History of the Production and Application of Light Committee

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Abstract—**The history of the Production and Application of Light Committee (PALC) is unveiled from its humble beginnings through October 1983. The organizational changes are recorded from a subcommittee status within the American Institute of Electrical Engineers (AIEE) in 1909 to its present position under the Industrial Utilization Systems Department (IUSD) in the Industry Applications Society of the Institute of Electrical and Electronics Engineers (IEEE). Through the years, committee work and the advancement of lighting technology were closely related and are not separated in the article. An extensive bibliography is included to give the interested reader an opportunity to obtain information on specific subjects or the lighting history in general. Special weight was put on the recent trend in energy conservation and lighting economy. Appendices list all PALC chairmen and the scope of the committee.**

INTRODUCTION

THE report on the history of the Production and Application of Light Committee (PALC) was based on information derived from AIEE and IEEE sources, meeting minutes, correspondence, and some first hand knowledge as committee chairman. The committee meeting minutes were available to the author for the last 20 years. Consequently, the history from 1964 on could be reported more explicitly than in earlier years. To illustrate the involvement of the committee in the advance of lighting technology numerous papers are cited as references. Occasionally some events in the history of lighting are mentioned here since two excellent papers have been published which deal with the history of lighting technology itself: one paper presented by R. L. Oetting in 1952 at the "Centennial of Engineering" [1] goes into minute detail, while the other paper, presented by Kao Chen in 1979 at the IAS Annual Meeting, commemorates the 100th anniversary of the incandescent lamp and reports on its history and present status [2]. Most of the papers sponsored by the PALC were published in the AIEE TRANSACTIONS (Electrical Engineering) until 1963. After the merger into the IEEE practically all of the papers were published first in the IGA/IAS Conference Records. Many found their way also into the IGA/IAS TRANSACTIONS. The history of PALC is reported up to October 1983 including the IEEE IAS Annual Meeting.

THE BEGINNING

Long before Thomas A. Edison made a practical incandescent lamp there was the carbon arc lamp which was demonstrated first by Sir Humphry Davi in 1801. When the year 1879 came around, the city streets of Cleveland were illuminated by carbon arc lamps that were produced by Charles F. Brush, and Edison marketed his carbon filament incandescent lamp. The American Institute of Electrical Engineers (AIEE) was founded five years later and after another 25 years, in 1909, the Electric Lighting Committee of the AIEE was created as a new subcommittee of the Meeting and Paper Committee. The author could not locate a document stating the original scope of the committee, but from early committee reports it can be concluded that the committee was concerned with the dissemination of information on illumination and light sources by holding technical meetings, sometimes together with the Illuminating Engineering Society (IES), and by publishing papers primarily in the AIEE TRANSACTIONS.

The first chairman of the committee was W. L. Robb of Troy, NY, with the following committee members: W. C. Eglin of Philadelphia, Louis A. Ferguson of Chicago, and Henry A. Lardener, A. S. McAllister, H. A. Wagner, and W. F. Wells, all of New York City.

The name of the committee and its status changed somewhat in the years to follow

- 1910 It was not listed any more as a subcommittee.
- 1913 Its name was changed to the "Electric Illumination Committee."
- 1914 Its name reverted back to the "Electric Lighting Committee."
- 1924 It was named the "Production and Application of Light Committee" and has retained this name until today.
- 1948 It became a part of the General Applications Division of the AIEE.
- 1963 It was consolidated with the Industry Division of the AIEE.
- 1964 With the merger of the AIEE and (Institute of Radio Engineers) (IRE) into the IEEE, the PALC came to the Industry and General Applications Group (IGA) of the IEEE. This group was upgraded in 1972 to the Industry Applications Society (IAS).

Appendix I lists the chairmen and their term of office which has been compiled from information from the IEEE Center of History of Electrical Engineering, the 50th anniversary issue of *Electrical Engineering,* May 1934, and from the PALC meeting minutes and correspondence.

The number of committee members have varied over the years. It started with seven members in 1909 and increased slightly to 12 and 14 up to the fifties. It now has a strength of 30 to 35 members.

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COMMITTEE ACTIVITIES

Early Years

The activities of the PALC were recorded in the annual reports to the Board of Directors of the AIEE up until 1923. Thereafter brief reports were published, mostly annually, in the October issues of the AIEE TRANSACTIONS. These short notices were augmented from time to time by technical progress reports covering two, four, or more years of technical advancements in the lighting field. Occasionally the PALC published in the AIEE TRANSACTIONS surveys of periods from 25 to 50 years.

The committee came into being at just about the same time that the metal filaments were replacing the carbon filaments. This is reflected in the papers sponsored by the Lighting Committee as it was called in the early days. The physical properties of metallic filament lamps [3] and the difficulty of producing tungsten filaments [4] were exposed in 1910. Five years later a paper was presented on the dimming of tungsten lamps [5], and later, in a joint session with the IES, a paper on street illumination was presented [6] by P. S. Millar who became the committee chairman later in 1925.

From the annual report of 1916-1917 [7] it is noted that the committee was still struggling to find some specific activity upon which it could concentrate its efforts and restate its scope.

> The Lighing and Illumination Committee considers that it may render a service to the Institute by securing papers on illumination topics .... The committee also considers that it may render some service to the Institute by incorporating in its annual report a brief statement of recent progress ....

The progress at that time consisted of improvements in lumen per watt of incandescent lamps, the introduction of the blue lamp with a spectral distribution close to daylight, and the application of floodlighting to the Statue of Liberty. In the period 1918-1919 [8] the committee joined forces with the IES to write the Industrial Lighting Codes. Much work was done on this subject by G. H. Stickney, who later became the chairman of the committee. Many projects were undertaken during this period to improve street lighting that were hampered previously by World War I. Luminaires with prismatic refractors were developed to break the glare of the street lights.

During the Midwinter Convention in 1919 [9] the committee sponsored three very successful sessions with the main topic, "Street Lighting Distribution Systems." Charles P. Steinmetz was credited with a paper about series circuits which drew a lengthy discussion afterwards. Interesting enough the topic at the next Midwinter Convention in 1920 was "Daylight Saving."

The progress reported was that the electrodes of luminous arc lamps had been improved by compounding the ingredients for the electrodes under high pressure which produced a higher lumen output and prolonged life. New installations of luminous arc lamps were recorded for many cities. Ward Harrison and Earl E. Anderson made a contribution to the state of the art through their paper "Coefficients of Utilization" [10] which presented a way of calculating the utilization of light for all ordinary types of luminaires in rooms of varied proportions. In the following year [11] it was noted that metal filament lamps outproduced carbon filament lamps by more than a factor of 10 : 1. Great strides have been made to improve the factory lighting in order to minimize accidents, increase production rates, and reduce errors. In the area of roadway lighting, new double reflector luminaires were introduced to concentrate the light more on the roadway.

The committee activity during 1922-1923 [12] was directed to increase the publicity on illumination related subjects. It also should be noted that the first "tipless" incandescent lamps were produced and that color coating was introduced. From now on only brief status reports were found in the TRANSACTIONS which did not go much in detail about the committee operations. The Technical progress reports informed the AIEE members about the advances in lighting. A very good example of this appears in a paper presented by W. D'Arcy Ryan, a member of the Institute, about the lighting features at the Chicago exhibition "A Century of Progress" [13]. It contains a wealth of information on architectural and roadway lighting. Hot cathode mercury and neon lamps were operated from three-phase circuits to minimize the stroboscopic effect. A variety of outdoor lighting standards can also be found which set the trend for future developments.

Other progress reports on lighting technology give a vivid picture of the advancements in the production and application of light in the years following up until the early sixties. It was during this period that the gaseous discharge lamp became an important factor in lighting and during which the double-coiled filament for incandescents was introduced [14]. In those years the membership of the committee varied between 12 and 15 and can be considered small with respect to the membership in recent years. Important advances were made in the early thirties in construction and application of high-intensity mercury vapor lamps [15]. By 1936 fluorescent lamps were being developed, but were not yet standardized for commercial use. Carbon arc lamps, formerly used widely in street lighting, have found their niche in the movie industry, both for studio lighting and for motion-picture projection. In the field of luminaires, mirrored surfaces were added to the reflectors using an electrolytic process. In 1932 the U.S. Standards Institute adopted the "Standards of School Lighting," and during the International Commission Illumination (CIE) meeting in 1936 in Germany the radiation of a black body was adopted as the primary standard of light.

By 1940 incandescent lamps for the photographic field met the demand of color photography by producing flood lamps with a predetermined color temperature of 3200°K. The 1940 PALC progress report [16] disclosed that it was now possible to deposite reflective surfaces on the inside walls of incandescent lamps, which led to the 5-in diameter spot and floodlights. At the same time the automotive sealed beam headlight was born. The integral parabolic reflector had guaranteed optically correct positioned filaments.

The new types of gaseous discharge lamps were developed so that the mercury lamps were now made in improved envelopes and had many more wattage ratings. The biggest step forward was made in the fluorescent lamp field. A new

standard series became available commercially with a variety of phosphor coatings to transform the ultraviolet (UV) radiation into pleasing visible light. Banks of (incandescent) floodlights appeared on high poles to illuminate night games in ballparks, stadia, etc. In roadway lighting, sodium lamps made intersections safer for both the driver and the pedestrian. With the help of the PALC members, codes for airport, highway, and schoolroom lighting were established.

In the field of lighting control inexpensive photoelectric relays have been incorporated in saturable reactor control circuits making the automatic control of incandescent lighting possible. Another meeting of the CIE was held in 1939 in the Netherlands, and it was reported from the PALC attendees that this session was the most fruitful of all the sessions that were held so far.

The period that follows encompasses the World War II and the post World War II era. With the knowledge of the science of seeing, enormous strides were made in the way light was produced and applied. Mr. Oetting's paper [1] covers the material in so much detail that the reader is referred to that excellent treatise.

THE LAST TWENTY YEARS

The last twenty years brought increased activity in the field of production and the application of light, which was caused by the rapid advance of technology in general, by greater awareness of economy, and by energy conservation in particular. The development of high power transistors and the mushrooming computer technology left its imprint on the illumination field.

The year 1964 was significant because of the merger of the AIEE and IRE into the IEEE. R. J. Wissoker, who was chairman at that time, can be credited with successfully completing the transition for the PALC which made it a part of the IEEE Industry and General Applications Group (IGA). The IEEE International Convention in March 1965 was the first meeting after the merger where the PALC presented five papers in a technical session. This was an opportunity to restate the scope of the committee.

> . . . Treatment of those matters in which the dominant factor is the application of electrical energy into light. PALC shall function as a liaison between organizations of the IEEE and other organizations dealing with related subject matter. Subcommittess shall develop papers and programs at general meetings and technical conferences.

Seven subcommittees were established at that time which spread the small committees too thin and consequently the tasks of the subcommittees were transferred to the executive committee six months later.

In 1966 the first annual meeting of the IGA was launched, and the PALC responded with the presentation of eight papers in two sessions. The papers reflected the advancing technology and reported on new light sources such as metal halide lamps [17], water cooled luminaires [18], and their use in industry [19]. Attempts were made to reduce the size of magnetic ballasts using semiconductor controls [20]. In the analytic field, methods were devised to evaluate magnetic ballasts by means of equivalent circuits [21]. Two sessions and one panel discussion were sponsored at the next IEEE International Convention in 1967 and thereafter the outlet for paper presentations was shifted to the newly established annual IGA meetings each October. Three PALC members were named as representatives of the IEEE to the U.S. National Committee to the International Commission on Illumination (USNC-CIE). Three assignments were also made to the American National Standards Institute (ANSI). One was made to each of the following committees: C-78 Lamps, C-82 Ballasts, and A-23 School Lighting. The operating year of the PALC was changed from July 1-June 30th to coincide with the calendar year which conformed to the IEEE policy.

During the late sixties cost effectiveness became an important factor in the design of commerical buildings. Hence, to minimize the total power demand for heating/air conditioning and lighting, methods were found to utilize the heat produced by the light fixtures for space heating in winter and to discharge such heat in the summer to the outside [22]-[25]. The computer quite often is enlisted to help design and operate the lighting systems. With this in mind the PALC sponsored at the 1968 meeting a full session aimed to upgrade the knowledge of the lighting engineers in the use of computers to their advantage [26]-[28]. During the following year the PALC strengthened its position in the standardization process by assigning five new members to the ANSI committees: A-23 School Lighting, A-85 Protective Lighting, C-42.55 Illumination Engineering-Definition of Terms, and A-11 Code for Lighting Factories. Metal arc lamps became more and more popular because of their high-intensity light with a spectrum resembling daylight that was ideally suited to illuminate night sports events for the color television cameras. This is reflected in two papers [29], [30] given at the IGA meeting in 1969. The advance of semiconductor technology made it possible to produce electronically controlled ballasts. A survey of the state of the art [31] shows that often transistor oscillators are used to create higher frequencies from 2000 to 20 000 Hz to advantageously operate fluorescent lamps [32].

In 1970 the PALC named Daniel Goldberg as representative to a joint IEEE IAS committee on "Electrical Distribution and Control of Lighting" for the purpose of writing recommendations for "Wiring and Lighting" for the upcoming IEEE Grey Book. The main topic of the PALC sessions in 1970 was the application of high-intensity discharge lamps [33], [34]. Other papers dealt with lead lag ballasts [35] and a dynamic lightmeter [36]. Silicon controlled rectifiers now became available in high power and voltage ratings and replaced saturable reactors in dimming of incandescent lamps for stage and other uses. The problem of undesirable acoustic noise was approached by one of the speakers at the 1971 meeting [37]. The luminaire design [38] and lighting system maintenance [39] were other topics addressed at this meeting.

The upgrading of the IEEE Industry and General Applications Group in 1972 to the Industry Applications Society (IAS) brought no changes to the scope or structure of the PALC. It was already reported that tests with fluoresecent lamp installations showed that it would be of advantage to operate the lamps at higher than the usual 60-Hz line frequency [31], not only because of the physically smaller

ballasts involved, but also because of the higher light intensity. One method used to increase the line frequency was the cycloconverter [40]. Since the PALC is not only concerned with the light sources but also with their application, a number of papers were presented that address subjects like warehouse lighting [41], [42], runway lighting [43], and underwater illumination [44]. On outdoor lighting, papers on tunnel lighting [56], the illumination of the George Washington Bridge [85], and outdoor farm lighting [45] were presented. During 1973 no PALC activity was reported. D. Goldberg and E. G. Kiener deserve credit for taking the initiative to bring the PALC back to a working organization. In 1974 an Energy Conservation Subcommittee was established within the PALC in which lamp manufacturers, industrial and commerical users, and consulting engineers were members.

Also in 1974 the IEEE was given seats on numerous Code Making Panels (CMP) of the National Electric Code (NEC). The PALC named E. G. Kiener to CMP 21 (now CMP 18) with D. Goldberg as alternate. Thus the PALC contributed to the 1975, 1978, 1981, and 1984 codes.

At the annual meeting in 1975, among other papers, circuits for high-pressure sodium lamps [46] were discussed and the NEC on Aviation Obstruction was questioned [47]. This led to a correspondence between the PALC and the Federal Aviation Administration (FAA) to point out the deficiencies of the code.

In 1976 the PALC activity grew substantially stronger. The recently established Energy Conservation Subcommittee started to work on the IEEE Standards Project #585 in the area of "Recommended Practice for Energy Optimization of Lighting Systems." During this time the IEEE IAS Technology Operations Department was replaced by five operating departments and the PALC came under the Industrial Utilization Systems Department. This change became effective in 1977.

A mathematical model was developed for High Intensity Discharge (HID) lamps by a member of the committee [48] which helped the lamp designer and user to evaluate the lamp performance under different operating conditions. A few years later another theoretical paper was added to those sponsored by the PALC. It dealt with a model to determine the terminal behavior of mercury arc lamps [49].

During the annual IAS meeting in 1977 for the first time the PALC sponsored a tutorial session which was extremely successful. Engineers not familiar with the newest developments in light sources, lighting system design tools, and lighting legislation were given an opportunity to improve their knowledge. The year 1978 was even more active for the PALC. Triggered by an alert from the Food and Drug Administration (FDA) regarding the exposure to UV from broken outer globes of HID, mercury vapor, and metal halide lamps, the PALC requested statistical information from the FDA in order to disseminate factual data among its members.

The PALC also provided services to write revisions for chapter 10 of the IEEE Grey Book and helped on the IEEE project #739 of "Recommended Practice for Energy Conservation." In addition the PALC sent a member to the National Bureau of Standards (NBS) meeting on "Performance Criteria for Energy Conserving Building Illumination Systems." Energy conservation was on everybody's mind, and a number of papers was generated on this subject for PALC technical sessions at IAS meetings. Cost reduction by planned maintenance [50], [51], industrial relighting programs [52], [55], and lighting economics [57], [63] were some of the topics addressed in those sessions. Modified fluorescent lamps [64], [67] and high frequency solid state ballasts [68], [70] pointed to another aspect of energy savings.

In 1979 new bylaws under which the PALC would operate were circulated, approved, and implemented. Representatives of the PALC attended two of the NEC meetings and also two at the NBS concerning a "Standard for Lighting Energy Conservation." The PALC in addition participated in drafting the "Energy Statement" released by the IEEE. The committee again was active on the IEEE Grey Book working on revisions of chapter 10 "Lighting," and chapter 17 "Conservation." In cooperating with the IES the task continued in preparing the chapter on "Lighting Wiring Systems" for inclusion in the *IES Handbook*. Most of the PALC members accepted the result of its own project (IEEE #586) on "Energy Conservation in Lighting Systems." An unusual number of four sessions were presented at the annual IAS meeting in 1980: two sessions on "Energy Saving Techniques in Lighting," one panel session on "Selecting and Applying the New Illumination Levels in Today's Lighting Design," and another technical session on "Lighting Technology in the Peoples Republic of China" [71], [74], in which four papers were presented by Chinese authors. This was the first participation of Chinese authors at any IAS meeting. With the demand for energy savings and efficiency still high, several speakers at the IAS annual meeting that year chose to address the following issues: "Energy Saving Incandescent Lamps" [75], "Analysis of HID Luminaires" [76], "Efficient Roadway Lighting" [77], and optimum performance on "High Pressure Sodium Lighting" [78]. Chapter 7 of the handbook *Energy Conservation Technology* was completed in 1982. The results of the project #585 "Energy Optimization in Lighting Systems" was incorporated in an expanded chapter 7 of the IEEE project #739 during 1983. All of this material will be published in the IEEE Bronze Book in 1984 with the title "Recommended Practice for Energy Conservation and Cost Effective Planning in Industrial Facilities." "Tomorrow's Lighting Technologies" was the PALC theme for the IAS meeting in 1982 at which two sessions were held [63], [66], [79]-[82].

During 1983 the PALC introduced several proposals for inclusion in the 1984 issue of the National Electric Code, most prominently for article 410 S "Lighting Track" and article 605 "Office Furnishings." At the IAS annual meeting this year two technical and one tutorial sessions were sponsored. The subjects were the integration of microcomputers and controllable ballasts [83], and fluorescent systems at 60 Hz and high frequency [84].

CONCLUSION

The PALC in early years had put the emphasis on dissemination of information about lighting technology, and its influence on codes and standards was limited. Its activities have ex-

panded drastically in recent years to include standards, codes, position statements, and contributions to handbooks so that the PALC can be considered an important committee within the IEEE IAS.

APPENDIX I

PALC CHAIRMEN

Term of office–July 1–June 30 the following year

1909–1910	W. L. Robb
1910–1912	Peter Junkersfeld
1912–1913	W. C. L. Eglin
1913–1916	E. P. Hyde
1918–1921	E. C. Clewell
1921–1925	G. H. Stickney
1925–1928	P. S. Miller
1928–1929	B. E. Schackelford
1921–1931	G. S. Merrill
1931–1933	W. T. Blackwell
1933–1935	J. W. Barker
1935–1937	A. L. Powell
1937–1939	Robin Beach
1939–1941	D. W. Atwater
1941–1943	E. M. Strong
1943–1945	W. C, Kalb
1945–1947	S. G. Hibben
1947–1949	Harris Reinhardt
1949–1951	E. H. Salter
1951–1953	R. C. Putnam
1952–1955	R. L. Oetting
1955–1957	J. F. Dickerhoff
1957–1959	D. W. Rowten
1959–1962	R. D. Churchill
1962–1964	R. J. Wissoker.

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Terms of office January 1–December 31st.

1964–1967	Claude H. Burns
1967–1969	I. Fishman
1970	C. W. Clarkson
1971–1972	B. M. Wolfframm
1973	D. Barnwell
1974–1980	E. G. Kiener
1981–1982	K. T. Risberg
1983–1984	Kao Chen.

APPENDIX II

SCOPE OF THE PAL COMMITTEE

1963: The scope of the PAL Committee is the treatment of those matters in which the dominant factor is the application of energy through its conversion into light, including necessary materials, devices, and mechanisms, in so far as these matters are considered of interest and value to the members of the Institute. This committee functions as a liaison between the Institute and various organizations dealing with the production and utilization of light such as, the Illuminating Engineering Society, the Optical Society of America, and others. Its activities include translating the theoretical and technical accomplishments of those organizations into terms of the practical aspects of the production and application of light, thereby serving to inform Institute members of important progress in this field. Where problems of electrical supply service, voltage, or distribution are involved, action shall be joint with the Transmission and Distribution Committee.

1983: The scope of the PAL Committee is the treatment of all the matters within the scope of IAS in which the emphasis or dominant factor specifically relates to light and lighting. The stated scope of the PAL Committee encompasses but is not limited to

1) The investigation and study of production and application of light with regard to
   - 1.1) energy optimization of lighting systems which comprise light sources, luminaires, ballasts, and controls,
   - 1.2) National Electric Code coverages in the area of lighting feeders (Art. 220), lighting fixtures (Art. 410), and other lighting subjects,
   - 1.3) ANSI activities in the area of standardization of light sources, luminaires, ballasts, and controls,
   - 1.4) performance of human activity and tasks.
2) The preparation and periodic revision of the IEEE standards falling under the committee's scope.

ACKNOWLEDGMENT

Kao Chen, the present Chairman of the PALC, E. G. Kiener, who held the PALC chair for a seven year period, and Robert Casey of the IEEE Center for the History of Electrical Engineering shall be recognized for their significant contributions.

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* Papers which won committee awards.
† Papers which won society awards.

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In Germany he designed telephone and telegraph apparatus for Siemens & Halske. Later in 1952 he worked on magnetic amplifier controls at North American Aviation in Downey, CA; later he worked on autonetics. By 1954 he became Chief Engineer at Magnetic Research Corporation, El Segundo, CA, and was responsible for the development of magnetic regulated power supplies. He was the first to use Silicon Controlled Rectifiers in high-power radar pulse generators. Starting in 1961, for several years he directed the R&D work for Automatic Check-Out Systems at Northrop Corporation, Anaheim, CA. In 1965 he moved to Sola Electric, Elk Grove Village, IL. He was Manager of Advanced Development and influenced the design of electronic ballasts for fluorescent lamps among a variety of assignments. Later in 1971 he was involved in the development of digitally controlled industrial temperature regulators at Eagle Signal, Davenport, IA. He retired in 1977.

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