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UNCLASSIFIED

29 Nov 1944

Capt. J. O. Ackerman

G. B. Kistiakowsky

Loose TNT for Lenses

PUBLICLY RE[illegible]
LANL Classification Group
P. Lang 6-5-98

Velocity measurements on loose TNT by X-1 Group have now rather definitely established a figure which is nearly 200 m/sec. faster than that obtained at Bruceton for the same density. We do not know as yet the source of the discrepancy but it may very likely be a difference in particle size distribution. If so, there will be a recurring difficulty with hand-tamped lenses, as new boxes of TNT will come into use.

It is, therefore, quite essential that at the earliest possible date you prepare a large standard batch of loose TNT to be used exclusively in lens construction. I believe this can be accomplished by mixing the contents of, say, ten boxes (i. e. 500 lbs.) in the large kettle. 500 lbs. of TNT should fill it to a reasonable level and, if you operate then the stirrer for about an hour with the kettle, of course, cold, you should get a fairly effective homogenization. The material from the kettle should be then filled back into the boxes and these marked so that they will be used for lens construction only and no lenses going to the field groups would contain other TNT. A sample of this homogenized material should be given to X-1 (Linschitz) for velocity measurements.

G. B. Kistiakowsky

GBK:he

Copies to: Lt. Comdr. Bradbury
Mr. Marley

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[illegible signature]

FINAL DETERMINATION
UNCLASSIFIED
L. M. Redman
NOV 06, 1980

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CLASSIFICATION CANCELLED
PER DOC REVIEW JAN. 1973

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P. Lang, 5-7, 6-5-98

[redacted]

29 November 1944

Captain Ackerman

T/5 Frank L. Macera

Report on X-2385, Irregular FM casting, Torpex (B-2)

Cast was pelleted with pellets 1/4" x 1" x 2" approximately, 12 lbs. of pellets were used. Mold was preheated to 75° C. Melt was poured at 80° C. When poured, water at 75° C was passed through cover for 4 hours. Water at 40° C was passed through body for 5 hours. Steam was left on riser for 5 hours.

Procedure:

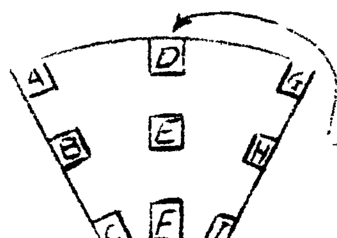
Melt was poured into the open mold to a depth of approx. 5". Pellets were then added slowly and pushed to the bottom. When enough pellets were added so that they began to show at the surface of the liquid, more melt was added. The same procedure was followed with the pellets and when the melt neared the top, the cover was put on and melt topped off the casting.

The casting, when taken out of the mold, showed some small spots of entrapped air at the interfacing; there was a slight bit of TNT segregation and rough surfaces on the cast top.

The X-ray report from Tenny's records reads as follows: Air channels up to 4x20 mm. Air bubbles up to 10 mm diameter, especially in the lower part of the charge.

When the cast was cut open it proved to be a fairly good one. The air bubbles were not cracks as the report may indicate, but seemed to be lines of low density or just discolored.

Samples for analysis were taken out of the face of half the charge. As shown:



Densities: A 1.798 D 1.785 G 1.793
B 1.798 E. 1.799 H 1.802 Average Density 1.801
C 1.820 F 1.806 I 1.812

Distribution: Average of the two runs:

	AL	RDX	TNT
A	17.1%	41.3%	41.0%
B	17.7	41.1	41.2
C	18.5	41.6	40.0
D	20.5	46.5	32.9
E	17.7	40.8	41.6
F		41.8	39.6

2277 0363

	AL	RDX	TNT
G	17.6%	42.1%	40.8%
H	18.2	41.6	40.3
I	18.2	42.8	40.1

Percentages of TNT found by subtracting from 100%.

Temporarily omitting sample "D" the maximum difference in percentage from the different samples is as follows:

AL 1.6%
RDX 2.0%
TNT 2.0%

The calculated averages for these samples is as follows:

AL 18.0%
RDX 41.6%
TNT 40.1%

The differences between the calculated averages and sample "D" are as follows:

AL +2.5%
RDX +4.9%
TNT -7.2%

Conclusions:

1. As a whole, the distribution throughout is fairly good and the pelleting technique seems feasible.

2. With an adequate riser and improved technique in topping off the cast when the cover is put on it would be possible to improve the distribution inthe section around sample "D".

3. Comprehensively, the density differences are close to the allowable limits.

November 22, 1944

Captain Ackerman

J. W. Stout

Report - temperature maintenance and control systems

Enclosed is a report, written by George Moore and Wesley Jones, outlining the fundamental design of temperature maintenance and control systems for molds and melting kettles which was requested in your memorandum of 28 October, 1944. The report also lists the items of equipment which will be required for the various systems. We have not included such details as lengths of pipe and specifications for ordinary pipe fittings because we are not informed as to the exact geometry of the space where the systems will be installed and also because the engineer making the actual installation drawings would prefer to add such details.

It is our understanding that if the proposed schemes appear satisfactory to you, you will arrange for the ordering of equipment, construction of necessary buildings, the making of detailed installation drawings and the actual installation of equipment. This would presumably be done through Major Stevens or Major Salfingere. It would be very desirable for Moore and Jones to keep in close touch with the installation engineer doing the detailed designing so that he will know what portions of the design are essential for proper operation of the systems and what may be changed to suit exigiencies of availability of equipment or space without impairing the sucessful operation. I think too that Moore and Jones should be present when the systems are first operated at S site so that they can see if everything works as expected and make recommendations for operating procedure.

J. W. Stout

Enclosure

PROPOSED SYSTEMS FOR TEMPERATURE CONTROL OF KETTLES AND MOLDS

Introduction.

This report contains our recommendations for the design of the temperature maintenance and control systems, as requested in Captain Ackerman's memorandum of October 28, 1944. The requirements given there can, we believe, be satisfied by the schemes we propose.

The use of circulating systems with storage and heating tanks was considered necessary mainly to conserve water. Aside from questions involving the selection of satisfactory control devices, the control of the water temperature is also easier if a large heat capacity is provided in each system (by the tanks, in this case,) than if, for example, steam and water were mixed directly. While the saving of steam did not in itself determine any of the choices we made, efforts were made in the design to avoid unnecessary waste of steam.

The selection of the temperature regulating devices required consideration of two principal types, exemplified by the Sylphon valve and the Minneapolis-Honeywell Gradutrol System. The former is attractive on account of the simplicity and self-contained nature of the instrument. The latter might be advantageous because of the greater flexibility it offers in the way of adjustable throttling range of the control and its greater range, but its complexity and the need for compressed air and extensive piping for the air are highly undesirable. We discussed these questions to some extent with Mr. Ross of W. C. Kruger Architects, as suggested by Captain Ackerman in the memo of October 28; he made some valuable comments in comparing these instruments. and pointed out that the sensitivity of the Sylphon regulator is not stated by the manufacturer (that is, its throttling range) and in any case, was not adjustable whereas that of the pneumatic control can be adjusted. Accordingly, we made an approximate determination of the throttling range of a ½" Sylphon valve, that is, the temperature change of the bulb required to cause the valve to move from closed to wide open. This appeared to be about 3°F or less, at about 150°F for a 120°-180°F bulb, the 3°F temperature drop occurring in about 20 minutes. Other tests indicated that it does not depend very strongly on the temperature setting or on the rate of cooling of the bulb. This throttling range seems to be sufficiently narrow for our purposes, and at any rate, this can be effectively adjusted by varying the steam pressure behind the valve, thus changing the steam flow for a given valve position so that we feel confident that this type of control will work very well under any of the conditions likely to be encountered.

Under Item (e) of the memorandum of October 28, there are required by the scheme proposed some thermostatic mixing valves. We have indicated a commercially available type which would be entirely suitable, if each is equipped with constrictions to insure some pressure drop at the valve. However, we are trying to locate some mixing valves made in smaller pipe sizes which might be more convenient to use. Although we believe the system as described will work very well, it may be desirable to change this detail.

We have not indicated any layout details, such as spacing of the outlets on manifolds and actual location of equipment, since this may depend on the space available; in addition, the installation of these systems will require more space than is now available in 3-4, but we assume that construction will be planned to take care of this.

Recommended System for Kettle Heating.

A system for controlling the temperatures of the large kettles must involve circulation of the water, since the required rate of flow through the jacket would make the water consumption prohibitive if it were run to waste. This circulation rate was estimated by imposing the requirement that its temperature shall not drop more than 1°F in passage through the jacket; then, with an estimate of the heat loss to the surroundings, the rate was found to be about 12 gallons per minute.

There is the possibility of using a single circulating pump and heater for all the kettles; since, however, the temperatures of the kettles may be different (from 80° to 92°C,) this would involve mixing hot water (92°C) with "cold" water (80°C) to produce the required temperatures in this interval. Calculation shows that there is a most unfavorable situation with regard to steam consumption, and under these conditions the steam consumed would be about 6 lbs./min. An equivalent refrigeration load is also placed on the device used to cool part of the water to 80°C. This waste of steam is unnecessary and readily avoided if an individual system is used for each kettle.

The scheme recommended is shown in the drawing (Fig. 1). For each kettle, there is a storage tank with steam heating coil, and a circulating pump. The steam flow is controlled by a Sylphon regulator with the controlling bulb in the tank. The steam requirement is now only that needed to compensate for heat losses to the surroundings, which should be approximately 0.1 lb. steam per minute for each kettle with a steady state or roughly the same as in the present set-up. While it is true that more equipment is required for this scheme than for one involving a single heater and pump, this is largely offset by the absence of a cooling device and the controls required for its operation. Moreover, trouble with one system would not prevent the operation of t'e others.

Description of Operating Procedure.

Before starting up, the tank should be hot (or it can be heated up while the melting is being done with steam;) valves B and C are closed and the by-pass G is open so that the circulating pump simply puts water through the by-pass back to the tank. The melting of the explosive can then be done by opening valves A and E; the water initially in the jacket will be removed through the trap. When the desired temperature has been attained and the melting complete, valves A and E are closed, B and C are opened and by-pass G is closed, so that water at the tank temperature is then circulated through the kettle. This will cause the level in the tank to drop, but the liquid level control F then opens to the supply line to fill the tank again; a drop in temperature is thereby produced, but the heater should compensate for this in a few minutes.

As regards the melting of the explosive, it should be mentioned that the proposed scheme does not provide any automatic method for shutting off the steam when the melting is complete and the temperature rises above the melting point of the material; if desired, the arrangement now in use for doing this may be used. An alternative and perhaps more satisfactory method would be to heat up and melt the explosive entirely with hot water, keeping the tank at say 190°F. The temperature difference is thus great enough so that the time required would not be too great although somewhat longer than it is with steam. For example, a rough calculation based on an over-all coefficient of 60 BTU/hr.-sq.ft.-deg F shows that with a ΔT of 10°F, the time required to melt the explosive would be about 30 minutes. The time for heating the solid to the melting point is much more difficult to estimate because values of the over-all coefficient for comparable situations are not available, but the time should not be much different from that in which steam is used. With this method the temperature would not tend to rise as rapidly when melting is complete as it would with steam, and could be more readily controlled. The water temperature can then be lowered manually by removing a few gallons of water at the drain, H, and resetting the Sylphon valve control point at the desired valve; cold water makeup from F lowers the temperature.

Description of the Equipment and Its Proposed Installation.

The circulating pump and the tank and heater unit could be installed in the present machinery room in S-4, although there is not too much room available. The pump should be mounted on the floor with the tank at least 5 or 6 feet above the pump so that the pressure at the pump intake will never drop below atmospheric. The tank is provided with tapped openings for pump, return, overflow and drain connections. The control valve can be mounted at a convenient location near the kettle, with about 20 feet of connecting tubing for the

2277 0370

bulb, for which a fitting must be made in the tank in a location approximately as shown. There is also required a pressure regulator in the steam line as shown, mounted also in an accessible place. The liquid level control is float actuated and must be connected near the top of the tank. The overflow serves to maintain the tank at atmospheric pressure and to drain any leakage from the float valve.

Each steam line should be equipped with a strainer to protect the pressure regulator and the Sylphon valve.

The following equipment is recommended for each kettle system:

(1) Worthington Centrifugal pump, Type 1-CF-1, 20 G.P.M., 30 ft. head; 3/4 HP, 1800 RPM, explosion proof motor. Worthington Pump and Mach. Corp., Bull. W-310-B-10, page 4.

(2) Crane tank and heater unit #144, Crane Co., Catalog 6140, page 161-2. The tank capacity is about 140 gallons, and has about 9 sq. ft. heating surface in the coil. The trap used on this should be at least 3/4" to provide ample condensate removing capacity at 5 lbs/sq. in.

(3) Fulton Sylphon Temperature Regulator #930, 1/2" Type "A" valve; Range #70-H (160-200°F.) A single seating valve is recommended because it may have to close tight. The connecting tubing must be at least 20 feet for the proposed installation, but this may be affected by changes in the arrangement of equipment.

(4) Crane pressure regulator, 1/2"; 5#-30# reduced pressure; Crane Co. catalog #41, p. 411.

(5) Sarco liquid level control; Type LPM, Size #0. Sarco Co. bulletin 450, page 457.

(6) 2 dial thermometers; range 60-220°F; Sarco type DTW, 3½" dial, bulb U; Sarco Co. bulletin 1100, p. 1101. Any available make of vapor tension thermometer for this range would be satisfactory, if it is equipped with union fittings.

Production System

Three independent systems are provided meeting the requirements of items b, c, and d of Captain Ackerman's memorandum of October 28. The schematic diagram for all systems would be the same with the exception that the system providing water at 80-90°C might not have a cooling system.

As indicated in the accompanying diagram water from a tank is circulated with a pump through a number of units in parallel. The tank water may be held at a fixed temperature with steam, the flow of which is controlled by a Sylphon regulator. When it is desired to cool the units the supply of steam may be shut off from the Sylphon valve D and a portion of the water allowed to pass through a Sylphon regulator at A to a cooling tower. The bulb of the regulator A is located in the mixing chamber B where the cooled and uncooled portions join. The flow through those molds in use may be held constant, regardless of their number, by a by-pass valve J so operated manually that there is a constant pressure drop across the molds. It is possible to install a valve which automatically maintains the desired pressure difference. An air actuated valve of this type is available.

The molds may be heated initially with steam admitted through valve L, the condensate being removed through I. Steam may be shut off and circulation may then be started. When circulation is to be stopped valves G and K may be closed, and water drained from the molds.

Captain Forrest has available a cooling tower of adequate capacity together with a spray pump and a circulating pump. It is not planned to use the latter. The water to be cooled would go out to a section of the cooling tower and back. Of the eighteen coils in the cooling tower two coils operated in parallel appear to be quite sufficient for each of the three sections of the production system. As previously indicated cooling may not be needed for one of these systems. The cooling of separate systems by the single cooling tower is entirely feasible.

<u>Description of the Equipment and Its Installation.</u>

The outlet manifold should be located lower than the outlet from the molds to facilitate removal of condensate. Piping may in general be 1¼" except for the takeoffs from manifolds to molds and for the line from tank to pump. The latter should be 1½" pipe. The tank outlet should be at least 5 or 6 feet above the pump inlet. Tanks should be insulated. Piping should be insulated with the exception of the lines to the cooling tower and with the possible exception of the $20-50^{\circ}$C system.

The following equipment is recommended:

(1) For each system a Worthington centrifugal pump, Type 1-CF-1, 30 g.p.m. - 38 feet head; 1 HP, 1800 RPM, T.P. motor. Worthington Pump and Machinery Corp., Bulletin W-310-B-10, page 4.

(2) Crane tank and heater units. Nos. 180, 144, and 140 for the $80-92^{\circ}$C, $40-75^{\circ}$C, and $20-50^{\circ}$C systems. The last tank has 40 gallons capacity. The steam traps should be 3/4". Crane Company Catalog 614C, page 161-2.

(3) The valves at A should be Fulton Sylphon Temperature Regulators #930-Type "A", reverse acting 1/2" valves for the ranges:

(a)	70-H; $160-200^{\circ}$F	The valves should be specified to operate over the entire range in each case.
(b)	62-K; $120-180^{\circ}$F	
(c)	50-K; $60-120^{\circ}$F	

The length of connecting tube must be ordered sufficiently long so that the insertion of the bulb in the mixer may be achieved. Fulton Sylphon Company, Catalogue A, page 20-7A.

(4) The valves at D controlling tank temperatures should be Fulton Sylphon Temperature Regulators #930, Type A, direct acting 1/2" valves having the ranges:

(a) 70-H, 160-200°F
(b) 62-K, 120-180°F
(c) 58-H, 90-130°F

The valves should be specified to operate over the entire range in each case.

Fulton Sylphon Company, Catalog A, page 20-7A.

(5) Crane steam pressure regulators - 1/2" - reduced pressure 5-30 p.s.i. Crane Company, Catalog No. 41, page 411.

(6) Sarco liquid level controls; Type LPM, size #0, Bulletin 450, page 457.

(7) Dial thermometers; range 60-220°F, 60-220°F, 50-150°F; Sarco Type DTW, 3½" dial, bulb U; Sarco Company bulletin 1100, page 1101. Other comparable thermometers would be suitable if equipped with union fittings.

(8) Sarco mixing chambers, 1¼"; page 801 bulletin #800.

Experimental System.

In this case since the temperatures of the various outlets must be independently variable, the scheme recommended involves mixing cold and hot water to obtain any desired temperature in the two lower temperature ranges. The high temperature outlets are to be supplied directly from the source, (the tank and heater unit,) at a controlled temperature, variable between 80° and 92°C. The cold water to be mixed with hot water, as indicated in Fig. 3, is obtained by cooling a portion of the tank water in the cooling tower, this portion being determined by the demands of the various mixers. The evidently wasteful procedure of heating water, then cooling it, is made necessary in order to avoid running water to waste, as would be required if cold water from the house lines were mixed with that from the tank. The steam consumed in doing this is not excessive, owing to the small number of units, and amounts in the worst case to about 2.2 lbs. per minute; this assumes hot water at 92°C, cold water at 20°C. Of course, steam consumption could be reduced by cooling the water only as much as is required at any time by controlling a by-pass on the cooling tower, but the saving of steam does not seem to be worth the complications thus incurred in the operation of the system.

A single circulating pump is used, and the controls on the tank are identical with those used in the systems previously described. The mixing valves designated by S_1 and S_2 in Fig. 3, to indicate the two ranges required, are Sarco water blenders with mixing chambers and adjustable thermostatic control; these can be obtained set at any temperature and can be manually adjusted from the exterior over a 58°F range. They are not, however, available in sizes smaller than 3/4", so that at rates of flow which will be used, the pressure drop through the valve is very small. Now the pressure difference between cold and hot water streams may be as much as about 1 lb./sq.in. under some conceivable conditions, owing to the drop through the lines to the tower and back. Hence, it would be necessary to provide these devices with constrictions in the two inlet lines to avoid the possibility of the hot water stream going through the valve into the cold water. This can be done with orifices about 3/16" dia. placed in the 3/4" inlet lines to the mixer, or in a number of other ways, so that

2277 0375

if these are the only available mixers, they can be used quite satisfactorily. We are attempting to locate some other types, made in smaller sizes, which might be more convenient to use.

In any case, the piping to and from the cooling tower should not be smaller than 1¼" pipe, and if any valves are placed in this line, they should be gate valves so as to minimize the above-mentioned difficulty. It is proposed to use four coil sections of the previously mentioned cooling tower for this system, thus leaving about ten sections available for other possible uses in the future.

If it is desired to heat the molds initially with steam, this may be done by connecting the sections of molds in series, closing valves E and F, and opening G and H. If this arrangement is used, the outlet manifold should be lower than the mold outlets so that condensate will be removed more readily.

<u>Recommended Equipment.</u>

(1) Worthington Centrifugal pump 1-CF-1; 20 g.p.m., 30 ft. head; 3/4 HP, 1800 RPM, explosion proof motor. Worthington Pump and Machinery Corp., Bulletin W-310-B-10; page 4. The pump inlet should be located at least 5 feet below the tank outlet.

(2) Crane tank and heater unit #180, Crane Company Cat. 6140, p. 161-2.

(3) Fulton Sylphon temperature regulator #930; type A direct acting 1/2" valve with range 70-H, 160-200°F. Fulton Sylphon Company, Cat. A, p. 20-7A.

(4) Crane steam pressure regulator, 1/2", reduced pressure 3-30 p.s.i.; Crane Co. Cat. 41, p. 411.

(5) Sarco liquid level control, type LPM, Size #0; Sarco Company, Bull. 450, p. 457.

(6) Sarco Water Blenders, Type MB; 3/4", iron body; 4 required set at 130°F.

(6 continued) Sarco Water blenders; Type MD-DS, 3/4", iron body; 4 required, set at 90°F. Eight 3/4" mixing chambers for these should also be obtained. Sarco Company, Bulletin 800, page 801.

(7) The orifices mentioned above may be constructed from thin discs by drilling 3/16" holes in their centers. These discs can be mounted in 3/4" flange union joints with gaskets, placed in the inlet lines to the blenders.

20 November 1944

Lt. Hopper

Captain Ackerman

Tests of a Method for Reducing Heavy Component Segregation.

1. This confirms Dr. Kistiakowsky's recommendation of last Friday that we conduct tests to determine whether the addition of a percentage of PETN to Composition B and Torpex would assist in reducing the segregation of the heavy components.

2. His proposal is to add sufficient percentage of PETN to cause the crystallisation of the eutectic at a temperature well above the freezing point of TNT. This means it may be possible to pour Composition B containing PETN addition at a comparatively high temperature; say, 95° C. The total percentage of PETN etc. should be so controlled so that a comparatively small drop in the temperature of the melt will cause PETN to freeze out, thereby introducing a solid component that would prevent further settlement of RDX.

3. Please assign this problem to personnel, allowing full latitude for tracing out the various phases which may be involved. I believe that I can find some information on the effect of PETN on the freezing point of the mixture if you will have the man concerned visit the library.

J. O. ACKERMAN
Captain, C. E.

JOA:mw

cc: Dr. Kistiakowsky