29 April 1960

MEMORANDUM FOR: Chief, TISD

SUBJECT: Final Report and Recommendations on the Photographic Chemical System

1. On 30 March 1960, the undersigned was directed to conduct a study which would result in the recommendation for a complete chemical mixing, storage, replenishment, recirculation, temperature control and analysis for the proposed photographic laboratory to be located at the new site. On 12, 13, and 14 April 1960, the undersigned attended a tri-services meeting at [redacted] sponsored by the [redacted] On 20 April 1960, the laboratory facilities at [redacted] were visited; on 21 April 1960, the facilities of the [redacted] were visited and on 26 and 27 April 1960 the chemical laboratories of [redacted] were visited. These recent trips were for the purpose of investigating methods and procedures as well as equipment used in a modern photographic laboratory for the most efficient operation of that type of laboratory with particular regard to the usage of the various photographic chemical solutions. It should be pointed out that the following recommendations are not based solely on these most recent investigations but rather upon the experience in this particular field over a considerable number of years. However, these most recent investigations did establish the most recent state of the art as it exists in both private industry and the military.

2. There are two schools of thought on this subject, the first being that in an intermittent type of operation, photographic chemicals are mixed in rather small quantities of 50 gallons or less from either bulk or packaged dry chemicals or concentrated liquids. These chemicals are prepared into working solutions by ordinary mixing procedures and are transported to the various processing stations and equipment either by hand, in buckets, or in small portable distributors. These chemicals are used during a working day and are discarded at the end of the shift or are left standing in equipment to deteriorate themselves and the equipment. It is reasonable to assume that this is the most inefficient modus operandi: 1) man hours, which are expensive and sometimes difficult to come by, are required almost on a daily basis to mix these chemicals; 2) the mixing of chemicals by this method is a task not cherished by most

laboratory technicians; 3) even though some of these chemicals are mixed into working solution from packages which have been weighed and compounded by the manufacturer or from concentrated liquids, there are considerable variables which must affect the final result with each new batch of solutions; 4) since these photographic solutions are expensive, it is reasonable to assume that a considerable amount of dollars are flushed down the drain each day in the form of partly used chemical formulae; 5) each new batch of solutions must undergo a breaking-in period in which the results are entirely unpredictable and only after a certain amount of usage of these solutions do they settle down and provide consistent results. It is very often in practice that at this point that they are discarded when in fact they have just reached a point of maximum usefulness and efficiency.

3. The other school of thought on this subject is to carefully compound a fairly large quantity of the various working solutions used in the photographic laboratory and to maintain these solutions almost indefinitely. It is needless to say that some few developer formulae do not lend themselves to this treatment; such a developer is used on most photo-mechanical emulsions for line and half-tone negatives in which extremely high contrast is obtained by a highly alkaline or caustic soda solution such as D-85 or Kodalith formula. Usually this formula is kept in two parts in which the organics and inorganics are combined immediately prior to use and then discarded within a period of 4 to 6 hours due to excessive oxidation caused by the combining of these incompatible chemical elements. However, the two parts of the solution have excellent keeping qualities while stored separately. Most other standard developer formulae have inherently good keeping qualities and long, useful lives if properly stored, filtered, and replenished and once they have been properly compounded and tested by sensitometric analysis, they are entirely predictable. The same is true of the acid fixing and hardening solutions commonly used for paper or film. If the free silver in these solutions is properly removed by silver recovery techniques, their useful life can be extended almost indefinitely.

4. In this more modern concept of photographic chemistry, the major emphasis on quality control is correctly placed in the proper compounding and the maintenance of these working solutions and the role of the technician's responsibility for this operation assumes a stature of major importance. In this case, the chemist is in fact the control officer for the photographic laboratory operation and he bears the responsibility for all products generated in that laboratory. We will say, certainly, that the very first step in the concept of the "white gloves" laboratory must begin and end with the proper photographic chemical supply system. By necessity, the system must be a completely enclosed loop to prevent excessive oxidation of the solutions and contamination of the air in the rest of the laboratory.

RECOMMENDATIONS

1. Space: In any proposed new location of the PIC laboratory a space not smaller than 20x40 feet should be allowed to house the tank farm. Ideally, this space should be located on the floor above and centrally located above the laboratory facility. In addition, a space should be provided adjacent to the tank farm for the chemical analysis section, approximately 12x20 feet.

2. Initial Mixing: There should be two 50-gallon and five 100-gallon mixing tanks of type 316 stainless steel with properly fitted floating lids and dished bottoms. These tanks would serve for the initial mixing or charging of the larger tanks in the tank farm. After the initial mix, these same tanks would be used to receive partially used solutions from the various processing stations, at which point the analysis sample would be taken.

3. Bulk Storage (Tank Farm): Bulk storage would consist of two 50-gallon sealed tanks of Type 316 stainless steel which would contain the two-solution developer for photo mechanical use. These two solutions would be combined at the processing station, used, and then discarded as the solutions are drained from the two 50-gallon storage tanks. The void would be filled with nitrogen to prevent oxidation. Five enclosed storage tanks of 300-gallon capacity would contain three standard developer solutions for film and paper, one fixing and hardening solution for film and one fixing solution and hardening solution for paper. These larger tanks would also be completely sealed against air and the void created filled with nitrogen.

In the bulk storage tanks the temperature of the various solutions will be maintained to within plus or minus one degree of the actual operating temperature of the solutions. A gentle circulation will be provided inside the tank to keep these solutions in proper suspension. Solutions entering and leaving the bulk storage will be properly filtered and cleaned of impurities.

4. Piping to Stations: Since the tank farm is situated on a floor above the photographic laboratory, the supply of chemical solutions to the various processing stations will be by gravity flow through PVC (polyvinylchloride) tubing of U. S. manufacture. All shut-off valves under low pressure will be also of PVC construction. Those valves under increased pressure from pumps will be of stainless steel construction and those parts of the necessary pumps will likewise be of Type 316 stainless steel.

5. Return to Intermediate Storage: The three standard developer formulae and the fixing and hardening solution mentioned in Item 3 above will be returned to the 100-gallon tanks mentioned in Item 2

above. In this fashion the tanks which were used initially to charge the tank farm are now being used to receive the returned solutions from the processing stations. By this method the partially used chemicals will not be returned to bulk storage immediately but returned to these intermediate tanks from which will be taken appropriate samples for chemical analysis by instrumentation. This system provides means of draining those pieces of processing equipment of their standing solutions so that the equipment can be properly flushed, cleaned, and buffered at the close of the working day. When these solutions have been properly replenished, they will be returned to the bulk storage and the intermediate storage tanks will again be available for mixing.

6. Water Treatment and Purification: All water used for the initial mixing of the photographic solutions will be properly filtered and purified to remove all solids, minerals, and algae from the local water supply. Water used for washing film and paper products generated in the laboratory will be filtered for solids. The Washington area water supply lends itself particularly well to purification and treatment by filtration rather than the more elaborate deionization processes.

7. Chemical Analysis: Samples taken from the intermediate storage facility will be analyzed by instrumentation such as the [redacted] spectrophotometer, the [redacted] PH meter and the [redacted] sensor rather than by chemical titration. The samples thus taken will be compared for signature and comparison with known standards. Those elements found deficient will be restored by the addition of proper concentrated solutions and those elements such as bromides found to be in excess will be properly neutralized in the intermediate storage system and then returned to bulk storage.

8. Flexibility: All three standard developer formulae and the two fixing and hardening solutions will be made available at each processing station using a continuous roll film or paper processor. In this fashion the proper developer for film positives, film negatives and paper can be interchanged in the processor with minimum delay and no volume loss of the solutions. Replenishment of these processing machines will be by separate integral systems associated with the equipment for continuous operation. Should it be necessary to change the type of developer in the continuous processor at some time during a working day, the partially-used solution in the developer compartment would be pumped back to intermediate storage and the compartment would be flushed with water and refilled with another developing solution. Another important consideration is that these processing machines are never left idle with standing solutions. It is at this time that the equipment suffers the most deterioration. During ascertained periods of inactivity for a particular piece of equipment, the entire machine would be drained, flushed, buffered, and refilled with water and leader material so that it could be run for a few moments each day to keep the equipment in the best operating condition.

9. Silver Recovery: A suitable silver recovery system would be employed for the fixing and hardening solution used for film. There would be no silver recovery for that fixing and hardening solution used for paper prints. The free silver recovered from the film fixing bath could be purified by one of a number of commercial silver purification plants and the monetary value of this silver used to defray the cost of the system over a period of years. Not enough free silver is recoverable from a paper fixing solution to make it economical to employ silver recovery.

10. Capacity and Cost: The system described above would provide chemicals sufficient to operate a photographic laboratory generating a volume of products three times increased over our present rate. The cost of such a system is very approximately estimated at [redacted] The benefits to be derived are immeasurable!

11. Floor Plan: As soon as possible, detailed floor plan of the proposed laboratory should be made available to the undersigned so that accurate cost estimates can be made regarding the installation of the above chemical system. Since most of the hardware required to build such a system is virtually hand tailored, it will be necessary to negotiate a contract as soon as possible in order to have all the component parts ready for installation and use by early fall of this year. Permission is requested to monitor such a contract as well as the installation in the proposed building.

[redacted]

PIC/TISD/TD&SS/[redacted]gm(3591) - 29 Apr 60