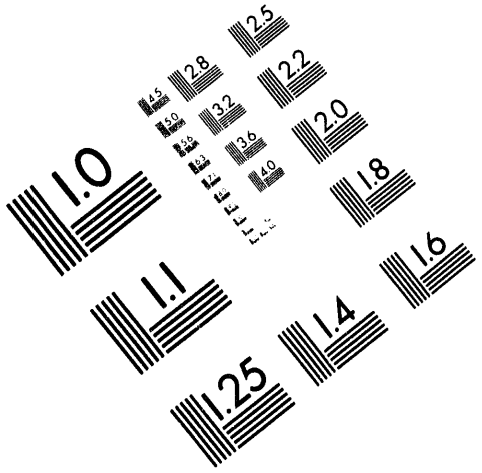

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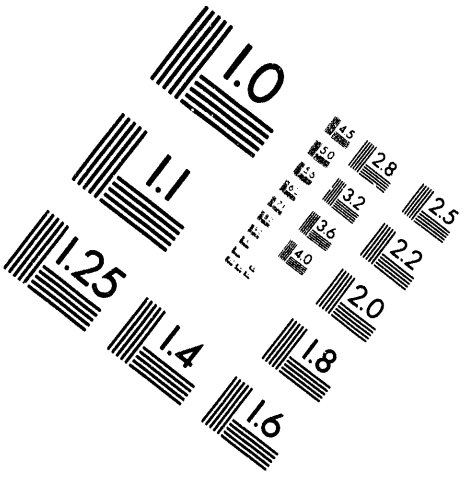

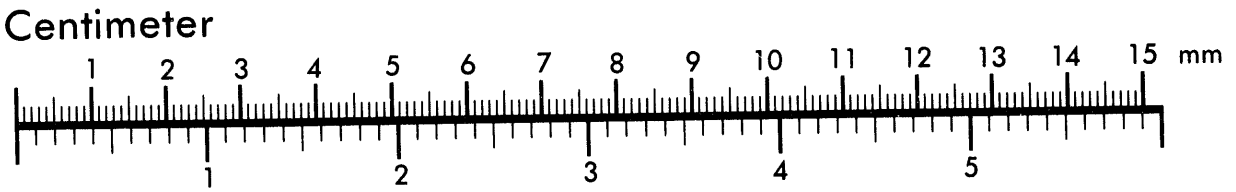

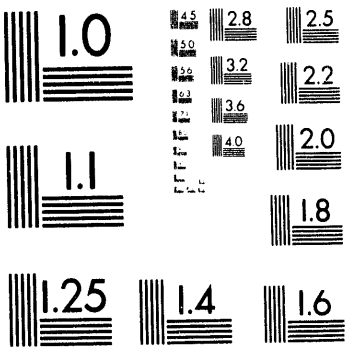

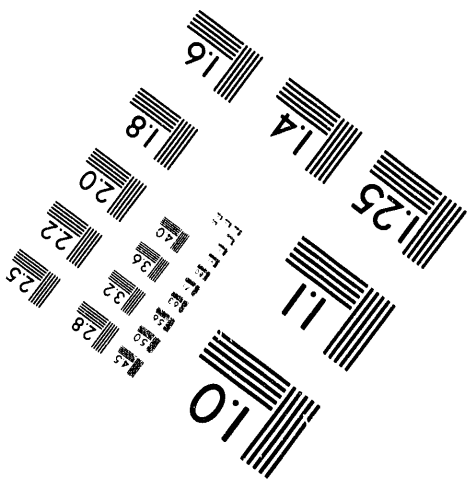

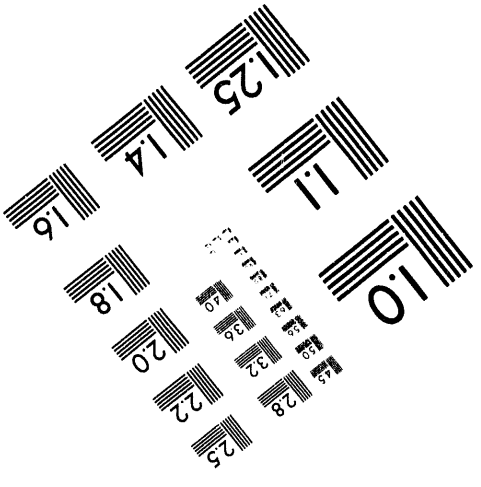

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REPORT OF VISIT OF DR. L. C. MATSCH MARCH 11 AND 12, INCLUDING DISCUSSION AT MEETING AT THE C REACTOR CONFERENCE ROOM

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REPORT OF VISIT OF DR. L. C. MATSCH
MARCH 11 AND 12, INCLUDING DISCUSSION AT MEETING
AT THE C REACTOR CONFERENCE ROOM

March 13, 1964

by

J. P. Cooke

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REPORT OF VISIT OF DR. L. C. MATSCH
MARCH 11 AND 12, INCLUDING DISCUSSION AT MEETING AT THE
C REACTOR CONFERENCE ROOM

BACKGROUND

Dr. Matsch was born in Hungary and studied at Vienna Technical Institute, receiving degrees in physics and engineering. At the end of World War II, he was operating a Krypton gas separation plant in Hungary, but left his home and personal effects and fled to Munich, Bavaria with his wife and infant son as the Russians entered the country. After the war he worked for a time with the German Linde Company (no connection with the American Linde Company except name) and eventually came to the United States when an immigration quota was available for displaced Hungarian citizens. He went to work for the Linde Division of Union Carbide in an engineering capacity upon his arrival in the U. S., and he and his wife are now U. S. citizens. He is currently Manager of the Engineering Development Division of the Linde Co., employing about 600 people including 200 engineers. His responsibilities include the design and construction of gas separation equipment and devices, improvement of their processes and economic analyses of the results. It was his group which developed the new improved distillation columns which have permitted extraordinary increases in through-put and efficiency in air separation plants, and which he would use in any purification system that he would design for Hanford.

The important point to be emphasized in relation to the previous proposal for gas purification is that this break-through in distillation technology will now permit the almost complete removal of the last 500 parts per million of Argon to a new low level of less than 20 parts per million.

VISITOR ORIENTATION

On arrival on March 11, Dr. Matsch was taken to the office of R. E. Plum in the 703 Building where the various phases of gas purification were discussed. Also, mention was made that the Richland AEC had received an inquiry from Washington regarding the effect of recent changes in operating practice on the through-put of process metal, along with a request for a complete economic analysis. In retrospect, the increase in average graphite temperature which has occurred with the high CO_2 test has necessitated an increased through-put of approximately five to eight per cent in order to maintain isotopic purity of product within the specification set up by the customer. The cost of this through-put increase is partially offset by (a) a reduced need for enrichment due to increased neutron reactivity at the higher temperature, plus (b) the demonstrated decrease in total gas loss, as well as (c) anticipated decrease in rupture rate because of the shorter in-pile exposure and the trend in recent ruptures toward corrosion-type failure rather than core metal failure. Since all these items are being factored into a current study by R&E's H. G. Spencer, and to avoid further discussion of unrelated information with Mr. Plum in the presence of Dr. Matsch, Mr. Plum was referred to Mr. Spencer for further information if it were needed immediately.

[redacted]

During a subsequent discussion with Dr. Matsch during the evening, he was briefed on the security aspects of the information he would receive at Hanford so that he could avoid disclosing (even inadvertently) classified information to anyone not authorized. This orientation emphasized the significance of the fact that anything remotely connected with power level, graphite temperature, through-put, etc., is classified, and not to be put in notes or transmitted in any way to unauthorized persons.

PLANT TOUR

An appointment was made with Mr. J. H. Hoage to visit his gas purification equipment location in 314 Building and briefly discuss some of his instrumentation requirements, in connection with the purification system being constructed for Hanford Laboratories.

On Thursday morning after leaving 314 Building, Dr. Matsch was briefly toured through 100-N, including as much as possible of the gas treatment section, including a typical drier room (it was impossible to take him into such facilities at other areas because they were in operation). Then both K Reactors were toured, outling their gas problems as well as the system layout. A similar visit followed at C Reactor and 115-B Building where the proposed location of the purification plant was inspected.

INFORMAL DISCUSSIONS

A 2:30 p.m. meeting was held in the conference room at C Reactor with interested individuals from IPD Operating and Engineering groups. No formal minutes were taken of this meeting, but a summary is included at this point for the benefit of those who were not able to attend. A schematic drawing of a reactor plant was placed on the blackboard which showed the reactor block, gas lines, driers, blowers, and isolation valves. It was pointed out that the cooler-blower room for 105-C was downstream of the driers and could be used for the purification equipment quite readily, since a by-pass valve and two room entry valves were already in existance in the tunnel, and the room is used only for storage. A suitable water supply and electric power are also available. The only drawback to this room is the fact that the reinforced concrete walls are two feet thick with a labyrinthine entry eight feet high and with five-foot-wide doors as the approach to the interior.

Dr. Matsch stated that insofar as the cold box equipment was concerned, there was no problem in putting it in this room, but the compressor might have to be dismantled to get it through the door and around the corners.

Dr. Matsch briefly described the flow sheet of his tentative process as follows:

The gas would be compressed to a nominal pressure of perhaps 250 to 300 psi and put through a multipass heat exchanger for cooling to near liquid nitrogen temperature, after which it would go to a small reboiler coil in the bottom of the main distillation column. From the reboiler the stream would go into a gas separator (a small distillation-type vessel in which the greater portion

of the nitrogen would be liquified along with all the Argon and Oxygen impurities). The gaseous portion from the separator would be practically pure Helium with a very small percentage of Nitrogen. The contaminated (and liquid) underflow fraction from the separator would enter somewhere near the middle of the distillation column and would be fractionated with the aid of reflux from the top and the reboiler vapors from the bottom until the product coming out the top was of a satisfactory purity to meet our specification.

This type of flow sheet differs from that previously considered in that a large separator was formerly the only vapor-liquid contacting vessel, and the new type Linde cryodistillation column is of much greater efficiency. The liquid coming out the bottom of the distillation column, containing all the impurities plus a moderate amount of nitrogen, will be passed through a heat exchanger to recover its refrigeration value and then vented to the stack. The purified gases will also pass through the same massive heat exchanger counter-current to the incoming feed so as to recover as much as possible of their refrigeration value before these gases leave the system. The raw gas from the compressor will be cooled, dried, and CO_2 trace impurities removed before entering the cryogenic section of the cold box.

Liquid Nitrogen will be required in small quantities to make up the refrigeration lost through the outer surface of the cold box and also to offset that lost in the cold exit gas (this will probably be within 5 or 6° of the temperature of the entering gas since the heat exchangers are so large and efficient).

Linde makes most of their cryogenic equipment from aluminum, using heliarc welding and standard fabrication techniques. The insulation will probably be vacuum powder-fill though there are other types which may be more economical for the smaller units.

Questions answered by Dr. Matsch covered the following points:

1. The volumetric capacity rating of the plant can be whatever level we request. We are giving Dr. Matsch a range of sizes for a high-spot cost study on:

   a. One hundred
   b. Two hundred cfm nominal capacity
   c. Four hundred

   Each of these three sizes of plant will be scoped for the following three sets of operating patterns. (In case two or more conditions can be most economically met by one design, this will be noted accordingly)

   a. Typical K Reactor composition of 70% to 97% Helium (95% at startup, decreasing to 70% in four days, then slowly increasing to 95%+ over two weeks).

   b. Typical old-reactor compositions ranging from 60% to 70% Nitrogen, which is the operational equivalent of the current 50% to 60% CO_2 composition.

[redacted]

c. Typical old-reactor gas composition and operating pattern prevailing before the initiation of the recent high CO_2 test (slow changes between 40% CO_2 and 10% CO_2), but with the equivalent Nitrogen percentages of 50% and 15% being substituted.

2. It is necessary at this point to emphasize the fact that in order for this relatively simple cryogenic gas purification equipment to function, it is necessary to eliminate CO_2 as a component deliberately added to our gas mixture. The equipment will remove such incidental CO_2 as occurs from burnout, but no specific provision is made for recovery of this CO_2 and/or reintroducing it into the stream. It is acknowledged that it would be possible to build a purification plant which would operate on CO_2 mixtures but such a plant would of necessity remove the CO_2 first, then purify the Helium in a unit similar to that proposed here, and subsequently reconstitute the desired mixture with the recovered CO_2. Such a system is considered unnecessarily complicated in light of the fact that the Nitrogen atmosphere experiment has proved so successful at the K Reactors.

   Furthermore, the purification section for the Helium in such a plant would be practically identical with the purification system outlined by Dr. Matsch, and if circumstances ever dictated return to CO_2, the appropriate equipment could be added. It is also probable that such a CO_2 removal section would be quite large, perhaps uneconomically so, when considered in relation to the extremely low cost of CO_2 as purchased at Hanford.

3. The various sizes of purification units which can be built would be, of course, tailored to match specific available compressor models. Because the compressor represents a sizeable proportion of the construction cost, and because the incremental cost versus size relationship for a cold box is somewhat less significant than that for compressors, it may be found economical at least in the initial installation, to provide an over-sized cold box with provision for an additional or a substitute compressor one each for high or low flow, but the relationship between capital cost and operating costs of such an arrangement would have to be evaluated as a separate study.)

4. In reply to questions regarding the effect of increased through-put flow (or increased flow of impurities) into the purification unit, Dr. Matsch explained that the efficiency of the unit and the intensity of the scrub effect in the condensor column increases with the through-put of condensibles Also, as long as the impurities are accompanied by a substantial quantity of Nitrogen (as would be the case with impurities originating from air), the effect of the increase of the impurities would be largely self-compensating until column flooding occurs.

5. With regard to increased capacity (or volume of input gas supplied to be purified), the compressor itself would be the bottleneck; the only reason for over-all volumetric capacity to vary from time to time would be the variations in four to six inches of water pressure equivalent produced by the existing circulation fans during speed adjustments in connection with drier changes which might be considered as a slight super-charge to the input.

[redacted]

6. The degree of Argon and Oxygen removal possible was discussed at considerable length. Argon is much more difficult to remove by distillation than Oxygen and, therefore, the removal of Argon to a level of 10 to 20 parts per million would eliminate the Oxygen beyond detectable limits of existing instruments. The limit for Helium purity would be in the range of 95% to 98% with the balance being Nitrogen. This small amount of Nitrogen is necessary in order to provide the proper column scrub in the final stages of the distillation unit, unless a third gas such as Methane or Ethane were introduced as a circulating nonexpendable intermediate.

   It is possible that such a use of hydrocarbon gas would be found desirable if Helium purities of 98% to 99% were to be demanded. However, it is currently believed that Helium percentages above 95 are generally unnecessary at Hanford, really being required only for composition changes in high percentage Helium range, which under the proposed conditions could be obtained through the composition control on the purification unit.

7. In discussion of the moisture content of the purified gas and of the input gas to the purification unit, it was necessary to give Dr. Matsch some kind of a yardstick on what performance could be expected of the current driers. A dewpoint between -40 and 0°F was considered to be the typical range with which his equipment would have to contend. The dewpoint of purified gas, of course, would be so low as to be incapable of measurement by any of our equipment. Thus, consideration could now be given to purification equipment as an alternative to that suggested for the K Reactors (See FES scope document HW-80425) in connection with the current K drier problem. For instance, if it is necessary to expend $350,000 to upgrade one of the K drier installations, it might well be more advantageous to install purification equipment at K and attain as a bonus practically zero gas usage and an ultimate impurity level far below anything that we have ever seen. Since it is not expected that the purification equipment would cost as much as $350,000, this avenue is the logical one for further exploration.

   Mr. R. E. Baars mentioned the possibility of a pull-back from the high CO_2 test currently underway. This may become necessary because of a restricted uranium supply due to offsite budget limitations. Lower graphite temperatures would permit higher goal exposures and lower throughput while still meeting product quality, and thus make the most of the available uranium supply. He pointed out that we should, therefore, not consider too seriously any substantial increases in graphite temperature as justification for the Nitrogen atmosphere test. It was brought out that such a pullback might ultimately increase the gas losses to their former magnitude before the high CO_2 test ($2,000,000 a year), and, therefore, render gas purification even more attractive economically than ever. It was also considered that the economics of maintenance patching as an immediate palliative to excessive gas loss would become a management imperative in spite of incomplete effectiveness and the cost of rear face outage time.

[redacted]

With full-stream purification it is theoretically possible to operate a gas system at subatmospheric pressure with leaks on the rear face but with an absolutely tight reactor envelope at all other locations. four to ten per cent air could enter through the rear face leaks, but be removed by the purification equipment before the gas was recirculated to the inlet. Process Standards for inlet gas would thus be fully met, and far surpassed, by the super-pure gas available from a gas treatment unit. We are reluctant to accept the subatmospheric pressure expedient as a complete and final remedy, and believe that further attempts should be made at patching the holes to reduce gas losses in the immediate future. Some progress has been made with the foaming at C Reactor, but from results obtained at other reactors (and even with the aid of a mass spectrometer leak detector) only 50% success seems to be possible. The actual life of the foam in this service is as yet undetermined, and though much improvement is possible, it is apparent that the rear face is never going to be absolutely gas tight.

In the line of R. E. Baars' disclosure, we have concluded that the proposed Production Test to be written for a Nitrogen atmosphere at C Reactor should be based entirely on the present graphite limits, with no change in the present operating parameters as far as this is possible. That is, an equivalent percentage (conductivity-wise) of Nitrogen should be substituted for the 60% CO_2 limit, and a new gas activity curve determined to correspond with the Argon content of the Nitrogen supply. In this respect it is anticipated that the Nitrogen supply will be a special truckload supplied by Linde with an Argon content of between 30 and 50 parts per million.

The above Production Test and further research is expected to clarify the economics of increased graphite temperatures which would be possible, with safety, when the pile atmosphere contains no oxidants. In fact a point to be made in this respect is that, in effect, a completely inert Nitrogen atmosphere removes from operational planning any restrictions on graphite temperature, including the present necessity for concern regarding local internal "Hot Spots" other than those necessary to prevent deterioration of shielding or to maintain the specified isotopic purity of product. Ralph Baars will keep us informed of developments along this line and will probably write the Production Test for converting C Reactor to Nitrogen, with the necessary detailed information regarding forecasted graphite temperatures being made available as soon as the AEC has determined what effect the changes in the fuel limitation picture will have on Hanford. Dr Matsch will utilize the data we have given him (as outlined on Page 6 and 7) and provide us with preliminary scope proposals on each of the several sizes of purification units, and submit an informal estimate of purchase price and rental price, together with estimated operating cost data.

Engineer
Mechanical Development Unit
Equipment Development Sub-Section
FACILITIES ENGINEERING SECTION

IRRADIATION PROCESSING DEPARTMENT [redacted]

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