# NFN - An Improved Ninhydrin Reagent for Detection of Latent Fingerprints

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A previous article in this bulletin[1] described some aspects of the research programme being carried out at AWRE Aldermaston under contract to PSDB on chemical methods for the detection of latent fingerprints on porous surfaces with particular reference to new reagents and techniques. This programme also includes an evaluation of reagents already in current police use. The most important of these is ninhydrin. The recommended formulations and development conditions for this reagent vary widely and are often not optimum for achieving maximum detection efficiency. This article briefly describes a new formulation for the ninhydrin reagent (N.F.N.) which offers important advantages in sensitivity, low toxicity, non-flammability and good non-ink-running properties. It has been successfully tested under operational conditions and is being recommended by PSDB for general police use. Some typical applications of the new reagent are discussed.

**Review of Ninhydrin Reagents**

Ninhydrin was first used for fingerprint detection nearly 20 years ago and since that time has established itself as the reagent universally used for the detection of prints on porous surfaces such as paper. It provides a means of detecting, with high sensitivity the amino acid and ammonia components of fingerprints and is relatively clean and simple to apply. The chemical reactions involved however are complex and its effectiveness depends on the reactant concentrations and the development conditions in terms of temperature and time, the latter being of particular importance in controlling the background colouration effects which arise for many substrates. The first reported reagent was by Oden[2] in 1957 who recommended an acetone solution of ninhydrin, acetic acid being added to maintain a high sensitivity. Since that time many claims to improved reagents have been made based on changes of composition, solvent and development conditions as shown in Table 1, but in general, little or no improvement over the original formulation was achieved. One of these reagents described by Crown[5], in which petroleum ether has been used as solvent, has made a significant contribution to the examination of documents by its improved non ink-running properties but the reagent appears to give poor sensitivity with some types of paper. This however, appears to be considerably improved by the addition of 1% acetic acid as illustrated in Figure 1.

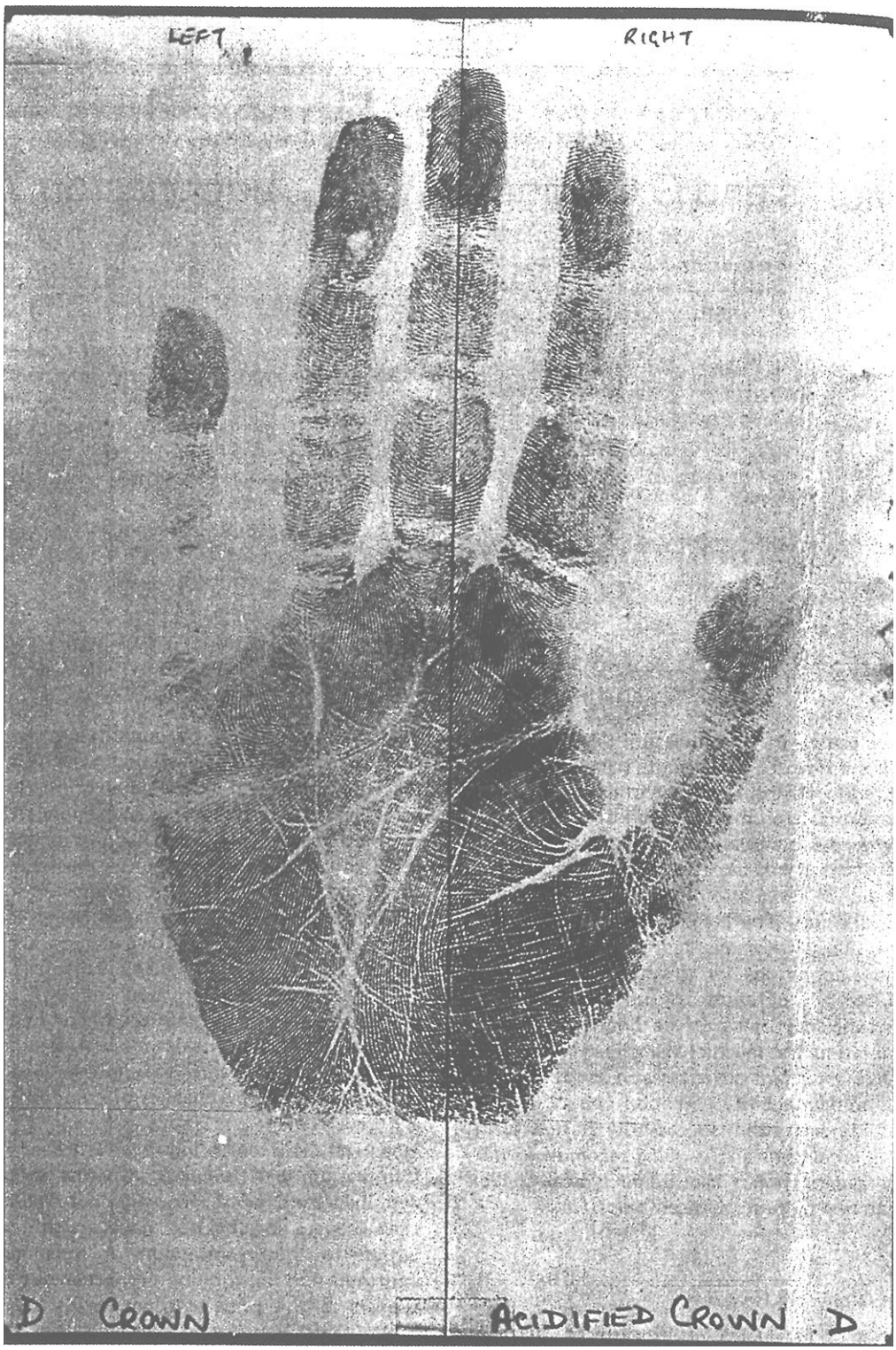



Fig 1 The effect of the addition of 1% acetic acid on the “Crown” ninhydrin reagent

TABLE 1

**SOME PUBLISHED NINHYDRIN REAGENT FORMULATIONS**

| Author | Solvent | Acetic Acid Conc. | Ninhydrin Conc. | Remarks |
|---|---|---|---|---|
| J. Oden[2] | Ether or acetone | 4% | 0.2% | Highest sensitivity for amino acids |
| H A Speak[3] | Ethyl alcohol | None | 1.5% | |
| N.S.Y.[4] | Acetone | None | 0.4% | Acetic acid omitted to avoid diffusion of chloride |
| D A Crown[5] | Petroleum ether | None | less than 0.7% | Good non ink-running properties. Highly flammable |
| H Fritz and H Jordan[6] | Acetone/water | 0.3% | 1% | Sample exposed to UV irradiation before treatment |
| A J Brooks Jn.[7] | Ethyl alcohol | None | 1.5% | Review article |
| D G Moony[8] | Ethyl ether | None | 0.5% | Highly dangerous in untrained hands |
| New Ninspray | Iso propyl alcohol unknown | Conc. | 1.2% | Proprietary aerosol pack |

**Improved Ninhydrin Reagent N.F.N.**

In considering possible modifications to ninhydrin reagents attention has been paid to safety, both in terms of toxicity and flammability since these are of particular importance operationally where laboratory facilities are often somewhat inadequate. All the solvents used in current reagents are highly flammable e.g. acetone or ether and under some conditions are potential explosives. Ignition by common electrical sources such as switches, fluorescent fittings or other contacts can readily occur and fires have been reported in fingerprint processing environments. The solvent trifluoro-trichloroethane (Fluorisol) which is essentially non-toxic, non-flammable and has little effect on most types of printing inks has been exploited as a suitable substitute. Further investigation revealed that ninhydrin is insoluble in this solvent but a solution can be prepared if a small volume of ethyl alcohol and acetic acid is first used followed by dilution with Fluorisol. The amount of the alcohol used must be kept to a minimum if the non ink-running properties and non-flammability of the Fluorisol are to be maintained. The formulation shown in Table 2 was devised to give a general purpose reagent capable of achieving consistent results with a wide variety of paper substrates with minimal background effect.
Recently a post-development treatment of the resulting fingerprint marks to give alternative colours or possibly a fluorescent image has been investigated. This in no way changes the sensitivity or properties of the NFN reagent and should prove useful tor coloured surfaces. The technique is at present undergoing operational evaluation.

TABLE 2

**PREPARATION OF NFN REAGENT**

It is essential that all glassware used for preparing solution should be thoroughly clean and dry.

**1 Stock Solution**

| | | |
|---|---|---|
| Mix:- | 25g | ninhydrin crystals |
| | 50 ml | glacial acetic acid |
| | 100 ml | absolute ethyl alcohol (ethanol) |

Dissolve the ninhydrin in the alcohol, adding the acid slowly and stirring until the solution is mixed. Filter and store in well stoppered bottles in the dark.

**2 Working Solution**

Mix 30 ml of stock solution with 1000 ml of Fluorisol (dried over molecular sieve type 3A) with stirring, allow to stand for 30 minutes and filter if necessary.

It must be noted that whilst the working solution is virtually non-flammable ethyl alcohol itself is highly flammable and strict fire precautions must be taken when making the stock solution. Additionally, with prolonged use the working solution will tend to lose Fluorisol by evaporation and hence the fire safety margin is reduced. Therefore solutions should not be left exposed to the air for long periods.

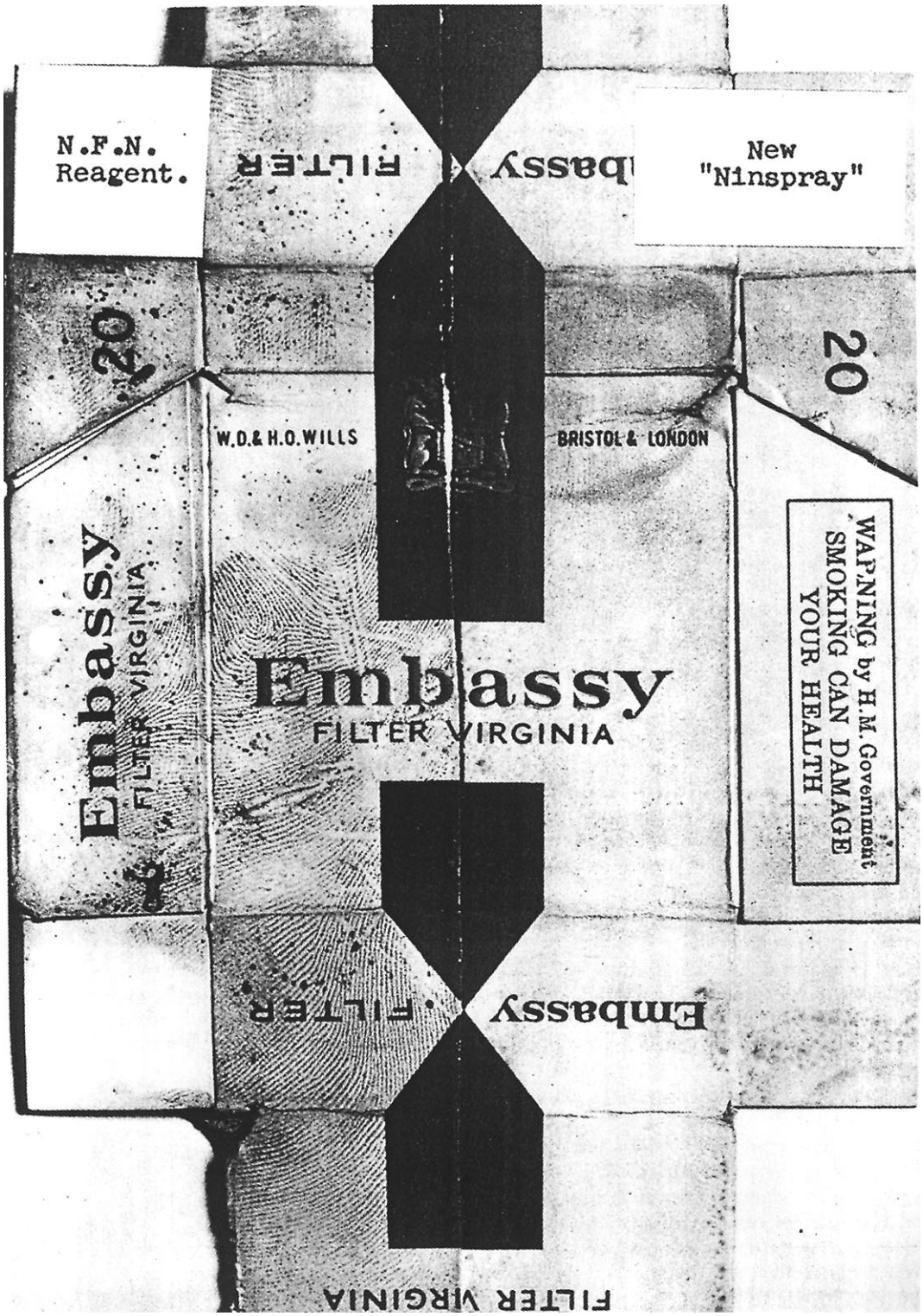
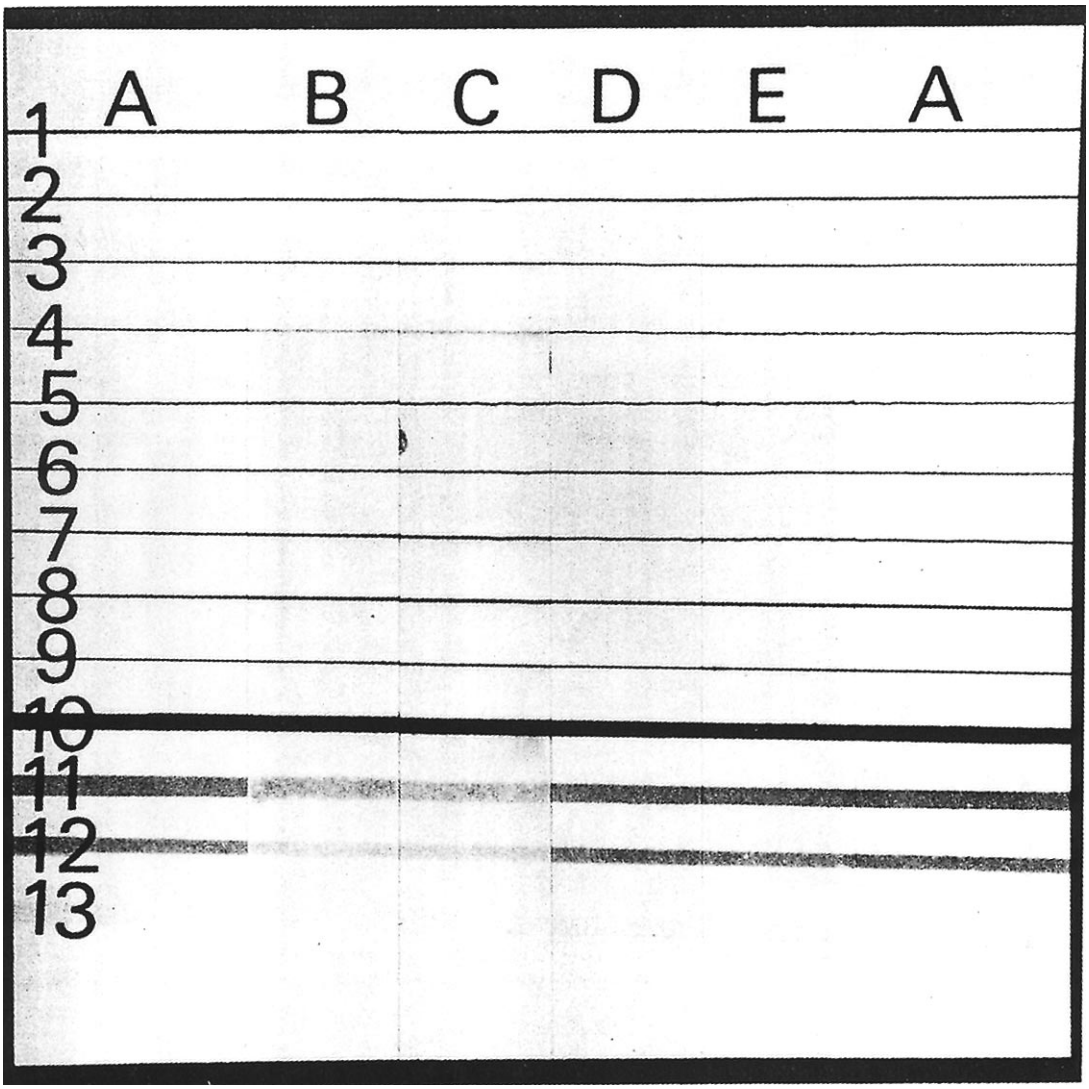



Fig 2 A comparison of N.F.N. with “Ninspray” using a palm print on a split Embassy Cigarette packet




**Key to strips**

A. Control strip. Not processed.
B. Processes with Ninhydrin in Acetone.
C. Processed with "Ninspray"
D. Processed with Ninhydrin/Petroleum ether/ Acetic Acid
E. Processed with the N.F.N. Reagent.

**Key to ink lines**

1 and 2. Writing inks.
3, 4 and 5. Ball point pens.
6, 7, 8 and 9. Fibre marker pens.
10, 11, 12 and 13. Felt marker pens.

Fig 3 A comparison of non ink-running properties for ninhydrin reagents

Fig 4 Application of N.F.N. to detection of fingerprints on the gummed surface of postage stamps


Fig 5 A comparison of freshly prepared N.F.N. with 6 months old reagent

**Method**

To achieve best development of the latent impression the sample is simply dipped in the NFN working solution until fully wetted (5-10 secs) and the solvent is allowed to evaporate at ambient temperature (or 2 mins). Brushing is an alternative technique but difficulties are encountered when spraying as an aerosol. The sample may then be heated for a short period, the duration of which depends upon the temperature e.g. 20 minutes at 60°C or 2 minutes at 120°C. The developed image can be viewed after 1 hour, though some marginal improvement is sometimes obtained after a further 48 hours. The optimum development conditions for any ninhydrin reagent depend to some extent on the particular substrate involved since the rate of development of the background colouration, due to the presence of ninhydrin positive materials if different from that of the print itself. In general the development of fingerprint marks with the NFN reagent is more rapid than with other formulations described. For substrates which give rise to background difficulties e.g. some types of surface coated papers including cigarette packets, high quality note paper and some postal orders the best results are achieved without heating, samples being simply stored in the dark for 24 hours, or occasionally up to 72 hours. With any of the above development conditions the most permanent image is obtained if samples are stored in sealed polythene bags in the dark.

**Results**

Under laboratory conditions using low background paper the sensitivity of NFN has been shown to be as high as any other ninhydrin formulations. However for surfaces exhibiting background colouration problems, the new reagent offers significant improvements as illustrated by a comparison with a commercial ninhydrin aerosol spray applied to Embassy cigarette packet in Figure 2. The effect of the reagent on most common types of printing inks is minimal as shown by comparison with other reagents in Figure 3. It has also been found to be effective for detection of prints on gummed surfaces e.g. sheets of postage stamps as illustrated in Figure 4.

**Operational Experience**

The NFN reagent has been evaluated under operational conditions by eight regional police forces over a period of 6 months. At a recent meeting organised by PSDB fingerprint experts were unanimous in their acceptance of NFN as an excellent general purpose fingerprint reagent and concluded that its use had led to a significant improvement in detection efficiency with an overall reduction in processing time. They also reported favourably on the non ink-running properties in the examination of documents and on the safety aspects. The shelf life of the reagent has been established to be not less than 6 months and no apparent difference has been observed using reagent stored for that period compared with fresh material (Figure 5).

In spite of the success of the new reagent it must not be concluded that this or any other formulation of ninhydrin will be universally applicable. Many absorbent surfaces remain which react so strongly with the reagent that the background colouration precludes its use for fingerprint detection. These include papers with particular surface coatings e.g. bank notes, some cheques and postal orders, rag based writing papers and surfaces which have been exposed to high humidity conditions. It has not been successfully applied to non-absorbent surfaces such as plastics or ceramics for which alternative chemical methods are under investigation.

**Conclusions**

The NFN is one of a suite of chemical reagents which should offer significant advantages in operational police use. This new formulation is being recommended by PSDB as a replacement for other ninhydrin reagents in current use and the continuing feedback of comments resulting from its adoption is to be encouraged if future problem areas are to be effectively identified. As research continues on the evaluation of new reagents for fingerprint detection it becomes more apparent that no single chemical system is likely to be applicable to *all* cases and that the future trend will be towards defining appropriate reagent selection criteria so that the most effective use can be made of new reagents as they become available.

**Acknowledgments**

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**References**

1 J R Morris, G C Goode and J W Godsell. Police Research Bulletin No. 21 1973.

2 S Oden. B.S. Patent 767,341. January 30 1957.

3 H Speak. Identification News. March 1964.

4 New Scotland Yard data sheet

5 D A Crown. J Criminal Law, Crimonology and Police Science 1969, 60, 258.

6 H Fritz and H Jorden. Arch Fur Kriminoligie. May 1970.

7 A J Brooks. Fingerprint and Identification Magazine November 1972.

8 D G Mooney. Identification News September 1973 9.