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USER GUIDE TO PHYSICAL DEVELOPER - A REAGENT  
FOR DETECTING LATENT FINGERPRINTS

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DECEMBER 1981

User Guide Number 14/81

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**SAFETY**

Throughout this guide it is assumed that operators are familiar with normal laboratory safety procedures and with the hazards associated with the materials and processes being used. Those responsible for staff using chemical techniques for the development of fingerprints are advised to contact the Health and Safety Executive which will inspect laboratories and recommend safe working methods. Further information on the toxicity of chemicals and necessary safety precautions can be obtained from the suppliers.

In the event of an accident medical attention should be sought immediately.

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**NCJRS**  
**JUL 6 1983**  
**ACQUISITIONS**

## 1. INTRODUCTION

Ninhydrin is the most commonly used reagent for the visualisation of latent fingerprints on paper. It reacts with amino acids in the fingerprint deposit to produce a pink/purple ridge image. It is easy to use and inexpensive. However there are instances when treatment with ninhydrin will fail to show any useful marks because:

- i. Some people do not deposit sufficient quantities of amino acids to produce a visible reaction with ninhydrin.
- ii. Amino acids are water soluble; if a piece of paper has been kept in a humid atmosphere or wetted since a mark was deposited the amino acids may have either diffused from the ridges or washed out completely.

A reagent called PHYSICAL DEVELOPER (PD) has been developed by the Atomic Weapons Research Establishment under contract to the Police Scientific Development Branch for use in these cases.

The physical developer reagent contains silver ions, a ferrous/ferric redox system, a buffer (citric acid) and detergent in an aqueous solution. The detergent prevents the premature deposition of silver metal. When paper is immersed in this solution metallic silver is deposited on its surface. Usually if any fingerprints are present the silver metal is preferentially deposited on them and they are seen to develop as dark grey images on a lighter background.

The components in the fingerprint deposit which are sensitive to physical developer have not yet been identified. Since they are not removed from the paper by water it is supposed that they may be waxy or fatty materials.

This is the only proven reagent for the visualisation of latent fingerprints on paper which has been wetted.

Physical developer is not a replacement for ninhydrin but a possible subsequent treatment in cases where ninhydrin has failed to produce useful fingerprints.

If the instructions in Section 3 are followed a stable, effective solution should result. However problems can arise due to the complex nature of the chemistry and SRDB will be pleased to help at such times.

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2. RECOMMENDED PROCEDURE FOR INCORPORATING PHYSICAL DEVELOPER INTO THE EXAMINATION OF PAPER

2.1 The silver deposited on the paper by physical developer treatment may obscure any handwriting present and will interfere with many other forensic tests. Where samples of blood, ink, paper, etc. are or may be required it is necessary to submit the paper to the Forensic Science Laboratory before proceeding with the fingerprint examination.

2.2 Process with ninhydrin unless the paper is or has been wet. Allow sufficient time for full development of the pink/purple images.

2.3 Photograph any useful ninhydrin marks as they will be washed away during physical development.

2.4 If ninhydrin has revealed no useful fingerprints or if the paper is or has been wet process with physical developer.

2.5 Remember that ninhydrin cannot be used after physical developer. Also physical developer cannot normally be used before or after metal deposition.

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3. PREPARATION AND USE OF PHYSICAL DEVELOPER

3.1 General Information

3.1.1 Wear laboratory coats and disposable gloves to avoid staining your clothes and skin. Whenever there is the danger of splashing chemicals into the eyes protective glasses should be worn. See SAFETY, page 1.

3.1.2 All the glassware must be kept solely for use with physical developer.

3.1.3 The glassware must be perfectly clean otherwise the silver will not stay in solution. Before each use, wash the glassware under running cold water using paper tissue. To remove more stubborn stains use detergent (but not scouring powder) and then rinse under the tap for 10 minutes. Finally rinse the glassware 3 times with distilled water. After use wash the glassware thoroughly under the tap to prevent staining and dry with a cloth or paper tissue.

3.1.4 Before using the still check that it is relatively clean inside - in particular ensure that the overflow is not blocked. Set up the still according to the manufacturers instructions. To test your distilled water add a few crystals of SILVER NITRATE to a sample in a small glass beaker. Any cloudiness means the still is not functioning properly. Contact SRDB for advice. The quality of the distilled water should always be checked if problems arise in preparation of the physical developer.

3.1.5 Distilled (not deionised) water should generally be used to make up the solutions. (For more information contact SRDB). Store the distilled water in a white polythene container (with a tap) at normal room temperature. A new container should be filled with distilled water and left to stand for a few days: the water must be then poured away. The clean container may then be used for storage. Always allow the distilled water to cool before use.

3.1.6 Keep the balance scalepan and spatulas clean to avoid contamination of chemicals.

3.1.7 Use disposable weighing boats on the balance to weigh out chemicals. Remember to zero the balance after putting the empty boat on the scalepan.

3.1.8 Keep the bottles of chemicals tightly closed when not in use. Silver nitrate must be kept in a dark cupboard.

3.1.9 To prevent mistakes get all the chemicals out before you start to make up the solutions then put each bottle away as soon as it is finished with. This will ensure that each chemical is used - and only once!

3.1.10 Liquids should always be measured out in a measuring cylinder since the volume markings on beakers are only approximate. Label the large measuring cylinder and one of the small ones "DISTILLED WATER ONLY" and then there is no need to wash them with tap water. Label the other small one "STOCK DETERGENT SOLUTION ONLY".

3.1.11 When using the magnetic stirrer adjust the speed of rotation to minimise the amount of air drawn into the liquid.

3.1.12 The magnetic followers and retrievers tend to get stained. Any deposit must be washed or scraped off after each use.

3.1.13 A considerable proportion of the cost of the physical developer solution is due to the silver content. A lot of silver is recoverable from the used solution and the recovery system already in use in your photographic department may be suitable. You must first check with the manufacturers that the other chemicals in physical developer are compatible with your system.

There are 2 solutions to be prepared: the stock detergent solution and the physical developer solution. One litre of the stock detergent solution is sufficient to make 25 litres of physical developer.

IT IS ESSENTIAL THAT THE STOCK DETERGENT AND PHYSICAL DEVELOPER SOLUTIONS ARE PREPARED ACCORDING TO THE INSTRUCTIONS. QUANTITIES OF SOLIDS AND LIQUIDS SHOULD BE MEASURED ACCURATELY AND THE ORDER OF PREPARATION ADHERED TO. MAKE UP THE SOLUTIONS QUICKLY AND AVOID THEIR EXPOSURE TO DIRECT SUNLIGHT.

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### 3.2 Preparation of the Stock Detergent Solution

3.2.1 Rinse a large magnetic follower with distilled water and place it in a 2 litre beaker.

3.2.2 Pour one litre of distilled water into the beaker, place the beaker on the magnetic stirrer and switch on.

3.2.3 Add 4 grams of ICN N-DODECYLAMINE ACETATE to the water. Put the weighing boat in the water as well if the detergent sticks to it.

3.2.4 Pour a little SYNPERONIC N or NDB into a small, clean weighing boat. Take up about 4(N) or 8(NDB) millilitres into a clean syringe, then expel the liquid into another clean boat on the balance until 4(N) or 8(NDB) grams are registered. Put the second boat and the detergent into the water. Throw away the first boat and its contents.

3.2.5 Stir the solution for 30 minutes.

3.2.6 Pour the solution into a clean one litre bottle taking care to transfer any matter which has not yet dissolved and leave for at least 24 hours before use. There should be no solids visible after this time.

3.2.7 The stock detergent solution may be stored for at least one year.

### 3.3 Preparation of the Physical Developer Solution

3.3.1 Rinse a small magnetic follower in distilled water and place it in a 100 millilitre beaker.

3.3.2 Pour 50 millilitres of distilled water into the beaker, place the beaker on the magnetic stirrer and switch on.

3.3.3 Weigh out 10 grams of SILVER NITRATE and add this to the water.

3.3.4 Stir for one minute and then put the SILVER NITRATE SOLUTION in a safe place for the time being.

3.3.5 Rinse a large magnetic follower in distilled water and place it in a 2 litre beaker.

3.3.6 Pour 900 millilitres of distilled water into the beaker, place the beaker on the magnetic stirrer and switch on.

3.3.7 Weigh out the following chemicals and add them to the water in the order given.

30 grams of FERRIC NITRATE

80 grams of AMMONIUM FERROUS SULPHATE

20 grams of CITRIC ACID

After all the chemicals have dissolved stir for a further 5 minutes.

3.3.8 Pour 40 millilitres of the STOCK DETERGENT SOLUTION (from a measuring cylinder) into the beaker and stir for 2 minutes.

3.3.9 Examine the SILVER NITRATE SOLUTION and ensure that all the solid material has dissolved. If necessary put the small beaker back onto the stirrer. When no solid material remains put the large beaker back onto the stirrer, add the SILVER NITRATE SOLUTION to the main solution and stir for 2 minutes.

3.3.10 Remove and clean the magnetic followers. THE PHYSICAL DEVELOPER SOLUTION IS NOW READY FOR USE.

3.3.11 The appearance of the physical developer solution may vary from a clear yellow to almost black in the beaker. When the liquid is poured into the processing dish it should be yellow.

3.3.12 Always check that the physical developer (whether it is a new batch or some that has been stored) is working satisfactorily before starting operational work. For this purpose keep a stock of paper that has been fingerprinted by a good donor and ensure that the marks develop at the same rate each time.

3.3.13 One litre of physical developer is sufficient for processing about one hundred cheques. The size and nature of other papers vary considerably and hence the development time and amount of solution needed will also vary.

3.3.14 The physical developer solution should normally be made up and used on the same day. However it is expensive to prepare and it is worth trying to keep any unused solution for a few days. USED SOLUTION MUST BE DISCARDED AND NEVER PUT BACK INTO UNUSED STOCK. Store the unused solution in the beaker in which it was made. Seal the beaker with clingfilm and put it in a dark cupboard. A white sediment may form but this does not affect the solution's properties. A darker deposit may indicate that silver has come out of solution and the solution may not then work.

### 3.4 Use of Physical Developer

3.4.1 Half fill 2 processing dishes with distilled water.

3.4.2 Pour about  $\frac{1}{4}$  litre of physical developer solution into a third processing dish.

3.4.3 Use photographic print tongs for handling the paper. Be careful not to crease or damage the paper by using the tongs to push the paper into the water or physical developer.

3.4.4 Wash the piece of paper in one of the dishes of distilled water for at least 5 minutes to remove any ninhydrin stains, amino acids, chlorides, general dirt. Longer washes and changes of distilled water may be necessary to remove heavier ninhydrin colouration although it is not essential to completely remove all traces of colour. Washing also reduces the effects of creases which will promote silver deposition. Fragile items such as very soft or partially charred paper have to be handled very cautiously when wet to avoid damage so do not prewash.

3.4.5 Immerse the washed paper in the physical developer solution and gently rock the dish. Silver will be deposited on the paper's surface causing the paper to darken. Usually if any fingerprints are present the silver will preferentially be deposited on them and the marks will develop as dark grey images on a lighter background. The paper should be removed when there is maximum contrast between the colour of the mark and the background.

Different marks on one piece of paper may develop at different rates so it will be necessary to compromise on the development time.

You will find that there are many types of paper and the processing time will vary considerably.

Some papers will go black immediately and it will be impossible to detect fingermarks on them.

3.4.6 To stop the reaction immerse the paper in the second dish of distilled water and agitate the dish. After 5 minutes change the water. After a further 5 minutes change the water again. Finally after another 5 minutes wash the paper for 10 minutes in running tap water. This long rinsing process is to ensure the complete removal of all the chemicals which would otherwise later discolour the paper and obliterate the fingermarks.

3.4.7 Lay the paper on paper towel at room temperature to dry or hang it in a drying cabinet at low temperature (30 degrees centigrade maximum).

3.4.8 It is often easier to see marks when the paper has completely dried out.

3.4.9 Photograph any useful fingerprints.

3.4.10 The fingerprints will not fade and will not normally be damaged by careful handling.

3.4.11 A weak fingerprint may be improved by retreatment with physical developer. However, there is the possibility that the fingerprint will be lost through over development. Also the fingerprints of those who have touched the paper since the first treatment may also be developed.

3.4.12 A record of the treatment of paper with ninhydrin and physical developer will provide useful guidance on development times, troublesome papers, etc. A suggested layout for a log book is given on the next page.

3.4.13 After a number of pieces of paper have been processed and the silver concentration has substantially decreased the development time will increase. When the development time becomes unreasonably long pour away the used solution (into your silver reclamation system). Rinse the dish with distilled water and refill it with new solution.

EXAMPLE OF A TYPICAL LOG BOOK AND IT'S USE

Case/Ref.No.	Articles	NFN	Treatment X/Reason	Marks of use after NFN	Marks redeveloped or improved by PD	New marks after PD	Remarks	Date Out
34. 123/79	Nat. West Cheque	✓		2	1	1		3/8/79
	"	✓		1	Nil	Nil		3/8/79
	Lloyds Cheque	✓		3	Nil	Nil		3/8/79
	Lloyds Cheque	✓		Nil	-	2		3/8/79
35. 234/79	4 x £20-00 BoE note	✓		Nil	-	1		9/8/79
36. 345/79	Letter	X	Wet	-	-	1		14/8/79
37. 456/79	Brown Wrapping Paper	✓		Nil	-	Nil		22/8/79
<hr/>								
4.9.79.	<u>NEW SOLUTION (J. BLOGGS)</u>							
1. 678/79	Barclays Cheque	✓		Nil	-	2		6/9/79
	"	✓		Nil	-	1		"
	"	✓		2	Nil	Nil		"
	"	✓		Nil	-	3		"
	"	✓		3	2	Nil		"
2. 789/79	Car hire agreement	✓		3	Nil	Nil	very high back ground fog	10/9/79
<hr/>								
7.9.79	<u>REMAINING SOLUTION (J. BLOGGS)</u>							
1. 891/79	Notepad paper	✓	used by P.SMITH	Nil	-	Nil		10/9/79
	Notepad cover	✓		Nil	-	2		10/9/79

#### 4. RADIOACTIVE TONING PROCESS

There are occasions when a mark found by physical development is difficult to see, e.g., on dark coloured or patterned papers. Also characteristics of a fingerprint may be obscured by underlying printing or writing.

In these instances it may be possible to remove the background interference and increase the usefulness of the mark using radioactive toning. However it must be stressed that this process can only enhance the image produced by physical development.

The radioactive toning process may only be carried out by trained staff in laboratories which have been approved for this radioactive work. Staff at the Scientific Research and Development Branch are able to carry out this radioactive toning process for certain cases.

During the process the silver which has been deposited on the paper and the fingerprints by physical developer treatment is chemically converted to silver sulphide: some of the sulphur used to make this sulphide is radioactive. The now radioactive areas of the paper emit radiation which will cause sensitive photographic film emulsions to darken. The paper is then sandwiched between 2 sheets of film for a time which is determined by the radiation level of the paper, usually several days, and then on development the film shows all the regions on the paper surface which have become radioactive. The fingerprints will only be more useful if the underlying background, ink, or contamination has not taken up the radioactive sulphur.

## 5. CURRENT RESEARCH

The long time taken to process each piece of paper is one of the main reasons why physical developer is not being used more extensively in Police Forces. At present a range of formulations is being tested to find a faster, stable solution.

An unexpected, but very promising property of the faster solutions is their ability to develop fingerprints of those known to be poor donors but this apparent advantage may prove to be a nuisance as it may lead to high background interference on operational material.

It may be some time before a new formula is recommended due to the lengthy laboratory and operational trials which are necessary to prove the value of a reagent.

## 6 BIBLIOGRAPHY

Listed below are previously published papers and reports on physical developers. The formulation and recommendations in this guide supersede all those previously published by the Home Office.

1. Janker, H, et al; Photographic Science & Engineering 13, 1-8, 33-49, (1969)
2. Collins, L E; Coles, R E; Stroad, P T; United Kingdom Atomic Energy Authority NRN 12/73
3. Fuller, A A; Thomas, G L; Home Office Police Scientific Development Branch Technical Memorandum 26/74.
4. Knowles, A M; Jones, R J; Clark, L S; H.O. P.S.D.B. Technical Memorandum 6/76
5. Knowles, A M; Lee, D; Wilson, D; H.O. P.S.D.B. Technical Memorandum 12/77
6. Mughal, M A; H.O. P.S.D.B. Technical Memorandum 21/77
7. Knowles, A M; Lee, D; Wilson, D; H.O. P.S.D.B. Technical Memorandum 5/78
8. Millington, S; H.O. P.S.D.B. Technical Memorandum 13/78

Equipment List

The operational trials of this process have been carried out using the following equipment.

Since the initial financial outlay is rather high, please contact SRDB staff to discuss the suitability of any existing equipment before making purchases.

<u>FROM GALLENKAMP</u>			
	<u>Quantity</u>	<u>Catalogue No</u>	<u>Approx Cost (1981)</u>
STILL	1	WGS-220-110R	113.00
BALANCE	1	BCJ-630-D	92.80
MAGNETIC STIRRER	1	SWT-310-DIOU	64.00
MAGNETIC RETRIEVER	1	SWX-510N	3.15
MAGNETIC FOLLOWERS	1 pk of 3	SWX-350-130L	2.50 (pk of 3)
GLASS TRAYS	6	DKB-430-050S	3.65 (each)
MEASURING CYLINDER (1 l)	1	CYL-300-150Y	5.50
MEASURING CYLINDER (50 ml)	2	CYL-300-070G	1.25 (each)
BEAKER (2 l)	3	BNB-300-270B	3.11 (each)
BEAKER (100 ml)	2	BNB-300-090D	70 (each)
SPATULA	1 pk of 3	SMJ-850-E	2.75 (pk of 3)
ASPIRATOR BOTTLE (20 l)	2	ASP-620-010N	19.15 (each)
POLYTHENE BOTTLE (1 l)	1 pk of 5	BTK-230-130J	4.80 (pk of 5)

FROM LOCAL PHOTOGRAPHIC SUPPLIER

PATTERSON HIGH SPEED PRINT WASHER	1	13.00
PATTERSON PRINT FORCEPS	2 pk	1.20 (pk of 2)

FROM RAVEN SCIENTIFIC

DISPOSABLE WEIGHING BOATS (100 ml)	1 pk	10.50 (pk of 250)
DISPOSABLE WEIGHING BOATS (30 ml)	1 pk	8.50 (pk of 500)

FROM RADLEYS

OCTAGONAL SPINBAR	1	F37110-0003	7.85
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FROM LOCAL SHOP

CLINGFILM	1 roll	
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Operators should have laboratory coats, disposable gloves, safety glasses and access to an eye wash bottle in case of accidents

Chemicals

<u>Chemical name</u>	<u>Grade</u>	<u>Quantity</u>	<u>Supplier</u>
Citric acid	AnalaR	1 x 500g	Chemical company
Ammonium ferrous sulphate	AnalaR	1 x 500g	Chemical company
Silver nitrate	Normal chemical	1 x 250g	*
Ferric nitrate	AnalaR	1 x 750g	Chemical company
N-Dodecylamine acetate ICN Cat No 9677	-	1 x 100g	Kodak, Liverpool
Synperonic N	-	125ml	SRDB

It is important to buy the correct grade of chemical. The prices will vary considerably between suppliers so it is worth shopping around.

\*Silver fluctuates in price daily although this is not normally reflected in the price of silver nitrate from the ordinary chemical companies. However Johnson Matthey do alter their price according to the silver market variations and it is well worth telephoning them for a quotation as well as BDH, Hopkin and Williams, etc. At the present Johnson Matthey's price is about a quarter of the other companies'. Johnson Matthey have a minimum order of £30 but the cost of production and packing would constitute a large proportion of such a small order. It is more economical to buy 500g or 1000g but it would not be advisable to try and store any greater amounts. To ensure that the silver nitrate does not decompose it is advised that about 250g is put into a small dark bottle which must be kept in the dark when not in use. The rest of the material should be tightly sealed and again kept in a cool dark cupboard until the small bottle needs refilling.

N-Dodecylamine acetate made by ICN Pharamaceuticals is now used instead of ARMAC. SYNPERONIC is the new trade name for the detergent formerly called LISSAPOL.

Useful Addresses

Home Office  
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 Woodstock Hill  
 Sandridge  
 St Albans  
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 AL4 9HQ  
 Tel: (0727) 65051

Chief Inspector J M Strachan  
 Mr T Kent  
 Mrs S A Hardwick  
 Miss R B Albinson  
 Mr V G Sears

Raven Scientific Limited  
 PO Box 2  
 Station Road  
 Haverhill  
 Suffolk  
 Tel: (0440) 705441

A Gallenkamp & Company Limited  
 PO Box 290  
 Technico House  
 Christopher Street  
 London  
 EC2P 2ER  
 Tel: (01) 247 3211

Kodak  
 Research Chemicals Sales Department  
 Acornfield Road  
 Kirkby Industrial Estate  
 Kirkby  
 Liverpool  
 L33 7UF  
 Tel: (051) 546 2101

Johnson Matthey Chemicals Ltd  
 Orchard Road  
 Royston  
 Hertfordshire  
 SG8 5HE  
 Tel: (0763) 44161

Radleys  
 London Road  
 Sawbridgeworth  
 Hertfordshire  
 CM21 9JH  
 Tel: (0279) 722661

Chemical Companies

BDH Chemicals Limited  
 Poole  
 Dorset  
 B12 4NN  
 Tel: (0202) 745520

Hopkin and Williams  
 PO Box 1  
 Romford  
 Essex  
 RM1 1HA  
 Tel: (01) 590 7700

It may be more convenient and economical to buy from a local chemical firm.  
 Both the companies above have distribution centres throughout Britain.

**END**