

# The Metal Properties Council—A Report to the American Welding Society

*Historically sponsored by ASME, ASM, ASTM, the Engineering Foundation—and now, AWS—the MPC is administering approximately 25 programs (including laboratory research) dealing with fatigue, fracture toughness, corrosion, nuclear reactors and coal*

BY ADOLPH O. SCHAEFER

A very important event to The Metal Properties Council, Inc., was the addition of the American Welding Society to the list of the national technical societies that sponsor The Metal Properties Council, Inc. This happened during 1978. It was announced and formalized at the Annual Meeting of the Board of Directors of the Council on October 12, 1978.

This brief description of the organization and operation of The Metal Properties Council, Inc., is offered to the members of the American Welding Society in the interest of promoting such a high level of mutual understanding that both organizations may achieve the maximum benefits from their formalized relationship.

Since The Metal Properties Council was spawned by a Joint Committee of the American Society for Testing and Materials and The American Society of Mechanical Engineers, it started out with two sponsoring technical societies. The longwinded name of the originating group was the ASTM-ASME Joint Committee on the Effects of Temperature on the Properties of Metals.

Recognition of the importance of the subject of the effects of temperature became apparent prior to 1920 with the realization that the necessary increase in both capacity and efficiency of central station electric power generation equipment could be gained only by the utilization of larger units operating at higher temperatures. The same representatives of the same companies were necessarily active in

The American Society of Mechanical Engineers in the work there on the Code for Boilers and Pressure Vessels and also in the American Society for Testing and Materials where standards were written for the materials used to make these boilers and pressure vessels.

The organization of the "Joint Committee," as it is often called, was a natural result of the situation. This was accomplished in 1919 shortly after the close of World War I.

The idea of a Metal Properties Council developed in the Joint Committee. A third sponsor was found in the Engineering Foundation which shared in supplying seed money necessary to start the project.

An actual beginning was made in 1965, and The Metal Properties Council, Inc., was incorporated under the laws of the State of New York as a not-for-profit corporation in 1966. At this time, the obvious interest of The American Society for Metals led that organization to join the other sponsors of the young Council. The four "sponsors" of MPC made it possible for an organization to be formed which was broadly representative of engineering and industry.

## Organization

The Metal Properties Council, Inc. (MPC), is a good descriptive title for a

very active technical organization, although the word "Materials" might better be substituted for "Metals." The properties that the Council is concerned with can perhaps best be described as "engineering" properties. The objectives, more formally stated below, are to make available to those who need it, reliable and meaningful information on the properties of materials.

Those properties may be termed mechanical or physical; they include those related to corrosion, erosion, and all other significant elements of the environments in which materials are used.

The need for reliable information is not new, but we are increasingly recognizing the numerous factors affecting the materials we use and, hence, their properties. We are also developing new test methods and equipment and refining our old. Materials, themselves, are changing as raw material sources come into existence and refining processes are modified. Finally, engineers are using materials in ever changing environments and under varied conditions, all of which affect their properties.

The Metal Properties Council, Inc., brings together producers and users of materials, provides forums in which they can discuss and discover their needs, develops programs to obtain the information found necessary, carries out such programs under constant technical review, analyzes and evaluates the results obtained in such programs; and, finally, makes all the

---

ADOLPH O. SCHAEFER is Executive Director, The Metal Properties Council, Inc., New York, New York.

information gained available to all through publication in the technical press.

Legally, The Metal Properties Council, Inc., is a not-for-profit corporation, organized under the laws of the State of New York, to do these things. It is appropriate to quote from the formally stated objectives of the Council before explaining its unique membership by participation, its effective dual organization, and before describing some of its achievements and current activities.

The Charter of The Metal Properties Council, Inc., states that, "The purposes of The Metal Properties Council shall be:

"a) To identify major unfulfilled needs for reliable data on the engineering properties of metals and alloys.

"b) To evolve, plan, and conduct programs for collecting, generating, and evaluating such data so it may be useful.

"c) To arrange for making such data available promptly by reports, publications, correspondence or other means.

"d) To keep informed of and to utilize the results of related activities, both national and international, in order to avoid duplication of effort, and

"e) To act as co-sponsor, with The American Society of Mechanical Engineers and the American Society for Testing and Materials, of the Joint Committee on Effect of Temperature on the Properties of Metals, and to raise funds for financing the activities of the Joint Committee."

## A Dual Structure

The successful organization of The Metal Properties Council, Inc., is dual in nature. A highly business-oriented Board of Directors is balanced by a broadly based Technical Advisory Committee. Both organizations are supreme in their respective fields.

The Board of Directors has 37 voting members. It is made up of presidents and vice presidents of a number of well-known corporations. There are also other executives on the Board, heads of institutes and associations, and one government agency. The Director of the National Bureau of Standards was a member of the original Board of Directors. The Managing Directors of the sponsoring technical societies are required by the Bylaws to be members of the Board.

It is notable that membership in The Metal Properties Council, Inc., is by participation. There are no dues. Members attend or contribute their thoughts and opinions in writing as required.

The entire Board of Directors meets once a year in a gala review of the year's achievements. An Executive Committee and a Finance Committee of the Board of Directors meet quarterly and decide all matters of policy as well as ensure that the affairs of the Council are proceeding favorably. These quarterly meetings determine the course of the Council.

All technical activities of the Council are conducted by the Technical Advisory Committee, which now numbers about 600 members representing over 200 companies. Here again, membership is by participation. The foremost technical talent of the country is found on this Committee which is also carefully watched to be sure that it is broadly representative of all elements of the engineering community including producers, consumers, general interest members, fabricators, all from a wide variety of industries. The Technical Advisory Committee meets quarterly. On these occasions subcommittee chairmen report on the many projects of the Council, submitting for approval new proposals for programs. Because of the rapid growth of MPC and the increase in its active projects, quarterly meetings of the TAC do not attempt to cover in detail all of the projects of the Council. One or two subcommittee chairmen at most are afforded a half hour each to describe their programs in depth. However, all are mentioned, and questions may be raised on any. All new projects must be approved by the Technical Advisory Committee before they are processed for funding.

## The Technical Advisory Committee

Subcommittees and Task Groups of the Technical Advisory Committee are responsible for programs in their particular fields of interest. The number, and their relative activities, change from time to time. The initial active group within the Technical Advisory Committee is known as Subcommittee 1, "Materials for Boilers and Pressure Vessels." Actually it has been expanded beyond that restricted field and is really the elevated temperature strength committee of the Council.

It was one of the first technical subcommittees organized by the Technical Advisory Committee. It started off by gathering and evaluating information on the materials utilized for construction under the ASME Boiler and Pressure Vessel Code. Under its leadership, Dr. George V. Smith has published his well-known "Evaluation Series," a typical title from which is "Evaluation of the Elevated Temperature Tensile and Creep-Rupture Prop-

erties of 3 to 9 Percent Chromium-Molybdenum Steels." (Available from ASTM as DS-59. Published September 1975.)

These books have been published by ASTM and are listed in the Annual Reports of The Metal Properties Council.

They constitute the authoritative information on the elevated temperature strength properties of the steels we use in our boilers and pressure vessels.

Laboratory facilities under contract to MPC conduct creep, stress-rupture, and elevated temperature tension tests on materials, particularly for pressure vessel applications.

Subcommittee 1 has also conducted a program (continuing), and plans to conduct others on weld metal as found in "Code" boilers and pressure vessels.

Another unique activity of Subcommittee 1 has been to conduct a long-time stress-rupture program on aluminum alloys. Two more years will elapse before this program, as it is now planned, will be completed. Already information from the program has been used to corroborate extrapolation procedures.

An important activity of Subcommittee 1 has originated in a Task Group interested in elevated temperature properties of materials for applications other than for boilers and pressure vessels. The area currently under investigation is that for gas turbines, and tests are currently being made on alloy A286 as affected by various heat treatments.

## Further Technical Activities—Subcommittee 1 Continued

The widely used alloy steel containing 2½ chrome and 1 molybdenum has been the subject of several active MPC programs and of the publications resulting therefrom. Initial studies were directed toward the elevated temperature properties of the steel in the quenched and tempered condition. Creep and stress rupture properties were studied of material tempered to several different strength levels. This work has been extended to the study of weldments of thick (4½ in., i.e. 114 mm) plates of this grade, the weldments being of several types and strength levels to correspond to the plates.

In addition to the work in Subcommittee 1 on 2½ chrome-1 moly steel there are other projects on this grade in progress under other subcommittees.

An extensive program on temper embrittlement of this steel will be completed and reported to the techni-

cal press during 1980. MPC has sponsored and developed several symposia on this steel, the latest one of which was held during May, 1980, at the ASTM A-1 Committee Week.

Interspersed creep and fatigue have been imposed on 2½ Cr-1 Mo steel and the results reported at several symposia and published in the technical press. High and low cycle fatigue tests are scheduled. Programs are planned for the future to investigate extremely thick (20 in., i.e., 51 cm) plates of this grade, and also to study its behavior with hydrogen when coated with austenitic steel either as cast and rolled or by weld deposit. Currently, creep tests of this grade in pressurized hydrogen are in progress in equipment designed specifically for this test.

Laboratory facilities are contracted for, and continuing test programs are in progress for creep testing, tension testing, Charpy V-notch testing, high and low cycle fatigue, and creep-fatigue interspersions tests.

### Other Subcommittees and Task Groups of the Technical Advisory Committee

The manifold activities of Subcommittee 1 have been described in detail because it is the oldest operating technical group of the Council. Still more remains to be said about it, but it is appropriate at this point to list the other subcommittees and task groups.

- Subcommittee 3 (2 has been merged into 1) deals with the complexities of Fatigue.
- Subcommittee 5 (4 has also been engulfed into 1) covers the subject of Relaxation.
- Subcommittee 6 deals with the materials utilized in nuclear reactors.
- Subcommittee 7 is interested in Fracture Toughness.
- Subcommittee 8 with the corrosion properties of materials.
- Subcommittee 9 with materials problems in processes for the conversion of coal, both liquefaction and gasification.
- Task Groups on nuclear reactors.
- Task Group on Composites.
- Task Group on Data Storage, Evaluation, and Retrieval.
- Task Group on Cast Iron.

There is even a standby Chairman for the possibility of a Task Group on Materials for the utilization of Solar Energy.

The many active programs being carried out by The Metal Properties Council, within this organizational framework, are each directed towards specific needs. These are the needs expressed by those individuals who participate in MPC technical commit-

tees. Since meetings and membership on technical committees are open to all, the way is open for others to bring their problems to MPC. If they find that their problems are shared by others, and viable programs can be devised to alleviate them, it is quite possible that they may be implemented by MPC.

The charter of The Metal Properties Council, Inc., is broad and new fields of interest are constantly being entered.

### MPC Programs

As a result of the activities of the committees, subcommittees, and task groups that have been described and listed, MPC has currently about 25 active projects. These usually comprise a contract with a suitable laboratory facility to conduct the work that has been outlined by the committee. All the contracts are administered by the staff of MPC and monitored by the originating subcommittee, all under the supervision of the Technical Advisory Committee.

The work is reported in books and papers appearing in the technical press.

MPC also holds symposia and seminars to bring out expressions of interest in materials subjects and to make available the latest information.

All of these activities are reported and listed in a printed Annual Report which is available on request. It is updated quarterly in MPC's news bulletin, "Frontiers."

The need and the demand for reliable information on the engineering properties of materials are both insatiable. Modern technology is subjecting materials to radically new service conditions, many of which effect changes in the properties of the materials. Newly developed methods of testing as well as improved testing equipment make possible more realistic data. Materials themselves change with variations in raw materials, processing, and fabrication.

All of this makes necessary constant testing and evaluation of our materials as a basis for sound and progressive engineering.

At the risk of seeming to present a catalog or listing of projects, the concluding sections of this paper attempt to indicate those areas in which MPC has current active projects. This list by no means limits the scope of MPC's interests. Next week's committee meetings may result in new programs in new fields. It is apparent, however, from this list that the organization that has come into being as The Metal Properties Council, Inc., is an effective means for companies and people to join efforts in real accom-

plishment.

Here are a few of the fields in which MPC has worked in addition to those already enumerated.

### Fatigue

There are four programs currently active in the study of fatigue of metals, and other aspects of this important characteristic of materials are being considered:

1. A facility for interspersed creep and fatigue of materials is kept in operation. It is presently determining the effects of notches on these properties. Characteristics of weld metal will be investigated in the future. This testing equipment and concept are unique with MPC. The work to date has been reported in several symposia volumes published by ASME.

2. A facility for high and low cycle fatigue is under contract and scheduled for a continuously reviewed program of testing. At the present time the materials being tested are chiefly those of interest to the ASME Boiler and Pressure Vessel Code.

3. A state-of-the-art study of our knowledge of fatigue characteristics of materials is being conducted, and will possibly be reported during 1980. Other studies of fatigue are to be noted in the list of publications of MPC.

4. Equipment is being constructed and tests are planned for high and low cycle fatigue testing of the materials found to be useful in the construction of plants for the gasification of coal. This should be operative in 1980, and reports may be expected in 1982.

### Fracture Toughness

Modern failure analysis has increasingly made use of the concepts of fracture mechanics and, hence, has looked for some measure of the fracture toughness of materials. The Metal Properties Council, Inc., has been extremely active in this field.

The most common and inexpensive test for this property has been the Charpy V-notch test. Despite its many shortcomings, there is much Charpy test data available, and it is not excessively expensive to obtain more. MPC has solicited test data from those who have it and has obtained fine cooperation. A consultant has been engaged to analyze the results, and to publish such analyses as soon as it becomes possible to do so. One such report has reached the public.

Special programs have utilized this test to appraise the fracture toughness of high alloy steel castings, and to test the effects of section thicknesses on such tests.

Subcommittee 6 has concerned itself with the effects of irradiation on fracture toughness.

Computer analysis of production test data on fracture toughness obtained on aluminum alloys has been carried out, and is now being reviewed by industry to determine its value to them.

Programs on weldments of thick carbon steel plate have been carried out utilizing wide-plate techniques, and more are contemplated. These have been reported.

Other programs have been designed and approved, but have not yet been implemented because of the lack of funds.

#### **Corrosion**

Probably the first activity of The Metal Properties Council, Inc., in this important area was designed to develop information on corrosion-fatigue characteristics of the cast bronzes used in ship propellers, particularly those for supertankers.

Present plans include an early start on a program on the corrosion-resistance of concrete reinforcement bar.

The largest and most active programs of MPC on corrosion are those being carried out by Subcommittee 9 on materials for use in the gasification and liquefaction of coal. Corrosion resistance is of primary interest in this field, and the effects of corrosion on properties are also of extreme importance.

#### **Nuclear Reactors**

It has been evident that many of the

programs already described will be useful to those building and operating nuclear power plants. MPC has a very active dual committee structure which has made important contributions to this industry.

The work MPC has done on "surveillance testing" is attracting considerable interest. In this program, those operating nuclear reactors place test samples of materials in exposed locations within the reactors. Such specimens are removed and tested during shutdown periods, and the effects of irradiation on the materials may be noted.

The Metal Properties Council, Inc., prepared and published the first textbook on this subject. It also published and circulated a manual for the selection of a laboratory for surveillance testing. The textbook has been completely rewritten, and it will be republished during 1980. Utility companies operating nuclear reactors are cooperating with the MPC program by reporting results of their surveillance test programs to MPC for analysis, evaluation, and report.

Many other things have been done for nuclear reactors including a unique and costly study on the behavior of fuel-cladding under LOCA conditions, a study of the shift in transition temperature resulting from irradiation, etc. A very active subcommittee expects to have three major publications during 1980.

#### **Coal**

The largest programs yet undertaken

by MPC are aimed to discover what materials will be useful under the extreme environmental conditions anticipated in equipment for the gasification and liquefaction of coal.

Metals and metal weldments are being tested in laboratory tests in gases, liquids, and in process streams containing solid particulate matter. Test samples are being exposed in available locations in pilot plants. Elaborate testing equipment has been designed and built to permit testing materials in simulated process environments—including gas mixture, temperature, and pressure—to determine the engineering properties under such conditions. Tests include weldments of some candidate materials, and in some cases there is need for the development of successful weld processes.

#### **Conclusion**

The recital of the catalog of programs of The Metal Properties Council, Inc., can be too long for human endurance. We would emphasize that the way is open to all to introduce programs designed to aid in the solutions of their materials problems and to participate in them. The Metal Properties Council, Inc., is delighted to be sponsored by the American Welding Society because so much of its work involves weldments. We know we have mutual problems.

All are encouraged to attend any of the quarterly meetings of the MPC Technical Advisory Committee.

## **WRC Bulletin 257**

### **February 1980**

#### **Analysis of the Ultrasonic Examinations of PVRC Weld Specimens 155, 202 and 203 by Standard and Two-Point Coincidence Methods**

by R. A. Buchanan, prepared for publication by O. F. Hedden

This report describes two methods of analysis of ultrasonic examination data obtained in a 13-team round-robin examination of three intentionally flawed weldments. The objective of the examinations is to determine the accuracy of independently detecting, locating and sizing the weld flaws, using a fixed procedure.

Computer programs to facilitate comparison of flaw locations with the ultrasonic data, for each of the specimens and both of the methods, are appended to the report.

Publication of this report was sponsored by the Subcommittee on Nondestructive Examination of Materials for Pressure Components of the Pressure Vessel Research Committee of the Welding Research Council.

The price of WRC Bulletin 257 is \$11.00 per copy, plus \$3.00 for postage and handling. Orders should be sent with payment to the Welding Research Council, 345 East 47th St., Room 801, New York, NY 10017.