Originally published in Advances in Cryogenic Engineering, Vol. 27,"Plenum Press, New York (1982), p. 1.

THE CRYOGENIC ENGINEERING CONFERENCE-A RECORD OF TWENTY -FIVE YEARS OF LOW TEMPERATURE PROGRESS

K. D. Timmerhaus

University of Colorado
Boulder, Colorado

INTRODUCTION

Cryogenics, a term commonly used to refer to very low temperatures, had its beginning in the latter half of the last century when man learned, for the first time, how to cool objects to a temperature lower than had ever existed naturally on the face of the earth. The air we breathe was first liquefied in 1883 by a Polish scientist named Olszewski. Ten years later he and a British scientist, Sir James Dewar liquefied hydrogen. Helium, the last of the so-called permanent gases, was finally liquefied by the Dutch physicist Kamerlingh Onnes in 1908. Thus, by the beginning of the twentieth century the door had been opened to a strange new world of experimentation where all substances, except liquid helium, are solids and where the absolute temperature is only a few microdegrees away.

The point on the temperature scale, however, at which refrigeration in the ordinary sense of the term ends and cryogenics begins has never been well defined. Most workers in the field have chosen to restrict cryogenics to a temperature range below -150°C (123 K). This is a reasonable dividing line since the normal boiling points of the more permanent gases, such as helium, hydrogen, neon, nitrogen, oxygen, and air lie below this temperature, while the more common refrigerants have boiling points that are above this temperature.

FORMATION AND EARLY HISTORY OF THE CRYOGENIC ENGINEERING CONFERENCE

Even though the liquefaction of air at 50 L/h by Linde in 1898 signaled the birth of industrial cryogenics, it was not until after World War II that cryogenic engineering emerged as a recognized field and not just a branch of refrigeration. In fact, the appointment of Professor

Samuel C. Collins of MIT as Professor of Cryogenic Engineering in 1949 was the first formal recognition of cryogenic engineering on a university campus. The year 1950 saw the Cambridge Corporation, though not organized for the cryogenic field, become a large cryogenic engineering concern. Shortly thereafter in 1952, Dr. Howard McMahon was asked to promote cryogenic engineering research and development at Arthur D. Little, Inc. Also in 1952, Herrick L. Johnston, Inc. entered this field and became another important cryogenic engineering concern.

The concept of the NBS-AEC Cryogenic Laboratory is generally credited to Dr. Edward F. Hammel who, as head of the Cryogenic Laboratory at the Los Alamos Scientific Laboratory envisioned the need for a government supported central cryogenic engineering facility to meet the expanding use of very low temperatures and low temperature refrigerants in various branches and agencies of the Federal government for rocket propulsion, separation of gases by distillation, production of large quantities of liquid hydrogen, and sophisticated weapons development. This central laboratory concept with the endorsement of numerous well-known researchers in the field received the support of the Atomic Energy Commission in 1950 and construction was initiated in Boulder, Colorado in the spring of 1951. Construction of the first building, to house the liquid hydrogen and liquid nitrogen plants, was completed in the spring of 1952, While the research laboratory was completed later that same year. The NBS-AEC Cryogenic Engineering Laboratory was officially made a section of the NBS Heat and Power Division that same year with Mr. Russell B. Scott as its chief.

Even though this was a new venture for NBS with but a limited number of trained personnel in the field, research moved ahead very rapidly. The principal work of the laboratory was divided into two complementary areas, namely, research on the fundamental and mechanical properties of materials used in cryogenic construction, and the development of cryogenic equipment, techniques and processes. (A complete description of the research programs undertaken during the first two years of the NBS-AEC Cryogenic Laboratory is given in Volume I of the Advances in Cryogenic Engineering.) The withdrawal of AEC support in 1954, however, introduced considerable concern as to the future of some of the research programs that had only recently attained a critical mass. In an effort to more widely publicize the NBS facilities and expertise, Mr. Scott, along with other members of the Laboratory, (B. W. Birmingham, W. B. Hanson, R. B. Jacobs, V. J. Johnson, and M. M. Reynolds), proposed the holding of a scientific meeting in conjunction with the dedication ceremonies of the NBS Boulder Laboratories. Thus, on September 3-10, 1954, the Central Radio Propagation Laboratory and

the Cryogenic Laboratory sponsored two parallel technical meetings and invited participation from scientists and engineers throughout the world. The emphasis on this first highly successful Cryogenic Engineering Conference which attracted over 200 participants was on the basic tools of cryogenic engineering, namely, equipment, instrumentation, insulation, processes and properties of materials.

No conference was held in 1955, but Russell Scott asked me, as a part-time NBS employee, to determine whether there was sufficient interest in another conference by the cryogenic engineering community. With the aid of a questionnaire, the response was determined to be positive, particularly if the conference was again held in Boulder. As a consequence, I was requested by Scott to assist Bascom Birmingham in organizing a meeting for September 1956. This meeting attracted more than 400 scientists and engineers from all parts of the world to discuss new developments covering essentially the same basic areas of cryogenic engineering as were covered at the 1954 meeting, with the exception of a special session on liquid hydrogen and liquid helium bubble chambers.

The delegates attending the 1956 conference overwhelmingly voted to have another conference in 1957 - provided it was again held in Boulder. It is really not clear whether this vote was a favorable response to the $2.00 registration fee for the conference that included a soft-cover copy of the Proceedings, the desire to again combine a vacation with business, the industrially-funded social hour at the rustic Estes Park Chalet the first night of the conference, or a general feeling that the expanded domain of cryogenic engineering really called for a separate meeting of its own since it was not finding a home in any of the other professional societies. The history of the Cryogenic Engineering Conference suggests that it was the latter argument that swayed the participants, but at the time one could very easily recognize that each one of these considerations entered into the favorable vote. All doubts relative to the establishment of an annual Cryogenic Engineering Conference were dispelled in 1957, when over forty papers were accepted for the Conference at Boulder. Once again the main emphasis of the meeting was on the further development of the basic tools associated with cryogenic engineering including presentations on cycle analysis of hydrogen liquefaction, ortho-parahydrogen conversion schemes, separation of hydrogen isotopes by distillation and operational experiences with unattended oxygen plants. To make the Proceedings of the conference as informative as possible an attempt was made to include a majority of the general discussion which followed each presentation. This concept was to go through several revisions in succeeding

conferences before procedures were finally evolved that have been found to be quite effective to date.

Regardless of how careful the planning is for a conference, there always seems to be something that still can go wrong. For example, to minimize the logistics of the 1957 conference, the social events were scheduled close to Boulder. One of these events' was a chuckwagon dinner on the top of Flagstaff Mountain directly overlooking Boulder. Everything seemed to be operating smoothly until the last bus broke down halfway up the mountain. Because of the large attendance at the chuckwagon dinner, the non-arrival of this bus was not detected for the better part of an hour. Fortunately, or unfortunately (depending upon your viewpoint) the missing bus was also carrying a large supply of chilled refreshments to meet the needs of the overflow crowd on top of the mountain. Since assistance for the stalled vehicle was not forthcoming, the guide associated with the bus began dispensing the liquid refreshment to the thirsty attendees. When help did arrive they found a rollicking group of delegates who really didn t care whether they got to the top of the mountain for the chuckwagon dinner or not. Nevertheless, after a transfer of buses they did arrive at their destination only to find that the Junior Chamber of Commerce who served as the hosts for the chuckwagon dinner had just packed everything away and were ready to leave. However, the J.C.'s, true to their service motto, once more unpacked everything and took care of the late arrivals.

Even with such unexpected mishaps, the attendees once again expressed a strong interest in having the next conference in Boulder. However, the workload of the NBS Cryogenic Engineering Laboratory had by this time picked up considerably and it was clear that the laboratory could not host another conference in the following year. Since Sam Collins of MIT was a member of the Conference Board, the other board members prevailed upon him to get MIT to host the conference in 1958. This he agreed to do, provided that support staff would be provided to handle the entire mechanics of the conference. Scott volunteered my services, and thus I added the duties of Program Chairman and Local Arrangements Chairman in addition to the duties of Secretary-Treasurer of the Cryogenic Engineering Conference and Editor of the Proceedings. This latter assignment was to prove during the following decade to be a busy as well as an interesting one since the Russian space shot in 1957 rapidly escalated the cryogenic engineering effort in the U.S. and made it one of the "hottest areas going".

By 1961 the U.S. space program was moving ahead very rapidly and cryogenic problems needing solutions seemed to be increasing

logarithmically. With the rapidly increasing work force in the space program, it became evident to the Conference Board that the Cryogenic Engineering Conference could be of real service by instituting a carefully designed seminar program at the conference which covered many of the problem areas being encountered in the day-to-day operation of the cryogenic systems associated with the space program. Thus, in 1962 the Cryogenic Engineering Conference at UCLA presented some twenty specialized seminars led by experts in the field. These proved to be so well-received that the concept was retained for the 1963 conference held in Boulder. These seminars were augmented with several general review sessions to provide additional background information for those who felt a need for such a review.

Setting up any type of conference can be rather involved and time-consuming, particularly when it involves not only the technical program, but developing and taking care of all the local arrangements at a location many miles from your home base. The incident with the social hour at MIT in 1958 is a good example. This event was scheduled to be held at the faculty club located on the fifth floor of one of the buildings adjacent to the campus. What was not checked out was that there was only one five-passenger elevator going to the fifth floor. You can imagine the traffic jam that occurred on the first floor near the elevator when over 400 attendees and guests tried to get to the faculty club at approximately the same time! To alleviate the long wait we finally resorted to bringing the waiters to the lobby, taking orders and then bringing the drinks down with the next empty elevator. Anybody taking the elevator on the next day must have wondered what bar he or she had stumbled into because the carpeted elevator was saturated with the aroma of mixed drinks that had accidentally been spilled the night before.

Other conferences held during the early years also seem to have had their unforgettable moments. To illustrate this, consider the 1965 Cryogenic Engineering Conference hosted by Rice University in Houston where one of the special events scheduled was a visit to the San Jacinto Monument, followed by a seafood dinner at the San Jacinto Inn. Since parking was limited at the latter facility, buses were rented to accommodate the majority of the attendees and their guests. Once east of downtown Houston, the five hundred and seventy foot monument, commemorating Texas' independence from Mexico, is visible for miles from the coastal lowlands. So, rather than taking the normal route along the river to the monument, the lead driver decided to take a shortcut utilizing the country roads which paralleled many of the canals which crisscrossed the lowlands. Unfortunately, only a few of the bridges over these canals were adequately constructed to carry the weight of the

buses. Thus, the parade of buses carrying the attendees kept shuttling back and forth alongside one canal and then another for more than half an hour trying to get closer to the monument clearly visible in the distance before the lead driver finally admitted that he was lost. Upon this disclosure, all of the other bus drivers volunteered that they knew the way and took turns leading the procession 'for the next half hour. When this did not bring any better results, they finally hailed a local farmer who graciously led them back to the main route and headed them in the right direction. (It goes without saying that the bus company was rather embarrassed about the incident and with tongue-in-cheek asked the conference not to publicize the company's recent scenic tour of the Texas coastal lowlands.) What makes this incident even more humorous now is that essentially the same situation had occurred at the 1964 Cryogenic Engineering Conference when conference bus drivers lost their way between Case Western Reserve University and downtown Cleveland.

With the attendance at the 1966 Cryogenic Engineering Conference approaching the thousand mark, it became obvious that the task of organizing the conference and serving as secretariat needed a more permanent office than could be provided for by the University of Colorado. With the 1967 conference, this office was established in the National Academy of Sciences in Washington, D.C. It remained there until 1971 when it was returned to Boulder and was assumed through the gracious assistance of Bascom Birmingham by the National Bureau of Standards. Annual meetings of the Cryogenic Engineering Conference were held through 1973, with the exception of 1971 when the conference assisted the International Institute of Refrigeration in co-hosting the 13th IIR Meeting in Washington, D.C. At the 1972 conference in Atlanta, the Conference Board decided on a biennial schedule alternating with the Applied Superconductivity Conference. This schedule has been maintained to date with meetings in Kingston, Ontario in 1975, Boulder in 1977, Madison in 1979, and San Diego in 1981.

EARLY DEVELOPMENTS IN THE PUBLICATON OF CONFERENCE PROCEEDINGS

A review of the first few volumes of the Advances in Cryogenic Engineering shows that the Proceedings of the 1954 conference was originally assembled by W. B. Hanson and published as NBS Report 3517. (It was later reedited when it was included as part of the Advances in Cryogenic Engineering.) The Proceedings of the next three conferences (1956,1957,1958) under the editorship of K.D. Timmerhaus were originally published locally in soft-cover form and supported entirely

through generous industrial contributions. To promote quality in the publication, a peer review system with graded reviews was initiated and papers were not accepted for publication until every comment by the three or more reviewers had been satisfactorily taken care of. Often this meant extensive revisions or rewrites of papers. It also meant rejection of between 5-15% of the papers presented at the conference.

With the advent of the 1959 conference, hosted by the University of California at Berkeley and attended by nearly 700 delegates, it became evident that the Proceedings of the Cryogenic Engineering Conference had to be made more permanent and professional in appearance. After considerable investigation, the Conference Board selected a relatively new publishing firm in New York that offered not only to reprint the first four Proceedings under hard cover, but to set up succeeding Proceedings in hot type all under the title of Advances in Cryogenic Engineering. This action permitted the editor to shift some of the publication and promotional problems to the publisher, Plenum Press. However, the move also had its disadvantages, since it added an additional delay of three or four months to the publication of the proceedings. This delay prompted the Conference Board to investigate the use of preprints at the 1960 meeting, held once more in Boulder.

The idea of the preprints was to request each author to supply 100 copies of his or her paper and these would be placed in a preprint room and attendees could pick up copies of papers that were of immediate interest to them. It was expected that only a fraction of the attendees would be interested in the preprints and then would be selective in their choice. No assumption could have been more inaccurate! The first hundred delegates who registered for the conference made such a stampede to the preprint room that student assistants hurriedly left their posts for safer duty. It was difficult to believe, but the sight was like Macy's bargain basement during a half-price sale. Everything that was on the tables including preprints, program signs, directions, conference supplies, and even newspapers, was hurriedly carted away. There was hardly a scrap of paper remaining in the room! Obviously, only a fraction of the delegates had had an opportunity to look over the preprints. By utilizing all of the secretarial and student help that was available, we managed within twenty-four hours to make spirit masters from the one set of preprints that had been retrieved earlier for editing purposes and from these another 100 copies of each preprint were reproduced. When the availability of these additional preprints was announced, there was a large exodus of delegates to the preprint room and the same bargain basement scene was reenacted for the second time. It was difficult to imagine that some two hundred delegates were going to carry back with

them as many as fifty to sixty preprints. This doubt was substantiated soon after the conference adjourned, when custodians returned hundreds of discarded preprints that they had found in rest rooms, empty classrooms, closets, dormitory rooms and trash bins allover the campus. Obviously, this experience provided us with many of the preprint guidelines that are still being followed at the present time.

In an effort to upgrade the quality of the papers to be presented at the conference and published in the Advances in Cryogenic Engineering, the Conference Board in 1961 established one award for the best research paper and another one for the best applied paper. The award originally consisted of a certificate for each author of the award-winning papers and a $100 check. This amount was raised to $200 some years later, and has recently been increased to $500. (In the case of multi-authored papers, the financial rewards per author can be rather minimal as evidenced a few years ago when eleven authors were involved with the award-winning paper.) Since the untimely death of Russell Scott, both awards have been designated as the Russell B. Scott Memorial Award.

Like the conference, publication of the Advances in Cryogenic Engineering has not only had its brighter moments, but also its darker ones. For example, in 1973 we were involved in editing Volume 19 of the Advances in Cryogenic Engineering and co-editing a four-volume Proceedings of the 13th Low Temperature Physics Conference. In an effort to speed up the publication of these two proceedings, the publisher decided to subcontract the publication of the page proofs to a firm in Israel rather than overloading the firm in England that had performed this typesetting for earlier volumes. The plan seemed to be working as anticipated until one shipment containing the marked-up page proofs of the last fifteen papers of the Advances in Cryogenic Engineering, and the first
twenty papers from the Low Temperature Physics Conference was on the jet plane that was hijacked by terrorists and eventually blown up in the Sinai Desert. This loss was not recognized for some time, since the publisher assumed that the subcontractor had run into some delays and the subcontractor assumed that we were delinquent in returning the marked-up page proofs. When it finally was established that the missing page proofs had been on the destroyed jet plane, it meant that the page proofs had to be reprinted and the entire proofing process repeated. This incident delayed publication of Volume 19 by approximately four months. The other proceedings fared even worse by having their publication delayed nearly six months, since additional scheduling conflicts were encountered with other texts being delivered by the publisher. Volume 25 of the Advances in Cryogenic Engineering, on the other hand,

experienced nearly a three-months delay because of an unexpected bookbinders ’strike.

Obviously, not all the delays in publication were the fault of the publisher. In general, the editor received excellent cooperation from the many authors desiring to have their papers published in the Advances in Cryogenic Engineering. However, a number of the volumes had one or two authors who either were always late in their reply to requests made by the editor or who, after reading the reviewers' comments, would return another copy of their paper without making a single correction and then insist that they had responded to all of the reviewers' comments. One such case probably stands out among the rest. The author of this specific paper, after being requested to make major revisions to his paper by four out of five reviewers of his paper, apparently decided to ignore those suggestions and returned another copy of his original paper and insisted that it be published in that *form*. In view of the various constructive comments made by the reviewers, and the editor's concurrence with those comments, the paper was entirely rewritten with the assistance of the reviewers and sent back to the author for approval. The revised version of the paper brought back a host of objections from the author. With the assistance of the reviewers, all of the author's objections were met and the paper again went back to the author. Once again, negative comments were put forth by the author as to why he did not like the revised version of his paper. However, after further minor improvements and the blessings of the reviewers, the author was informed that because of the delay that it was causing to the publication, he had three choices. Either he could revise the original paper himself, taking into consideration the reviewers comments, he could withdraw the paper, or he could accept the revised version and avoid the task of rewriting the paper if acceptance for publication was to be forthcoming. The author rather reluctantly chose the latter route and the paper was published. Fortunately, this rather strong stance by the editor was later justified when the Conference Awards Committee nominated this paper among several for the Russell B. Scott Memorial Award. It was, of course, not selected as the award winner when the prior history of the paper became available to the committee.

As noted earlier, such incidents were exceptions. In most cases relationships with the authors could not have been better. Each exhibited an attitude that was not only highly cooperative, but also very professional. It was a pleasure working with such dedicated individuals and this interaction will be missed as the editorship of the Advances in Cryogenic Engineering is assumed by Dr. R. W. Fast in 1981. There is no

doubt, however, that it is in capable hands and that he will carry on the past traditions of the series. We wish him well in this new responsibility.

A review of past volumes of the Advances in Cryogenic Engineering shows that the industry has matured considerably since the first Cryogenic Engineering Conference in 1954. At that time, the emphasis was essentially on air separation, liquid nitrogen, and oxygen technology, and the developmental problems associated with small scale liquid hydrogen and liquid helium production. The space age in the 60's greatly accelerated the need for material and thermophysical property data, new insulation concepts, large-scale handling, transfer and storage of liquid hydrogen and oxygen, operational safety, and other space-related problems.

The 70's, in turn, emphasized more of the applications utilizing cryogenics. Foremost among these were applied superconductivity and LNG. There are presently 26 volumes and 27 books in the series (Volume 10 was published in two parts). This constitutes a total of approximately 15,500 pages with over 1700 presentations. It should be pointed out, however, that Volumes 22, 24, and 26 are devoted strictly to the Proceedings of the International Cryogenic Materials Conference, which has been held jointly with the Cryogenic Engineering Conference since the Kingston, Ontario meeting in 1975.

ACKNOWLEDGMENTS

Let me once again express my appreciation to all the many individuals who have so ably contributed to the advancement of cryogenic engineering during the past twenty-five years that I have been associated with the field. They are the ones to be congratulated since, without their dedication and hard work, there wouldn't have been any Cryogenic Engineering Conference and accompanying series, the Advances in Cryogenic Engineering. The more than fifteen thousand pages covering essentially every aspect of cryogenic engineering fundamentals and applications are a lasting tribute to their many fine accomplishments.