**DOCUMENT TITLE PAGE**

| Identification Numbers (if applicable) | Cummins Report | REPORT DISTRIBUTION |
|---|---|---|
| Program Project No. 22820 | #0721-79019 | Master P.I.C. 50231<br>(1) Info Center 50120<br>(2) Info Center<br>(3) Info Center<br>(4) Author M. Thommen 50231<br>(5) M.S. Lantz - 50231<br>(6) T. Earl CMC 070<br>(7) B.W. Ferrill 20725<br>(8) R.E.Hoffmeister 50196<br>(9) D.D. Hughes 50186<br>(10) J.C. Walter - 50114<br>(11) Vehicle Test - 50231 |
| Pilot Inst. Center No. | Title Testing of Rotary Exhaust Brake (REB) in Cummins Test Vehicles | |
| Test Project No. 0143 | | |
| Other | Author M. Thommen | |
| Date 11/15/79 | | |
| Dept. No. 0721 | Dept. Name Vehicle Test | (5) |

## SUMMARY


PURPOSE:

To determine system component temperatures under actual operating conditions. Also, to investigate field complaints of acceleration hesitation after extended braking.

RESULTS:

1. Average maximum temperatures of various components were:

| | Engine Power Mode | REB Mode |
|---|---|---|
| Turbine Casing and Exhaust Manifold | 1300°F | 850°F |
| Isolation Chamber and Air Cylinder | 210°F | 180°F |
| Clevis | 389°F | 290°F |

2. Road speeds from 30 mph to 55 mph had no influence on the temperatures, nor did application of the REB during full engine power conditions.

3. There was no occurrence of acceleration hesitation after extended braking with functioning rail and throttle switches or with the switches disabled.

4. Application of the REB during Engine Power Mode did not result in any excessive engine or REB temperatures. Black smoke in this operating condition was excessive and was observed to be a function of the REB position.

ACTION: Further testing to evaluate the braking effectiveness of the REB is scheduled pending availability of a driveline torque-meter (M. Thommen) Release of the REB should stipulate a minimum fuel pump throttle leakage setting of 75-100 cc/Min to avoid performance complaints (D. Hughes).

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INTRODUCTION:

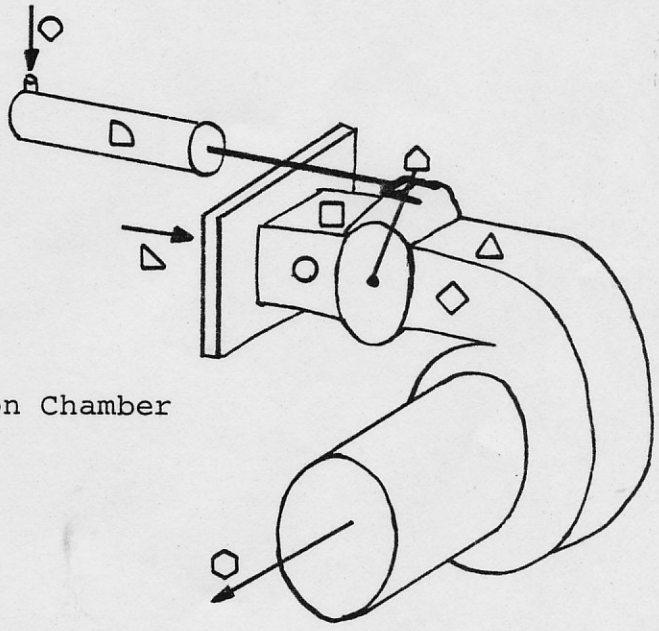
Cummins developed a new REB where braking effect is generated by mechanically providing exhaust restriction which increases engine pumping work. The REB is activated by an air cylinder with a feedback of exhaust manifold pressure to avoid high back pressures on the valves. There is an isolation chamber in series with this feedback system to prevent contamination of the air cylinder supply. Also the isolation chamber eliminates heat transfer from exhaust gas to the air cylinder. The entire REB is mounted in a high temperature zone of the engine compartment, close to the exhaust manifold. It was requested by Accessories that a test be conducted to determine if any various components of REB are exposed to excessive temperatures.

INSTRUMENTATION:

Parameters recorded on the KAYE DATALOGGER and REMEX PAPER TAPE PUNCH WERE:

Temperatures:

- Exhaust Gas Before Turbo
- Exhaust Gas After Turbo
- Top Turbo Before REB
- Side Turbo Before REB
- Top Turbo After REB
- Side Turbo After REB
- Clevis
- Surface of Air Cylinder
- Gas at Inlet of Isolation Chamber
- Air Inside Air Cylinder



Other

- Engine RPM (*)
- Rail Pressure (*)
- Exhaust Manifold Pressure (*)
- Air Cylinder Pressure (*)
- REB Dashboard Switch (*)

Parameters marked by an asterisk were also monitored on a Gould Brush Recorder.

TEST PROCEDURE:

High speed tests (55 mph) were run on I-65 and low speed tests (30 mph) at the Walesboro Airport Test Track. The Performance Load Trailer was used to simulate upgrade/ downgrade operation at stable engine rpm.

The truck was run in full power mode with Performance Load Trailer #140 for 10 minutes until all temperatures were stabilized. Speed was held stable by the trailer, then the throttle was released by the driver to go into braking mode. This configuration was also held for 10 minutes to get temperatures stabilized.

After this period, the throttle was snapped open to look at the transient response of the engine.

DISCUSSION:

As shown on Attachment I, during full power operation below 1500 rpm, the exhaust temperature after expansion exceeded turbine inlet temperature and did not follow the general shape of the torque curve. A faulty thermocouple is suspected. All other system temperatures appeared to be reasonable under both braking and power conditions and are not considered to be excessive.

REB component temperatures are shown on Attachment II. Of primary concern was the Viton Seal in the Air Cylinder which can withstand only 250°F, and the Clevis which is designed for approximately 600°F. Neither of these temperatures were exceeded; however, the ambient temperature averaged only about 55°F during these tests. As ambient temperatures increase, the exhaust and engine compartment temperatures will also increase by at least a 1:1 factor (Ref. CR 0721-79011 by C. R. Riffle).

There was a suggestion to introduce a Rail Pressure Switch to disable the REB at 10 psi Rail Pressure if a throttle switch failure occurs. It seems that there is no need for it because the engine can operate only in the no-air mode when the REB is applied, and the low power and escessive smoke would immediately alert the driver, who could then use the dashboard switch to disable the REB.

As a result of complaints from an REB Field Test vehicle, Accessories had requested that potential acceleration hesitation after extended braking be investigated. Service Engineering

had found the problem to be low throttle leakage on the Field Test vehicle. Results from a recent Vehicle Test project confirmed this and indicated that a minimum throttle leakage setting of 75-100 cc/Min is required to eliminate the hesitation (Ref. CR 0721-79014 by N. L. Smith). It is recommended that throttle leakage setting of 100-125 cc/Min be specified for REB installations.

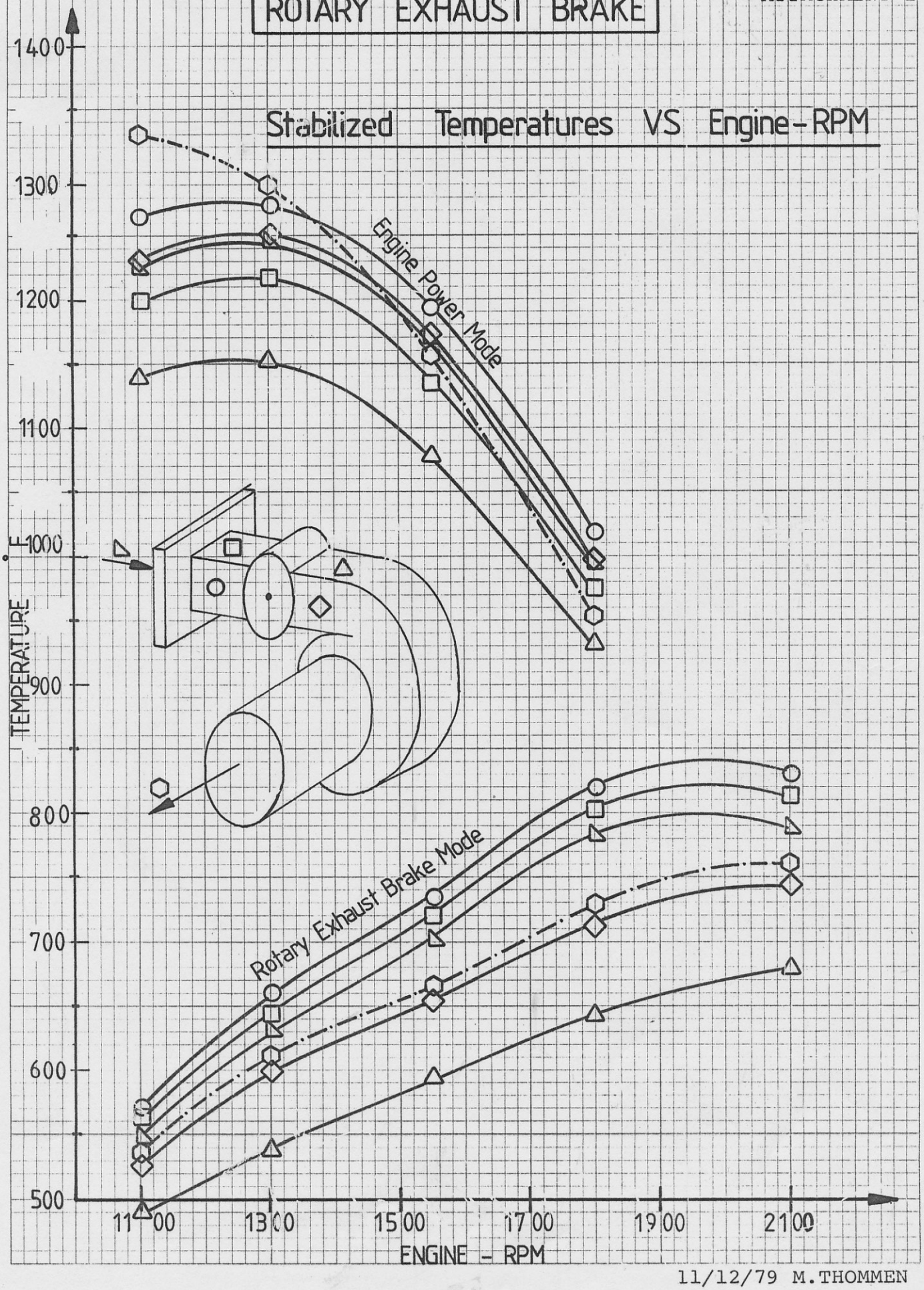
Engineer - Vehicle Test

M. Thommen/sh
X-5629
Attachments

ATTACHMENT I

# ROTARY EXHAUST BRAKE

## Stabilized Temperatures VS Engine-RPM

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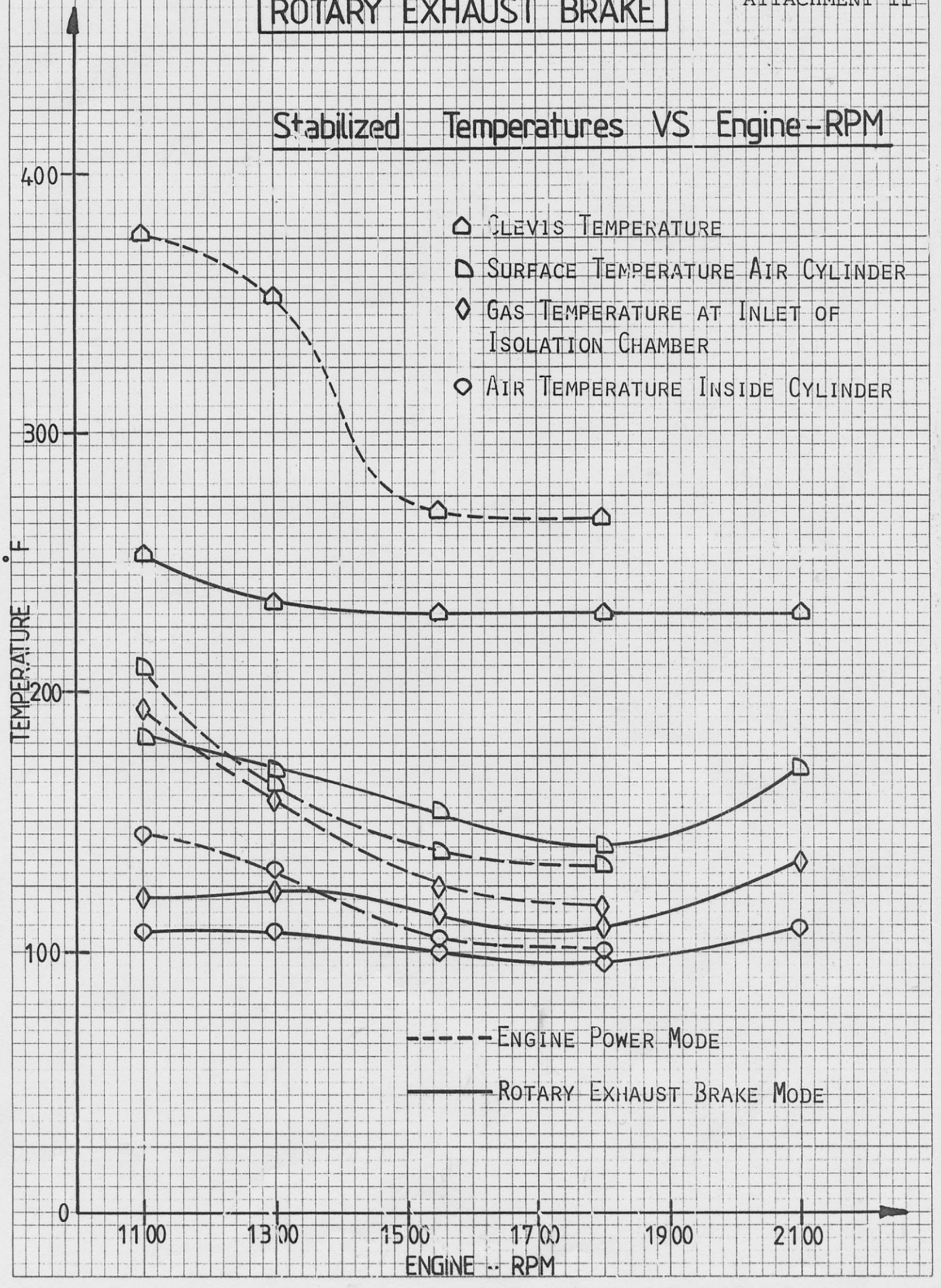
# ROTARY EXHAUST BRAKE

ATTACHMENT II

## Stabilized Temperatures VS Engine-RPM



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TEST EQUIPMENT

The test vehicle was Cummins Test Unit 29 with Performance Load Trailer Unit 140.

The test truck was equipped with the following engine:

| | |
|---|---|
| ENGINE MODEL: | NTC-350 |
| HP / RPM: | 3500/1900 |
| SERIAL NO: | 10506435 |
| CCPL: | 0369 |
| FUEL PUMP: | 3476 |
| THROTTLE LEAKAGE: | 75 CC/MIN |