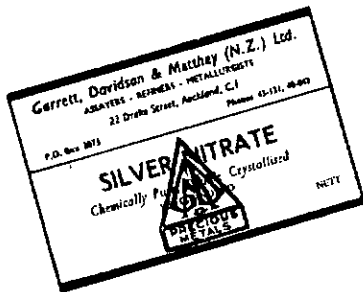


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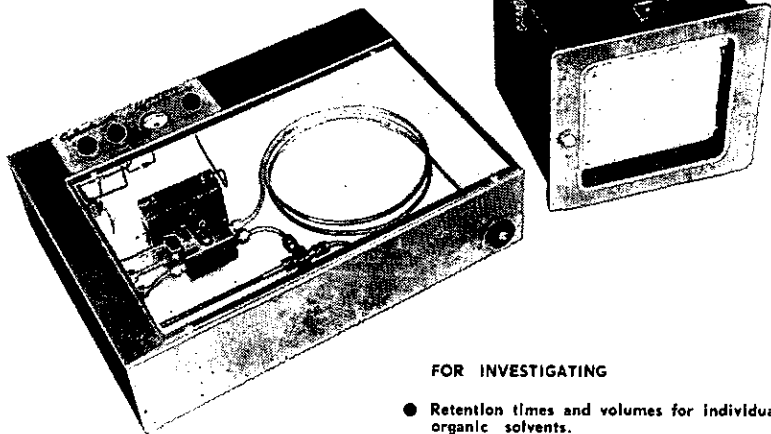
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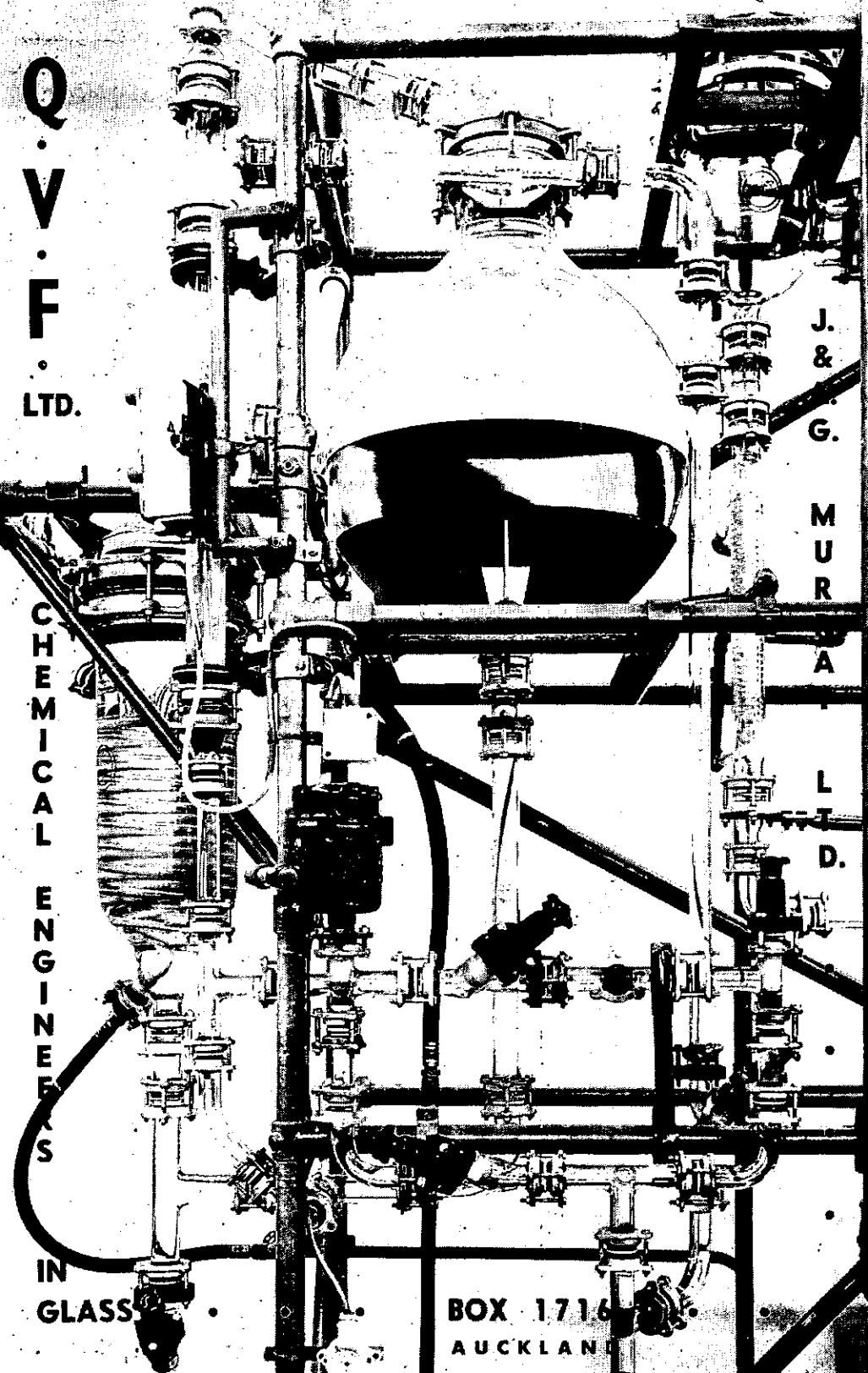
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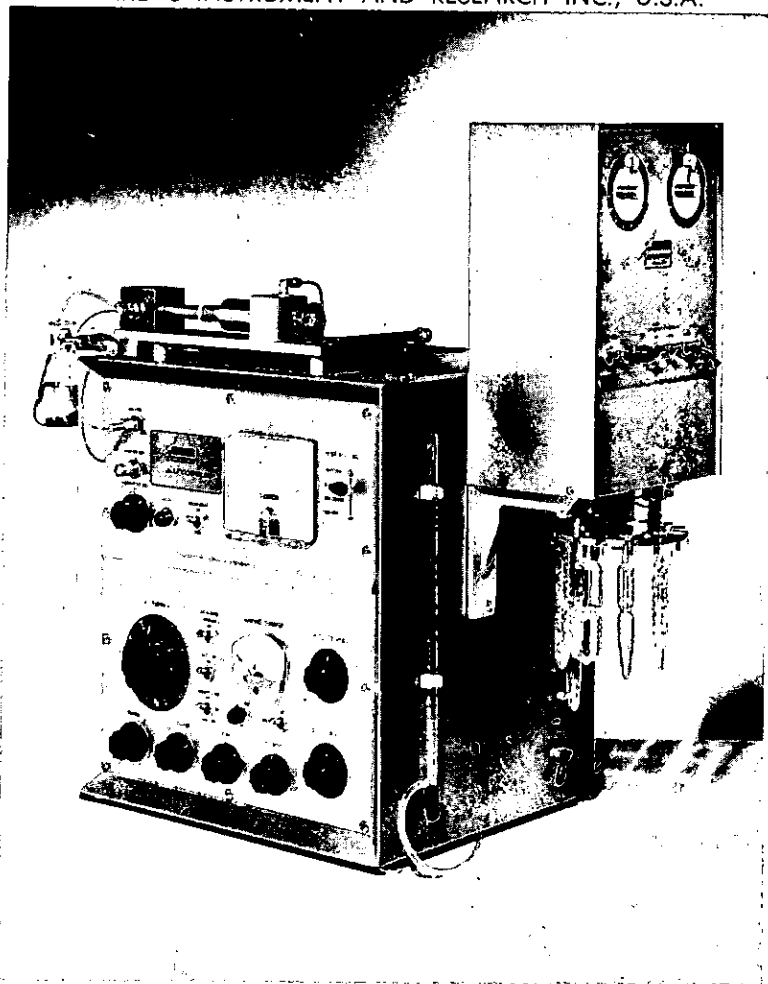
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# JOURNAL OF THE NEW ZEALAND INSTITUTE OF CHEMISTRY

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## SAFETY IN SCIENCE

The article "Safety and First-aid in Science" in this issue should serve to remind Institute members that many of the materials and machines which they manipulate are potentially dangerous and that chemists have a duty, to themselves and to their colleagues, to ensure that chemicals and apparatus are handled safely. This duty extends especially to comparatively untrained assistants. Before a method is passed to such assistants to operate, the responsible chemist should consider the chemicals used and the processes to which they are subjected and give explanations and special instructions where necessary.

Mr Horn's point that many chemists are ill-informed about hazards is well made — the title of this editorial becomes something of an aphorism if one gives to "science" its basic meaning of "knowledge". His guide to sources of information should assist members to check the safety of their procedures.

Equally cogent are Mr Horn's strictures on carelessness and indifference. Mishaps do not necessarily happen the first time or in the first 100 times a dangerous process is carried out; but when familiarity has bred insouciance, and repetition confirmed a bad practice, the variation of an uncontrolled factor may complete the critical conditions necessary for an accident. "Getting away with it" is neither a safeguard before the event nor an excuse after it.

Mr Horn's suggestion that the appendix could be issued by the Institute to those just starting in the profession will be considered by the Council. In publishing it in its present form we invite comments from members for improvements if this proposal is adopted.

Emphasis on safety must not of course be developed to the point of timidity in the use of potentially dangerous materials, where these are necessary. To go that far would stultify the spirit of scientific enquiry. Yet it is even more contrary to scientific method to ignore the known properties of materials when they are put to use.

With these thoughts we commend Mr Horn's article and suggestions to members.

## SAFETY AND FIRST-AID IN SCIENCE

A. H. HORN

*Agricultural Chemist, Lincoln College*

It is fair to remark on the extent to which our scientists fare forth on their careers with only the shakiest ideas of the safety and first-aid measures needed for the hazards of their craft. This obliviousness — fair dinkum she'll be right — is largely the result of the treatment given this topic by our university teachers, certainly in the past. They do not neglect it altogether, but their approach is distinctly casual.

In the writer's experience, hazards in undergraduate practical work were dealt with *en passant* in lectures, and often without first-aid instruction. Moreover, most teachers like to avoid laboratory hazards as much as possible; these so avoided tend to be forgotten altogether. In any case, the items encountered are lost in the morass of notes (if recorded at all), and, as the years fly past, they are forgotten from disuse, or worse, misremembered.

No-one is likely to deny our responsibilities to those about us at work, and the relative simplicity of filling this gap in our scientific education makes the situation doubly reproachful. Sources of information on common and uncommon hazards, safety practice, first-aid and its understanding — all this could be covered in a very few lectures and demonstrations, and thus make an integrated record of knowledge, to be kept and referred to in later years and in unforeseen circumstances.

There should be a certificate of proficiency in scientific safety and first-aid as a requisite to graduation, just as one is required for an engineering degree (B.E.). Or one could be made a requisite for membership in the N.Z.I.C.

So far, I have been very rude to our university people, but the rest of us are no better, it seems. When the situation is pointed out, little interest is shown — initially.

Why? Partly because really serious accidents are rare among our acquaintances, partly because we all think we know what to do, partly because we hope accidents will never happen, partly because we do not know where to find the necessary information without spending a lot of time searching.

About actual accidents, the rarity of really serious cases among professional scientists is only apparent, to judge by the number of near misses one hears (but does not read) about. Some of these, thanks to time and good

raconteurs, almost constitute a boffin folk-lore; but the humour if any comes after the event and first among those with no responsibility in it. An eye destroyed, a face scarred, a life lost, chronic poisoning, all these and more have happened in New Zealand laboratories from accidental causes.

Statistics published by the N.Z. Department of Labour for 1961 show 11 reported cases resulting in permanent disabilities, 13 other cases serious enough to involve time off. These statistics derive from compensation insurance records classed as "chemicals and chemical products". Mostly workmen are involved, but there were a few professionals. Abstracts of a representative selection of these records, very kindly supplied by the Chief Inspector of Factories, show the prominence of accidents due to splashes received when opening or filling containers. Verbal comment from a medical officer (Department of Health) relates to two recent cases of severe hydrofluoric acid burns to hands sustained by people who were well aware of the hazards, and who took suitable precautions. The one precaution missed was the state of their gloves, which had minute perforations in them.

A student swallowed some acid in an undergraduate laboratory, whereupon the instructor gave him some alkali to neutralize it. In other case, sodium from a Lassaigne test found its way to a wet sink, with gratifyingly spectacular consequences till a passing staff member decided to quieten it, which he did with alcohol. Then all hands left for the fire extinguisher.

These people were not technicians, or student demonstrators; both were Ph.D.'s and, let me emphasize, very highly regarded and well known chemists. The point is that a high I.Q. and basic chemistry are not enough. In an emergency the best mind can miss vital practical points especially when these are a bit unfamiliar — the human gut is not a test tube, as in the case above. First-aid requires some simple but special knowledge, requiring to be learnt — too often learnt from painful experience. We should make humble use of what medical science offers us.

It was a minor mishap in my laboratory that led eventually to this article. The mishap was a technician swallowing a pipetted reagent — fortunately a very dilute one, and suspiciously a highly ethanolic one — and I realized belatedly that I did not know whether it was poisonous or not, nor did I know where to find out. Fortunately the technician is still thriving.

In this ignorance I seemed to have much — far too much — company. Part of the difficulty experienced was not knowing where to start, because of lack of publicity for those books written for chemists (e.g., R.I.C. handbook) and also because much of the information naturally is in the medical literature, for many chemists both unfamiliar and not conveniently accessible.

To save fellow chemists in a like state the unnecessary task of re-finding sources of information, and to give those who desire a brief indication of what it is all about, there is an appendix to this article.

I would like to suggest that providing it is found suitable, reprints of the appendix be given to all chemistry and chemical engineering graduands each year, for their benefit and also as valuable publicity for the N.Z.I.C. Other disciplines may become interested also. It would be more desirable and authoritative if the appendix was issued by the N.Z.I.C. rather than by an obscure individual author. To this end I invite the Institute to take it over and alter it if and as desired; I would willingly relinquish any authorship claim upon it.

Once discovered, there is a surfeit of information and one needs to keep to the few most useful publications, which in turn lead to further references if the need is felt. There is no point in our making still another handbook; there are more than enough good ones — and cheap ones at that — available now. If we carry out the scheme suggested, a periodic bringing up to date will be necessary, but this is hardly likely to be onerous. The sources of information and a brief outline of the possibilities of their use should enable any chemist, safety officer, etc., to derive easily his own simple scheme for local circumstances, or invest in a published handbook. The sources could equally easily be used for devising a short lecture or lectures. A very brief outline of the hazards should help draw the attention of new graduates to the scope of precautions necessary for consideration.

## **GUIDE TO SAFETY AND FIRST-AID IN CHEMISTRY**

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  - (b) Pamphlet No. 98 *Diseases Arising from Occupation*.
  - (c) Pamphlet No. 100 *Agricultural, Commercial and Household Poisons*.
  - (d) Pamphlet No. 112 *Eye Protection at Work*.
  - (e) Pamphlet No. 115 *Occupational Dermatitis*.
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- (16) Ministry of Labour, Great Britain. *Toxic Substances in Factory Atmospheres*. Safety Health and Welfare, New Series No. 8. H.M.S.O. 12 pp. (1s.)

Periodicals available in New Zealand: *Safety Engineering*; *Industrial Medicine and Surgery*; *National Safety News*; *Brit. J. Industrial Medicine*.

### **Comment on Bibliography**

The selected references are a starting point only. Further references will be found in (3), (4), (13) and to a lesser extent in others.

The R.I.C. handbook (1), except for its chapter on radioactivity, is devoid of further reference. However, it is issued with excellent authority, and is intended for using, not musing. Its directions are clear, concise and practical, and the variety of remedies are kept to a minimum, thus simplifying the first-aid kit. For coverage, aptness for the laboratory situation, and its notably low price it cannot be excelled.

The Fisher wall chart appears to be the only one available from either commercial or official sources, so far as the chemical laboratory is concerned. In order to attract customers, it necessarily covers more ground perhaps than any one set of local hazards requires. Its system of cross referencing could be made a little clearer for people in a hurry. On the other hand, one should regularly refamiliarize oneself with the directions and procedure and not leave this till the emergency "panic" occurs.

The medical authorities differ occasionally regarding procedure, doses and treatment, a fact of some surprise to a layman. If one devises one's own first-aid scheme — wall chart, kit, antidotes — it is well to consult the doctor who will be called on for further treatment, and the Department of Health. Doctors and Health Department officers are very willingly helpful, and will resolve any difficulties in this respect. The disagreements referred to are usually minor as far as first-aid is concerned, but one or two bigger discrepancies occur at the medical practitioner's level, for example, use of stomach pumps for swallowed corrosives.

Reference (15) is an excellent example of a handbook issued by a laboratory to its staff.

Reference (6) is a handbook recommended to and widely used by N.Z. doctors.

## Bibliographical Analysis

|                                 | Hazards               | Safety          | First-aid                       |
|---------------------------------|-----------------------|-----------------|---------------------------------|
| Mechanical, machinery           | 8c                    | 7a, 7d, 8c      | 8a, 9b                          |
| Electrical                      | 2, 14                 | 2, 14           | 2, 14                           |
| Chemical:                       |                       |                 |                                 |
| Fire                            | 1, 3                  | 1, 2, 3         | 1, 2, 3, 6,<br>12<br>9a, 11, 15 |
| Explosion                       | 1, 2, 3               | 2, 3            |                                 |
| Poisons and Fumes               | 1, 3, 4, 5            | 1, 2, 3, 7c, 15 |                                 |
|                                 | 6, 7c, 9a             |                 |                                 |
|                                 | 10, 11, 13,<br>15, 16 |                 |                                 |
| Explanatory medical back-ground | 4, 6, 11, 14          | 7b, 7c          | 4, 5, 6, 11, 13                 |
| Recommended acquisitions        |                       | 1, 3, 7c, 15    |                                 |
| Laboratory handbook             |                       | 15              |                                 |

## Some Common Hazardous Chemicals

| Substance                                 | Recorded fatal doses | Antidote   |
|---|----------------------|--|
| Conc. acids                               | 1 ml<br>or<br>1 g    | Water + MgO, Mg(OH) <sub>2</sub>   |
| Conc. alkali                              | 1 g                  | Water + dilute acetic or citric acids  |
| Cyanides (HCN)                            | 50 mg                | Fresh Fe(OH) <sub>2</sub> ; amyl nitrite inhalations; injected NaNO <sub>2</sub> , Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> |
| Arsenic (As <sub>2</sub> O <sub>3</sub> ) | 100 mg               | Fresh Fe(OH) <sub>2</sub> ; BAL injections   |
| Bromine                                   | 120 mg               | Water + Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>  |
| Barium salts                              | 800 mg               | Na <sub>2</sub> SO <sub>4</sub>  |
| Mercury salts                             | 1 g                  | "Universal" antidote or Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> ; BAL injections   |
| Oxalates                                  | 5 g }                | Ca salts; injections   |
| Fluorides                                 | 5 g }                |  |
| Phenol                                    | 10 g                 | Castor or olive oil  |
| Heavy metal salts                         | 5 to 10 g            | "Universal" antidote; injections   |

Maximum Concentration for Working Day Exposures  
(ref. 16)

| Gas              |             | Fumes, Dusts   |
|------------------|-------------|--|
| O <sub>3</sub>   | 0.1 ppm v/v | Chromates (as CrO <sub>3</sub> )                       |
| Br <sub>2</sub>  | 1 ppm v/v   | 0.1 mg/metre <sup>3</sup>                              |
| SO <sub>2</sub>  | 5 ppm v/v   | Parathion 0.1 mg/metre <sup>3</sup>                    |
| NO <sub>2</sub>  | 5 ppm v/v   | H <sub>2</sub> SO <sub>4</sub> 1 mg/metre <sup>3</sup> |
| HCN              | 10 ppm v/v  | D.D.T. 1 mg/metre <sup>3</sup>                         |
| H <sub>2</sub> S | 20 ppm v/v  | Cyanide (as CN) 5 mg/metre <sup>3</sup>                |
| Benzene          | 25 ppm v/v  |  |
| NH <sub>3</sub>  | 100 ppm v/v |  |
| Amyl alcohol     | 100 ppm v/v |  |

### First-aid: General Comments

This is not a complete set of directions, but is intended to outline briefly some major points (whose details should be ascertained from the literature) in order to give the uninitiated an inkling of what is involved.

(1) *External splashes*

Wash copiously with water. Use soap, etc., as removal demands.

(2) *Eyes*

Wash continuously with changing *water only* for at least 15 minutes. Always be sure to see the doctor. Avoid bicarbonates.

(3) *Heat burns*

Minor ones — use a protective cream, *e.g.*, brulidine. Major ones — sterile dressings only and prevent infection; treat patient generally for shock.

(4) *Swallowed strong acid or alkali*

Most important to dilute these quickly (about a hundred-fold) with water. Neutralizing antidote should be taken when ready, but not waited for. Avoid carbonates.

(5) *Swallowed poisons*

Oral antidotes used with emesis (vomiting). If no antidote known, use milk (canned), or "universal" antidote, or even just water. Do not give an unconscious patient oral antidotes.

(6) *Emesis*

Avoid it with corrosive materials, and certain liquids (kerosene) which may thus enter the windpipe. Avoid also if the patient is in convulsions.

Emesis may be difficult to induce with salt, mustard, etc. Tickling the throat is better, but it also fails with some people.

(7) *Injections*

Must be left strictly to medical practitioner. Sterile solutions and syringes should be kept handy.

(8) *Antidotes*

May conveniently be premeasured in single doses, kept in individual small containers,

(9) *Labelling*

Label layout is important for quick finding of antidotes.

(10) *Safety showers*

May be inexpensively devised with an overhead plastic container and gravity fed nozzle, suitably hung.

(11) *Glass wounds*

Do not probe — leave this to the doctor.

(12) *Bleeding*

Pressure bandages are very much better than tourniquets, especially in the layman's hands.

(13) *Fractures, wounds*

Most educated people have had some acquaintance in their careers with the work of the St. John Ambulance Association. Such knowledge should be brushed up from this source.

(14) *Artificial respiration*

Excellent account reference (14).

(15) *Biological infections*

If implanted in a laboratory accident, wash quickly and report immediately to the doctor.

(16) *First-aid implies second aid*

Do not become too ambitious. One acts only to help the patient and then the doctor when he arrives.

(17) *Be fair to the doctor*

The doctor you are likely to consult in an emergency should be warned of your possible hazards, which may lie outside his normal practice. This preparedness may be vital.

(18) *The negative*

Know also what *not* to do (e.g., the non-use of acids, alkalis and carbonates). Otherwise the patient may suffer worse consequences and the doctor's task become more difficult.

## CHEMILUMINESCENCE IN LIQUIDS

T. I. QUICKENDEN

*Chemistry Department, University of Canterbury,  
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Some chemical reactions in liquids emit a faint glow called chemiluminescence. These reactions give products having a surplus of electronic energy which is emitted as light. Chemiluminescence occurs at ordinary temperatures, which contrast sharply with the high temperatures needed for incandescence. The glow of fluorescence also occurs at ordinary temperatures, but is caused by absorbed light and not by a chemical reaction.

Chemiluminescence can be conveniently demonstrated by adding 3-30% hydrogen peroxide to a mixture of equal quantities of 0.1 M pyrogallol, 1 M sodium carbonate and 10 M formaldehyde solution. A faint rosy glow is visible in complete darkness. A much brighter display can be made by adding a solution containing 0.01 M potassium ferricyanide and 0.01 M hydrogen peroxide to a solution of 0.0005 M luminol (5-amino phthalhydrazide) in 0.02 M sodium hydroxide. Huntress *et al.* (1) describe a convenient synthesis of luminol, and give a number of suggestions for displaying its luminescence.

Reactions in living matter sometimes emit light, a phenomenon known as bioluminescence. This attractive glow is found in luminous bacteria, glow-worms, fire-flies, some fungi and certain crustacea. Robert Boyle (2) examined a number of living systems which give out light and found that when oxygen was removed, the light gradually faded. We now know that oxygen is necessary in some form or other for nearly all chemiluminescent reactions, whether in living or non-living systems.

A number of reviews (3, 4, 5) summarize our present knowledge of bioluminescence, and a more popular account (6) contains many coloured plates of luminous plants and animals. A recent development is the discovery by Strehler (7) of a feeble light which is given out during photosynthesis.

The mechanisms of bioluminescence are often inferred from the simpler reactions which emit light in non-living systems. This review is largely concerned with the latter, and the following table contains the more common chemiluminescent reactions that occur in liquids.

| Reaction   | Typical Reactants   | Conditions for Maximum Light   |
|--|---|--|
| Oxidation of the phthalic hydrazides (8)                                 | Hydrogen peroxide with ferricyanide in alkali                         | An NH <sub>2</sub> group in the ortho position to the phthalhydrazide ring |
| Oxidation of the biacridinium salts (9)                                  | Hydrogen peroxide with stannites                                      | N,N'-dimethyl biacridinium nitrate (Lucigenin)                             |
| Oxidation of pyrogallol (10)   | Formaldehyde with H <sub>2</sub> O <sub>2</sub> in alkali             |  |
| Oxidation of Grignard reagents (11)                                      | Air   | When magnesium is joined to an unsaturated carbon atom                     |
| Oxidation of xanthene dyes (12)  | Hydrogen peroxide in alkali; also (13) pyrogallol with O <sub>2</sub> | When the dye is fluorescein, rhodamine, eosin or uranin                    |
| Decomposition of anthracene peroxides (14)                               |   | 9,10 diphenyl anthracene   |
| Oxidation of siloxene Si <sub>4</sub> H <sub>6</sub> O <sub>4</sub> (15) |   | Most Redox systems   |

### THE PROCESS OF CHEMICAL EXCITATION

When a molecule has a surplus of electronic energy it is said to be excited. This excess energy may be radiated as light, lost to other molecules during collisions or degraded internally to heat.

A scheme for a simple chemiluminescent reaction is shown in Fig. 1.

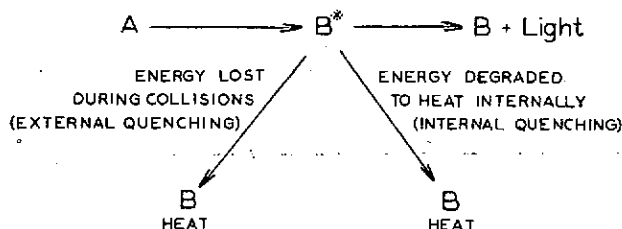


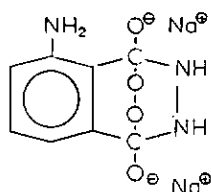
FIG. 1: Scheme for a simple chemiluminescent reaction.

In this scheme, A represents the reactants, B\* the products which are in an excited state, and B the products in their usual ground state, which can be reached by light emission or by the two types of quenching.

The structure most commonly associated with chemiluminescence is the peroxide bridge. It is well known (14, 16), for instance, that the photo-oxides of anthracene can decompose to give anthracene, oxygen and a faint light.



Similarly, Drew and Garwood (17) have isolated a bridge peroxide of luminol, which also emits light on decomposition. In both cases, which are typical of organic peroxides, the highly electronegative peroxide bridge presumably polarizes the electrons of the molecule into the configuration of the excited state. When the peroxide bridge breaks, the electrons evidently return to their ground state with the emission of light.



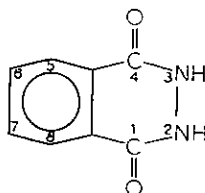
*Luminol peroxide*

The electronic structure of the excited molecules which emit chemiluminescence is not clear. Two types of structure are possible. The molecule may have an unpaired electron and hence be in a triplet state, or alternatively, may have only paired electrons and be in a singlet state. Eyring (18) proposes that chemiluminescence comes from a molecule in a triplet state, while Reid (19) favours emission from a singlet level. The question is difficult to settle experimentally, because the techniques for detecting triplet states — *e.g.*, optical absorption (20), electron spin resonance (21) — require a higher concentration of triplet species than can be conveniently secured.

#### LIGHT FROM THE PHTHALIC HYDRAZIDES

Of the reactions previously listed, those of the phthalic hydrazides have received most study. In 1928 Albrecht (8), following Lommel (8), observed that the ortho-amino phthalic hydrazide (luminol) would emit a bright light in the presence of hydrogen peroxide and a catalyst such as potassium ferricyanide or haemin.

By comparing the light from various phthalhydrazide derivatives, a number of workers (22-26) have tried to find why luminol, with NH<sub>2</sub> in the 5- position, should glow so brightly.

*Phthalic hydrazide*

A few derivatives, the 5-OH, the 5-NHCH<sub>3</sub> and the 6-N(C<sub>2</sub>H<sub>5</sub>)<sub>2</sub> show a light comparable with the glow of luminol. The unsubstituted phthalic hydrazide is only about 1/5,000 as bright. It is often concluded that electron donating substituents enhance chemiluminescence, most especially when in the 5 - position of luminol. These rules have many exceptions, however.

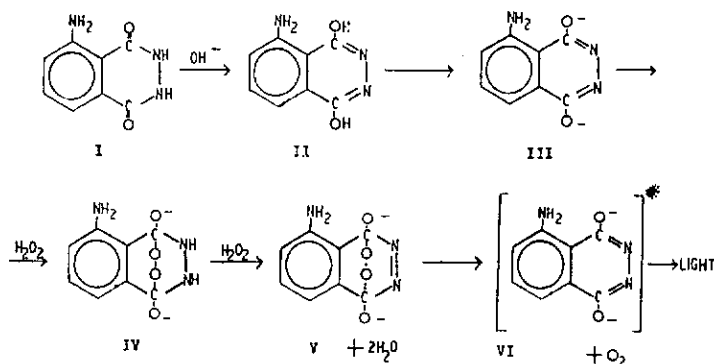
Because a substituent alters the intensity of chemiluminescence it is sometimes incorrectly supposed that excited molecules are necessarily being formed at a different rate. This need not be so, as the rate of internal quenching of excited molecules (Fig. 1) may also change with the substituent. As a result, the proportion of excited molecules which emit light may differ. Changes in the rate of internal quenching could be detected with measurements of fluorescence efficiency, and it is unfortunate that studies of substituent effects have not included these.

A wide variety of added substances, K<sub>3</sub>Fe(CN)<sub>6</sub> (8), NaOCl (27), MnO<sub>2</sub>, and colloidal metals such as platinum (28), many copper and cobalt complexes (29, 30), RuCl<sub>3</sub> and VOSO<sub>4</sub> (31) and haemin (8) increase the intensity of light when luminol is oxidized with hydrogen peroxide, but decrease its duration. Other substances such as KCN and Na<sub>2</sub>S (32) and hydroquinone and phenol (23) reduce the light intensity. As in the case of substituents, the effect of added substances can be twofold. As well as affecting the reactions which lead to excitation, an added substance may quench the excited molecules once they are formed (Fig. 1). Measurements of the reduction of fluorescence by an added substance could be used to discover any such quenching process.

A technique recently described by Bersis (33) could be used to measure fluorescence and chemiluminescence at the same time, in the presence of added substances. Bersis excited the fluorescence with intermittent light and separated the steady, background chemiluminescence from the fluctuating fluorescence.

THE MECHANISM OF THE CHEMILUMINESCENCE OF  
LUMINOL

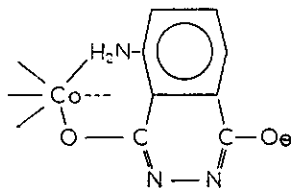
Some workers (8, 34) consider that the energy of the light from luminol comes from the decomposition of luminol molecules. Others (18, 35) claim that the decomposition of hydrogen peroxide provides the energy, and that luminol is lost only in side reactions. The mechanism of Drew (35), modified slightly by Reid (19), follows the second suggestion and is based on the isolation of the luminol peroxide IV by Drew and Garwood (17).



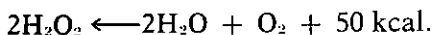
The substances II and III are accepted as intermediates because when their formation is prevented by methylating nitrogen and oxygen atoms respectively, chemiluminescence is almost absent (25). An alkaline solution is necessary for light emission, probably because it favours the formation of III. The next step is the formation of the luminol peroxide (IV) which is oxidized by a further molecule of hydrogen peroxide to V. When the peroxide bridge breaks, excited luminol molecules (VI) are formed and these subsequently emit light.

At some stage which is not clear, the luminol ion must again become protonated, despite the adverse pH of the alkaline solution. This is indicated by the spectrum of the chemiluminescence, which is similar to (8, 36) or identical with (37) the spectrum of the fluorescence from an acid solution of luminol. The fluorescence of an acid solution is generally attributed (18) to the protonated species II.

Ojima (29, 30) proposes that some ions, which catalyse the chemiluminescence, aid the formation of the peroxide bridge by chelating with a luminol ion as shown in the following diagram.



The major defect of the previous mechanism is its inability to account for all the energy of the emitted light. As luminol is regenerated in the last step, the overall reaction is simply



Unfortunately, the blue light emitted by luminol would require at least 65 kilocalories per mole of oxygen formed. To overcome this difficulty, Eyring (18) has proposed a mechanism involving four molecules of hydrogen peroxide, two of which form a hypothetical intermediate with luminol, having the triplet structure championed by Eyring. The intermediate has not been isolated.

Several free radical mechanisms (38, 39, 40) have been proposed to explain the inhibiting effect which free radical scavengers have on the light intensity. Weber *et al.* (40) combine a free-radical scheme with the peroxide mechanism of Drew (35).

Albrecht (8) originally suggested a mechanism in which a molecule of luminol was destroyed to provide the energy of each photon given out. According to Albrecht, hydrogen peroxide oxidizes a luminol molecule to give the reactive intermediate, di-imine,  $\text{NH} = \text{NH}$  which reacts with and excites another luminol molecule.

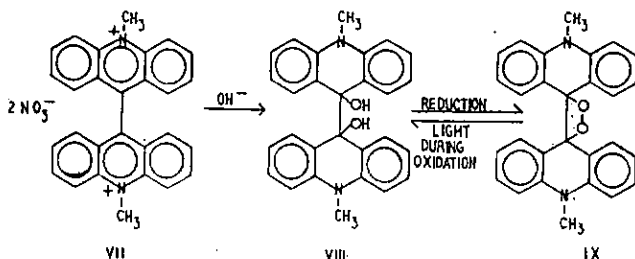
This mechanism is usually rejected for two reasons. One is that the rates of light emission and luminol decomposition are not obviously related (23). The other reason, which would be convincing if true, is that the number of photons emitted per molecule of luminol destroyed is too large for the above mechanism, which could not permit more than one photon per molecule. A survey of the literature shows that the highest photon yield reported, is about 0.33 photons per molecule (39), and that the usual yields (27, 41-43) are about 0.005 or less, depending on the conditions. On these grounds and because of recent work on di-imine (44) this mechanism, which could account for all the energy of the emitted light, merits further study.

#### THE CHEMILUMINESCENT BIACRIDINES

The salts of the biacridines (9) are the only known chemiluminescent materials which equal or surpass luminol in brightness. Lucigenin (VII) which has the structure shown, is the best known example. It glows feebly in a

solution containing hydrogen peroxide and the light is greatly intensified if osmium tetroxide or reducing agents such as stannites are added (9).

The following mechanism was advanced by Gleu and Petsch (9) to explain the observation that both an oxidizing and a reducing agent were essential for chemiluminescence. Hydrogen peroxide, which behaves both as an oxidizing agent and a reducing agent, evidently meets the requirements of the reaction less effectively.



The peroxide intermediate IX is analogous to the luminol peroxide of Drew, but has not been isolated. According to this mechanism, no lucigenin (VII) is destroyed, because in the light-emitting step the peroxide is reduced back to the carbinol (VIII). As in one of the luminol mechanisms (35), the overall reaction is the decomposition of two molecules of hydrogen peroxide to water and oxygen, with the liberation of 50 kcal per mole of oxygen. Once again, this is insufficient energy to account for light in the blue region of the spectrum.

Kautsky and Kaiser (45) propose a different mechanism in which VIII decomposes into N-methyl acridone during the light-emitting step.

#### SOME TECHNICAL USES OF CHEMILUMINESCENCE

Because the emission of light often depends on pH and sometimes depends on Redox potential, chemiluminescent materials have been used as indicators in volumetric analysis. The light emitted at the end point is easily visible, even in highly coloured or turbid solutions, where colorimetric or fluorescent indicators fail. Two reviews (46, 47) give access to details of the methods, and a recent modification (48) seems particularly effective.

As the haemoglobin in blood causes luminol to glow brightly, it has been used (49) in forensic chemistry to detect traces of blood. Chemiluminescent materials have

also been used to study mixing and flow in liquids (50). Mayneord *et al.* (51) have used the light emitted by the phthalic hydrazides to detect and estimate traces of hydrogen peroxide formed by X-rays in water.

#### WIDESPREAD CHEMILUMINESCENCE OF VERY LOW INTENSITY

It is sometimes stated that nearly all reactions in liquids emit minute amounts of light—about one photon from  $10^{14}$ – $10^{15}$  molecules. These comments date from the interesting but neglected work of Audubert (52), who detected ultraviolet photons in very low yield, from a wide range of chemical reactions summarized below.

1. The reaction of NaOH with  $H_2SO_4$ , and other acid-base reactions in water.
2. Atmospheric oxidation of sulphites and of pyrogallol.
3. Reactions of the alkali metal amalgams with water.
4. Oxidation of glucose by potassium permanganate.
5. Oxidation of ethanol by chromic acid.
6. Electrochemical oxidation of aluminium.
7. The reactions in various living systems.

To count the emitted photons, Audubert used ultraviolet-sensitive Geiger tubes (53), in which a pulse is caused by the emission of electrons from a photo-sensitive surface. Such tubes are sensitive to wavelengths around 2,000Å. As this work was done over 25 years ago, the methods of light detection were not always reliable. Nevertheless, several observations similar to Audubert's have recently been made. Strehler (7) has observed a feeble chemiluminescence accompanying photosynthesis, Ahnstrom (54) (1961) has detected photons from the anode during electrolysis of organic compounds and Shliapintokh *et al.* (55) (1960) have detected feeble light from a number of organic reactions. Dimbat and Harlow (56) (1962) have recently observed feeble light from acid-base titrations in non-aqueous solvents.

The reactions of Audubert (52) are at present being investigated by the writer in conjunction with Dr W. S. Metcalf. The major experimental problem in this work is to measure reliably very small light intensities which will produce only minute photocurrents in a detector. Under these conditions, the pulses due to individual light photons are large compared with the mean photocurrent, and it is better to count the pulses than to measure the current.

In brief, each photon incident on the cathode of a photomultiplier tube may liberate an electron which triggers a pulse of some millions of electrons from the tube. These pulses are amplified further, separated from small noise pulses and counted. With the best photomultipliers, about 1 in 5 of the incident photons is counted. With shielding from cosmic rays and  $\gamma$  radiation, with cooling and with anticoincidence circuits, the inevitable background counts can be reduced to five or six per minute. Under these conditions light fluxes of fifty to one hundred photons per second per square centimetre can be measured reliably.

Recent measurements with such equipment indicate that some at least of the reactions that Audubert described, do emit light. This work is proceeding and will be published.

The theoretical challenge is to account for the production of high energy photons from a diversity of reactions. Eyring (58) suggests that black-body radiation excites the reactants which then yield products also excited, but with a higher excitation energy than before the reaction. Hence ultraviolet or visible photons could be emitted when only infra-red were absorbed, the energy difference coming from the free energy of reaction.

It is also conceivable that in the microscopic region surrounding two reacting molecules, very high, transient temperatures may be generated. These "hot regions" might be the source of visible and ultraviolet radiation, which is a quite insignificant part of black body radiation at room temperature.

#### MITOGENETIC RADIATION

Some biophysicists, notably Gurwitsch (59), claim that cell division is accompanied by emission and stimulated by absorption of ultraviolet photons. The literature supporting this view extends to over five hundred papers and reviews, mostly in the Russian and German languages. Biological detectors are often used to detect the ultraviolet emission, and the following outline of a typical experiment illustrates their use (Fig. 2).

A material containing rapidly dividing cells, such as an onion root, is directed at a detector such as a yeast culture. The number of cell divisions in the yeast are counted, and compared with those in a control experiment where the onion root is not present. Under such conditions, Gurwitsch (59) has claimed a significant increase of cell growth above that of the control, when air or quartz separated the specimens, but not when glass was interposed. This observation

if it is real, indicates radiation in the far ultra-violet, which passes through air or quartz, but not glass.

Much of this type of work is unsatisfactory, and criticisms have been levelled at inadequate control of experiments (60, 61) and at the statistics used (62, 63). Some work has not been reproducible (60, 61). Nevertheless, a few papers (64, 70) withstand these criticisms.

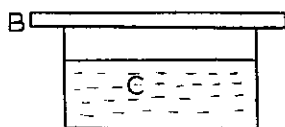


FIG. 2: Detection of mitogenetic radiation. A, emitter which contains rapidly dividing cells (e.g., onion root); B, interchangeable glass or quartz plate; C, detector (e.g., growing yeast).

A number of workers, some successful (52, 65) and others unsuccessful (66), have attempted to detect the emitted light with U.V. sensitive Geiger tubes. There have been some recent and successful attempts (67-69) to detect the radiation with sensitive photon counters, similar to that previously described. The signal-to-background ratios have not, however, been high.

There are a number of impartial reviews (70, 71) of this subject, particularly the account by Hollaender and Claus (71). The case against mitogenetic radiation has been forcibly presented by Lorenz (66). If, as seems indicated, most chemical reactions emit a feeble chemiluminescence, it should not surprise us if living systems behave similarly.

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## THE END OF THE SECTION

### N.Z. Section R.I.C. Disbands

For several years before the New Zealand Institute of Chemistry was formed there existed a Dominion-wide organization of chemists who were Fellows or Associates of the Institute of Chemistry of Great Britain and Ireland and who had combined in 1926 to form the N.Z. Section of that Institute. With the granting of a Royal Charter to the parent body, this organization became the N.Z. Section of the Royal Institute of Chemistry. As the N.Z. Institute of Chemistry has grown in membership and activities, the R.I.C. Section has tended to decline and the question of disbanding has been under discussion for some time. At a meeting held during the Palmerston North Conference last year, following a postal ballot among members, the motion to disband was adopted. Although this step appears logical and almost inevitable, and will remove some redundancies arising from the existence of two professional bodies for chemists in New Zealand, many of the older members of both Institutes must feel some regret and nostalgia at the passing of the Section after 37 years of activity.

It is intended that, when the affairs of the Section are wound up, a Corresponding Secretary will be appointed

to maintain liaison between the parent body and members of the R.I.C. in New Zealand. He will be responsible for organization necessary to continue the Easterfield Award, which is financed by the R.I.C., and the general policy towards educational affairs previously adopted by the Section.

Mr W. L. Mummery, who acted with Mr T. A. Glendinning and the late Mr A. M. Wright in founding the Section, and who was the first Secretary, has prepared notes on the history of the Section for circulation to its members. An account of the collaboration between the two Institutes in organizing the Combined Conferences from 1935 to 1958 was given by Dr G. M. Moir in the April, 1961, issue of the *Journal*. It is hoped to publish later this year an account of the development and activities of the Section, together with a list of the office bearers.

Although the Section ceases as an entity, the work which it started in New Zealand will to a large extent be continued within the N.Z. Institute of Chemistry which it helped to inaugurate and to which most of its members belong. Indeed, there could hardly be a better definition of the purposes of the N.Z. Institute of Chemistry than that which Professor Easterfield, the first Chairman, gave in his retiring address in 1929 as the objective of the Section:

The objective of the N.Z. Section has been, and still is, reciprocal; first, to show the community the nature and value of the chemist's work and secondly, to consolidate the profession by mutual interchange of thought on each other's varied interests.

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### Professor Coulson

Professor C. A. Coulson, F.R.S., of Oxford University, will visit Institute branches during April. Prof. Coulson came from Aberdeen to take up an I.C.I. Fellowship at Oxford in the early 1940s, and after a period in London, returned to Oxford, where he is now Rouse Ball Professor of applied mathematics. His interests have been primarily in the theoretical aspects of chemistry, wave mechanics, and the application of mathematics to chemical data. His book, *Valence*, is an important contribution to this field.

Prof. Coulson has also concerned himself with the relationship of science to religion and is author of works on this subject. His visit to New Zealand has been arranged by the Methodist Church in association with the universities.

**PRESIDENT, 1963-64**

The President of the New Zealand Institute of Chemistry for 1963-64 is Mr S. G. Brooker, Chief Chemist to Abels Ltd. He was born in Christchurch and educated at Christchurch Boys' High School and Victoria University College, graduating M.Sc. (2nd class honours) in 1932. He joined the Chemical Laboratory of the Department of Agriculture in Wellington in 1930, under Mr B. C. Aston, and remained there for five years. Mr Brooker then spent a year at Auckland University College engaged in postgraduate research



with the late Prof. F. P. Worley, on the composition of long-buried kauri wood. In 1936 he joined Abels Ltd. in Auckland as Chemist and has remained there ever since. Mr and Mrs Brooker have four children, two of whom are married.

During his service with Abels Ltd., Mr Brooker has made a valuable contribution to the industrial use of oils and fats in New Zealand, and has published several papers on various aspects of the chemistry of oils and fats. He spent a period overseas in 1956-57 visiting margarine factories, universities and research institutions. However, Mr Brooker's interests in oils and fats are not all-consuming. He is co-author (with Dr R. C. Cooper) of *New Zealand Medicinal Plants*, a handbook of the Auckland Museum (1962), and (with B. F. Cain and R. C. Cambie) of "A New Zealand Phytochemical Register, Part I" (*Trans. Roy. Soc. N.Z.*, 1963). Further, he lists among his hobbies, together with philately, the collection of named reactions. Some of the information which he has assembled was used by Wheeler and Gowan in their book on this subject.

Among his diversified interests Mr Brooker includes service since 1932 as a lay preacher of the Methodist Church. Thus is revealed the authentic source of those ecclesiastical stories with which he enlivened the 1963 Conference dinner and with which he aptly illustrates his addresses.

Since he joined the Institute in 1942 (he was elected a Fellow in 1948), Stan Brooker has been almost continuously in office on various Institute committees. He was Secretary to the Auckland Branch 1942-48, Chairman and Delegate to Council 1948-50, Editor of the *Journal* 1949-54, has served on the Membership Committee and Rules Revision Committee, and has been Honorary Librarian since 1956. During his service as Editor the *Journal* increased in size and standing, with publication of authoritative articles and reviews, without losing its essential character as a recorder of Institute news and affairs.

Mr Brooker has been equally active in other scientific societies. He has combined editorial and industrial interests by providing news paragraphs on chemical industry and research in New Zealand for *Chemistry and Industry*. He was an Honorary Secretary for the 8th New Zealand Science Congress in 1954, has been a member of the Council of the Auckland Museum since 1954, and of the Council of the Royal Society of New Zealand since 1956.

It is particularly appropriate that, in a year in which the Institute hopes to resolve discussions about its relationship to other scientific bodies, the President should be a member with extensive experience on the Council of the Royal Society.

### THE VICE-PRESIDENT

The Vice-President and President Elect for 1963-64 is Professor S. R. Siemon, Professor of Chemical Engineering, University of Canterbury, Christchurch.

### HONORARY FELLOWS

At the Council Meeting in August, 1963, four members who have given distinguished service to the Institute and to the development of the profession of chemistry in New Zealand were awarded the highest honour which the Institute bestows—election to Honorary Fellowship. An account of the careers and achievements of these new Honorary Fellows is given below.

#### **R. Gardner, D.Sc., M.I.Chem.E., F.R.I.C.**

Dr Roy Gardner was born in Masterton and received his early education there. On leaving school he was apprenticed to the late Mr H. T. Wood, pharmaceutical chemist, of Masterton. He qualified in pharmacy and spent a few

years in that occupation in various parts of New Zealand. He then took the B.Sc. course at Auckland University, afterwards transferring to Otago where he graduated M.Sc. with first class honours in 1922. He was on the teaching staff of King Edward Technical College, Dunedin, for about ten years, meanwhile continuing research, chiefly on essential oils of N.Z. plants. In 1927 he sat and passed the Royal Institute of Chemistry's Fellowship examination in food, drugs and water. In 1930 he was awarded the D.Sc. degree. From 1933 onwards he has practised in Dunedin as consulting industrial chemist. He has also given a few lectures each year in the applied chemistry course at Otago University and is now lecturing in pharmaceutical chemistry in the new B.Pharm. course there.

Dr Gardner was a foundation member of the New Zealand Institute of Chemistry, a member of Council for some years and President in 1940-41. He also served on the Membership Committee for a number of years.

He is also a member of the Institution of Chemical Engineers.

Besides his work and his family (including several grandchildren), Dr Gardner's interests include bowling and chess and he is at present President of the New Zealand Chess Association. He has had a longstanding interest in economics, and in the early 1940's published a book, *The Basis of Prosperity in New Zealand*, on this subject.

#### **T. A. Glendinning, M.Sc., F.R.I.C.**

Mr Glendinning, one of the Institute's oldest members, had had extensive experience in industrial chemistry in England before he commenced the long association with teaching in New Zealand for which he is best known. He received his early education at a Scottish academy school then went to Leeds University at a time when Smithells and J. B. Cohen were Professors of Chemistry there. He took a four year course for students entering industrial chemistry, which led to examination for Associateship (1892) and Fellowship (1895) of the Institute of Chemistry. He took up an appointment as Under Brewer in Yorkshire, became a head brewer in Lancashire and finally held the position of Chemist to the famous Scottish brewery firm, Tennant and Co. During his early years in this field he published papers in the *Journal of the Institute of Brewing* and three papers on gravimetric estimation of sugars and

enzymic hydrolysis of starch, in the *J.C.S.* The paper on enzymic hydrolysis, with H. T. Brown, includes an explanation of earlier work by Kjeldahl on the activity of diastase.

Mr Glendinning came to New Zealand before World War I. After sampling a variety of occupations, including flax milling and gold mining during his first three years here, he decided that salaries for industrial chemists were so low that there was more inducement to teach science than to practise it. He became Science Master at Wellington Technical College and held this post for the next 23 years. Although he normally taught (both science and mathematics) five days and three evenings a week, during the earlier years he continued studies and graduated B.Sc. and then M.Sc. with 2nd class honours in 1921. Later he wrote several text books in general chemistry and food chemistry, which were widely used in secondary schools. After retirement from the Technical College he returned to teaching during the war years at Scots College, Wellington, Nelson College, and Nelson College for Girls. Later he undertook private coaching for examinations.

Mr Glendinning was an early Chairman of the Wellington Branch and later Branch Secretary. His main contribution to Institute affairs was, however, as Honorary General Secretary-Treasurer, a position which he took up in 1933 and held during seven years of great importance in the early development of the Institute.

#### **K. M. Griffin, M.Sc., F.R.I.C.**

Mr Griffin was born in Nelson and during his early education there his interest in chemistry was stimulated by W. F. Worley, father of another Honorary Fellow, the late Professor F. P. Worley. Coming to Wellington he joined the Dominion Laboratory staff and studied as a part-time student at Victoria University College. After eight years he was transferred to Auckland to open the first branch of the Dominion Laboratory and during over thirty years as Government Analyst was responsible for providing and developing the application of chemistry in the public health and forensic services and in industry in the Auckland province. The part played by Mr Griffin in a number of celebrated criminal trials earned him a high reputation as an expert witness. He retired from this position in 1958.

Mr Griffin was elected an Associate of the Royal Institute of Chemistry in 1922, was a foundation member of the

Section in New Zealand and became a Fellow in 1927. In 1937 he visited laboratories in the United States, Canada and Great Britain, studying forensic methods and, in particular, systems of treatment and utilization of sewage. Subsequently he published an important report on Water Pollution Control.

Mr Griffin filled a unique role in the formation and development of the New Zealand Institute of Chemistry. When the predecessor of the Auckland Branch, the Auckland Chemical Society, was formed in 1925 he was the first vice-president but he later took over for several years the post of secretary. It was in that capacity that he was responsible for calling the meeting of chemists from various parts of the country which inaugurated the Institute. He was Chairman of the Auckland Branch for 1944-45 and became President of the Institute for 1955. The forthright but constructive criticism of Ken Griffin provided a stimulus to Council and members on a number of issues in the development of the Institute. Thrice in previous biographical notes in the *Journal* he has been honorably described as "the watch-dog of the Institute"; but, because he was concerned more with maintaining integrity and ethical standards within the Institute than with protecting it from evil without, we prefer to call him "the conscience of the Institute".

#### **G. A. Lawrence, O.B.E., B.Sc., F.R.I.C.**

Mr Lawrence was born at Harpenden, England, in 1893, his father being assistant to Sir Henry Gilbert at Rothamsted. The family came to New Zealand in 1901. Gilbert Lawrence served with the Advance Party in Samoa at the outbreak of World War I, later with the 5th Reinforcements at Gallipoli in 1915, and was wounded and invalidated home in 1916. He then entered the laboratory which his father had established some years before for private analytical and consulting services, practising under the title of H. W. Lawrence and Son until the present company was established in 1955. Mr Lawrence studied science at Victoria University College, graduated B.Sc. in 1922 and was admitted to Fellowship of the R.I.C. in 1926, being the first candidate to sit the examination for Fellowship in New Zealand.

The Lawrences, father and son, with continuous service of over 56 years between them, were foremost among pioneers of industrial chemistry in New Zealand. Starting

chiefly with agricultural chemistry, particularly the use of basic slag and other fertilizers, they applied their knowledge to the rapidly emerging meat freezing industry in the early twenties and gradually entered into many fields in industry and commerce. Mr Lawrence was a founder member of the New Zealand Association of Refrigeration (now the Institute of Refrigeration Engineers), became its President and is now an honorary member. He was also a foundation member of the Standards Institute in 1932, was appointed to represent the N.Z.I.C. on the original council and has now served as an Institute representative for over 30 years. He was Deputy Chairman of the Standards Institute Council, 1949-51, and Chairman 1951-53.

Mr Lawrence was similarly one of the founders of the N.Z.I.C. He was the inaugural Chairman of the Wellington Branch and a member of the Council, and served as President, 1938-40. He had earlier been Chairman of the N.Z. Section of the R.I.C., 1935-37.

Mr Lawrence has given service over many years on local bodies, being elected Commissioner of the Johnsonville Town Board in 1932, a post from which he retired in 1939 after 5 years as Chairman. During the depression he played an active part in relief work organization, and during World War II was Chief Warden for the district. He has served also on the local Electric Power Board and Highways Board, and played a leading part in securing electrification of the Johnsonville Railway. He was appointed a Justice of the Peace in 1948. Mr Lawrence was awarded the O.B.E. in the last New Year Honours list.

In a personal note to the Editor, Mr Lawrence points out that he must be one of the few persons now living who knew both Lawes and Gilbert of Rothamsted. "As a small boy," he states, "I often saw them at the laboratory and I well remember accompanying my late father to Lawes' funeral." How much of the history of modern chemistry is compassed within a generation; and how strongly the roots of New Zealand agriculture and industry lead back to Broadbalk Fields!

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### NOMINATION OF OFFICERS

Nominations for the positions of Vice-President and General Secretary-Treasurer must be forwarded to the Secretary of the Institute by June 30. Nominations may be made by Branches, or by any six members. The Vice-President is automatically nominated for the position of President.

## BRANCH CHAIRMEN, 1963-64

### AUCKLAND

The Chairman for 1963-64 is again Mr P. J. Gallaher. Details of his academic career and experience were published in the *Journal* for February, 1963.

### WAIKATO

Dr E. B. Davies, who was Branch Chairman for 1956-57, has again undertaken this office. Dr Davies joined the Chemical Laboratory of the Department of Agriculture in 1926, under the late Mr B. C. Aston. He graduated M.Sc. from Victoria University College in 1931 and from 1935 to 1937 worked at the Macaulay Institute for Soil Research, Aberdeen, where he obtained the Ph.D. degree of the University of Aberdeen.

In 1937 he was appointed Officer-in-Charge of the Fairlie Terrace Laboratory, responsible for soil, plant and fertilizer work for the Extension Division, Department of Agriculture. In 1945 he was transferred to the newly formed Rukuhia Soil Research Station where he is at present Senior Principal Scientific Officer in charge of research in soil chemistry. He has been associated chiefly with the establishment of a soil testing service for advisory work, with investigations on the reactivity of agricultural limestones and the fineness of grinding required for effectiveness, and with the finding of widespread molybdenum deficiencies in New Zealand. Latterly he has been particularly interested in uptake of applied selenium by pasture species.

A Fellow of the Institute, Dr Davies was Chairman of the Wellington Branch in 1944, and of the Waikato Branch in 1957 and also served on the Council for some years. He was President of the Waikato Branch of the Royal Society in 1954 and 1962, Waikato delegate on the Council of the Royal Society 1954-56 and President of the N.Z. Soil Science Society 1958-60.



### WELLINGTON

Miss J. M. Mattingley has been elected Chairman of the Wellington Branch for a further year. Details of Miss Mattingley's career were recorded in the February, 1963, *Journal*.

### MANAWATU

Dr E. L. Richards, this year's Branch Chairman, was born in Wellington and educated at Rongotai Boys' College.

In 1945 he commenced employment as a cadet with the D.S.I.R., first in Head Office and then in the Dominion Laboratory. While so employed he studied at Victoria University and in 1950 graduated M.Sc. with first class honours in chemistry. He was then commissioned in the New Zealand Defence Scientific Corps and in 1951 sent to Bristol University from which he graduated Ph.D. in 1955 after working on the interaction between amino compounds and sugars. After a year at the Low Temperature Research Station, Cambridge, Dr Richards returned to New Zealand and was seconded to the Dairy Research Institute where he stayed until taking up his present position as Senior Lecturer in the Chemistry and Biochemistry Department of Massey University of Manawatu. Dr Richards was elected an Associate of the Institute in 1956 and a Fellow in 1963.



### OTAGO

Chairman of the Otago Branch for 1963-64 is Dr Jack Dacre, Senior Research Officer with the New Zealand Medical Research Council at the University of Otago Medical School, Dunedin. Dr Dacre graduated M.Sc. with honours in chemistry from Auckland University in 1946, and Ph.D. in biochemistry from the London School of Hygiene and Tropical Medicine in 1950. After three and a half years with the Dairy Research Institute (N.Z.) at Massey College, he joined the newly formed Toxicology Research Unit, now Pathology Research, at the Otago Medical School in 1954. Dr Dacre's research

interests include the metabolism of microorganisms, the toxicology of food and colour additives, and pesticides and the application of radioisotopes in these studies.

Dr Dacre was elected Associate in 1945 and Fellow in 1958, has served on the Manawatu and Otago Branch Committees and was Secretary for the Conference held in Dunedin in 1959. He was awarded the Institute's Chemical Essay Prize for 1960 for his review "Metabolic Pathways of the Phenolic Antioxidants".

## COUNCIL MINUTES

### ABRIDGED MINUTES OF A MEETING OF THE COUNCIL, NOVEMBER 27, 1963

All officers and delegates were present except Dr E. L. Richards (Manawatu) who was represented by Dr R. W. Bailey.

#### *Officers and Committees*

Officers and committees for the ensuing year were appointed. (The full list of officers and committees was published in the December issue.)

#### *Honoraria*

*Resolved:* That the honorarium for the General Secretary be £60, and for the Editor £45.

#### *Journal*

The Editor reported briefly on *Journal* matters. The late publication of the *Journal* is still a matter of some concern and the Editor will continue his efforts to have this rectified.

*Resolved:* That for 1964, 900 copies of each issue of the *Journal* be printed for the Institute.

Council noted that a new publication *Chemistry and Industry in New Zealand* is to appear in 1964, and agreed to the use of the addressograph plates for publicizing the journal.

#### *Associate by Examination*

It was agreed that the General Secretary should prepare a statement on the question of Associateship examinations for circulation to Branches along with the suggested Regulation and Syllabuses drawn up by the Examinations Committee.

#### *Conference 1964*

The 1964 Conference will be held in Hamilton and accommodation has been tentatively reserved in hotels and motels in the city. Conference meetings will be held at Hamilton Girls' High School and possibly also at the Technical College.

#### *Branch Grants*

*Resolved:* That Branch grants for the present financial year be £20 per Branch.

#### *Vice-Presidents*

At the Annual General Meeting, Dr Shorland had suggested there may be advantages if the term of office of the President was two years. It was agreed that a more satisfactory solution might be to enlarge the Council by having a second Vice-President who would in the normal course of events become first Vice-President and then President in succeeding years. It was agreed to ask Branches for their views on this proposal and if appropriate to prepare the necessary changes in the Rules for consideration at the next Council meeting.

#### *Membership*

*Resolved:* That the Membership Committee be asked to consider the Bachelor of Food Technology Degree of Massey University of Manawatu to decide if in their view it should be acceptable as a qualification for admission to the Associateship under Rule 8.2.2.

#### *Chemistry in Action*

*Resolved:* That £5 be paid to the Canterbury Branch to assist with the cost of production of *Chemistry in Action*.

#### *Conference Advance*

*Resolved:* That £20 be advanced, by way of a loan to the Conference Committee.

*Registrar's Salary*

*Resolved:* That the Registrar's Salary be £240 per annum for the term of office.

*R.I.C. Funds*

The General Secretary reported that the N.Z. Section of the R.I.C. is to cease functioning as at present and that the Institute had been asked to administer certain special funds from the N.Z. Section R.I.C. It was agreed that the Institute should undertake this responsibility. It was noted that the Easterfield Medal award will continue to be administered by the R.I.C.

*Association with the Royal Society of New Zealand*

Council discussed the general concept of affiliation with the R.S.N.Z. in the light of the report of the sub-committee which had met with a sub-committee of the Council of the R.S.N.Z. It was agreed that a full detailed statement should be prepared and circulated to Branches in the expectation that Council could reach a firm decision in May. The President, the Vice-President and the General Secretary were asked to prepare the statement, which will be given coverage in the *Journal*.

*National Committee on Chemistry*

When New Zealand joins I.U.P.A.C. a National Committee on Chemistry must be set up and the R.S.N.Z. had suggested that the Sectional Committee on Chemistry of the R.S.N.Z., possibly enlarged, should serve as the National Committee at least temporarily.

*Resolved:* That it be suggested to the R.S.N.Z. that the National Committee on Chemistry should be formed from the Sectional Committee together with the President and the Vice-President of the N.Z.I.C., and that the President of the N.Z.I.C. should be the chairman of the National Committee.

*National Research Advisory Council*

The Secretary reported that Council had been invited by the Minister of Scientific and Industrial Research to suggest names for consideration for appointment by the Governor-General as members of the N.R.A.C. After discussion it was resolved that four names should be submitted, subject to approval by those to be named.

*Overseas Visitors*

The Secretary reported that Professor C. A. Coulson, F.R.S., will be visiting New Zealand in April, 1964. The visit was arranged by the Methodist Church of New Zealand and assistance with finance was sought from the Institute and from the universities.

*Resolved:* That £50 be contributed towards Professor Coulson's expenses.

*A.N.Z.A.A.S.*

*Resolved:* That Dr A. D. Campbell, Dr R. D. Topsom and R. W. Olliff be asked to represent the Institute at the general Council meeting of the A.N.Z.A.A.S. in Canberra in January, 1964.

*Education in Chemistry*

The R.I.C. have asked N.Z.I.C. to handle the N.Z. distribution of *Education in Chemistry*. The discount offered will more than cover anticipated distribution costs. It was agreed that N.Z.I.C. should accept responsibility for distribution and that publicity should be given in the December issue of the N.Z.I.C. *Journal*. (*Education in Chemistry*, first issue January, 1964, is a new R.I.C. quarterly. The annual subscription is £2, and orders may be placed with the Registrar, N.Z.I.C.)

W. E. HARVEY,  
*General Secretary*

## THE REGISTRY

### Associates

(Elected November 27, 1963)

- BARTON, Allan Francis Murray, M.Sc., University of Auckland (Ph.D. student).
- BORREN, Albert Marlow (Qualification equivalent to M.Sc. from Utrecht), Philips Electrical Industries, Lower Hutt (Technical Director).
- BROWN, Lindsay Russell, B.Sc., D.I.C., Kempthorne Prosser & Co., Wanganui (Assistant Works Manager).
- COLEBROOK, John Garry, B.Sc., Abels Ltd., Auckland (Chemist).
- CROTTY, Francis Patrick, M.Sc., South Canterbury Frozen Meat Co., Invercargill (Chief Chemist).
- DEMPSEY, Barry John, Bitumix Ltd., Auckland (Chief Chemist).
- GREGERSON, Bent, B.Sc. in Dairy Technology (Copenhagen), D.R.I., Palmerston North (Chemist).
- HERON, Henry James, M.B., Ch.B., Department Obstetrics & Gynaecology, Medical School, Dunedin (Research Officer).
- HODGSON, Gary Thomas, B.Sc., Reid (N.Z.) Rubber Mills, Auckland (Chemist).
- KAY, George Alfred, B.Sc., Riccarton High School (Assistant Master).
- PRICE, Harlech Craig, B.Sc., Reid (N.Z.) Rubber Mills, Auckland (Technical staff).
- RICKARD, Clifton Edward Frank, M.Sc., Chemistry Department, Auckland University (Junior Lecturer).
- SHANAHAN, Rory, M.Sc., Dominion Laboratory, Auckland (Scientific Officer).
- SMALL, Charles William, M.Sc., Pathology Department, Green Lane Hospital, Auckland (Biochemist).
- STANDISH, Nicholas, M.Sc. (N.S.W.), University of Otago (Lecturer in Metallurgy).
- STEDMAN, David Ingle, M.Sc. (Hons.), South Otago High School, Balclutha (Teacher).
- TARRANT, Peter Alan, M.Sc., Henderson High School, Henderson (Teacher).

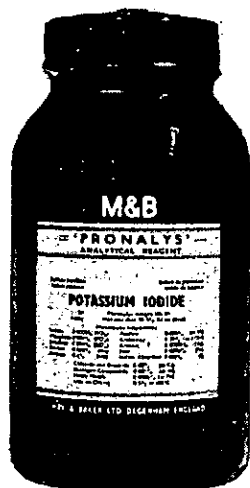
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1. Sully, B. D., *Analyst*, 1962, **87**, 940-3.



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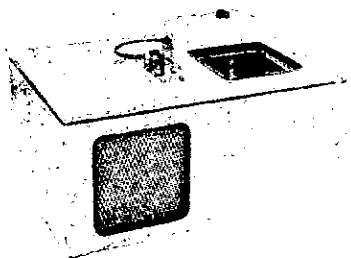
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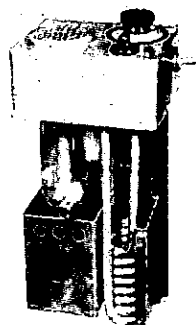
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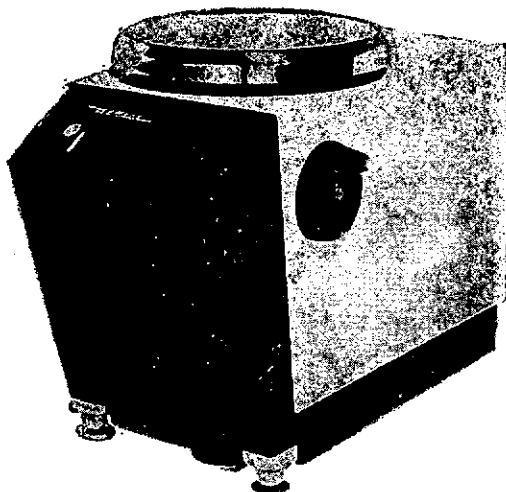
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