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Advanced Emission Test Cell Facility
in Ann Arbor

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(Page23-26)

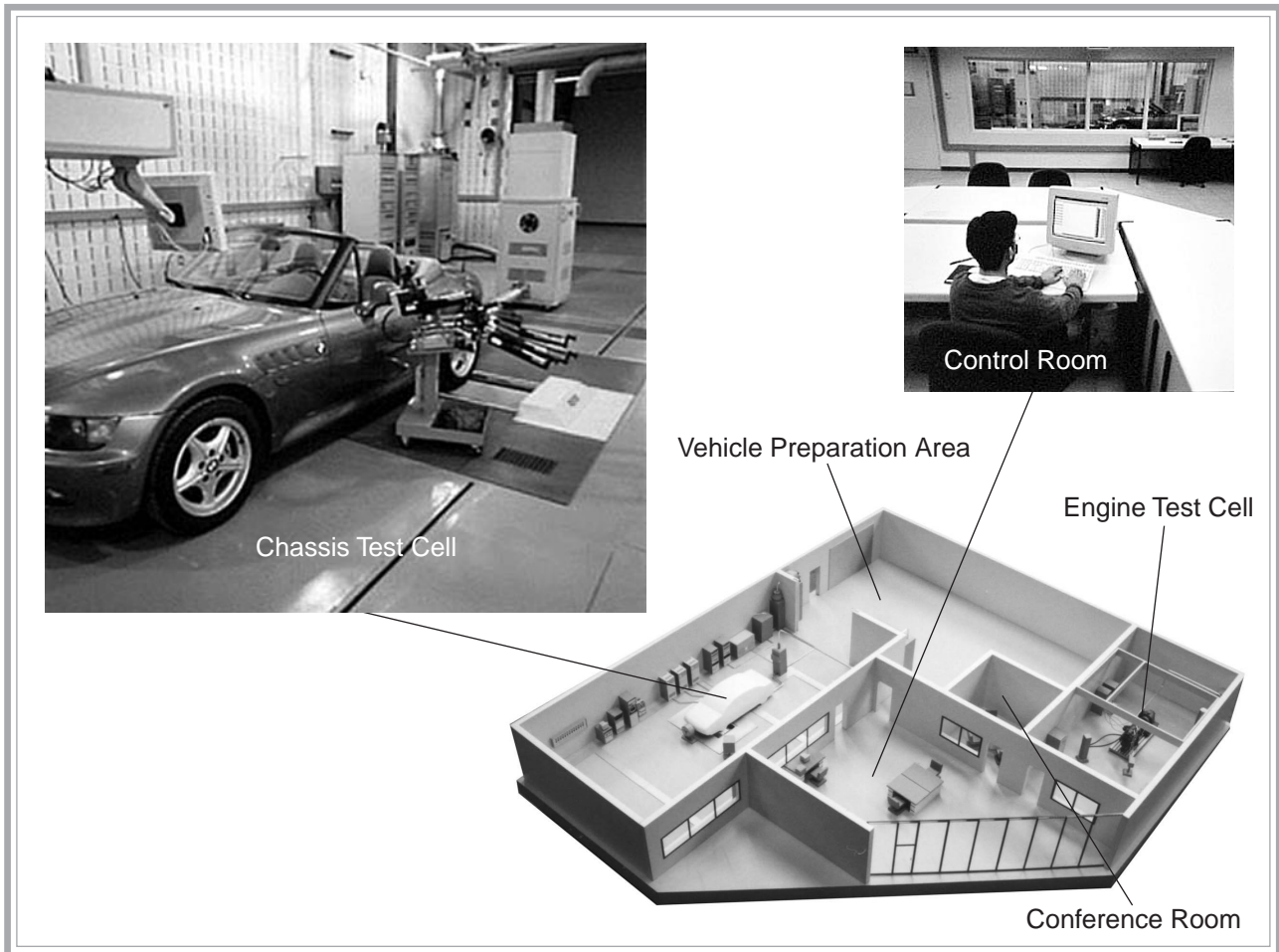
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Feature Article
特集論文

Advanced Emission Test Cell Facility in Ann Arbor

Frank Commiskey

(Horiba Instrument Inc.)



要旨

最新の自動車排ガステストラボが、ホリバグループの米国子会社 Horiba Instruments Incorporated (HII)の Ann Arbor Facility (ミシガン州)に 1999年3月に開設された。この施設には、最新の台上排ガステストセル、エンジンテストセル、車両準備室、制御室、そして会議室などが設置されている。このラボは ULEV 車からの排ガスを計測するための計測機器を取り揃え、自動車業界に向かってかつてない程の野心的な提案を試みている。超高感度の分析計、新たなサンプリング手法、総合的な計測システムの設計などにより ULEV 計測の実現を支えている。本稿では、ULEV の計測に向かって挑戦する、新しいラボの概要と設備機器を紹介する。

Abstract

An automotive emissions test laboratory was recently established at Horiba's Automation Division in Ann Arbor, Michigan. The new facility features a state-of-the-art chassis emissions test cell, engine test cell, vehicle preparation area, control room, and conference room. The laboratory is equipped with instrumentation to test Ultra Low Emission Vehicles (ULEV), an application which presents unprecedented challenges to the automotive industry. Ultra-sensitive analyzers, new methods of exhaust sample handling, and special attention to the total system design are critical to the success of ULEV testing. This paper gives an overview of the new laboratory and provides details on the equipment and strategies that have been implemented in the chassis cell to address the ULEV challenge.

1. Facility Overview

Although Horiba has an automotive test laboratory in Japan, there were several compelling reasons to build a new facility in the United States. First, Horiba's global engineering capabilities have expanded in the past decade, and it became clear that an overseas laboratory was necessary to support international development efforts and local customization of products. A parallel objective was to establish a better way to demonstrate our products and systems to potential customers outside of Japan. Since product demonstrations are best in a realistic setting, building a laboratory was the obvious answer to this need. In addition, as emissions testing has become more complex, the need for training has become more critical. An important purpose for the test facility, therefore, was to provide a training ground for customers and employees.

The test facility has been designed to accommodate many

different types of instrumentation that can be changed-out on a continuing basis. This flexibility achieves three objectives: 1) it allows us to keep the facility equipped with state-of-the-art solutions for demonstration to customers; 2) it permits products under development to be tested in an integrated environment; and 3) it allows simultaneous operation of multiple sets of equipment to support side-by-side product comparisons. To achieve this flexibility, the test cells and control room were designed to be spacious, and all utilities (electrical, HVAC, gas lines, etc.) were sized to handle extra equipment.

2. Chassis Test Cell

Since ULEV testing is a chief concern of our automotive customers, the first set of equipment for the chassis test cell focuses on this application. As the flow diagram in **Figure 1** illustrates, the test cell is equipped for dual-catalyst efficiency testing and bag analysis. Among the products that support this application are the following:

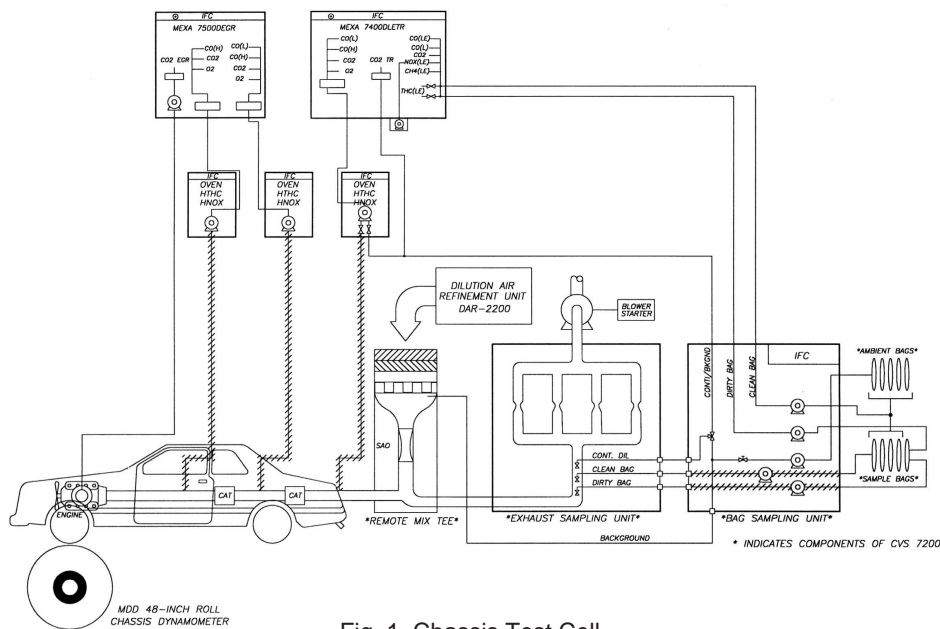


Fig. 1 Chassis Test Cell

アフターバーのエンジン・エミッション・テストラボ

設備の概要

ホリバは、1990年に自動車計測試験用ラボ(アクティブゾーン21)を設置して研究開発を支援してきた。ホリバグループのグローバル化の進展にともない、海外にも先進的なテストラボの設置が必要になってきた。テストラボには、次の3つの要件が具備されていなければならない。

- 1) お客様からの問題提起に対し最新の解答を提供し続けること。
- 2) 開発した製品を様々な環境条件下でテストできること。
- 3) 同時に複数の機器を比較評価できること。

シャーシテストセル

本ラボは、お客様のご要望にお応えして、今最も関心の深いULEV計測用として次に示すような最新のエンジン計測機器を備えている。(Fig. 1)

2.1 Medium Duty Chassis Dynamometer (Model MDD-48-108-200HP-AC)

During a test, the vehicle runs on the chassis dynamometer, which approximates actual driving conditions by simulating inertia, road load, windage, and grade. Horiba has designed and manufactured chassis dynamometers since 1980. The MDD is our newest large-roll AC dynamometer, and it offers such advantages as above-ground calibration and maintenance, an innovative torque measurement system for superior load sensitivity, inertia response times below 65 milliseconds, and exceptional simulation accuracy with our patented Feed-forward Inertia Road Load Simulation Technology (FIRST).

2.2 Automatic Driving System (ADS-1100)

The automatic driving system includes actuators to operate the clutch, accelerator, break, and ignition so that the vehicle can be driven on the dynamometer without human intervention. The mechanical unit is light-weight and can be easily installed in the seat of any vehicle. The control system includes special algorithms for “learning” the characteristics of a vehicle so that it can accurately control it to a predefined driving schedule during a test.

2.3 Constant Volume Sampler (CVS-7200S)

The purpose of a CVS is to dilute the exhaust with ambient air to prevent water condensation, measure the total diluted exhaust volume, and collect proportional samples of the diluted exhaust in bags for later analysis. Our test cell is equipped with a modular system that includes a heated Remote Mixing Tee (RMT), an Exhaust Sampling Unit (ESU), and a Bag Sampling Unit (BSU).

Since ULEV emissions are extremely low and difficult to measure accurately, it is important not to over-dilute the exhaust. In addition, water condensation and hydrocarbon hang-up are key concerns with low level emissions. The CVS-7200S uses several techniques to address these concerns. The remote mixing tee dilutes the exhaust gases with heated dilution air to maximize water suspension. The exhaust sampling unit has four critical flow venturis that provide 15 different flow rates between $8\text{m}^3/\text{min} \sim 30\text{m}^3/\text{min}$, making it possible to select the lowest optimum flow rate for each vehicle. Sample lines carrying the diluted exhaust to the bags are also heated to prevent condensation. Finally, the bag sampling unit includes a separate sample line and pump for cold start emissions (the “dirty bag”) vs. the remaining “clean” phases.

min, making it possible to select the lowest optimum flow rate for each vehicle. Sample lines carrying the diluted exhaust to the bags are also heated to prevent condensation. Finally, the bag sampling unit includes a separate sample line and pump for cold start emissions (the “dirty bag”) vs. the remaining “clean” phases.

2.4 Dilution Air Refinement System (DAR-2200)

This system reduces the levels of THC, CO, and NOx in the background air before it is introduced into the CVS. Dilution air is drawn into the system, heated to a controlled temperature, then passed through a two-stage catalyst converter system. The air is then cooled through a heat exchanger and finally passes through a NOx oxidizing agent and activated charcoal. The purified air is piped to the remote mixing tee where it is mixed with the exhaust.

2.5 Emission Analyzer Systems

(MEXA-7400TR-LE and MEXA-7500DEGR)

The MEXA-7000 analytical equipment is used to determine EGR, pre-catalyst, mid-catalyst, tailpipe, CO₂ tracer, and bag concentrations. The system in our test cell includes three ovens with heated analyzers to measure total hydrocarbons and NOx at the engine, mid-catalyst, and tailpipe. The raw samples are then piped from the ovens to the cold analyzers. The MEXA-7000 requires only 1/3 of the exhaust volume of traditional systems, which is a benefit when dealing with the small exhaust volume of ULEVs.

For bag analysis, the MEXA-7400-TR-LE system is equipped with ultra-sensitive, low-emission analyzers. When measuring very low hydrocarbon concentrations, even a small amount of hang-up is problematic. Therefore, the total hydrocarbon analyzer (FIA-726LE) is heated and has separate lines for “clean” and “dirty” samples. Although this analyzer is capable of achieving a 1 ppm range, calibration gases are currently not available to support such a low range. Therefore we currently use the 5ppm range of the FIA-726LE.

Very low CO analysis is achieved with an ultra-sensitive NDIR (10 ppm range). When measuring such low concentrations, the interference of CO₂ is particularly

2.1 中量車シャーシダイナモメータ(Model MDD-48-108-200HP-AC)

ホリバは1980年以来種々のシャーシダイナモメータを設計・製作してきた。MDDには次のような利点がある。
校正とメンテナンスがし易い。

優れた負荷感度と格段のシミュレーション精度を誇っている。

2.2 自動運転システム(ADS-1100)

ADSは車両を所定のモードに従ってダイナモメータ上を自動的に走行できるようにした自動運転ロボットシステムである。各種のアクチュエータと高い学習機能を持ち、正確な運転制御が可能となる。

2.3 定容量サンプリングシステム(CVS-7200S)

CVSの目的は、水が凝集しないように大気で排ガスを希釈し、希釈された排ガスの総量を計測し、後の分析のためにバッグに希釈された排ガスに比例した試料を採取することである。ULEVからの排ガス濃度は極めて低いため、過剰な希釈、水分の凝縮、HCのハングアップに気をつけなければならない。CVS-7200Sは、リモートミキシングティ(RMT)、排ガスサンプリングユニット(ESU)、バッグサンプリングユニット(BSU)などのモジュールから構成され、精度の高いサンプリングが可能である。

2.4 希釈空気精製システム(DAR-2200)

ULEV計測では、希釈空気中のTHC, CO, NOxなどのバックグラウンド濃度を減少させることが重要である。

troublesome. To address this problem, the MEXA Main Control Unit uses a polynomial algorithm to correct the interference in real time. In addition, the analyzer is calibrated through the bubbler that is used to check CO₂ interference.

2.6 Automation Systems

(VETS-7000, VETS 7000-NT, and CDTCS)

The control room is currently equipped with houses three automation systems for vehicle emissions testing: the VETS-7000, the VETS-7000NT, and the CDTCS. Although only one automation system is used at a time, our design accommodates all three so that our new software developments and customer-specific modifications for any one of them can be tested as well as providing customer demonstrations.

Each automation system includes software to control the test sequence and equipment, acquire data, and calculate the results. The systems differ in their hardware platforms, user interface, reporting capabilities, and targeted users.

3. Conclusion

The new test facility in Ann Arbor represents a renewed commitment by Horiba to address the needs of our customers with integrated solutions. By duplicating the environment in which customers use our equipment, we can better understand the challenges they face and more efficiently develop instrumentation and systems that meet their testing needs. As we look toward the future, we see many exciting opportunities for product development, training, and demonstrations in the facility.



Frank Commiskey

Director
Engine Measurement System Div.
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DAR-2200では大気を加熱した後、2段式触媒コンバータを通過させ、ふたたび冷却後、NO酸化剤と活性炭を通して精製する。

2.5 排ガス分析装置(MEXA-7400TR-LE and MEXA-7500DEGR)

MEXA-7000シリーズは、EGR率、プリキャット、ミッドベッド、テールパイプ、CO₂トレーサ、バッグ濃度などの測定に使われるが、従来の1/3のサンプル流量で可能なため、ULEV計測に威力を発揮する。バッグ分析計MEXA-7400 TRLEは超高感度分析計を備え、フルスケール10ppm又は1ppm(c)の分析ができる。

2.6 オートメーションシステム(VETS-7000, VETS-7000-NT, and CDTCS)

コントロールルームには、VETS-7000, VETS-7000NT, CDTSCの3種類の自動車排ガス試験システム・データ処理システムが設置されており、各種の試験にフレキシブルに対応できる。

3. まとめ

今回の新しいテスト設備は、お客様から投げかけられる様々な課題に対し、お客様と同じ環境に立って考え、解答を提供するために設けられたものである。この設備により新製品開発、トレーニング、デモンストレーションなど計り知れない効用がでるものと期待している。

(抄訳 編集部)

