INTERNATIONAL THERMONUCLEAR EXPERIMENTAL REACTOR

ITER NEWSLETTER

Vol.2, No.5 May 1989

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, AUSTRIA

INSIDE

COMMUNICATIONS AND INFORMATION FLOW WITHIN THE ITER ACTIVITY

by C. Flanagan, Member of the ITER Special Group at Garching

As a world-wide co-ordinated fusion activity, ITER requires the capability to communicate information among all partners rapidly. This means regular (daily) communication between individuals at the fusion institutions in the European Community, Japan, the Soviet Union, and the United States. The communication also includes individuals at the ITER Technical Site in Garching, West Germany, those sited at the International Atomic Energy Agency in Vienna, and those at governmental bodies of the four Parties.

The communications take all forms; these include face-to-face working sessions, exchange of written correspondence (memos, letters, reports), telephone, facsimile transmission of written material, and electronic transmission.

Joint Working Sessions

The Joint Working Sessions occur at the ITER Technical Site located in Garching twice a year, one a short session (1-2 months) and the other, a longer session (about 5 months). During these sessions, typically 40-50 professionals co-located at Garching work together on intense design activities and are supported by home technical experts in each country. A large volume of communications is required between those at the Technical Site and at the home institutions.

Between Joint Working Sessions, the information flow continues and there is increased emphasis on communications between individuals in the different countries. Even within a given country, there is a constant need for wide-spread, rapid communications since, in general, there are participants from many different institutions. A small staff (approximately seven persons) is located permanently at the Technical site in Garching to aid the co-ordination and communication efforts between Joint Working Sessions.

Documentation System

Copies of all technical documents are provided to each partner so that a complete file of all technical correspondence can be maintained in each country. A listing of all ITER technical correspondence is now provided monthly to the institutions of each of the Parties having led ITER responsibility (Japan Atomic Energy Research Institute, Japan; Lawrence Livermore National Laboratory, USA; and I.V. Kurchatov Institute of Atomic Energy, USSR). The European Community participants have access to the central files maintained at the Garching Technical Site.

Facsimile Transmission

When timely exchange is important, technical information and short documents can be transmitted between participants by facsimile transmission. This system is heavily used by the ITER participants. The capability now exists to send such information from each Party to each of the other Parties. This process permits easy, clear transmission of any written material, including graphics and technical sketches and drawings.

It is interesting to note that frequently the material arriving at the ITER Technical Site in Garching arrives in Japanese and Russian as well as in English.

Electronic Transmission

A world-wide network exists that permits high-speed transmittal of any information that can be processed by the electronic systems. Typically the electronic uses include electronic mail (E-mail); transmission of large quantities of numerical data generated in scientific calculations; transmission of text files of various sizes; on-line computation by technical staff using their large scientific computers; and electronic transmission of Computer Aided Design drawings. All of these occur within the ITER activities.

An example of the electronic transmission system and associated interfaces used by ITER is given in Figure 1. This example shows the IBM/VAX system at the Max Planck Institute of Plasma Physics, Garching and indicates the various linkages between the various sites, including Garching, the various partners, and the IAEA in Austria. Access to the system is from a computer terminal and remote logon is accomplished using a public network protocol; these take a variety of forms such as DX-P, TYMENET, DDX-P, BITNET and EARN.

Several world-wide computer networks are available to communicate over the connecting transmission media. One widely used network is BITNET, which is a communications network throughout Europe, Asia, Canada and the USA,

ITER ELECTRONIC MAIL

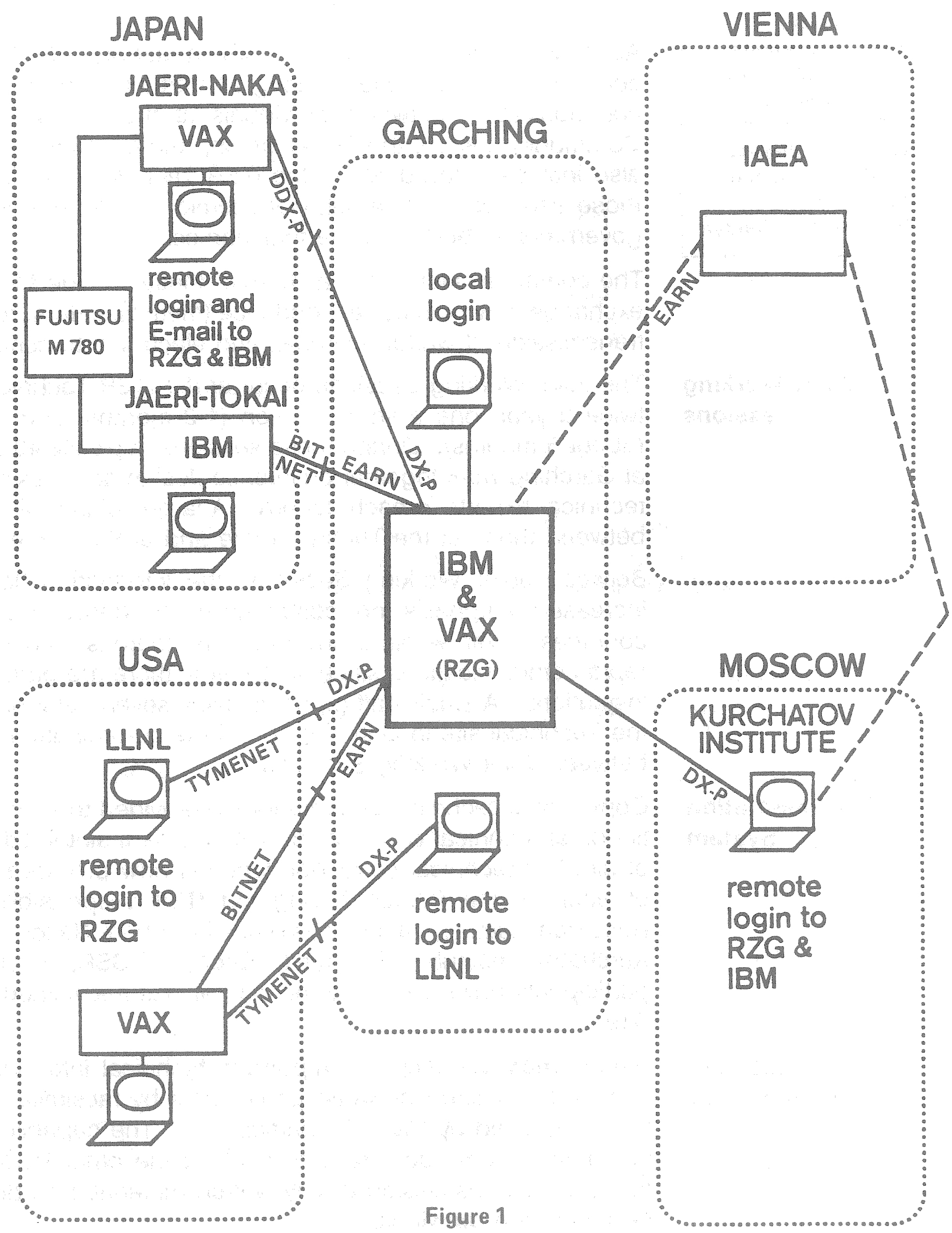

Figure 1

approaching 2000 nodes at about 500 institutions in the USA alone. Major parts of the network are BITNET in the USA, NETNORTH in Canada, EARN (European Academic Research Network) in Europe, and ASIANET in Asia (Japan has the only connections so far).

Communications using the electronic transmission systems requires each user to know how to access the person to whom the communication is addressed. Just as such information is needed to send regular mail by the postal service or to use the telephone, it is also needed by each user to send electronic mail. Each user at a given host computer has a user identification. Sending electronic mail requires the network to know the user identification and address and typically, the system routing is accomplished automatically by software; the sender only has to know the user identification and the host. For example, incoming mail to individuals at Garching would be addressed to XYZ@DGAIPP1S, where XYZ represents the user identification and the remainder is the address for the IBM at IPP.

Use of electronic transmission requires the user to learn how a typical system works and then to adapt to the peculiarities of the specific system and network being used. There are many ways to use each system and each system functions in its own way. There is no magic formula to get communications between any two points in the world-wide network. The paths are numerous and frequently conflicting. Still, once mastered, the system provides a rapid pathway for transmitting information efficiently and generally accurately.

In addition to text and computer numerical file information, Computer Aided Drawings (CAD) can be transmitted electronically. To date, drawings generated at Garching have been successfully transmitted to the USA and drawings generated in the USA have been successfully transmitted to Garching. Also, two-dimensional CAD transmission from Japan to Garching has been tested successfully. Similar capability remains to be developed for use between the other partners. The transmission of CAD drawings are limited by cost and by the lack of standardization of software and associated interface requirements. They typically require the use of interface conversion software to enable drawings generated on the sending CAD system to be converted and readable by the receiving CAD system.

Future Expectations

Recognizing the need for good communications, considerable time and efforts is expended in the communications process. As the ITER design efforts continue with more focus and more definition, it will increasingly become important for all participants to have easy access to the "reference" design information. An on-line data base of this information is planned such that any participant will have instant access to all design information from any site.

Improvements are always desired and this includes finding the best ways to communicate as well as finding the best combinations of software and hardware systems to use. Longer term needs include improved electronic transmission of drawings and the use of optical scanning equipment as this technology matures. There will be a continuing need in ITER to make use of the best available communications capability. The expectation is that the ITER activities will continue to expand the use of these communications avenues.

FUSION REACTOR SAFETY DISCUSSIONS

by J. Raeder, Member of European Community ITER Team

Safety and environmental (S&E) aspects of fusion power are being systematically considered in all of the on-going world's major fusion programmes. There are broad efforts, of which ITER is a part, to develop appropriate design philosophies and procedures that recognize and properly account for the unique characteristics of the fusion energy source and the technologies that will be employed in its utilization. In support of these efforts, the IAEA recently sponsored a meeting of S&E experts from around the world on Selected Aspects of Fusion Reactor Safety.

This meeting, the fourth in a series, was held in Jackson, Wyoming, USA, on 4-7 April 1989. About 40 participants reviewed and discussed the state of S&E expertise on deuterium-tritium fusion based on magnetically confined plasmas.

Principal Safety-related Advantages of Fusion

In essential design principles, plants based on fusion reactions will follow basic safety concepts already developed for now-conventional nuclear power sources, i.e., fission power plants. In detail, however, there are decisive differences between fission and fusion devices with respect to potential consequences of normal operation, including waste management, and the possible courses of accidents. With respect to normal operation, the most important difference is the creation of radioactive fission products but no radioactive fusion products. There is residual radioactivity due to reactions of neutrons with the surroundings in both cases although not in equal amounts. With respect to safety from accident consequences, the most important characteristic of fusion is the expected inherent self-termination of the fusion process under accident conditions. So-called "passive safety" appears to be achievable in fusion power plants because no criticality problem exists and the lingering energy sources that could drive accidents are low compared to fission, whereas the volumes and surface areas are large if magnetic confinement is used.

Most of the fusion device components are novel and have not yet been built at the performance level and scale that will be finally required. Fusion now is in the process of detail evaluation of its risks and of development of its safety-related guidelines, mostly due to the incentive of constructing next generation devices.

The agenda of the meeting at Jackson reflected the fact that fusion devices with major nuclear characteristics are approaching realization. It concentrated on S&E topics such as:

1. programmes for next-step devices,
2. assessment methodologies,
3. implications of the activation product inventories,
4. deterministic component analyses,
5. waste management and its consequences, and
6. operational experience drawn from existing fusion experiments.

Although the coverage could only be partial in terms of these broad topics and the work behind them, a concerted effort was made to bring out definitive information and, insofar as possible, to draw conclusions in the areas discussed below.

Passive Safety as a Design Goal of ITER

ITER and NET were presented under the topic of next step devices. ITER was characterized by the proposal to adopt the design goal of passive safety as far as practical. A set of working design targets for radiation protection, a list of significant accident initiating events, a benchmark of dispersion and dose models, and a variety of further worldwide homework being performed within the framework of the ITER Conceptual Design Activities were reported. NET was presented as an example of how work on a device strongly assists in formulating and guiding a concrete S&E programme.

Presentations on assessment methodologies were centred around "systems studies" and "risk determination." Main points debated were the claim for completeness in a priori failure detection and the failure rate data base which is not yet in an adequately developed state.

Activation product inventories will build up in all DT devices due to the neutrons released. Emphasis was on calculation of inventories, release mechanisms and off-site doses. As to the dose quantification, activation products are an involved topic (compared to tritium) because a very large number of isotopes play a role. Though these isotopes are less prone to release than tritium, emphasis on them has to be significantly increased in the future.

Various components and accidental situations were discussed in terms of deterministic analyses including divertor plates, further in-vessel components, super-conducting magnets, various loss of cooling situations and chemical reactions. Design solutions supporting thermal radiation were shown to have a high potential of precluding major component melting under nuclear afterheat conditions. Natural coolant convection has an even higher potential and seems to cope with the problem even if fusion cannot be shut down promptly. Hot spots, however, appear possible, divertor substrates under loss-of-flow conditions being those raising most concern. Another hot spot of a completely different nature but having a significant damage potential is an electric arc which might ignite at various locations of super-conducting coils.

The radioactive waste issue was broken down into various aspects such as disposal in existing or near term repositories, the radiological impact of it (waste isotope mobility in geologic structures playing a major role), and the practical challenge presented by JET's operational waste. A persisting problem precluding definition of working targets or model repositories which would be very useful for scoping studies is the lack of relevant internationally accepted regulations.

Experience from operating devices (TSTA, D III-D, TFTR) was both interesting itself and indicative for next step devices. The point was made that conventional safety (electricity, mechanics, toxicity, operation) will accompany nuclear safety which presently tends to dominate thinking. An important message seems to be TSTA's (Tritium Systems Test Assembly) claim of being extrapolable to next generation fusion devices with respect to operational tritium releases.

Work Is Planned For Future

The work of the meeting at Jackson was concluded with the formation of three working groups to investigate further and produce reports on the following three topics:

1. application of risk assessment methodologies and failure experience to the next experimental fusion devices,
2. activation product safety: data base and analytical capability, and
3. international status report on fusion safety and environmental concerns.

Meeting participants were in accord that fusion power offers a very attractive potential for safe supply of energy, particularly with respect to freedom from accidents with significant consequences for the public. It was repeatedly noted, however, that this potential can be realized only if its exploitation is unwaveringly held as a goal of fusion and a firm design requirement. These statements are certainly not new, but need continual reemphasis.

Editor's Note

The anniversary of the beginning of intensive joint work on ITER seemed to be an appropriate time for reflection on the human aspects of this remarkable international, intercultural undertaking. Dr. Ettore Salpietro, who has been actively engaged in the midst of the ITER joint work from its beginning, responded to a request from the Newsletter editor with the article that follows.

"IN MEDIO STAT VIRTUS"

by E. Salpietro, Leader, Basic Device Engineering Project Unit

Melting National Characteristics For Mutual Benefit

Working on the ITER project has proved to be very challenging and exciting, not only due to the technical and scientific aspects but also because of the personal relations. In the ITER activities, people have gathered in Garching from all over the world to work on a common project, as a single team, to produce a single design. They come from different backgrounds, have different customs, normally speak different languages, and when they speak the working language of ITER (English), they sometimes attach different interpretations to the same word. And yet the work is progressing, not just despite the differences but in some respects better because of the differences. Hence the title of this article.

A design is not simply the outcome of well quantified scientific and technical analyses but is also a compromise of different personal experiences and judgements with objective evidence. The personal judgements are the problem: everyone has his own one, behind which stands his own logic. Through extensive discussions, some of which can become rather heated, we try to identify and understand these logics in order to arrive jointly at the best solution.

An example is the approach to the analysis of some design problem: the Western countries make extensive use of computers and numerical analysis while the USSR favours a semi-analytical approach. This is the ancient debate as to whether an inductive or deductive method is best in science. As usual "in medio stat virtus": the best is a combination of the two, while occasionally we are supporters of one of the two approaches.

The team assembled in Garching is only a part of the total, with perhaps 3 times the number of the joint team working in their home laboratories on the design of ITER, plus others on the technology to support it. This means that good connections with the home teams are essential. With some of them we have established good connections via computer links, telefax and telephone, while with the others we have to work at improving our communication channels. The participation at the ITER joint work sessions in Garching is not confined to a fixed group, and this frequently enables us to put a face on the voice at the other end of the telphone in discussions with the home laboratories.

Some of the ITER participants have had the benefit of previous international experience in the frame of INTOR, LCT or JET. The Europeans, regarded in the framework of ITER as one partner, actually come from 12 different nations. I find that our JET experience has helped a lot in dealing with the human relationship inside of ITER, with people becoming more tolerant than is normal in a national environment. I really admire the Japanese members for their ability to cope with the attitudes and customs of the other members, so different from their own. Westerners frequently go straight to the point without the circumlocutions called for by the renowned Japanese politeness. Consequently, I have seen colleagues from Japan shocked when confronted for the first time with the direct approach used in the team. Our USSR colleagues are settling down well into the team and are appreciated for their warm friendliness, while colleagues from the US side contribute their enthusiasm and cheerfulness. The Europeans do not seem to me to have developed a unique identity. It is more the national character which suffices: the Germans are well organized, the English with english humour (and a unique ability to write the working language of the team!) and the Italians with a vigorous contribution to discussions. As I look back over the past year, I am convinced that without this "melting pot" for characteristics we would not have progressed in the design as far as we have done. From the comparison of different ideas we were able to converge on the best in a very short time.

FUSION PUBLICITY

by P. Haubenreich, ITER Council Secretary

There has recently been an enormous increase in the number of people in the world who recognize the words "nuclear fusion" and have some feel for the potential benefits of fusion energy. Regardless of the eventual fate of "cold fusion," the reports in the popular news media have introduced some useful facts about fusion to multitudes who previously had practically no knowledge or feeling for its significance. For example, the following is an excerpt from the lead article in the May 8 Newsweek, entitled "the Race for Fusion."

"The appeal of fusion is undeniable. It would be cheap and clean. And it would rewrite the international economic order: energy-poor nations would not have to depend on foreign suppliers. A conventional fusion plant would run on two heavy forms of hydrogen. One, deuterium, comes from water; there is enough in the top 10 inches of Lake Superior to supply America's present electricity needs for 5,000 years. The other fuel is tritium, produced from the metal lithium. When these two isotopes fuse, they release energy -- and little else. Fusion generates no greenhouse gases which, by warming the planet, may raise sea levels and cut food production as agricultural belts shift. It releases no gases that cause acid rain. Fusion cannot run out of control, as can atomic reactions in power plants today, which split atoms. Fusion does yield neutrons, which cause radioactivity. But the radioactivity is so low that it would not need the complex burials of today's 'radwaste.'"

Although fusion scientists and engineers might have reservations about some of this article's statements, one basic part of the message that we have been seeking to get across to the public has now been impressed on the consciousness of people in all walks of life. That is, that fusion promises to be a source of energy that is much less threatening to the earth's environment than are other sources. One result may be that ITER scientists and engineers will be "put on the spot" by a public who expects from ITER the earliest and fullest assurance of their newly awakened hopes.

IAEA ACTIVITIES ON ATOMIC AND PLASMA-MATERIAL INTERACTION DATA FOR FUSION

by R. Janev, Division of Physical and Chemical Sciences, IAEA

IAEA Co-ordinates Development of International Data Bases

During the past fifteen years, the IAEA has been actively pursuing activities aimed at producing and developing an international numerical data base on atomic and molecular (A&M) processes relevant to fusion. These activities have recently been extended also to include plasma-material interaction (PMI) processes. The Agency's programmes in these areas are being formulated and monitored by the Subcommittee on Atomic and Molecular Data for Fusion of the International Fusion Research Council, and are carried out by the IAEA Atomic and Molecular Data Unit, in strong collaboration with the national A&M data centres for fusion (organized as an international Atomic Data Centre Network). Significant progress has been made in establishing the evaluated A&M data base for fusion, which now contains recommended cross section data for all collision processes of the basic hydrogen plasma constituents. Complete, or nearly complete sets of collisional and radiative data also exist for the most important plasma impurities (carbon, oxygen, iron) and, in the case of ionization, for all atoms and ions of fusion interest. Evaluated data sets for some fundamental PMI processes (ion backscattering, physical sputtering, particle induced electron emission) for fusion relevant materials are planned to be ready by the end of this year.

In implementing this major objective, the Agency also promotes, co-ordinates and supports programmes oriented to the generation of A&M and PMI data which are of immediate interest to the on-going fusion research. Examples are the Co-ordinate Research Programmes (CRP) on "A&M data for fusion plasma diagnostics" (1981-1984), the on-going CRP on "A&M data for fusion edge plasmas", and a planned CRP on the particle-surface interaction processes.

Exchange of Information

In order to facilitate the information exchange between atomic physics and fusion communities on data availability, accuracy and needs, regular specialists' meetings are organized on specific problem areas. Such meetings also provide a forum for assessment of priorities in data production and evaluation efforts and/or of the quality of A&M and PMI data bases used in fusion application codes. Important recent examples of such type of Agency activities are the Advisory Group Meeting (1985) on the data base for iron ions, the Specialists' Meeting (May 1988) on the carbon and oxygen data base (both resulting in the near completion of corresponding data bases) and the Consultant's Meeting (May 1988) on the atomic data base-fusion application codes interfaces (resulting in adoption of a common system for data exchange between atomic data centres and fusion laboratories).

ITER Requirements Are Strongly Reflected In IAEA Programmes

Although the Agency's long-term programmes in the field of atomic and plasma-material interaction data for fusion are defined within a broader context, the ITER conceptual design data base requirements are strongly reflected in the content and schedule of its short-term activities in this area. The IAEA has recently (April, 1989) convened a Specialists' Meeting on the "Atomic Database for Neutral Beam Penetration into Large Tokamaks" at which a completely evaluated data base was set up for neutral beam heating and current drive codes, including ITER-relevant beam and plasma parameters.

An Advisory Group Meeting on "Particle-Surface Interaction Data for Fusion", also organized recently (April, 1989) by the IAEA Atomic and Molecular Data Unit, critically analyzed the data status and needs in the area of plasma-material interactions, primarily from the view point of current large tokamak experiments and ITER design PMI data requirements. Appropriate data production and evaluation programmes were formulated at the Meeting for this critical issue of ITER conceptual design, which will be included in the immediate future Agency activities in this area. The on-going CRP on A&M data for fusion edge plasmas is also strongly focussed on aspects relevant to ITER plasma energy and particle exhaust and impurity control scheme (processes with low charged impurities, hydrocarbons, molecular hydrogen processes, etc). Creation of data bases for heavy impurities (e.g. tungsten), fusion alpha particle diagnostics, material behaviour under off-normal plasma-wall conditions, are some of the items in the "next-step" Agency plans.

The strong interactions among the pertinent segments of atomic physics and fusion communities have been and continue to be instrumental in the establishment and development of the IAEA atomic and plasma-material interaction data for fusion. The ITER conceptual design activities have significantly strengthened this interaction and enhanced its output efficiency.

ITER EVENTS CALENDAR - 1989

Joint Work Session	Garching	1 June - 20 Oct
ISTAC Meeting	Garching	26 - 28 June
ITER Council Meeting	Vienna	12 - 13 July
Symposium on Fusion Engineering	Knoxville	2 - 6 Oct
ISTAC Meeting	Vienna	15 - 17 Nov
ITER Council Meeting	Vienna	30 Nov - 1 Dec

Starting on 1 June 1989, the third session of joint work in Garching will reach a major milestone by the end of August when the major design decisions will have finally been made. Completion of the interim report on ITER design is expected by mid-October 1989.

In support of the ITER team design work, several specialists' meetings will be held in Garching during the summer session on the following topics:

Current Drive/Heating Modelling	12 - 16 June
Electromagnetics	20 - 22 June
Basic Device Engineering Requirements/Siting	10 - 12 July
Diagnostics	10 - 14 July
Power/Particle Control (Model Validation)	17 - 21 July
Safety	31 July - 4 Aug
Tritium Fuel Cycle	1 - 8 Aug

The ITER NEWSLETTER is prepared and published by the International Atomic Energy Agency, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria. Telex: 1-12645, Cable: INATOM VIENNA, Facsimile: 43 1 234 564, Tel.: 43 1 2360-6393/6394. Items to be considered for inclusion in the ITER Newsletter should be submitted to N. Pozniakov, ITER Secretariat.

Printed by the IAEA in Austria
May 1989

89-02141