

Internal Combustion Engine Division Newsletter

Tony Siegel, Editor

Summer 2001

Chair's Message



Stuart Bell

Greetings to all Internal Combustion Engines Division (ICED) members! For our new members I offer a hearty welcome to you on behalf of all of our division. Our division has the mission

to promote, encourage and recognize the advance of art, science and practice of Mechanical Engineering in the field of Internal Combustion Engines. It is certainly my honor to serve as your division chair. I shall look forward to the upcoming year as one that will offer our division new opportunities to fulfill our mission, to better serve our members, and to have a positive impact on our respective professions.

As we look ahead to the coming year, we are fortunate as a division to have an exceptional Executive Committee to provide guidance to the division. Our Executive Committee includes: Steve Fritz, Vice-Chairman, Administrative Programs; Victor Wong, Vice-Chairman, Technical Programs; Greg Gutowski, Assistant Vice-Chairman, Administrative Programs; Neil Blythe, Assistant Vice-Chairman of Technical Programs; Andy Pope, New Administrative Member; Jim Garrett, Division Secretary; Alan Anderson, Division Treasurer; and Terry Ullman, Past Division Chair. Two other individuals who are

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Stempel to receive Honda Medal



Robert C. Stempel

The prestigious Honda Medal will be awarded this year to Robert C. Stempel. The Honda Committee of the ICE Division, headed by Professor Phillip Myers of the University of Wisconsin, cited

many reasons for Mr. Stempel's selection. In the documents they submitted nominating him they said, "The Committee judges that Robert Stempel is an outstanding candidate for this award as evidenced by his engineering contributions to the reduction of emissions from automobiles, his managerial contributions to General Motors and his current and continuing contributions to improvements in batteries and fuel cells for use in future automobiles."

Currently, Robert Stempel is Chairman of Energy Conversion Devices, Inc. (ECD), an energy and information company headquartered in Troy, Michigan. ECD and its subsidiary, Ovonic Battery Company, developed the nickel-metal hydride battery, a powerful, robust, environmentally safe battery widely used in consumer electronic products. It is now being introduced as the power source for electric, hybrid electric, and fuel cell vehicles. ECD, using its amorphous materials

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2001 FTC at Argonne Lab

Argonne National Laboratory will be hosting the Fall 2001 Technical Conference from September 23 - 26, 2001. In addition to over fifty technical papers on engine research by well-known international organizations and authors, several social events are planned. A highlight of the conference will be the 2001 Honda Lecture presented by Dr. Patrick F. Flynn who has selected as his topic: "How Chemistry Controls Engine Design".

Everyone interested in internal combustion engines is encouraged to attend this meeting to share and discuss the latest progress in our field with experts from industry, academia and government laboratories. The setting, Argonne National Laboratory, is a United States government institution dedicated to leading-edge research. A tour of engine-related facilities at Argonne is included in the program. A set of tours for the spouses and friends of the attendees is also being planned. Plan on attending this conference with your spouse or significant other and have a wonderful and productive time.

Please register early. Details can be found on the internet at <http://www.asme.org/divisions/ice/> then select "Conferences". Non-United States citizens from some sensitive countries must register 30 days before the conference for security reasons.

Raj Sekar

Chair's Message

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critical to our division are John Bendo, our ASME staff representative, and Tony Siegel, our newsletter editor. This is a dedicated, hard-working group. Please feel free to call on us with any questions, comments or suggestions that you may have in the upcoming year.

The key activity of our division is annually sponsoring two technical conferences. The conferences highlight renowned keynote speakers in the area of I.C. engines; include technical papers with the latest information on new engine development and design and the related technology for supporting engine development; provide opportunities to network with our peers and exchange critical information which enhances our performance in our jobs; and provide the opportunity for us to tour state-of-the-art research and engine manufacturing facilities across the country. I can think of no better or more economical program to help each of us stay current and abreast of developments in our professions than attending and participating in our division conferences.

The upcoming year has two exciting technical conferences slated for our division. Our Fall 2001 conference will be hosted by Argonne National Laboratory in Chicago, Illinois and the Spring 2002 conference will be hosted by Fairbanks Morse Engine Division in Rockford, Illinois. Again, these conferences will include a full schedule of technical paper presentations, special speakers and a number of social events. Find the individual conference articles in this newsletter for details of these meetings and mark those dates on your calendar.

In closing, *my charge to you is to be active in the division, to participate in at least one of our two annual conferences (as an author or just attendee), and to involve someone new in our division by encouraging them to join the division, by inviting them to one of our technical conferences, or by getting them to be an author of a technical paper for one of our conferences.* Again, I am delighted to be serving as your division chair and look forward to working with you to continue the growth of the ICED.

Stuart Bell

Ullman Gives Thanks

As I enter my final year of service on the executive committee as Past Chair, I feel relief, yet regret. I'm happy to pass on the responsibilities to the incoming Chair, but as my responsibilities diminish, so will my involvement with a great group of engine engineering professionals. The executive committee,

along with the Associates, make the role of chairing this Division a pleasure and an honor. These volunteers perform the real work, orchestrating successful Spring and Fall ICE Technical Conferences to disseminate information and establish a forum for the exchange of ideas on engine-related topics. The conferences are so important in today's demanding market as we are faced with increasingly stringent emission regulations and increasing fuel prices.

Moving through the various positions of the executive committee has enabled me to be involved with many fine people, including various committee members, session organizers, authors, reviewers, panelists, lecturers, honor and award recipients, ASME staff, and an overall fantastic group of Associates.

Thanks for the opportunity!

Terry L. Ullman

Spring 2002 Conference in Rockford

On April 14-17, 2002, the ICED Spring Technical Conference will be hosted by Fairbanks Morse and held at the Best Western Clock Tower Resort and Conference Center in Rockford, IL. The Clock Tower Resort is located just off I-90 at the East State Street exit and is easy to reach from all directions especially for those traveling from O'Hare airport in Chicago. A very reliable bus service is available from O'Hare airport to the hotel.

The conference will have a strong Technical Program covering a wide range of engine related topics. The Technical Program will begin on Monday with a Keynote Speaker. Three parallel sessions will be held on Monday and Tuesday and will span the range from fundamental research to practical in-use applications such as engine performance, emissions, diagnostics and modeling, alternative fuels, friction, lubrication and wear, engine systems and component design. The proposed session titles are:

- Ignition and Combustion
- In-Cylinder Flows and Sprays
- Natural Gas and Alternative Fuels
- Emissions with Emphasis on Power Generation
- Large Bore Engines for Power Generation Markets
- IC Engines in Electrical Power Industry
- Failure Analysis
- New Technologies for SI Engines in the Gas Compression Industry

On Wednesday morning, there will be a tour of the Fairbanks Morse facilities

and attendees will be returned to the hotel by noon. Fairbanks Morse manufactures the Opposed Piston engine, Alco engine, and is a licensee of many Pielstick and MAN engine products. The tour will cover manufacturing of engine components as well as test and assembly facilities. All conference participants and spouses/guests are invited for the tour. The Fairbanks Morse plant is located in Beloit, WI approximately 20 miles North of the hotel.

A number of social events are planned. On Sunday evening the conference will kick off with the Early Bird reception. You can enjoy having dinner at one of Rockford's fine restaurants after the reception. On Monday evening a dinner followed by an entertainment program is being planned and on Tuesday a cocktail reception with hors d'oeuvres is planned for people to get together before they go out to dinner. The Spouses and Guests Program will include two fun days of sightseeing in Rockford.

Participants will enjoy the unique environment of the ICE conference surrounded by people with a common interest in engines.

Frank Aboujaoude and Neil Blythe

Flynn to give Honda Lecture



Patrick F. Flynn

The title of the 2001 Honda Lecture is "How Chemistry Controls Engine Design". It will be presented at the ICED Fall Technical Conference in Chicago, September 23-26, 2001.

The Soichiro Honda Lecture has been established as a National Lecture by the ASME to recognize achievement and significant contribution in the field of personal transportation. Dr. Patrick F. Flynn has been selected as the 2001 Honda Lecturer.

Dr. Flynn obtained his BS and MS degrees from the University of Minnesota and a Ph. D. from the University of Wisconsin. He worked at the Cummins Engine Company for 30 years until his retirement in October 2000 as Vice President of Research & Technology. He held this position for over 10 years. Dr. Flynn has authored and co-authored over a dozen technical papers in the field of modeling engine performance, combustion and emissions.

Madan Goyal

Stempel to receive Honda Medal

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technology, has also developed solid hydrogen storage systems, fuel cells with non-nobel metal catalysts, and flexible, thin-film photovoltaic products.

Mr. Stempel retired as Chairman and Chief Executive Officer from General Motors Corporation in November 1992. He was named Chairman and CEO in August 1990. Prior to serving as Chairman, he had been President and Chief Operating Officer of General Motors since September 1, 1987.

Bob Stempel's interest in automobiles goes back to his high school days when he began to work as a mechanic in a New Jersey automotive repair garage. Continuing to work repairing cars and trucks as he completed his engineering training, he decided to become involved with the design and manufacturing of vehicles, hence his decision in 1958 to join the Oldsmobile Division in Lansing, Michigan, in an entry-level engineering job. Prior to entering general management in 1978, he held a number of top engineering positions.

During his almost 35 years with General Motors, Bob Stempel had been part of many "automotive firsts" that we all experience and expect in our new cars and trucks today. His accomplishments include:

- Improvements in fuel storage systems that resulted in safer and more crash-worthy designs.
- Was in the forefront of actions to reduce emissions from automobiles such as the Positive Crankcase Valve (PCV) System that cut unburned hydrocarbons by 30%.
- Played a key role in the development of the first modern, mass-produced front-wheel drive car, the 1966 Toronado, that established the practicality and durability of that vehicle drive system.
- Participated in the development of the fuel-efficient, transverse front-wheel drive powertrain configuration introduced in 1980 that is used by most manufacturers on front-wheel drive cars today.
- Led the development of the catalytic converter and engines that operated on unleaded fuels to further lower emissions of HC and CO for General Motors. This patented technology is used today by virtually all automotive manufacturers worldwide.
- Convinced the oil companies to produce and distribute the unleaded fuel needed by the catalytic converter-equipped cars.
- Encouraged the development of electronic computer-controlled fuel and ignition systems that minimize engine

emissions while maximizing fuel efficiency.

- Always interested in improving automotive safety, he was active in the development and installation of rear-seat safety belts and anti-lock brakes (ABS) as standard equipment on recent GM cars and trucks.
- A "futurist" who enjoys leading-edge technologies, he helped develop the world record-setting solar power car, "Sunraycer," that won the race across Australia (1,950 miles) in 1987. This General Motors experimental project led to the development of the very efficient electric car, "Impact," which entered production as "EV-1".

In his current position, he continues to be active in the automotive industry working with several manufacturers of electric, hybrid electric and fuel cell powered vehicles developing high power, high energy NiMH batteries, solid hydrogen storage systems and fuel cells.

Mr. Stempel earned his engineering degree at Worcester Polytechnic Institute (BSME 1955) and his business degree at Michigan State University (MBA 1970). He was elected to the National Academy of Engineering in 1990. He was elected Life Fellow of the American Society of Mechanical Engineers (ASME) in 1999. He is also a member of the Society of Automotive Engineers (SAE) and the Engineering Society of Detroit (ESD).

He continues to work in several manufacturing areas, helping to provide a national, long-range focus on quality, including emphasis on applied research and education. A long-time student of Dr. W. Edwards Deming, Mr. Stempel is committed to quality in every aspect of business activity and the concept of teamwork in the work place.

Mr. Stempel is a member of The Business Council. He serves as chairman of the National Commission Against Drunk Driving headquartered in Washington, D.C., and Chairman of the Council of Great Lakes Industries supporting the industrial and environmental activities of the Council of Great Lakes Governors. Mr. Stempel is also active in numerous community, educational and charitable groups.

The award will be presented to Mr. Stempel at the Honors Assembly portion of the 2001 ASME Congress at the New York Hilton on November 14, 2001. For details, please see the ASME website, www.asme.org.

Pope Joins Executive Committee



Andy Pope

The Executive Committee of the ICE Division had chosen Andy Pope as the New Member, Administrative. The New Member makes a six-year commitment to serve on the Execu-

tive Committee in a variety of capacities. He starts as New Member in either an "Administrative" or a "Technical" role and progresses through positions of increasing responsibility until he becomes Chair and then Past Chair before leaving the Executive Committee.

Andy Pope graduated from the University of Dayton with a Bachelor of Science degree in Mechanical Engineering Technology and joined Cummins Engine Company as a Service Engineer. The KV16 engine was being developed at that time and he was responsible for initiating the "Infant Care Program" which required him to baby-sit the first few engines that went into the mines in Utah and Montana.

Andy left Cummins and went to work for Cooper Energy Services at the Superior Plant in Springfield, Ohio as a Development Engineer. He was involved with the development of the "Clean Burn" engine and spent a considerable amount of time on field inspections and start-ups. From the lab, he moved into Project Engineering, starting as a Project Engineer, and then onto Senior Project Engineer where he was responsible for the design and introduction of a new up-rated eight-cylinder gas engine. From this position, he moved into New Products as a Design Engineer where he was responsible for the design and development of a dual-fuel version of a new medium-speed metric diesel engine model line. This was later to become the Superior 2400 series.

Upon leaving Cooper, Pope joined the National Forge Company as a Liaison Engineer in the Crankshaft Marketing department where he was responsible for the sales and technical support of crankshaft products worldwide. While at National Forge, he completed the Master of Business Administration program at Gannon University.

Andy recently left National Forge to explore the world of the self-employed. Andy and his wife, Annette, formed a partnership, A&A Enterprises, many years ago when they started selling race cars. Since then they have been involved with everything from computers to sales and marketing. Under the A&A umbrella he is currently working as the Manager-Business Development consultant for Park-Ohio Forged and Machined Products.

Caterpillar Hosts 2000 Fall Technical Conference

Caterpillar, Inc. hosted the 2000 Fall Technical Conference in Peoria, Illinois, USA. The meeting was held from September 24-27, 2000 at the Holiday Inn Brandywine. Attending the meeting were 169 engineers, including 14 students.

The conference began with the 2000 Honda Lecture titled "Combustion in Gas Fueled Compression Ignition Engines" by Professor Ghazi Karim of the University of Calgary. The technical program included 11 technical sessions, where 50 technical papers were presented.

One of the highlights of the Conference was a tour of Caterpillar facilities. The first stop on the tour was the Mossville engine plant where Caterpillar equipment engines and many of America's highway truck engines are produced. The second stop on the tour was Caterpillar's Sales Demonstration facility for an interesting and entertaining program featuring a wide variety of Caterpillar equipment in action.

The ICE Division Honors and Awards banquet was held on Tuesday evening where the hard work and achievements of those supporting the ICE Division were recognized. A special thanks goes to the Local Arrangements Chairman, Mr. Bernie Richards of Caterpillar, who led the Caterpillar team to a very successful conference.

Steven G. Fritz, P.E.

CIMAC Holds World Congress

The 23rd CIMAC World Congress on Combustion Engine Technology was held in Hamburg, Germany, on May 7-10, 2001. Participants included manufacturers of diesel engines and gas turbines, users, shipowners, power station and rail operators, suppliers, oil companies, scientists and classification societies.

The last Congress was held in 1998 in Copenhagen, Denmark. This year's conference was the 50-year anniversary (the first Congress was in 1951) and included over 700 attendees, 70 exhibitors, 140+ technical papers, 3 panel sessions, and numerous technical poster sessions in the exhibition hall.

Applications included marine propulsion, power generation and rail traction and included sessions on medium-speed engines, high-speed engines, slow-speed engines and gas turbines. Gas engines, research and development, micropilot, emissions, turbochargers, tribology, engine components and Navy applications were also covered.

Spouses' programs were available daily and included bus and boat sightseeing / shopping tours to museums, harbors, the City of Hamburg and outlying areas. Post Congress tours were also available to local shipyards, engine manufacturing

facilities, a nuclear power plant and an excursion tour to Berlin.

The CIMAC Congress is an event, not unlike our own ASME ICE Division conferences, where professionals gather, both technically and socially, to share views and find solutions to technical, commercial and market problems. The aim of both forums is to strengthen the internal combustion engine business by using the organizations as a platform for collaboration within the industry.

The outgoing CIMAC President, Steve Dexter, has done a remarkable job of continuing and improving the CIMAC tradition. The new President is Nikolaos Kyratatos who will serve for the next 3 years. The next CIMAC Congress will be held in Kyoto, Japan, on June 7-11, 2004. I will keep you informed of this event as it unfolds, as well as the upcoming dates and technical themes / content for "CIMAC Days" events which occur twice a year in the Spring and Fall.

*Greg Gutoski, Chair
CIMAC U.S. National Committee*

Successful Spring Technical Conference Held

Over 140 attendees enjoyed the beautiful spring weather and the history of Philadelphia as they attended the 2001 Spring Technical Conference held April 30 thru May 2, 2001. The meeting was hosted by the Propulsion and Power Systems Department of NAVSEA Philadelphia, Ship Systems Engineering Station (SSES). The event featured 56 technical papers and presentations.

The conference kicked-off with a keynote address titled "Technology Advancement in the Military, Challenges for the 21st Century" which highlighted the status of U.S. military resources and modern technological challenges. Con-

gressman Curt Weldon, Chairman of the House Armed Services Readiness Subcommittee, delivered the keynote address. He has close ties to the conference host organization, and to the citizens of SE Pennsylvania, and provided a unique perspective to the conference participants.

The two-day technical program which followed, featured twelve technical sessions consisting of presentations and panel discussions on key areas of ICE research, design, controls, modeling, lubrication and wear. The conference concluded with a tour of the SSES Surface Ship Systems Engineering Complex and Machinery Systems R&D Center.

Enrico Giampaolo

New ICED Associates

The Associates group of the Internal Combustion Engine Division of ASME consists of those who serve our division by taking active roles. During the past year the following persons have been elected to the Associates group:

Dr. Paul L. Flynn
G.E. Transportation Systems
Erie, PA

Dr. Jacob Klimstra
Wartsila, Nederland, bv
Zwolle, Netherlands

Dr. Roger Sierens
University of Gent
Gent, Belgium

Bradley J. Schelske
Ricardo, Inc.
Belleville, MI

With the addition of the above, we now have 134 Associates, 15 of whom are Senior Associates.

Bruce Chrisman

Coolspring Power Museum Named as Heritage Collection

The History and Heritage Committee of ASME International has designated the Coolspring Power Museum, Coolspring, Pennsylvania as a Mechanical Engineering Heritage Collection. The Coolspring Power Museum holds the largest collection of historic internal combustion engines housed in one location and is the most historically significant and mechanically interesting in the entire country. The majority of these engines were built between 1890 and 1920 and were used in industrial applications. The collection documents the early history and evolution of the internal combustion engine. The collection is housed in 13 buildings and consists of approximately 250 engines with a significant number mounted and operational.

A Landmark Ceremony Program was held Saturday morning, June 16, 2001 at the Museum. ASME International President, William A. Weiblen, presented a bronze plaque designating the site as a Mechanical Engineering Heritage Collection to Clark Colby, President, Coolspring Power Museum.

Others in attendance included: Dr. Mahesh C. Aggarwal, Vice-President, Region V; Marilyn Reeder, History & Heritage Chair, Pittsburgh Section; William DeFotis, ASME History & Heritage Committee; and Dr. Paul Harvey, one of the original founders of the museum and now a Vice-President of the Coolspring Power Museum.

I attended the ceremony on behalf of the Internal Combustion Engine Division and as History & Heritage Chair, Central Ohio Section of ASME International. This museum is truly phenomenal and should be visited by all Internal Combustion Engine aficionados.

Mel Helmich

European Railway Emissions Update

The International Union of Railways (UIC) was founded in 1922 to establish standards to facilitate cross-border rail traffic between its constituent members. International rail traffic is regulated by UIC leaflets containing technical specifications for rolling stock interoperability as well as for infrastructure, signalling, and catenary and for agreements for operational regulations and principles for commercial practice. Some leaflets are enforced on a mandatory basis (e.g. for braking systems, wheelsets, draw-hooks and buffers), whereas others are only recommended (e.g. for diesel engines for rail traction). UIC has around 150 member railways in Europe, Africa and Asia.

ERRI, the European Rail Research Institute, a foundation of the European railways and the Research and certification body of UIC, has been working since the beginning of the 1950s on diesel traction. International research was thought necessary for diesel engines as a result of maintenance and traction problems. From the beginning of the 1970s, European railways were under increasing pressure as a result of the public perception of emission problems with their locomotives.

In most European countries during the latter half of the 20th century, wide scale electrification programs saw to the replacement of steam locomotives with very little replacement by diesel traction. As a result, about 85% of the railway traffic in Europe use electrified lines. Diesel traction tends to be limited to secondary lines with locomotives, which are equipped with small- and medium-sized diesel engines compared to those in use in the US. With the exception of some countries like Great Britain, Portugal and Greece, all major railway lines in Western and Central Europe are electrified.

The European railway industry tends to be focused on the development and production of electric traction units, with only a very limited sector producing diesel locomotives for switcher services. Main line locomotives above 2500 kW engine power are still an exception. European diesel engine manufacturers are not attempting to increase the power output of their engines, as the railway market for big engines is only marginal. As a result, railway-engineering directors did not pay much attention to the exhaust emissions of their railway vehicles until the increased environmental sensitivity of the 1980s.

UIC Leaflet 623, developed in the 1980's, describes the procedure for type testing diesel engines for railway applications and includes exhaust emission limit values based on test procedures given in ISO 8178-4 F cycle. Since the first issue of the leaflet in 1984, permissible pollutant limits of the exhaust gases have dropped significantly, as shown in Figure 1.

However since UIC Leaflet 623 is not mandatory, it is not applied by every UIC

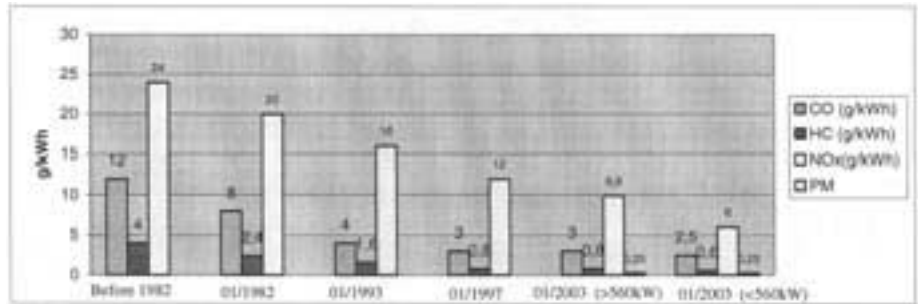


Figure 1

member-railway, especially if the vehicle in which the engine is installed is not designed for cross-border traffic (such as shunting locomotives). An investigation in 1999 showed that only 25% of the European railways had detailed information about their vehicle emissions (see ERRI report B 208 RP 4), most of them not even having the necessary measuring equipment. Although this is discouraging, the situation is not so different from that in North America. EPA itself assumes that diesel locomotive emissions are currently substantially higher than specified in their Tier 0, although they only have estimates on which to base this assumption.

Until recently, governmental environmental authorities in Europe did not pay much attention to diesel locomotive and railcar emissions. This approach changed a few years ago, when diesel emissions in marshalling yards situated in densely populated European downtown areas resulted in major protests by local inhabitants. To avoid potential discrepancies between national legislation, UIC reacted promptly by creating uniform emission limits for diesel locomotives to become mandatory as soon as possible for every UIC member railway.

The relevant European Rail Research Institute (ERRI) Specialists' Committee was asked to draft a new mandatory UIC Leaflet 624 using the above mentioned steady state F cycle of ISO 8178-4 (a compromise of different applications in railway vehicles, consisting of 60% idling, 15% intermediate speed and 25% full load conditions). The validity of this cycle is well established since it was developed in the mid 80's and has been proven repeatedly in 98-99 by several line tests carried out with main line locomotives in the UK and different kinds of railcars in Germany and the Netherlands.

Unlike the United States, the majority of European vehicles use diesel-hydraulic propulsion, making an in-situ emission test, as prescribed by EPA regulations, almost impossible.

Measuring the exhaust emissions produced by a diesel-electric locomotive is comparatively simple - the entire traction power from the locomotive can be dissipated via a load bank. Obviously, even this technique requires a certain amount of preparation and not every workshop is equipped with a load bank capable of dis-

sipating the entire output from a heavy main-line locomotive, as the small number of European diesel-electric locomotives dating from the 70's are not equipped with powerful dynamic brakes.

The problem with diesel-hydraulic locomotives is as follows:

Throughout the tests, the locomotive is secured in such a way that it cannot move. The entire output from the engine is transmitted to the hydraulic transmission and converted into heat, which has to be absorbed by the transmission oil. The heat exchanger for the transmission then has to dissipate the engine's entire power output, in the form of heat, by passing it to the cooling water. In normal service, the efficiency of the transmission rises rapidly as the locomotive starts to move; as speed increases, more power is converted into motion and less into heat.

The transmission oil heat exchanger is not designed for the extreme case of an engine running at full power with the locomotive immobilized and cannot transfer all the heat from the transmission to the cooling water. As a result, the temperature of the transmission oil rapidly reaches unacceptably high levels. In normal service a safety device would automatically reduce engine power before transmission oil reaches such a high level.

From the above account, it will be clear how difficult it is to measure emissions on a stationary diesel-hydraulic locomotive at full power. One has to start off with the transmission oil cold and can only carry out measurements for a maximum of one minute. Clearly, the engine will not have reached normal operating temperature at the end of this period, and the emission characteristics will not yet be those of steady-state running, making reproducible recordings impossible.

Roller rigs used by some railways to simulate vehicle dynamic tests do not have the braking capacity to dissipate more than a few hundred kW and therefore are not an appropriate alternative.

Therefore the ERRI Specialists' Committee decided to retain the proven method to carry out emission testing with the engine at the manufacturer's test cell with supervision by ERRI as the certifying body of UIC.

Every new type of diesel engine, regardless of whether the vehicle is in local or international use, has to meet the new emission limits.

The following limits will be in force from 1st January 2002:

Pollutant	Permissible level up to 2200 kW g/kWh	Permissible level from 2200 kW g/kWh	
	UIC I	UIC II	UIC III
Power limit		P < 2200 kW	P > 2200 kW
CO	3	2.5	3
NO _x	12	6	9.5 (n > 1000 l/min) 9.0 (n <= 1000 l/min)
HC	0.5	0.6	0.8
Smoke Index	1.6 (2.5)		
Particulate		0.25	0.25

Table 1

- 1) From an air throughput less than 1 kg/s the value increases linearly from 1.6 to 2.5
- 2) For engines with a nominal power output greater than 2200 kW, a particulate emission of 0.5 g/kWh is acceptable, on an exceptional basis, until December 31, 2004. However, it is recommended that the limit value of 0.25 g/kWh be observed. From January 1, 2005 a limit value of 0.25 g/kWh will be made mandatory for all engines.

Limit	Effective Date	NO _x	CO	PM
UIC II g/kWh	Jan 1, 2005	9.5 or 9.0	0.8	3.0
EPA g/kWh	Jan 1, 2002	9.9	0.74	3.0

Table 2

As it can be seen, particulate emission control is added in 2003, whereas smoke measurements will only be maintained without a certain limit to keep an easy-to-measure indicator before and after engine overhaul.

Table 2 gives an approximate comparison of the values for large engines with the actual EPA limits for main line locomotives. The comparison however is problematic since the test cycles are different and EPA rules need a measurement at the exhaust pipe of the vehicle.

The significant difference in the values concerning particulate emissions was the reason why engines with a power output above 2200 kW were given an exemption until the end of 2004.

An accurate comparison between UIC limits and EPA limits remains problematic since the EPA test cycle is completely different from ISO Cycle F. Firstly, the EPA regulations differentiate between "line-haul" and "switch" (shunting). Line-haul locomotives have to comply with both sets of regulations while shunting locomotives naturally have only to comply with the shunting cycle.

The EPA has set the boundary between shunting and line-haul locomotives at N = 2,300 bhp (1,716 kW). All locomotives with a rated power N of less than 1,716 kW are classed as shunting locomotives.

A typical American diesel locomotive has

Notch	Line-haul [%]	Shunting [%]
Idle	38	59.8
Dynamic Brake	12.5	0
1	6.5	12.4
2	6.5	12.3
3	5.2	5.8
4	4.4	3.6
5	3.8	3.6
6	3.9	1.5
7	3.0	0.2
8	16.2	0.8

Table 3

8 notches, plus "Idle" and "Dynamic brake" positions. The test cycle represents precisely this situation, weighted for each notch:

As every notch has to be measured during at least 6 minutes at each speed, and measurements at full power (Notch 8) are conducted for at least 15 minutes, it is clear

The F-cycle was created in 1985 after several measurements on different European railways, with a number of different types of vehicles and trains. In 1998 the question was raised whether there should be a distinction between the cycles for railcars and main-line locomotives. The use of modern railcars equipped with truck engines has led to a renaissance of passenger transportation on secondary railway lines. Recent test results with EWS (English, Welsh and Scottish Railways, the biggest freight carrier in Great Britain) main-line locomotives and a variety of NS (Nederlandse Spoorwegen, the Dutch National Railway) and DB (Deutsche Bahn, the German National Railway) railcars proved that the cycle in its current form is still an optimal solution (see ERRI report B 208 RP 4).

Table 4 shows the average values from those test results:

Railway	Idling	Partial load	Rated speed
EWS	55%	18%	28%
DB	58%	20%	22%
NS	62%	15%	23%

Table 4

Figure 2 demonstrates the differences between the ISO F- and the EPA-cycle:

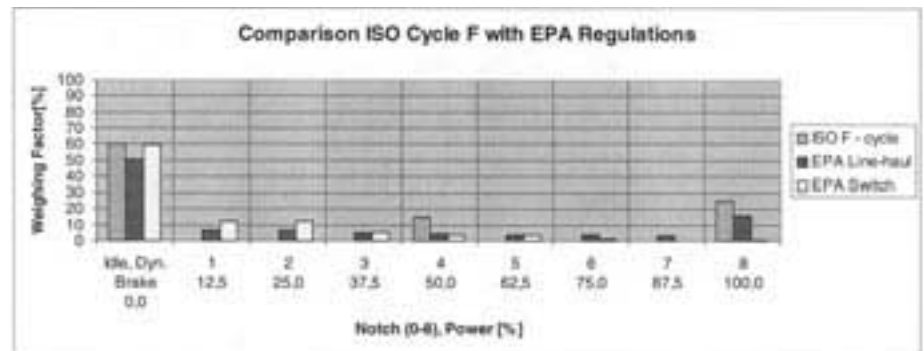


Figure 2

that diesel-hydraulic locomotives could not undergo the EPA test.

The F-cycle of ISO 8178 is comparatively simple. It comprises steady state measurements at idling, intermediate speed and full throttle with the following weighting factors:

- Idling (5% load): 60%
- Intermediate (60-70% of nominal speed, full torque): 15%
- Rated speed: 25%

The high percentage of idling can be explained by taking into account two main factors. The first is the long periods during which a main-line locomotive is waiting in a station or a marshalling yard (the engine cannot be switched off as many vehicles use the traction engine to provide compressed air for braking as well as energy for heating and/or air-conditioning). Secondly, a locomotive returns to idling even during running conditions. After an initial acceleration phase during the starting period of a train, the throttle is often completely closed and the train maintains its speed for long periods of time due to its low running resistance.

When EPA Tier 2 (Table 5) becomes effective in 2005, the comparison of the pollutant limits will be as follows:

At that time the difference in particulate emissions will almost have vanished and the limits in other pollutants are then more stringent in the EPA tests.

Since the non-mandatory UIC Leaflet 623 has been the only method in Europe to prove that an engine is able to meet the pollutant limits, ERRI Specialists' Committee B 208 P proposed to split it into two independent Leaflets.

The whole Performance and Endurance test procedure to demonstrate the engine's capability to fulfill the specific demands of railway applications remains in UIC Leaflet 623 (voluntary application). It is up to the railways whether compliance with this Leaflet is included in their specifications or whether they accept other means to guarantee the engine's durability and capability for railway applications.

The newly created mandatory UIC Leaflet 624 contains only a control procedure

Tier 2	Effective Date	NO _x	CO	CO ₂	PM
UIC (g/kWh)	Jan 1, 2003	9.5 or 9.9	0.8	3.0	0.25
EPA (g/kWh)	Jan 1, 2003	7.4	0.4	3.0	0.27

Table 5

procedure for the pollutant emissions of the engine together with the determination of the power and torque curves and fuel consumption. For the moment it only contains specifications for the initial engine certification, the procedure of production line testing remains under the commanding railways' own responsibility. As for the railways' main competitors, road transportation and waterway transportation, there is currently no repetitive in-use emission testing mandated. UIC railways decided, for the time being, not to pursue forcing compliance from all transportation modes, but it is known that investigations in that direction are underway.

In a time of increased environmental awareness, the railways do not want to lose their reputation as an environmentally

friendly mode of transport. Compliance with ever-decreasing exhaust gas emission limits will also be increasingly significant for railway vehicles driven by combustion engines.

Target figures are already envisioned for UIC III, to come into force by 2008:

Tier 3	Effective Date	NO _x	CO	CO ₂	PM
UIC III (g/kWh)	Jan 1, 2008	6.0	0.5	2.5	0.20
EPA (g/kWh)	Jan 1, 2005	7.4	0.4	2.0	0.27

Table 6

These figures (Table 6) are at present target objectives and need to be reconsidered before 2005. Some feel the densely populated nature of Europe justifies a further decrease, even though diesel traction is responsible for less than 1% of air pollution. It can be anticipated that the new UIC

regulations will have a significant effect on exhaust emission levels of railway vehicles and will strengthen the railways' position as a low-emission transport mode for freight and passenger traffic.

For additional information concerning ERRI's work on diesel emissions within the European railways, including further developments, please visit ERRI's or UIC's website or contact me directly by phone, fax or e-mail:

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ICED Presents Awards

During the Fall Technical Conference held last September in Peoria, IL, the following awards were presented.



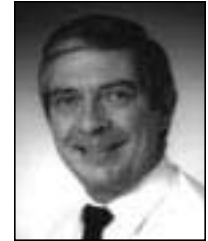
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