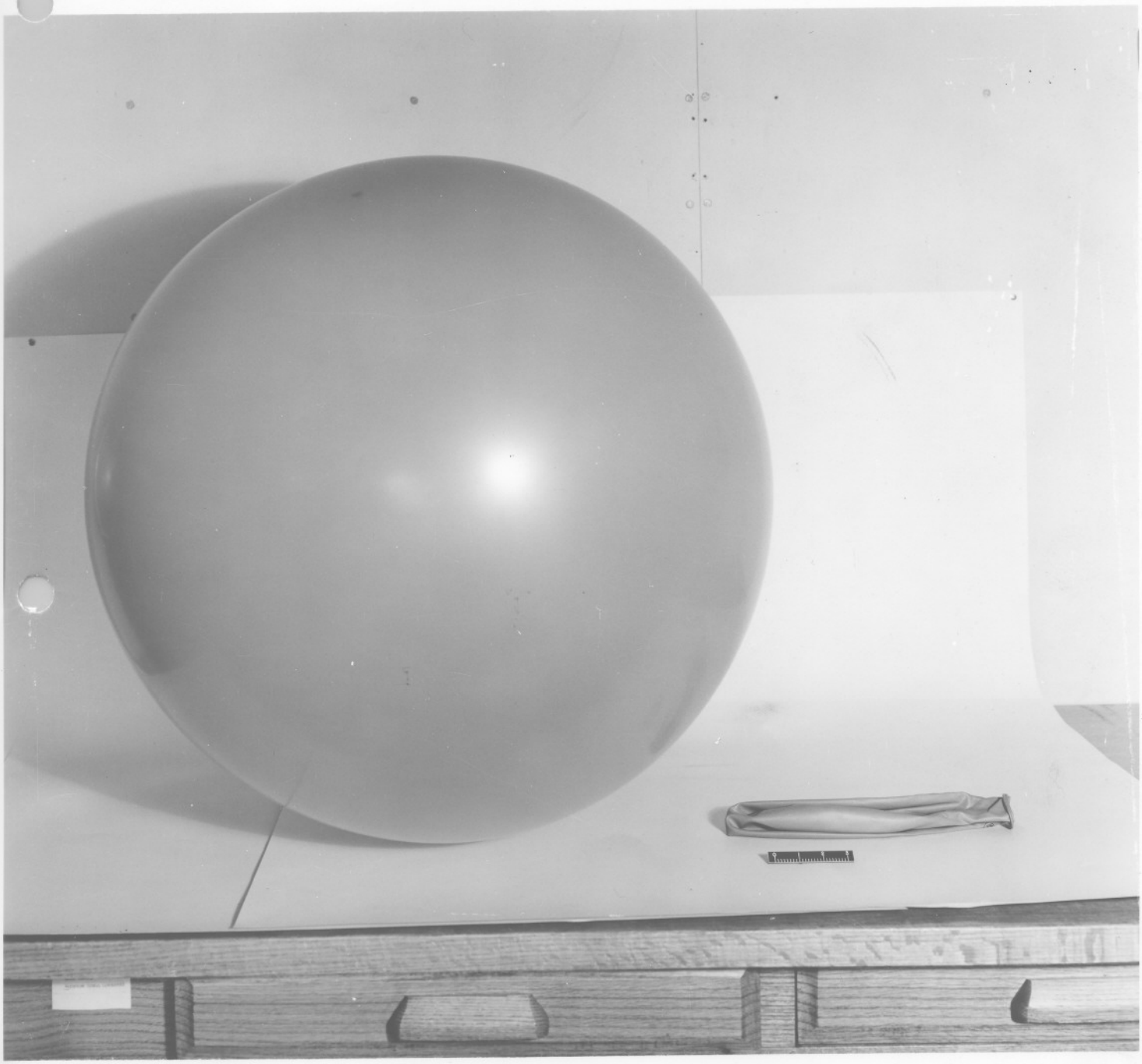
UNCLASSIFIED



UNCLASSIFIED

30 GRAM BALLOON (ML-50 Pure Gum; ML-51 Black; ML-64 Red; ML-155 Orange; ML-156 Yellow)

Part of Meteorological Equipment . Inflated (Left) . Deflated (Right)

SCGSS-IAB-(30)-7-20-43

~~SECRET~~

HYDROGEN GENERATORS
INTRODUCTION

Large quantities of hydrogen are needed by the Armed Forces for meteorological purposes. The hydrogen was formerly generated at central points and transported to the field in steel cylinders requiring tremendous shipping facilities both to and from the fields of action. Due to the war, shipping facilities were at a premium, and steel became a critical item, which created the immediate need for a substitute for hydrogen cylinders to fill the requirements of the Armed Forces.

PRELIMINARY INVESTIGATION

In August 1940 the Air Corps at Langley Field, Virginia recommended investigation by the Signal Corps Laboratory the problem of procuring and developing an equipment to be transported by truck or trailer which can be used to generate hydrogen gas from chemicals. The equipment was to be used as an emergency source of hydrogen gas for meteorological units in the fields which were not near sources of commercial hydrogen. A hydrogen generating equipment used by Pan American Airways was inspected, later a model was procured.

Suggested Military Characteristics were forwarded to the Chief Signal Officer on 26 November 1940 in 2nd Wrapper Indorsement, file FM(SCL) 665.2 Project 9-5, OCSigO 413.44 (SCM-1(8-19-40). By February 1941 a model of a hydrogen generator for Laboratory experiments had been designed at the Signal Corps Laboratories and was being tested to determine the efficiency of generation.

~~SECRET~~

CALCIUM HYDRIDE METHOD OF GENERATION

In January 1941 an investigation of the calcium hydride method was started. This method uses calcium hydride and water instead of ferrosilicon, caustic soda and water as employed in Hydrogen Generator ML-185-() and seemed to be more desirable because of the possibility of controlling the generation cycle, decreased space, weight required for equipment, and the absence of poisonous by-products.

In July 1941 an investigation was conducted to determine the most suitable method of dehydration of the hot gas. In November 1941 a model of a hydrogen generator including a condensing heat transfer unit had been constructed. This unit was tested and found adequate.

In January and February 1942 experiments were carried on regarding methods of feeding calcium hydride into the reaction chamber in the form of pellets and then tablets.

Two types of generators which use calcium hydride were developed:

A small, single-charge unit to produce a maximum of 25 cubic feet per charge, weighing approximately 2 lbs. The nomenclature Hydrogen Generator ML-303/TM was assigned in July 1943. (See Inclosure 2.)

A larger unit weighing about 120 pounds to produce 100 cubic feet of hydrogen per charge. This unit was designed so that the generation of gas could be stopped at any time and continued when additional gas was needed. Nomenclature Generator ML-165-T2 (Hydrogen) was assigned in May 1943. (See Inclosure 3)

In October 1942 a sample Generator ML-165-T1 (Hydrogen) was submitted

for test by the Independent Engineering Company and necessary modifications determined. Procurement of twelve generators of the latest design was initiated. In November 1942, a contract was awarded to the Smith Welding Corporation for the development model of a hydrogen generator based on their standard acetylene generator. Nomenclature Generator ML-165-T2 was used for this model.

This Laboratory in cooperation with the American Can Company developed a lightweight sheet metal generator weighing one pound nine ounces. This model was assigned nomenclature Hydrogen Generator ML-303/TM(XP-1). A limited number of Hydrogen Generator ML-303/TM(X)O-1) are being used by the Army Air Forces in special fields of operation where extreme portability is necessary.

In accordance with authority contained in letter file SPSAR 413.6 Meteor. dated 1 September 1943 to Director, Eatontown Signal Laboratory from OCSigO, two each Generators ML-165 (Hydrogen) and five each Generators ML-303/TM(XO-1) were shipped to the Field Artillery Board, Fort Bragg, North Carolina for an extended service test. The service test is still under way.

DEVELOPMENT OF SODIUM BOROHYDRIDE

In April 1943 a contract was awarded to the University of Chicago for the development of sodium borohydride for use in the generation of hydrogen. A practical laboratory technique was developed which is being used in the pilot plant development by the Ethyl Corporation. In June 1943 a contract was awarded to Ethyl Corporation to develop a pilot plant for production of sodium borohydride which could be suitable for commercial production, and also, to develop a hydrogen generator suitable for use with sodium borohydride. Material has

been produced in the pilot plant and has been tested with several model generators with promising results.

EMPLOYMENT

Hydrogen generators are required for supplying hydrogen for meteorological balloons - both pilot and radiosonde. These balloons are used by Army Air Force Weather Stations in gathering meteorological data for forecasting weather and by artillery units of Army Ground Force in determining meteorological corrections for artillery fire and sound ranging.

Generator ML-185-() (Hydrogen) is the only standardized generator. One thousand or more have been procured and are in use wherever American forces are operating.

Generators ML-165-() and ML-303/TM(XO-1) are being service tested. A limited number of the latter are used in field of operations where extreme portability is necessary.

DEVELOPMENT

Military Characteristics for the hydrogen generator were recommended by SCTC Meeting 189, 24 March 1941. A copy is included as Inclosure #1.

GENERATOR ML-185-( ) (Hydrogen)

On 20 April 1942 Pan American Airways Hydrogen Generator PAA-1940 was approved for procurement by the Signal Corps as the first commercially available generator to meet the needs of the Army. This generator was satisfactory equipment for the production of hydrogen, but considered heavier than desired and the residue of the reaction was extremely caustic. On 24 June 1942, nomenclature, "Generator ML-185-( ) (Hydrogen)", was assigned to Hydrogen Generator PAA-1940 and Specification No. 74-50 prepared. Generator ML-185-( ) (Hydrogen) utilizes ferrosilicon, caustic soda and water and has several features which were undesirable for general field use when compared to the calcium hydride method. (See Par. 3 below).

The Field Artillery Board service tested the Generator ML-185 ( ) (Hydrogen) from 1 October 1942 to 28 November 1942. The object of this test was to determine the suitability for field artillery use. The Field Artillery concluded that Generator ML-185-( ) (Hydrogen) with slight modifications was suitable for Field Artillery use and preferable to hydrogen cylinders. The Coast Artillery Board and Antiaircraft Artillery Board concurred with the recommendations of the Field Artillery Board's report.

~~SECRET~~

S.C.T.C. No. 189
3-24-41

EXHIBIT A
CHARACTERISTICS
HYDROGEN GENERATOR

General: To provide a means for the emergency generation of hydrogen gas for meteorological balloons when commercial sources are not available.

Size: Should be readily transportable by means of a truck or trailer.

Weight: Not to exceed 300 lbs.

Construction: Sufficiently rugged to minimize danger to using personnel. A safety valve should be provided to blow off at a pressure well within the tested limits of other parts of the equipment.

Gas transfer: Means should be provided for transferring generated hydrogen to the tanks normally used for storage of this gas.

Process: Should involve the use of dry chemicals only, or dry chemicals and water.

Safety: The ingredients should be non-poisonous.

Rate of Generation: Not less than 800 cubic feet per 24 hour day.

~~SECRET~~

~~SECRET~~

LIGHTWEIGHT CEILING LIGHT PROJECTOR
INTRODUCTION

In connection with the development of Mobile Meteorological Station SCM-1, there were a number of items of standard equipment which required modification to adapt them for use in a mobile station. One of these was Ceiling Light Projector ML-121, which was impractical for use in this station because of its excessive weight and size, and high power requirements.

PRELIMINARY INVESTIGATION AND DEVELOPMENT

With the idea in mind of developing a suitable ceiling-light projector which would fulfill the requirements of a mobile station, and utilize Wire W-110-B rather than an expensive cable, development of lightweight equipment was initiated in the latter part of 1941. By February of 1942 a laboratory model of a portable ceiling light projector had been constructed. This model weighed approximately 50 lbs. in comparison with 140 lbs. for Ceiling Light Projector ML-121, and used less than 5% of the copper and 36% of the rubber required for the cable in Ceiling Light Projector ML-121. A suitable mirror and lamp were provided in order to permit cloud ceiling measurements up to 10,000 feet. In May 1942, accessories for the lightweight ceiling light projector were provided to allow remote control by the observer from a distance of 1000 feet. An automatic voltage stabilizer was later developed to provide the proper lamp voltage for both local and remote operation where power facilities were available.

With the procurement of twenty Mobile Meteorological Stations SCM-1-T3

~~SECRET~~

in August 1942, twenty lightweight ceiling light projectors were included. These were purchased from United States Metal Products Company, in accordance with the model as developed in the Signal Corps Laboratories. Although not standardized, several additional procurements of lightweight ceiling light projectors have been made since that time for inclusion in later models of Mobile Meteorological Station SCM-1 and also Meteorological Station AN/TMQ-1, and approximately 150 units are now in the field in the various theaters of operation.

CURRENT DEVELOPMENT

Although military characteristics have not been set up, authority was given in letter from OCSigO file SPSRD 111 R&D Program FY-1943 dated 10 February 1943 to set this development up as a separate project.

Preliminary drawings and specifications for this equipment were completed in May 1943 incorporating additional improvements. Twelve ceiling light projectors of the latest design were procured in June 1943 from Crouse-Hinds Company, ten of which were used in service-test models of Meteorological Station AN/TMQ-1, developed under another project. This is illustrated by Inclosure 1. For use with Meteorological Station AN/TMQ-1 a hand generator was developed to permit local operation of the projector in those locations where power supply would not be available.

At the present time development of a complete self-contained portable ceiling light equipment set is in progress. In addition to the projector proper, this set includes a hand generator, voltage stabilizer, clinometer, steel tape, and a carrying case which also serves as a support. A directive dated

12 May 1943 file SPSAR 413.6 Meteor., was received from the OCSigO to procure five models of lightweight ceiling light projectors for service test. These models are of the type described above and procurement has been initiated.

EMPLOYMENT

The Army Air Forces are the only using arm for this equipment to date. It is particularly valuable for their service because of its small size, light weight, and reduced power requirements which make it suitable for transportation to forward areas by aircraft or truck, and because its performance is comparable to that of the standard Ceiling Light Projector ML-121 which is only applicable for fixed station use.

METEOROLOGICAL MAPS, FORMS, CHARTS and PLOTTING DEVICES.

Authorization	Descrip. of Item or Device	Present State of Develop.	Use and Advantage of Development.
Le. fm. CSigO 5 Mar. 43	Request made that the Lab. furnish procurement data covering charts for recording meteorological instruments.	Contact was made with the Nat'l Bureau of Standards, the U.S. Weather Bureau, and Julien P. Friez from which sources samples of paper and specifications for various kinds of paper were obtained. On 10 Sept. 1943 the project was transferred to OC, Insp., Avon Branch, FMSL.	
Le. fm. CSigO 19 Mar. 43	"Meteorological Data Sheet for Artillery (100 gram balloon)." Similar to Form S.C. No. 206 except that it is designed for use with 100 gram balloons.	Samples of proposed Form S.C. No. 236 were mailed to OCSigO on 3 Dec. 1943.	This form will serve the same purpose in connection with wind observations on the 100 gram balloon as Form S.C. No. 206 serves in observations on the 30 gram balloon, namely, for recording zone winds and ballistic winds. Form S.C. No. 206 is not suitable for the first mentioned purpose due to difference in ascensional rate of the two types of balloons.
Verbal Dir. fm. Chief, Engr. Div. Feb. 43	"Diurnal Pressure Change Correction Chart, in Millibars." An adaptation of a similar U.S. Weather correction chart having the corrections expressed in inches.	Proposed charts submitted to OC, Met. Branch, 8 Dec. 1943, for forwarding to the Weather Wing, Army Air Forces, for consideration.	Charts will be used by forcasters in making allowance for the diurnal change included in the reported pressure tendencies. Since pressures are reported in millibars auxiliary charts used with pressure data must be in terms of the same unit.

Le. fm. CSigO 14 Jan. 43	"Barometric Corrections" Form #79. A card, about 2 3/4" x 5 1/4" in size, on which the constant corrections to a given varometer are entered and summarized. The revised form has provision for entering the corrections in millibars as well as inches.	Revision completed. Proposed forms are to be forwarded to OCSigO for approval.	Revision necessitated by changing from inches to millibars in measurement of pressure. Old form therefore obsolete.
Le. fm. CSigO 14 Jan. 43	Correction card for scale error and capillarity of barometer. Form #81. About 2 1/2" x 5 1/4" in size. Used for entering correction for scale error and capillarity by official testing barometer. The revised form has provision for entering the correction in millibars as well as inches.	Revision completed. Proposed forms are to be forwarded to OCSigO for approval.	Revision necessitated by changing from inches to millibars in measurement of pressure. Old form therefore obsolete.
Le. fm. CSigO 27 Apr. 43	Original request was for development of device for computing wind shear factors and direction of isentropic isobars on Plotting Board ML-122. Investigation revealed that the plotting required in the evaluation of wind shear factors and direction of isentropic isobars can be accomplished on Plotting Board ML-122 by the use of Rule ML-126 and Scale ML-177.	Instructions for the use of Plotting Board ML-122, Rule ML-126, and Scale ML-177, in combination for obtaining wind shear factors and direction of isentropic isobars were sent to OCSigO, 3 June 1943.	The development of a new tool became unnecessary.

Le. fm. CSigO 12 May 1943	Pibal Graph, Form S.C. No. 204 (Revised 15 Sept. 1943). A form about 11" x 17", with a coordinate grid about 8" x 13 1/4" along the margins of which there are vertical scales graduated in kilometers, thousands of feet, and thousands of yards above sea level; along the top margin are scales of wind direction to ten degree points and to compass points, as well as punch card code figures; and along the bottom are scales for wind velocity in miles per hour and meters per second.	Form is being printed at Government Printing Office.	Form S.C. No. 204 has been designed for use in plotting upper air wind speed and direction from data obtained in pilot balloon observations on the 30 gram and 100 gram balloons, from the surface to the top of the flight. It has the advantage over older graphs designed for this purpose in that the altitude can be read off after the graphing has been completed in either meters, feet, or yards, and the velocity scale extends over the range from 0 to 120 miles per hour.
Le. fm. CSigO 10 Aug. 43	S.C. Charts ML-123-C and ML-123-D, Adiabatic Charts. These charts supersede ML-123-A and ML-123-B and are based on the Weather Bureau Charts 1126A and 1126B, the latter being used as models.	Revised charts forwarded to OCSigO, 30 Aug. 1943.	Charts ML-123-C and ML-123-D have horizontal height scales for plotting the pressure height curves, and vertical height scales by means of which the pressure at 5, 10 and 20 thousand feet, and at 10, 13 and 16 km. can be read off the chart very conveniently. These scales are lacking on Charts ML-123-A and ML-123-B.
Le. fm. OSigO 17 Aug. 43	Form No. 80, "Correction of Mercurial Barometer for Temperature." Originally this table of corrections to be applied to the reading of the barometer to reduce the reading to standard temperature contained corrections in inches for the temperature range 16 to 105°F and for barometer readings from	Revision completed. Tables are to be forwarded to OCSigO for approval.	The revised table will make possible reduction of barometer reading to standard temperature whether barometer is graduated to read in inches or in millibars. The extension of the temperature scale to 120°F and 50°C will make the table adequate for use in very hot climates where the original table was inadequate.

	24 to 31 inches. The revised table will have corrections in inches for the temperature range to 120°F and for barometer readings from 22 to 31.5 inches, as well as a table for interpolation between tabular correction values. In addition, it will have corrections in millibars for the temperature range 0 to 50°C and for barometer readings from 740 to 1060 millibars, as well as a table for interpolation between tabular correction values.		
Le. fm. CSigO 2 Nov. 43	The project involves inclosing any meteorological map, chart, diagram or table within two thin sheets of vinylite which are heat pressed together to form one sheet.	Report on informal investigation of vinylite meteorological charts was submitted to OCSigO, 22 Dec. 1943. Service test quantities of these charts will be available by 1 Feb. 1944.	Surfacing existing meteorological paper charts with plastic material is expected to provide a longer life, greater durability, and a more satisfactory writing surface for the charts.
Le. fm. CSigO 12 Aug. 43	A Circular Psychrometric Slide Rule for Low Temperatures. Designed for evaluation of dewpoint and relative humidity from given temperature values in °C for the range 0° to -50° of the dry bulb and wet bulb thermometers and for pressures ranging from 1000 to 400 millibars, scales being computed for every 100 millibars. For the evaluation of the dewpoint the design is based on description and drawings submitted by OCSigO, 12 Aug. 1943. Necessary scales for evaluation of relative humidity have been added.	Laboratory models of the psychrometric slide rule were made in the Laboratory in Oct. 1943. Two copies were immediately made available to Mr. Wilson, ESL, for use at Mitchel Field, L. I., N. Y. in a special project involving determination of the moisture content of the atmosphere on the basis of data obtained from psychrometers mounted on aircraft. One copy was forwarded to OCSigO, 10 Nov. 1943.	This slide rule was designed and laboratory models were made because a specific need existed for some means of evaluating dewpoint and relative humidity at low temperatures and low pressures. By making laboratory models and utilizing them in solving the problems the slide rule was designed for it was possible to evaluate the basis design submitted for study and comment.

Le. fm. CSigO 12 May 43	Meteorological Slide Rule, 20 inch. This slide rule will be similar to the 20 inch Log Log duplex rule, manufactured by Kauffel, Esser, except for special scales and scale arrangement. On the front face the standard K, A, B, Sin Tan, C. D, and L scales will appear. On the reverse side there will be eleven specially computed scales for obtaining dewpoint relative humidity, vapor pressure, and mixing ratio.	Computation and typing of scales and drafting of the rule have been completed. Design is awaiting approval by Technical Advisor. After basic design has been approved, 10 rules will be procured for field test.	This slide rule will in the first place serve the general purpose for which any standard slide rule is designed, and in the second place will make possible by simple settings the evaluation of dewpoint, relative humidity, vapor pressure, and mixing ratio; the three first mentioned elements being evaluated in surface observations, and the last mentioned in radiosonde observations.
Le. fm. CSigO 12 May 43	Scale ML-311/TM. Scales for computing Isentropic Isobar Data. Consists of a transparent sheet of vinylite, 6" x 12" x 40". on which have been engraved the Lapse Rate Template, the Wind Direction Template, and the Wind Velocity Difference. Template; three scales originally computed by the U. S. Weather Bureau for use in obtaining isentropic isobar data from simultaneous pilot balloon and radiosondi observation data. The Wind Direction scale and the Wind Velocity Difference scale are for use on Form SC No. 204 and the Lapse Rate for use on Chart ML-123-C.	Scales are at present in production. The Sillcocks-Miller Co. is to produce 2000 units.	The combination of the three originally separate scales on one sheet of vinylite has the advantage of compactness and the plastic material on which they are inscribed insures durability as compared to paper, the material on which two of the scales were originally printed.

Le. fm. CSigO 12 May 43	"Tables, Computation and Conversion for Radiosonde Observations". These tables are of U. S. Weather Bureau origin. Directive requested that a manuscript of a single manual to include all charts and tables to which reference is made during the process of evaluating radiosonde observation data be prepared. The revision included reduction of all tables to the same size, rearrangement of the tables in the order in which they are most frequently used, and rearrangement of the material on certain pages as well as an extension of some tables.	Manuscript was prepared and forwarded to OCSigO for approval by about 1 Sept. 1943.	By having all the tables of uniform size, durably bound in a heavy cover, and arranged in the order in which they are most frequently used, the tables will have a longer life and afford greater ease in use.
Le. fm. CSigO 25 Aug. 43	After the submitted description and sketches of "Calculator for Observers," had been studied the conclusion was reached that the device could not be practically developed for pressure reductions since the design limited its use to the station for the elevation above sea level of which it had been constructed Usefulness of a device for obtaining sea level pressure from any given values of station pressure, temperature, and height above sea level being apparent, especially at mobile weather station, the development of a universal model was undertaken.	The designing of the universal model and the necessary computation of the scales was accomplished between Sept. and 1 Oct. 1943. Subsequently approximately six laboratory models were produced, one of which was forwarded to OCSigO on 9 Nov. 1943 for appraisal.	By placing the discs in certain positions relative to each other it is possible to reduce station pressure to sea level pressure to obtain "altimeter setting", to obtain the pressure at a specified height above the station, to obtain the distance between two isobaric surfaces and in general, to obtain the solution to problems involving atmospheric pressure temperature and altitude.

	This Pressure Computer consists of four concentric discs of from 8" to 12" diameters, and an indicator arm of transparent plastic material with an engraved hairline. Discs are held together by a rivet placed at their common center. Ten scales are inscribed on the discs which allow pressures to be expressed either in inches or millibars, station elevation above sea level either in feet or meters and temperatures either in °F or °C. The range of the pressure scales is from 23.5 to 31.5 inches (800 to 1070 mc.), the temperature scales from - 50°F to 135°F (-48°C to 58°C), and the altitude scales in feet and meters are unlimited since they are logarithmic and continuous.		
Le. fm. CSigO 7 Dec. 43	Graphing Board ML-312/TM consists of a sheet of tempered Masonite, 18" x 20" x 1/4". Spring slip at top for holding Form SC #204, two plastic scales, and a moveable plastic ruler. Scales graduated in minutes corresponding to the elevations of both 30 gram and 100 gram balloons above the observation point. Scale at left of board reading upward from the bottom of the sheet scale at right reading downward from the top. The moveable plastic ruler remains at right angles to the scales, and is graduated in terms of wind speed and direction, corresponding to the ordinates on From SC #204.	Development and drafting completed. Ten graphing boards will be available for service test by 1 Feb. 1944.	The graphing board has been designed for use with Form S.C. #204. Through its use greater accuracy can be obtained in the plotting of the wind speed and direction as obtained from pilot balloon observations than otherwise would be possible and a saving of from 50% to 75% of the time required to plot a pilot balloon flight can be affected.