 2015**

Time Period	Run 1	Run 2	Run 3	Averages
	1007-1107	1134-1234	1254-1354	
<b>Process Conditions</b>				
Engine Speed, Revolutions Per Minute:	993	998	998	<b>997</b>
Brake Horsepower:	4709	4608	4617	<b>4645</b>
Load, Percent:	99.5	97.3	97.5	<b>98.1</b>
Fuel Flow, SCFM	573.0	561.2	562.8	<b>565.7</b>
Suction Pressure, PSIG:	545.1	559.9	564.0	<b>556.2</b>
Catalyst Delta P, Inches of Water:	2.47	2.47	2.47	<b>2.47</b>
Catalyst Inlet Temperature, degrees F:	770.9	771.5	774.5	<b>772.3</b>
<b>Inlet Gas Conditions</b>				
Drift Corrected Oxygen Concentration, Dry (Percent):	14.47	14.20	14.13	<b>14.27</b>
Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):	386.60	384.39	382.20	<b>384.39</b>
Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):	354.66	338.52	333.03	<b>342.07</b>
<b>Outlet Gas Conditions</b>				
Drift Corrected Oxygen Concentration, Dry (Percent):	12.11	12.17	12.27	<b>12.18</b>
Drift Corrected Carbon Monoxide Concentration, Dry (ppmdv):	3.67	3.02	2.94	<b>3.21</b>
Drift Corrected Carbon Monoxide Concentration (ppmdv @ 15% O2):	2.46	2.04	2.01	<b>2.17</b>
CO Percent Reduction Efficiency (≥ 93% Per 40 CFR Part 63, Subpart ZZZZ):	99.3	99.4	99.4	<b>99.4</b>
Emission Rate, Grams Per Brake Horsepower:	0.005	0.004	0.004	<b>0.005</b>
ROP Emission Limit, Grams Per Brake Horsepower <sup>1</sup> :	0.2	0.2	0.2	<b>0.2</b>
Drift Corrected Nitrogen Oxides Concentration, Dry (ppmdv):	62.7	57.1	56.0	<b>58.6</b>
Emission Rate, Grams Per Brake Horsepower:	0.52	0.47	0.47	<b>0.49</b>
ROP Emission Limit, Grams Per Brake Horsepower <sup>1</sup> :	0.5	0.5	0.5	<b>0.5</b>
Volatile Organic Compounds (as NMOC) Concentration, Dry (ppmdv):	0.63	0.63	0.38	<b>0.55</b>
VOC (as NMOC) Emission Rate, Grams Per Brake Horsepower:	0.005	0.005	0.003	<b>0.004</b>
40 CFR Part 60, Subpart JJJJ Emission Limit, Grams Per Brake Horsepower:	1.0	1.0	1.0	<b>1.0</b>

<sup>1</sup> The ROP CO and NO<sub>x</sub> emission limits are more stringent than the applicable limits in 40 CFR Part 60, Subpart JJJJ, which are as follows: CO = 4.0 grams/HP-hour; NO<sub>x</sub> = 2.0 grams/HP-hour.

**FIGURE 1**

**Methods 3A, 7E, 10 & 25A Sampling Apparatus Schematic**



**FIGURE 1**  
**DRY AND WET**  
**EXTRACTIVE GASEOUS**  
**SAMPLE APPARATUS**

**FIGURE 2**

**Caterpillar Model G3608 Stack Schematic  
(EUENGINE1)**

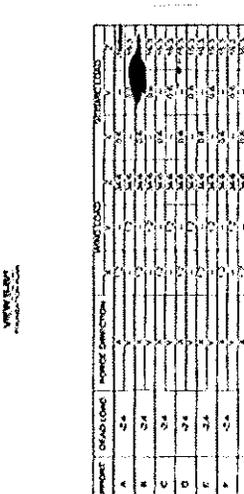
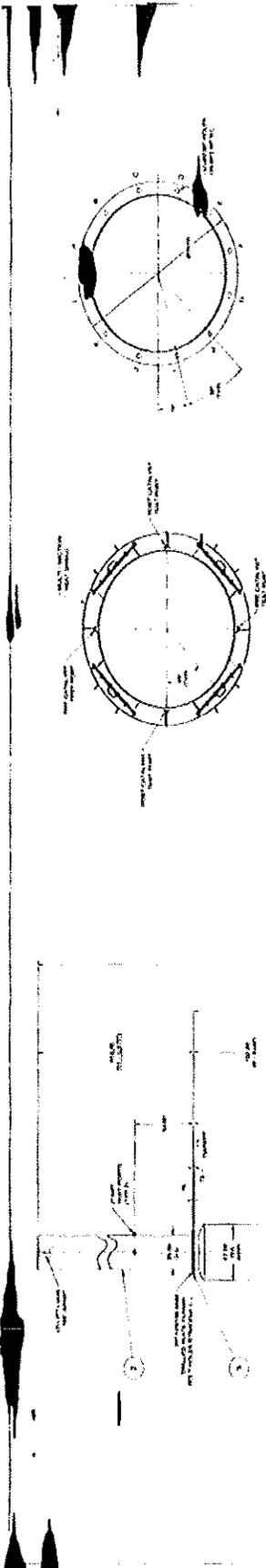
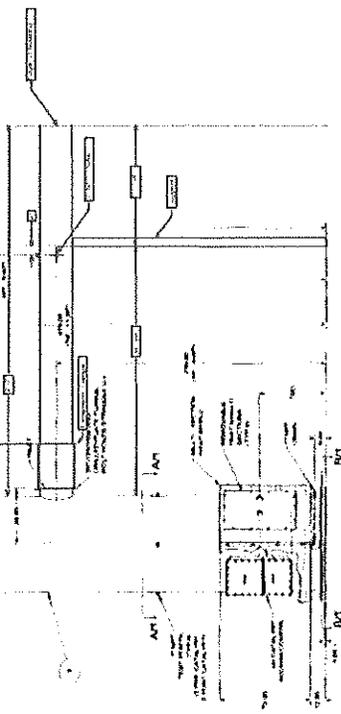


TABLE #1

ITEM	QTY	DESCRIPTION	U.S. PART #	WEIGHT (LBS)
1	1	COMPONENT	100	100
2	1	MOUNTING BRACKET	50	50
3	1	MOUNTING PLATE	25	25
4	10	MOUNTING BOLTS	10	100
5	10	MOUNTING NUTS	10	100
6	10	MOUNTING WASHERS	10	100
7	10	MOUNTING SPACERS	10	100
TOTAL SYSTEM WEIGHT				500

Item	QTY	DESCRIPTION	U.S. PART #	WEIGHT (LBS)
A	24	...	...	...
B	24	...	...	...
C	24	...	...	...
D	24	...	...	...
E	24	...	...	...
F	24	...	...	...
G	24	...	...	...
H	24	...	...	...
I	24	...	...	...
J	24	...	...	...
K	24	...	...	...
L	24	...	...	...
M	24	...	...	...
N	24	...	...	...
O	24	...	...	...
P	24	...	...	...
Q	24	...	...	...
R	24	...	...	...
S	24	...	...	...
T	24	...	...	...
U	24	...	...	...
V	24	...	...	...
W	24	...	...	...
X	24	...	...	...
Y	24	...	...	...
Z	24	...	...	...



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**FIGURE 3**

**Caterpillar Model G3616 Stack Schematic  
(EUENGINE2, EUENGINE3 & EUENGINE4)**

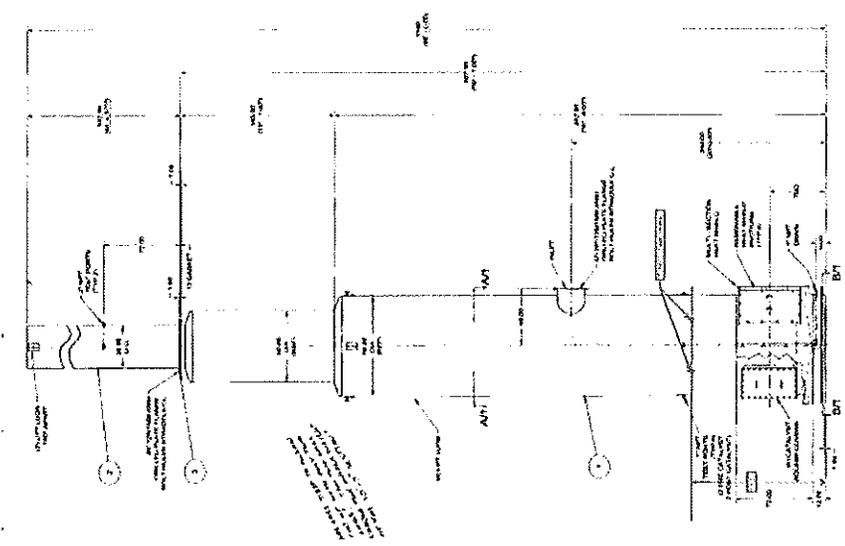
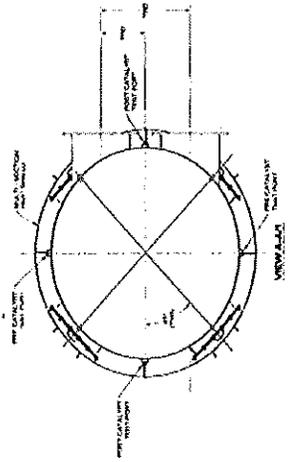
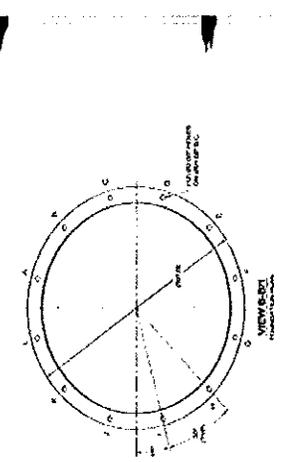


TABLE #1

ITEM	QTY	DESCRIPTION	U.S. PART #	REMARKS
1	1	FLANGE	10-100	
2	1	FLANGE	10-100	
3	1	FLANGE	10-100	
4	1	FLANGE	10-100	
5	1	FLANGE	10-100	
6	1	FLANGE	10-100	
7	1	FLANGE	10-100	
8	1	FLANGE	10-100	
9	1	FLANGE	10-100	
10	1	FLANGE	10-100	

SUPPORT	DEAD LOAD	WIND DIRECTION	WIND LOAD	SEISMIC LOAD
A	0.5	A	0.5	0.5
B	0.5	B	0.5	0.5
C	0.5	C	0.5	0.5
D	0.5	D	0.5	0.5
E	0.5	E	0.5	0.5
F	0.5	F	0.5	0.5
G	0.5	G	0.5	0.5
H	0.5	H	0.5	0.5
I	0.5	I	0.5	0.5
J	0.5	J	0.5	0.5
K	0.5	K	0.5	0.5
L	0.5	L	0.5	0.5
M	0.5	M	0.5	0.5
N	0.5	N	0.5	0.5
O	0.5	O	0.5	0.5
P	0.5	P	0.5	0.5
Q	0.5	Q	0.5	0.5
R	0.5	R	0.5	0.5
S	0.5	S	0.5	0.5
T	0.5	T	0.5	0.5
U	0.5	U	0.5	0.5
V	0.5	V	0.5	0.5
W	0.5	W	0.5	0.5
X	0.5	X	0.5	0.5
Y	0.5	Y	0.5	0.5
Z	0.5	Z	0.5	0.5

COMMENTS

1. CHECK ALL DIMENSIONS AND MATERIALS AGAINST THE DRAWING.

2. ALL DIMENSIONS SHALL BE IN INCHES UNLESS OTHERWISE SPECIFIED.

3. ALL DIMENSIONS SHALL BE TO CENTER UNLESS OTHERWISE SPECIFIED.

4. ALL DIMENSIONS SHALL BE TO CENTER UNLESS OTHERWISE SPECIFIED.

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0 1 1

DATE: 10/1/53

BY: [Signature]

FOR: [Signature]

PROJECT: [Signature]

SCALE: 1" = 1'-0"

UNIVERSAL SILENCER

18-8000004

0 1 1

DATE: 10/1/53

BY: [Signature]

FOR: [Signature]

PROJECT: [Signature]

SCALE: 1" = 1'-0"