ITEM No. 9.
FILE No. XXX—15.

AGFA FILM FACTORY
WOLFEN

COMBINED INTELLIGENCE OBJECTIVES
SUB-COMMITTEE

LONDON—H.M. STATIONERY OFFICE

AGFA FILM FACTORY - WOLFEN.

Reported by:

S/Ldr. G. C. BROCK, M.A.P.

NB. Collaboration: Col Robinson (CIOS Item 313. Separate report by Robinson now held by Dr Jordan) 5/3/47.

CIOS Target No. 9/133.
Physical and Optical Instruments & Devices

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE
G-2 Division, SHAEF (Rear) APO 413.

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Introductory.

The period 28/5/45 to 9/6/45 inclusive (12 days was spent at Agfa Plant. The period 22/5/45 to 27/5/45 was occupied on the outward journey, and 10/6/45 to 14/6/45 on the return.

On reporting to Major Johnson-Ferguson at 'T' Branch and receiving my orders, I learned that two Agfa Technicians, Dr.Meyer and Dr. Meskat, were being held in the Wiesbaden town gaol. Major Ferguson felt that I should interrogate these men at once, and should not proceed further until I had contacted an American party, who were expected to arrive shortly for the same purpose. After an unsuccessful search through two prisons, I found the men in the Albrechtstrasse gaol, together with another Agfa technician, Dr. Schilling. Neither the men nor the prison authorities could give any reason for their detention. After a preliminary interrogation of Dr. Schilling I returned to 'T' Branch and told Major Ferguson that it would be far more satisfactory to have the men in their own plant for questioning. The American party headed by Col. Potts had by then arrived and after a second interrogation it was stated by Col. Potts that Dr. Schilling had been imprisoned in the mistaken belief that he was a V2 expert. Col. Potts had then no further interest in Dr. Schilling and he had never had any interest in the other Agfa technicians. With the help of Col. Gleszer, authority for their release was obtained from SHAEF , and on 26/5/45 they were taken to Camp Dentine. I checked out of Camp Dentine on 27/5/45 through Major Hurley, and reached the Agfa plant at Wolfen the same evening.

Wolfen is in the Military Government area of Bitterfeld and I therefore handed over the Agfa technicians to the local Commandant Major Lewis. He allowed them to return to their homes, as no reason for their detention was known. I obtained a receipt for them before leaving Bitterfeld. Their presence on the spot proved invaluable. Major Lewis provided accommodation and messing, and was in general extremely helpful

On my second day in the plant I met Lt. Col.Robinson who had been sent out by M. of S. He had flown direct to Leipzig, getting there in four hours from London. As my quarters in Bitterfeld were much closer to Wolfen than his at Leipzig, he subsequently joined me, with Major Lewis's approval and was able to save much travelling

* Col Robinson's Report (C.I.S Rep 313) was held by Dr Joshua Was apparently put out by M.O.S.

time every day. This apparent overlapping of investigations was not really a waste of effort, because Col. Robinson is a manufacturing expert, and was able to cover the production side more thoroughly than I could have done, thus saving my time and doing a better job in those sections. In many branches our investigation was joint, but we agreed to make separate reports, and to collect samples etc. in complete independence. Col. Robinson speaks fluent German, which was of great assistance. *

On 10/6/45 I left Bitterfeld in company with Col. Robinson, who had been ordered to return via Dentine and Wiesbaden. We changed transport at Dentine and proceeded to Wiesbaden on 11/6/45 (the reason for returning via Dentine is not clear, as no written record of our transit was taken). After reporting at 'T' Branch we had to wait two days for flying weather, finally getting a Dakota from Frankfurt on 14/6/45 and reaching Croydon at 1.30.p.m.

Policy of Investigation.

The Agfa plant and laboratories are so large and cover so many fields, that a general policy had to be fixed for limiting the scope of the investigation and the samples to be removed. It was decided to examine only those processes and items of equipment which were of direct or indirect interest for the furtherance of air photography, and not to spend time on matters in which the Germans appeared to have no advantage over us. In general, attention was given to research and basic principles rather than to details of production.

It was unfortunate that there had not been time before leaving England to contact the British base manufacturers and learn their interests and in the circumstances I obtained what appeared to me to be the salient facts.

As regards equipment, I could have asked for the removal of large quantities of sensitometric and general scientific apparatus but none of this would have quite fulfilled our requirements in the appropriate spheres, and so it was left.

It was thought (incorrectly) that an inspection of the Mipolam works might provide information of value to D.Inst. P., who are interested in bakelite moulding

of tanks etc. but apart from this examination of synthetic resin moulding, no attempt was made to cover the non-photographic sections of the Agfa plant. (Staple fibre and cellulose, viscose rayon etc).

Previous Investigations.

Prior to my visit, the plant had been examined, according to my orders, by Major Warren (Sig.C) and Capt. Borthwick (REME) acting through CIOS, also Commander Chancellor (Navy, Tech. Mission to Europe). It had also been visited by Mr.McMaster of Kodak Ltd., and by Col. Cuthbertson (U.S.Army) who had arranged for the removal of all stocks of Agfacolor film and processing chemicals, an automatic plotting densitometer and agfacolor cine printer.

Agfa Personnel Interviewed.

Dr. Gajewski - General Manager of the Agfa factory. Apart from our first meeting we did not have any conversations.

Dr. Miller - Manager of the photographic part of the factory. Has worked in America at Binghampton - speaks very good English. Dr. Miller was at first very pleasant, but when manufacturing recipes were requested, refused and became obstructive, saying that to divulge them would ruin Agfa's chances of competition in the world market. After discussions with the Military Government, however, he agreed to release the information required, and no further obstruction was encountered.

Professor Eggert - Director of Research. Said that he was Anti-Nazi and was on a list to be shot because he would not divorce his Jewish wife. Was fully co-operative.

Dr. Kuster - Research on Graininess, sound recording etc.

Dr. Meyer - Economist, buyer of raw materials etc. Speaks fairly good English and was largely used to interpret. Also has a very good general knowledge of the work of the factory and was useful on that account.

Dr. Muskat - "Technical Developments" i.e. design of new types of machinery for the production departments. Also familiar with most of the scientific work, and a very versatile man. Was extremely co-operative, and was the channel for much of the information obtained.

Dr. Schilling - Sensitometric and other testing on production materials. Also development of methods for processing and printing Agfacolor materials.

Dr. Berger - Assistant to Dr. Schilling.

Dr. Hebbel)
Dr. Kairies) - Emulsion manufacture and coating.
Dr. Walter)

Dr. Zeh - Sensitising dyes. Also gave information about Agfa-colour coupler compounds.

Dr. Bauerle)
Dr. Guhring) - Base manufacture.

Dr. Van Driessen - Production of new instruments for scientific research.

Dr. Rolle - Processing chemicals.

In general the Technical Staff were co-operative, especially after Dr. Miller had been interviewed by the Military Government. Co-operation was better towards the end of the visit than at the beginning.

As the factory and laboratories were not at work, some of the key personnel could not be interviewed, but no serious difficulty was caused thereby. Dr. Schneider head of colour research, had left the Wolfen area for Thuringia, but it was not thought necessary to find him.

Few names could be obtained of German Government workers in air Photography. The head of Luftwaffe photography was believed to be Oberstingenieur Spiweck, but Dr. Schilling said that the personnel filling this post changed very rapidly. The head of air survey was Dr. Gessner.

On a second visit to Germany it was found that prior to the Russian occupation of Wolfen, Gajewski, Miller, Eggert, Schilling and Van Briessen had been evacuated to Munich, while Bauerle and others had gone to Gosler and Meskat to Dormagen.

Description of Agfa Factory.

The Agfa "Film Fabrik" is situated on the main road through Wolfen in the south end of the town. The factory perimeter encloses an area of 500 Morgen of which about one quarter is devoted to the production of photographic materials. Research and administration are housed in a separate four storey building at the main entrance. Colour research and general photochemical research have each a wing of this building with a ground area of some 1,500 sq. yards. (Total floor area about 6,000 sq. yds. in each wing). The research and administration offices are in the main block which covers about 4,000 sq. yds. of ground.

The research laboratories are extremely well equipped as to space, services and apparatus, and in all respects appear to have had far more money spent on them than any comparable organisation in this country. The office accommodation and equipment is also most impressive in scale and quality.

The production plant, while in general apparently adequate for its purpose did not convey the same impression of lavish expenditure as the office and research side. The chemical mixing plant in particular impressed by its general air of slovenliness.

The photographic products comprise -

Amateur roll and Leica film
Cine film of all kinds
X ray film
Professional cut film and plates
Filters of all kinds (inc. safelights)
Sensitising and filter dyes.
Aircraft film of all kinds.
Agfacolor film (Neg. & Pos. 35 mm. 35mm and larger sizes reversal, airfilm experimental lengths)
Packed chemicals (but the chemicals themselves are made elsewhere)

The film output averaged about 900,000 sq. metres per month until the end of 1943. Air film was about one tenth of the whole output. Most of the base was made on the premises, the rest came from Eilenburg.

Conditions of Arfa Factory.

No bombs have ever fallen on the Wolfen plant, which was untouched until the last few days of conflict. A small detachment of Wehrmacht then took refuge in the buildings, and in the fighting required for their eviction great damage was done by tank and artillery fire, small arms and mortar fire, aircraft strafing, and the explosions of a nearby ammunition train. Following the cessation of fighting, extensive looting and wanton damage occurred, for which troops, liberated foreign workers, and criminal German elements are all blamed. By far the most serious looting took place in the research and testing laboratories, where the hope of gain was greatest (i.e. cameras, films, microscopes etc) since the film store had been destroyed. During my visit only a skeleton staff were in the factory, which was not working, and no attempt appeared to have been made to clear up the debris.

Details of the damage are as follows:-

Building 175, Film Store - Completely burnt up, with loss of 150,000 spools of roll-film, 9,000,000 metres of cine film, 150,000 sq. metres of X ray film and all stocks of cut film and aircraft film. But the plate store and packed chemical store were unharmed.

Building 117, Central Workshop - Completely destroyed.

Building 114, Insulating Foils. - Partially destroyed.

Building 135, Electrical & Mechanical Workshop. - Destroyed except for carpenters shop.

Building 172, Glass Store. - All raw glass for plates (100,000 sq. metres) destroyed.

Building 198, Main Gelatine & Chemical Store. - Completely destroyed.

Main Power Station. - Chimney badly holed.

The drawing office and records were also destroyed.

The production plant in general suffered only superficial damage except that the emulsion after-ripening plant was burnt out. This would not, however, greatly hinder production which could probably be started in a few weeks. Research, on the other hand, has been so badly disorganised that many months would be required. These are matters of only academic interest, since the U.S. Army has removed all raw material stocks and the Wolfen area is in the Russian zone of occupation.

General Course of Agfa Photo Research during the War.

In general the Agfa war-time research appears to have been concentrated on colour in the hope of capturing the post-war market, particularly for commercial 35 mm film work. The Agfacolor negative-positive process, while not incorporating any principles unknown to us in 1939, has been extensively developed and excellent results achieved. Ufa Studios in Berlin and others have produced some half-dozen entertainment and instructional films, the best of which were of very fine quality by current standards. Research for war-time needs was unknown, in the sense in which we understand it in England, and close contact with Government Research organisations does not appear to have existed. There was no organisation corresponding to our A.P.R.C., and the Agfa research workers appeared to be quite unfamiliar with the problems of air photography. In this we are, of course dependent on the good faith of those who informed us, but if there was deception it was extra-ordinarily well and consistently maintained among several men, all of whom appeared anxious to co-operate. The mystery is partly explained by Professor Eggert's state-ment that he and many of his research staff were in bad odour with the Government on account of their known Anti-Nazi views, and that he had specially asked to be kept free of all research having military value. The only research for the Luftwaffe which I discovered was carried out in Dr. Schilling's testing laboratory. One

aspect concerned the development of night film for maximum speed and the other the use of Agfacolor for air photography.

Professor Eggert knew of no researches on lens-film resolving-power and seemed unaware of the nature of the problems examined by A.P.R.C. e.g. the Lens Survey conducted by Dr. Tearle. After extended questioning he recalled the name of a Dr.Hirch at the "Erprobung-stelle" Rechlin (which appears to correspond to R.A.E.) who might have worked on resolving-power (Rechlin is in the Russian zone).

Eggert said that no advances had been made during the war in the speed/graininess ratio of emulsions. The emulsions supplied to the Luftwaffe had not changed during the war. The Luftwaffe had no specification for air film and had asked for supply of the types which Agfa thought would be best. (This does not quite agree with our evidence from publications by Schmieschek, working at Rechlin in 1936, who concluded that a fine-grain high contrast type of emulsion is best. Presumably the Luftwaffe asked for the Aeropan type on Schmieschek's advice). Eggert was specially questioned about an intelligence report received in 1941 concerning German Press accounts of a revolutionary technique of air photography. This was said to involve the use of a miniature camera with a special emulsion of high speed but much finer grain than anything previously known. Eggert said that he also had seen newspaper reports of this development, but was quite sure that it was merely Press talk, and reiterated that Agfa emulsions have not substantially higher resolving-power than their British equivalents.

Professor Eggert and Dr. Kuster said that no new methods of measuring graininess had been developed, as they were perfectly satisfied with their method based on the Callier coefficient. In 1939 Mr. Davies of Kodak was in correspondence with them on this subject and sent them some sample films in which he claimed that the Callier coefficients did not run parallel to graininess as judged from enlargements. Eggert and Kuster measured these films on their own apparatus and obtained results differing from Davies but in complete agreement with the enlargements. The strips were then re-measured by Frieser at Dresden on another apparatus, his results agreed with Eggert's. The war prevented further correspondence with Davies, but the investigation was written up, and I obtained a copy of the report.

Questioned about infra-red Eggert said that the only war-time advance had been an improvement in keeping quality of plates sensitised to the longer infra-red at about 12,000 A.U. No stocks of these were available and they were not used by the Luftwaffe.

Some research was devoted to methods of counteracting the shortage of raw materials but without notable success. The most serious shortage was of iodine, but this never held up production to any great extent. The Government priority was first for X ray film and second for air film.

No emulsion for night photography had been made faster than the Aerorapid known to us. Attempts had been made to increase its speed but always failed due to excessive fog.

Before the war Eggert had about 35 senior research workers, but this staff was reduced to one-third, the others being diverted to different war industries.

Materials supplied to Luftwaffe.

The following materials were supplied to the Luftwaffe.

Type.	Remarks.
1. Aeropan film	Standard for recce. and survey. Also supplied on grey base for Robot cameras.
2. Aerorapid	High speed for night photography. Also supplied on grey base for Robot cameras.
3. Infra-red	Sensitivity peak at about 8100 A.U. Said to be very little used.
4. Isochrom)16 mm Isopan F)& 35 Isopan ISS)mm for camera guns	)High speed ortho (most used)) Medium speed pan) High speed pan.
5. Agfacolor	Supplied for experiment only. Neg. pos and paper.

Apart from (5) we were familiar with all of the above. Nevertheless samples were obtained for checking.

Agfa also supplied packed chemicals to Luftwaffe formulae with which we are acquainted.

It is of interest to note that all air-film was supplied on Topographic nitrate base. Dr. Schilling said that this was for convenience in manufacture and supply, as the Luftwaffe was aware that topo. is required only for mapping.

It was stated that no special tropical film, packings or processing formulae had been developed. Film for Libya was given the normal hardening applied to all Agfa film for pre-war overseas market, and then stood up satisfactorily to normal handling methods.

Technical Advances Related to Air Photography.

Night Photography. Dr. Schilling said that the Luftwaffe developed their night film for maximum speed in Atomal developer, for 30 mins at 30°C, using Pina-Weiss desensitiser to keep down fog. This treatment was claimed to give a speed increase of 2°DIN (60%) over full development in metal - hydroquinone. "Atomal" is an Agfa fine-grain packed developer. A sample was obtained and the constitutional formula of the essential organic reducing agent, as well as the recipe, but no Pina-Weiss was available. Schilling said that "Aerorapid" is hard enough to stand up to this high temperature development.

Agfacolor Air Photography. Dr. Schilling had had some co-operation with the Luftwaffe in the use of Agfacolor. The materials supplied were the standard negative, positive and paper. The negatives were given slightly longer development than normal, otherwise standard routine was followed. No filters were used and the overall blueness of the results was corrected in printing. (This is a very bad way of working). Some results were seen. The paper prints were better than the positive transparencies but were not quite as good in colour-balance and colour-discrimination as the Kodacolors we have produced. The definition and detail were very poor, due to lens aberrations and vibration, and the specimens were not considered to be worth bringing back. Dr. Schilling said that Commander Chancellor had removed all his best samples. He claimed that Agfacolor had been considered

very promising by the Luftwaffe and that it showed colours "not visible to the eye". We have had sufficient experience of colour to know that such claims are exaggerated. Agfacolor negative requires an explosure of 1/50 sec. at F/8 in sunshine for a ground scene, thus it is about 1/8 the speed of Super XX and about 1/2 the speed of Aero Kodacolor.

Manufacture of Film Base.

All the machines are of the band type. Bands were stated to give a higher output than wheels. There are twelve machines using copper bands 30 metres long and 140 cms wide, and sixteen using copper bands 16 metres long and 140 cms wide.

The production consists of nitrate and acetate base. Triacetate is also made, but is used for unsulating foils and not for photographic purposes. One of the larger machines produces the equivalent of about 1¼ million feet of 35 mm film per month, and the total output is of the order of 20 million feet per month.

The manufacture and treatment of the copper bands is of vital importance. Two firms make bands. Krupps of Berndrof near Vienna supply copper and nickel bands already joined. Kupfer and Drahtwerke of Osnabruck supply only copper bands, unjoined. Agfa have devoted a great deal of effort to methods of testing and joining the bands, chiefly under Dr.Meskat's direction. The bands are made of the purest electrolytic copper, the best quality coming from Canada. Purity is tested spectroscopically and also by heating three trips to 1000°C in oxidising, reducing and neutral flames respectively. After this heat treatment each strip is subjected to a destructive bending test. Pure metal shows no difference between the three strips, but copper containing oxide breaks more easily after heating in the reducing flame, due to reduction of the oxide and deposition of metal in a different crystalline form. The 30 metre bands are 900 mm thick with a tolerance of + 20 mm. The 16 metre bands are 600-700 mm thick with a tolerance of ± 10 mm. The thickness is measured at numerous points by absorption of X rays or by an electrical capacity method which automatically records on a cathode-ray tube. (Nickel bands have a polished surface and can be measured by a light interference method). The joining was claimed to be a process requiring very great skill, but we arranged a demonstration and do not consider that it should be

beyond the scope of a British engineering works. The ends of the band are brought together with a slight overlap, a ribbon of silver solder being gripped in the overlap, and clamped firmly against an asbestos faced iron bar. The solder contains 75% silver and 25% copper, and a borax flux is used. The join is heated with acetylene blowpipe and the solder melted, a roller meanwhile being run over the heated area under fairly high pressure. The operator runs along the whole length of the band in this way. The edges of the overlap are next ground off and the join hammered out flat and stretched. A final grinding is given to remove unevennesses and the join is then ready for checking thicknesses, which is done at every 5 mm across the width on each side of the soldered joint.

Before use the bands must be given several coats of cellulosic material to ensure a smooth surface and fill up any slight unevennesses. The coats are applied from the normal casting trough. The first layer is nitrate, applied in the following solution

10% Collodion in methanol	- 1.5 litres
Methanol	- 13.5 litres
Acetic Acid	- 0.5 litres

The thickness of the layer is varied according to the excellence of the copper surface. A typical specimen was about 0.012" thick. The acid is used to get adhesion to the copper and also to the succeeding layer.

The second layer ("Unterguss") of cellulose acetate, is applied in the following solution

"Cellit" (Cellulose acetate)	- 100 kilos.
Acetone	- 320 kilos.
Benzene	- 40 kilos.
Ethanol	- 40 kilos.

A third layer (Oberguss") of hydrolysed cellulose acetate, is next applied, in the following solution.

"Sericose" (Hydrolysed Cellulose Acetate)	- 100 kilos
Acetone	- 385 kilos
Water	- 100 kilos
Propanol	- 86 kilos

Finally, the "oberguss" is treated with 10% potash in methanol to "neutralise the polar groups and prevent adhesion of the cast base." A wash of methanol completes the process.

The casting solutions have the following compositions

Nitrate.		Acetate.	
Collodion (dry weight)	- 100 kilos.	56%cellulose acetate	- 100 kilos
Ethanol (with 2% Tolvol	- 110 kilos	Acetone	- 320 kilos
Ether	- 330 kilos	Ethanol (with 2% Tolvol	- 38 kilos
Camphor	- 11 kilos	Tolvol	- 19 kilos
Butanol	- 2.5 kilos	Phthalic acid di-methyl ether	- 5 kilos

The collodion comes from Eilenburg and the acetate from I.G. Dormagen.

The casting trough is adjustable for height and width of slit in the usual way, and the casting solutions are controlled for viscosity and temperature.

The casting solution is initially run out on to a cloth band to facilitate the first stripping. The stripped film leaves the machine after traveling the full length of the copper band and passes at once through a water-bath to reduce static charges. It then leaves the first half of the machine, passes over an open space of about 6 feet and enters the drying cabinets. At this stage it contains 20-25% of solvent and is very flabby. Most of the solvent is driven off in the first drying chamber, which is followed by subbing. The substrating formulae are as follows

Subbing Formulae.

Acetate		Nitrate.	
Gelatine	600 gms	Gelatine	660 gms
Water	1250 cc	Water	1320 cc
10% Phthalic Acid	1700 cc	10% Salicylic acid in methanol	1650 cc
Methanol	30 litres	Methanol	72 litres
Acetone	60 litres	Acetone	11 litres
Nitrate casting Solution.	4 litres		

After subbing, anti-curl or anti-halo backings are put on in the same machine if required. After a final drying the film is reeled up and stored.

Topographic base is stored for two days after manufacture, to allow the solvents "to diffuse from the inner magma throughout the film".

After this ageing treatment the film is re-dried in a chamber through which is blown air at 110°C and steam at 120°C and 0.6 atmospheres pressure. The drying time here varies from 6 to 20 minutes.

Solvent recovery is practised, but the air circulating around the machines is not completely freed of vapours. The "air" for the casting machines contains a high percentage of nitrogen as a safeguard against explosions. This is continuously recorded. The oxygen percentage is also continuously recorded outside the casting room and alarm bells ring if it rises above 10%. (I was surprised at the absence of the elaborate sprinkler systems and panic doors usual in British factories where nitrate film is handled).

It was interesting to learn that many German 35 mm. release positives are now printed on acetate-base film, as a result of a Government order. It was stated that prints on Agfa acetate will stand up to at least 500 projections.

(N.B. It was subsequently found out that the formulae for acetate casting given above refers only to roll-film base. The base for kine film is cast from the following formulae:

"According to Dr. Rohn of I.G.Dormagen, 35 mm safety base was made from Cellulose Acetate of 58% combined Acetic Acid and cast from a solvent mixture of 85% by weight, Methylene Chloride, plus 10% Chloroform, plus 5% Amyl Alcohol; and plasticised with a mixture of Triphenyl Phosphate and dimethylphthalate in proportion of 15 parts of the plasticiser to 85 parts of Cellulose Acetate."

Manufacture of Emulsions.

As black and white emulsions were being covered thoroughly by Col. Robinson, I did not examine the

formula book and took only samples of interesting products. Col. Robinson informed me that Agfa had no methods of special interest. As regards Agfacolor, we both felt that the opportunity of obtaining information on the manufacture of the coupler compounds should not be missed, even though we had no special applications for the process itself. The particular characteristic of Agfacolor is that the colour couplers in the three emulsion layers are prevented from wandering by union with long-chain hydrocarbon molecules, whereas in Kodacolor the same end is achieved by dispersing the couplers in resin globules. This was known in 1939 but the precise details were a secret. Agfacolor would seem to offer at least the possibility of a less grainy image than Kodacolor, and I was certainly impressed, in the screened pictures which I saw, with the high resolving-power compared to Technicolor. The recipes for the preparation of the couplers and the formulae of the sensitising dyes constitute sufficient information, according to Col. Robinson, without any details of the actual emulsion manufacture.

The film and plate coating plant was examined, but nothing of special importance was seen. I understand, however, that Col. Robinson found a few points of interest especially in the plate department.

Chemical Packaging.

Agfa manufactured a wide range of packed chemicals for all purposes. The chemicals themselves were not made on the premises, apart from some purification of amidol and subliming of pyro. It was surprising to find that although there were occasional evidences of ingenious design, e.g. in bottle-filling plant, the department in general was dirty and untidy, badly laid out in some respects and often with small regard for lighting and ventilation and the health of the workers generally. The complete formula book was examined, but only a few recipes were considered of sufficient interest to copy. These are given herewith; the constitution of the numbered compounds follows. All quantities are grammes per litre unless otherwise stated.

X ray Rapid Fixer Powder.

Anhydrous hypo	165 grams.
Sodium Bisulphite	16 grams.
Ammonium Chloride	27 grams.

Alunal Hardener Powder for Addition to Fixing Baths.

A. Sodium acetate	-	9.5 grms.
Boric acid	-	1.0 grms.
Sodium bisulphite	-	12 grms.
M.13	-	0.08 grms
B. Potash Alum	-	10 grms.

A & B are separately packed in a double tin.

Atomal Developer (Fine Grain and High Speed)

A. Mu 1089	-	6 grms
Pycrocatechin	-	10 grms
Hydroquinone	-	4 grms
B. Anhydrous Sodium Sulphite	-	100 grms
Anhydrous Sodium carbonate	-	25 grms
Potassium Bromide	-	1 grm
M.19	-	1 grm

(For highest speed use at 30°C with desensitiser).

Atomal Replenisher.

A. Mu. 1089	-	12 grms
B. Anhydrous sodium sulphite	-	30 grms
Anhydrous sodium carbonate	-	30 grms
Sodium metaphosphate	-	2½ grms.

Rodinal (concentrated single solution developer (for 600 litres).

Dissolve 34 kilos of para-aminophenol in 340 litres of water. Add 558 kilos of a 30% solution of potassium sulphite at 55°C followed by 50 kilos of a 34% potash solution, then 5.52 kilos potassium Bromide in a little water, followed by 42 grms. P.1347. Filter and allow to stand 14 days.

Roll Film Developer.

Mu. 1000	-	2.5 grms
Hydroquinone	-	2.5 grms
Sodium sulphite cryst.	-	48 grms
Potassium carbonate	-	28 grms
Potassium Cromide	-	0.5 grms

Universal Hardening Fixer.

A. Boric acid	-	4 grms
Sodium acetate	-	8.9 grms
M.13	-	0.1 grms
B. Anhydrous hypo	-	160 grms
Anhydrous sodium sulphite		31 grms
Crystalline ammonium chloride	-	26 grms
M.19	-	0.4 grms
M.23	-	1.6 grms
C. Potash alum.	-	40 grms
Citric acid	-	3.6 grms

Special Compounds.

M.13 = Sodium hexametaphosphate -) prevents sludge
) in hard
M.19 = Sodium metaphosphate -) water.
Mu.1089 = Oxyethyl - orthoaminophenol. Fine grain developer.
M.23 ∓ = Ethylene diamine tetra acetic acid. Increases Developer life (Agfacolor).
Bi.1554 = Benzotriazole?) anti
P.1347 = Anthraquinone - 2.3 triazole - sodium sulphonate))
Bi.607 = Anthraquinone - 1.2 triazole sodium sulphonate)) fog-
Mu.1000 = Oxyethyl para aminophenol. Developer.) gants.

or blue tones etc.

Note: Formula of M.23 given as $N\text{-}CH_2\text{-}CH_2\text{-}N$ with $COOH\text{-}CH_2$ and CH_2COOH groups.

Tropical Packing etc.

It was stated that no special tropical packings had been developed for the Libya campaigns, and no rapid processing chemical kits were used by the Luftwaffe.

Processing of Agfacolor.

35 mm. Agfacolor was processed in tube machines of the Geyer type. The main plant was in Dr. Schilling's

test laboratory, but a smaller one was set up in the Color Laboratory. 16 mm was processed on frames, and roll and Leica film in deep vertical tanks. Most of the tanks and associated equipment were constructed of Mipolam.

The processing solution mixing and movement were well organised with efficient filtering and storage devices.

Full details of the processing formulae are available for inspection at MAP. In principle nothing new is involved but there are one or two points of interest. The colour developer is a hydroxy derivative of di-ethyl-paraphenylene -diamine. The stop-bath is primary potassium phosphate. The bleach is pot ferricyanide buffered with primary potassium phosphate and secondary sodium phosphate. A sulphite bath follows bleaching and precedes fixing.

Instructions for preparing the colour developer compound and also the coupler compounds used in the film, are available at MAP.

Filter Manufacture.

Agfa make filters by the normal procedures and nothing of particular interest was found. Gelatine filters are cast on collodion-coated plate glass and stripped. Filters for subsequent cementing are cast direct on "Spiegel-glas" and are not stripped. Canada Balsam has been replaced by "Cedax" resin a sample of which was obtained.

The compensating filters used for Agfacolor printing etc. are made from Toluidine (Blue) (cyan) Geranol (Magenta) and Tartrazine (Yellow).

Safelights are coated on a machine similar to a plate-coater. The quality of those seen was not good, as the coating was uneven and not very clear.

Sensitometric Testing & General Photochemical Research.

Testing of production materials was carried out in the "Prufungstelle" under the general direction of Dr. Schilling. Negative emulsion were tested on DIN sensitometers which are well-known and call for no special comment. DIN strips were developed by brush in glass dishes. 35 mm strips were developed in

continuous processing cine-tanks, and roll-film strips on frames in tanks, this being done in the attempt to simulate the practical developing conditions wherever possible. A high intensity sensitometer was seen, employing four 500 watt lamps in an integrating sphere, with a step-wedge exposure modulator and drop shutter. In the Research Laboratory a short-time sensitometer for sound film was seen. This was very similar to the Kodak model. A machine for producing wedges of any desired gradation was available. Various visual and photo-electric densitometers of normal type were seen. A newly made apparatus for developing sensitometric strips was also seen here. This was similar to the machine in the Harrow laboratories of Kodak Ltd., employing a revolving drum with vertical axis, but made entirely of Mipolam resin instead of stainless steel. This was considered to be of inferior design to the Kodak version in several respects. The agitation is probably not so good, as the circumference of the drum is smooth and circular, not stepped as in the Kodak model, and the tanks also are simple cylinders.

The research laboratory contained apparatus for research in sound-recording, (including work on the Donner effect) and was very well equipped with physical and optical instruments of all kinds, e.g. Electron microscope, all kinds of X ray tubes, two Zeiss microphoto-meters, numerous photometric instruments, spectrographs etc. but no cameras. (It was stated that 150 Leicas and Contaxes had been held here but all were looted). Many instruments were buried under broken glass and overturned furniture. Among these was the visual "Granulometer" used to measure graininess via the Callier coefficient. Photographs and drawings of this were obtained. A photo electric granulometer was also inspected.

All lenses had been looted from microscopes, projector lanterns, epidiascopes etc.

Schillings sensitometric testing laboratory also contained plant for processing roll films, 16 mm and 35 mm films, and Agfacolor 35 mm and 16 mm reversal, roll and Leica film. None of this was damaged but apart from roll-film processing for the Army, no work was being turned out. Studios for shooting test lengths of cine film and Agfacolor were located both in Schilling's laboratory and in the main Photochemical Laboratory.

Testing of Film Base.

Dr. Schilling's testing laboratory was very well equipped for general mechanical tests on film base and other "Foils," e.g. triacetate insulating foils. Numerous Schopper machines were available for static and dynamic breaking tests at normal, high and low temperatures, also machines for testing breaking by folding, and projector mechanisms for practical life tests, with projecting microscopes for investigating the course of perforation-cracks. The whole of this laboratory was air-conditioned to 45% R.H., with a buffer room to prevent disturbance of the equilibrium by entering personnel. In addition, several small rooms were available at other humidities e.g. dry, 30%, 60% 80%.

Dr. Schilling was interrogated on the subject of topographic base in general. He talked quite freely but did not bring out many new ideas. Tests are made on raw film by taking strips along and across the length, and on coated film by copying a graticule about 10 cms square which is subsequently measured up after conditioning to the required humidity. Schilling felt that even topo base is an unsatisfactory product from the mapping point of view. The properties of the material depend on the type of emulsion coated on to it, the way in which the emulsion is dried, the subbing and backing, the batch of emulsion and base, and the processing and drying conditions of the negative. He said that spirit drying was disastrous, and that the best condition was to process without tension, and dry without tension using air at 30°-40°C and 5 to 15% RH subsequently conditioning for at least 3 hours and preferably 12 hours to 60% R.H.

The Luftwaffe always measured mapping film in a room controlled to 60% R.H. and were supposed to leave their films unrolled for 12 hours to condition, but he believed that in practice this was not always done. They were also supposed to do a check by comparing the distances between collimator marks with those on the camera itself, but again Schilling thought this was often neglected.

Schilling distinguished a reversible shrinkage, an irregular shrinkage, and a slow long period shrinkage. The first could be eliminated by careful conditioning, and when this was done all distortions should vanish. In practice there always remains the irregular shrinkage which varies all over the film and is not reversible with humidity variations. This corresponds to what we define as "the maximum displacement of a point".

Schilling said this was due to irregular solvent evaporation and could be largely eliminated by baking the film, but of course, this could not be done in practice. The regular reversible shrinkage was required to be less than 0.5% and the irregular, which cannot be expressed as a percentage, should not exceed 0.02 mm. Agfa apparently do not use the term "differential distortion" and Schilling considered that it was not a valid expression in view of the fluctuations of the irregular shrinkage. He said that a plot of the deviation of graticule points from their true positions showed less spread after conditioning than before.

The graticule copies are measured up on a Zeiss spectroscopic comparator having only one direction of travel and a traverse of 10 cm. This was accurate to 1 mu, and was a very good instrument of its type, but not of particular use to us. Schilling also had a Zeiss stereo comparator, but this was a 1918 model and was only accurate to 0.1 mm. It was rarely used.

Dr. Schilling asked if I had ever heard of a new type of American dryer, reports of which had reached him through Sweden. From his description this must have been the A5 Fairchild. He had heard it was bad from the point of view of base distortion. This suggests that the Luftwaffe have not used this type of dryer which is in fact very free from distortion.

I asked Schilling and his assistants if they knew the coefficient of thermal expansion of film base. They said that it was "smaller than any metal" and hence unimportant, which does not agree with our view.

Colour Research.

As already mentioned an entire wing of the main building is laid out for colour research. This is principally devoted to organic chemistry connected with colour development and sensitising dyes, but also had its own independent processing station for Agfacolor cine and still work, full size projecting theatre with editing and titling rooms, etc. and numerous darkrooms. The organic labs. were rather badly damaged by tank artillery and resulting fires. None of the personnel were present, except Dr. Zeh but it was felt that little could be gained by non-expert discussion with these chemists, and none were called for interrogation.

Climatic Testing.

Several cellar rooms fitted for climatic testing were inspected. These had their own independent air conditioning plant which gave the required temperature and humidity by blowing in appropriately treated air. The normal tropical test was run at 30°C and 85% R.H., but higher temperatures and humidities could be maintained if required.

A separate room had dry heat chambers maintained at 60°C. This laboratory was used for testing synthetic materials of all kinds, as well as photographic emulsions and packings.

Miscellaneous.

1. Luftwaffe Processing.

Particular enquiries were made about the processing methods used by the Luftwaffe, but no evidence could be obtained that they have ever used anything but spool-tank development and hand printing. When asked why continuous machinery for large-scale output was not used Schilling could only suggest that it is insufficiently mobile and flexible.

2. Robot Cassettes.

It was known that Robot cassettes are urgently wanted in England. Agfa do not make them, but Professor Eggert was taken to Leipzig, where he is a well-known figure, and enquiries were made all important photographic shops. The answer was invariably that no stocks had been held for some time and that no communication with the Robot firm existed. The manufacturer (Berning & Co.) was stated to have been bombed at Siegen and to have transferred to Dusseldorf, Elisabeth-Strasse 27, but it was presumed that he had been bombed there also.

3. Deutsches Celluloid Fabrik-Eilenburg.

The biggest German base factory is at Eilenburg, on the river Mudle. As this was near Bitterfeld, an attempt was made to see the plant. Col. Robinson knew that the factory, was probably on the Russian bank of the river but went to the town to confirm this. The Military Government there had not heard of the works, but the

local burgomeister assured us that it was in fact in Russian hands. (His daughter had worked there during the war). The burgomeister gave us an address where the former director, Dr. Faustens might be found. This was -

Bei Thomas
Hohenpriessnitz,
Kreis Delitsch,
Nr. Leipzig.

Hohenpriessnitz is a small village some 15 miles from Delitsch. We confirmed that Dr. Faustens was in fact living there, but he was away on the evening of our visit. It was not felt that a further special visit could be justified, and no further action was taken.

4. Dump of Aircraft Cameras Nr. Delitsch.

In the Agfa plant I met an American infantry lieutenant who reported having seen a dump of German aircraft cameras and ancillary equipment in a beer-hall. The only direction he could give were that it was in a circle of 4 kilometres radius centered on Delitsch. With the help of the local A.M.G. (Major Moreman) this dump was eventually located, but the U.S. Army had removed everything. Major Moreman invited me to inspect a Luftwaffe aerodrome nearby and I thoroughly examined it. It was completely derelict, and although several burnt-out fighter aircraft with camera holes were found, no photographic equipment could be located.

5. Infra-Red Photography (Czerny method)

Professor Eggert called our attention to a method of infra-red photography proposed by Czerny.

Reference: Czerny. "Uber Photographic in Ultra - Roten" Zeitschift fur Physik - Page 1. volt 53, 1929.
and Czerny & Mollett - Zeitschrift fur Technische Physik - 1937, p.532.

Briefly, the method works as follows.

A very thin film of collodion is treated on one side with a thin film of metal deposited by evaporation to give a black layer. The other side, just before exposure, receives a thin oil film, which is also deposited by evaporation. Infra-red light from the object is imaged by a lens on the collodion where it is absorbed by the

black film. The differential heating of the collodion causes a corresponding evaporation of the oil film and this gives rise to interference effects with visible light projected on to the film through a half silvered mirror. The "picture" is observed also through the half-silvered mirror. Dr. Kister said that he had seen pictures produced in this way. They last for a few minutes and are best seen by green light. The quality of the results is relatively crude by normal photographic standards, but Eggert and Kuster both felt there was considerable promise in the idea.

Czerny had sent his apparatus to Professor Eggert for safety from bombing, but it had been completely smashed by the Poles, and all that could be distinguished was an optical bench and some lens holders.

Information about other German Manufacturers (from Dr. Miller)

Zeiss film factory, Berlin.

Film base plant intact, emulsion plant destroyed.

Kodak A.G. - Berlin.

During the war made cine pos and neg. and X ray film but no air film.

Agfa-Leverkusen.

Paper factory. Probably could produce Correctostat. Bombed but production 50% of normal.

Perutz - Munich.

Bombed and out of action for 6 months.

Schweinfurt Gelatine Works.

Badly bombed.

Action Recommended.

1. Contact base makers in England ascertain if copper bands are needed, if so send representatives to Osnabruck and inspect Kupfer and Draht Werke.

2. Send representatives to Leverkusen to investigate Agfa paper plant.

3. Send representative to Dusseldorf to investigate Robot factory there.

4. Investigate Perutz at Munich.

Documents Removed.

Copies of the following documents relating to the manufacture or use of Agfacolor materials were removed.

22.1 Preparation of Coupler Components F.546, F.550, F.654, Z.169, F.535, F.542, Koe. 30Z.

22.2 Operating procedure for the Agfacolor negative/positive Process (Including manufacture of color developer).

22.3 Instructions for Using the Agfa Matching Filter Plate.

22.4 Working Instructions (& Formulae) for the Agfacolor Negative/Positive Process (Cine film 35 mm).

22.5 Agfacolor - Paper Developing Instructions.

22.6 Sensitising Dyes - Formulae for Agfacolor Materials.

The following documents are not in the same category as those listed above, since they have all been published in Germany. Nevertheless they were not always available outside Europe, as many were published during the war years.

22.7 "Die Farbenphotographie" by Dr.W.Schneider. A semi-technical account of the Agfacolor process.

22.8 "Verroffentlichung des Instituts fur Farben-photographie and der Staatlichen Academie fur Graphische Kunste and Buchgewerke Zu Leipzig."

22.9 Agfa Color Charts.

22.10 Film und Farbe" - a symposium on color kine-photography & color vision.

22.11 "Veroffentlichungen des Wissenschaftlichen Zentral-Laboratoriums des Photographischen. Abteilung Agfa". Complete set up to 1939.

A plan of the Agfa factory premises was also removed.

Samples Removed.

Small samples of the following products were taken for test.

(a) Aeropan Film.

(b) Aerorapid Film.

(c) Isopan FF, F and ISS Film.

(d) Isochrom Film.

(e) Agfacolor Kine negative and positive.

(f) Agfacolor 35 mm. Reversal Film.

(g) "Atomal" Developer.

(h) Infra-Red Plates.

(i) "Milkrat" High Resolution Plates.

Of these all but (e), (f) and (g) have been tested. They show no unusual properties and correspond to materials previously known under the same names.

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