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The Chief of the Malaria Section  
has the honour to communicate hereunder the  
following note:

## RESIDUAL SPRAY EQUIPMENT UTILITY

An attempt to rationalize Divergent Points  
of View of the Insect Control Organization  
and the Equipment Fabricator

by

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The term "residual spray", when it refers to an applied insecticide, may be considered comparatively recent terminology, but efforts to develop the technique involved are not new. Ever since chemical means of insect control have been used, ways have been sought to increase their effectiveness, by prolonging the potency of the poison and by assuring adherence for the longest possible time to the surface on which the insect habitually rests. The early attempts at long-term control were not usually referred to as "residual" spray applications; in fact, no one term seems to have been in universal use to designate this desirable characteristic.

Prior to 1940 insecticides were used chiefly in agriculture, where the effectiveness of the chemicals was limited to the length of time they would adhere to foliage or the bark of trees, or even to the backs of cows during the hours the animals were in the milking stanchions. Only comparatively small quantities of insecticides were used to control pests on the ground, on the walls of buildings, or on other natural adult resting places.

The search for "persistent" larvicides in mosquito control was only casual. Attempts were made to develop oils that would remain on water surfaces for indefinite periods and also to keep Paris Green floating for a few days so that its effectiveness against Anopheles larvae would be maintained. None of these efforts was outstandingly successful.

The period of real advancement in residual sprays commenced soon after 1940, with the recognition of the inherent property of "persistence" in DDT and in subsequently synthesized formulations of a similar nature, and the application of these insecticides to adult resting places.

As these sprays began to be utilized in public health work for the control of insect vectors, increasing attention was given to spray equipment. Up to this time equipment had been designed to distribute bulk quantities of insecticides, comparatively low in concentration and value, to agricultural crops, only a small percentage of the total being used to control insects harmful to man and animals. In public health work the emphasis was the reverse, and the equipment had to be modified accordingly. However, although the chief impetus toward residual spray development has thus come from the public health field, the period of intensive use of large quantities of insecticide in that field is coming to an end. On the other hand, the need for control of agricultural pests is still vast, and agriculture will continue to be the principal market for insecticides and spray equipment.

The fact that the suggestions for improvement and modification of equipment came mainly from the smaller market for such equipment, public health, might have posed a serious problem for the manufacturers. Fortunately, however, most public health workers have realized that, in order to achieve the improvements they considered necessary, they must be able to prove that their suggestions could be gainfully used in the larger field of agricultural pest control as well. Whenever they have been able to show that a refinement can be so adapted, the acceptance of the refinement by the fabricators has been practically assured.

Actually, few drastic alterations have been recommended by public health workers; rather the aim has been to improve details of construction. This approach is logical, since older types of equipment did embody principles adaptable by improvement to newer problems. Suggestions have been made as to capacity and weight of equipment; functional requirements in the field under severe operating conditions; materials of construction, including the use of stainless steel wherever practicable; resistance of all sprayer parts to corrosion by insecticidal chemicals; correct formulation of insecticides so as to reduce abrasion of important accessories such as nozzle tips; hose types which are lighter in weight, longer lasting and less expensive. These and other improvements have been suggested, even demanded, by persons primarily interested in public health activities. Practically all of the suggestions have been adopted, or are under consideration, by the manufacturers.

Before accepting any such suggestion, the manufacturer must of course be satisfied that the improvement will be profitable to him. Even improvements that appear fairly minor to laymen may involve considerable capital investment for special tools or jigs, and the maker naturally wants to protect that investment. When the refinement is applicable to his entire field of production, he will introduce it quickly. When the field for it is limited or the improvement is expensive, then a demand for it must first be established.

Sometimes several years have elapsed between the initial use of a refinement and its final widespread adoption. The pressure regulator is a case in point. This accessory had been used for a number of years on heavy duty spraying equipment. With the advent of residual sprays, it was found that the regulator was especially useful in assuring uniform insecticide distribution with low pressure, manually operated equipment. In so far as is known to the author, it was first used in this connexion in 1940, in a malaria control investigations programme involving pyrethrum as a space spray.<sup>1</sup> Although no new principle was involved in adapting the regulator to low pressure equipment, it was several years before it was available in this form as

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<sup>1</sup> Knipe, Fred W. & Sitapthy, N. R. (1942) Notes on Improvements Made to Equipment for Spray-killing of Adult Mosquitoes. Amer. J. trop. Med. 22, 4, 429-446.

standard equipment. Recognition of its value is now widespread, extending beyond public health work to specialized fields of agriculture. It was even referred to recently by an old-line manufacturer as the most important improvement in sprayers in his memory.

A factor of considerable concern to the manufacturer, and of still greater concern to workers in field operations, is the problem of equipment maintenance. It can truthfully be said that the greatest menace to the long life of any piece of spraying equipment is improper maintenance.

Sprayers can be designed for any desired capacity and they can be constructed so as to withstand reasonably severe field use, but they cannot be constructed to maintain themselves. At this point the human element enters. Casual surveys and reports from reliable and experienced field observers indicate that approximately 90 per cent. of all equipment difficulties are caused by failure to clean the equipment thoroughly and maintain it - that is, a failure on the part of the human element.

Inadequate training and supervision of personnel are largely responsible for this state of affairs. Inattention on the part of subordinate field personnel is another important factor. Admittedly the situation cannot be entirely corrected, but while it exists failure of a correctly designed piece of equipment cannot fairly be ascribed to the manufacturer.

There is no real alternative to proper maintenance. Equipment designed to withstand excessively rough usage would be highly impractical - both cumbersome and too heavy. To be usable, machinery must be within certain weight limits. It is frankly impossible to design equipment that is entirely self-cleaning or that never needs a screw tightened or a gasket replaced. The manufacturer supplies, as far as he is able, equipment that uses a minimum of constructed parts and sees to it that these are properly made so as to require a minimum of upkeep. Once he has done this, he has met his obligation to the user of the equipment. In the case of the pressure regulator, to take it again as an example, the manufacturer has performed his duty

when he has done the following: designed the regulator and every other part of the apparatus so that there are a minimum number of pockets in which insecticide may lodge and resist displacement; removed as far as possible obstructions to the smooth flow of the insecticide; used factory methods that assure smooth and rounded flow lines to the maximum extent; and given rigid inspection to completed parts involving the line of insecticide flow.

Although the necessity for maintenance cannot be entirely eliminated, improved design, coupled with properly machined parts, can materially reduce the amount of maintenance any piece of equipment requires. Of course, a higher grade product will be more expensive. Might it not be good policy, however, to design and construct a piece of equipment that requires a minimum of attention and pay slightly more for it in the first instance, rather than purchase at a low price an inferior sprayer that may require frequent and in the end costly maintenance?

Maintenance is a challenge to every man involved in control of insects affecting both human health and human food supply. There is no simple and complete solution to the problem, but a concerted effort by interested parties can unquestionably bring about improvement. Public health personnel, agricultural personnel, and equipment manufacturers, working together, can materially aid in improving and prolonging the period of usefulness of the equipment, first by rationalizing and understanding one another's problems, then by working to solve those problems to their mutual benefit. In the end, however, it will still be the prime responsibility of those who supervise the use of the equipment to see that it is properly maintained and to bear in mind that in the majority of cases equipment fails because of inadequate attention during use in the field.