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Operations and Logistics of Ice-Cap Party Crystal, 1954

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OPERATIONS AND LOGISTICS OF ICE-CAP PARTY CRYSTAL, 1954

by
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ABSTRACT

Party Crystal was a small mobile scientific party whose purpose was to make snow studies on the ice cap, as a part of the Corps of Engineers activities in northern Greenland in the summer of 1954. The over-all rate of travel was slow, with a great deal of time spent at test stations en route. Wannigans were used for living quarters and weasels for hauling the wannigans and a variety of scientific equipment. Fuel consumption averaged 1.8 mi/gal. The 5-in-1 and C-rations which formed the bulk of the food supply were not satisfactory because of the weight involved — 7.4 lb/man/day including packaging were required. It is expected that the operational details will be useful for planning future projects of this nature and, to a certain degree, for planning any small ice-cap party.

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I. INTRODUCTION

1. The Corps of Engineers' activities in northern Greenland (1954) included a small mobile scientific party whose purpose was to make snow studies on the ice cap; this was Corps of Engineers' Project 12 and was known as Party Crystal in the field. This report covers the operational and logistical aspects of Party Crystal's activities. The work carried on by Crystal was very specialized. It is expected that the operational details will be useful for planning future projects of this nature and, to a certain degree, in planning any small ice-cap party. Perhaps the main difference between Party Crystal and other ice-cap parties lies in its time schedule. The over-all rate of travel was slow, with a great deal of time spent at test stations en route. A seismic party, for example, covering the same area would be able to move faster.

II. PERSONNEL

2. The group consisted of six men as follows:

2 men from SIPRE

(a) Party Leader	Mr. Carl S. Benson
(b) Asst Party Leader	Mr. James A. Bender, 25 May-7 July Mr. Richard H. Ragle, 8 July-21 Aug

4 men from Transportation Corps Arctic Group

(a) Navigator	2nd Lt Jerry J. Cotter, 04016288
(b) Medical Aidman	SFC Michel P. F. Barillet, RA14290951
(c) Mechanic	Pfc Dale R. Beranek, US55409012
(d) Radioman	Pvt William W. Sanderson, US51273306.

According to plans made prior to the field season, Mr. Bender left Party Crystal on 7 July to begin his own program of research and Mr. Ragle joined the party in Mr. Bender's place.

Lt Cotter was relieved from his duty as navigator of Party Crystal on 8 July. He was picked up by a Poleax* swing, which passed Crystal on the trail, and returned to Thule for work on a test program. Pvt Sanderson left Party Crystal on 2 August because of illness. He was evacuated by air to Thule.

III. EQUIPMENT AND SUPPLIES

Trail equipment.

3. Most of the trail equipment was drawn from the Transportation Corps Arctic Group. The party traveled and lived in weasels and wannigans. The wannigans were the light, canvas-covered models that were originally used in 1952. The major items of equipment and supplies essential to travel and living on the ice cap were as follows:

Four weasels M-29C (numbers 16, 17, 19, and 20)
Two canvas-covered wannigans (living quarters for two men in each wannigan)

* Designation for tractor supply trains.

Two cargo sleds (1-ton capacity)
Fuel, lubricants, and spare parts for weasels
Rations
Communication equipment
Navigation equipment
Arctic clothing and individual mess gear. (A portion of the Arctic clothing for the civilian members of the group was furnished by the men themselves, and some of it was furnished by SIPRE.)

The additional trail equipment may be listed under two headings:

Trail equipment per weasel:

Quantity	Item
1 ea.	Fire extinguisher CCl_4 type (fits on weasel)
1 ea.	First-aid kit
1 ea.	Probe bar, 12 ft long
1 ea.	Steel cable, 20 ft long
1 ea.	Shovel (scoop type)
1 ea.	Ice ax
1 ea.	Sled tongue complete with clevices
1 ea.	5-gal water can
1 ea.	Gasoline nozzle
1 ea.	Grease gun
1 ea.	Jack
1 ea.	Blowtorch
1 ea.	Flashlight w/extra batteries
5 lb.	Scrap rags
2 ea.	Bars of mechanics soap
4 ea.	GI blankets
1 ea.	GI brush
1 ea.	Whisk broom
1 pr.	Skis and ski poles (w/wax for dry and wet snow)
1 pr.	Crampons
1 pr.	Rubber hip boots

Trail equipment for the group:

a. Emergency equipment

2 Large fire extinguishers (15-lb CO_2 type)
1 Five-man arctic tent w/tent pole (see general trail gear below)
2 Signal pistols
12 Red flares (parachute type)
20 Smoke grenades (10 red, 10 yellow)

b. Medical equipment

1 Medical chest (foot locker)
First-aid kits (already mentioned, one per weasel)

c. General trail gear

1 Five-man arctic tent w/tent pole. This is considered as emergency equipment as well as an item of general trail gear (3-ft wooden stakes and other items of equipment were used in place of the small aluminum tent stakes, which are useless in snow)
4 Spare tow bars: old-type, straight bar with loops at each end (included so that two wannigans or sleds could be hooked together if necessary)
1 Spare towing tongue; triangle reinforced type
6 Spare towing clevices
2 Barrel pumps (1 diaphragm type, 1 rotary type)
75 5-gal gas cans for gasoline, oil, and white gas
2 Pointed-nose general-purpose spades
2 Crowbars
2 Wrecking bars
2 Ice chisels
1 Crosscut saw
1 Ripsaw
2 Hatchets with claw (roofer's type)
5 Blocks of wood (assorted dimensions) for jacks
3 Canvas tarps (20- x 20-ft canvas fly)
2 lb Nails (assorted), roofing nails, 3-in. nails, etc.
1 Reel of safety wire, 10 ft
3 Large frying pans
1 Coleman Handy gas plant stove, 5-in. burner model 457G (gasoline) (furnished by SIPRE)
10 Rolls of adhesive tape (5 yd long, 3 in. wide)
Rope:
200 ft sash cord #8
100 ft manila, 1/2 in.
120 ft nylon climbing rope, 1/2 in.
1 5-lb can of waterless soap

d. Navigation equipment

1 Theodolite, Wild T-2, complete
1 Pocket watch, Hamilton, 24 hr
1 Compass, sun w/case
1 Magnetic compass mounted on navigation weasel
1 Barometer, aneroid
1 Altimeter
1 Pair dividers
1 Protractor, plastic, 4 in.
1 Weems Aircraft plotter
1 Triangle, 45 deg
1 Ruler, engineer-scale, 6 in.
1 Architect scale, 12 in.
Publications:
Bowditch, *American Practical Navigator* (1943).
Navigation and Nautical Astronomy, 10th Ed. (Dutton) (1951)
Nautical Almanac, 1954
H.O. #214, 70 deg through 79 deg

Publications (Continued):
Vega Tables of Logarithms
Charts
Logbook

e. Communication equipment

Radio set SCR-193 consisting of:
1 Radio receiver BC-312
1 Radio transmitter BC-191
1 Transmitting tuning unit TU-6
1 Transmitting tuning unit TU-7
1 Dynamotor unit BD-77
Supply of miscellaneous equipment such as:
Radio tool kit, spare fuses, message blanks, and pencils

f. Weasel parts and maintenance tools

1 Complete mechanics tool kit including soldering iron, copper tubing, and other miscellaneous items
1 Carburetor
1 Generator
1 Fuel pump, electric
2 Sets of ignition points
50 Spark plugs
2 Condensers
2 Coils
1 Voltage regulator
2 Fan belts
1 Idler wheel
1 Drive sprocket
1 Set of guide wheels for tracks
2 Sets of bogie wheels

Arctic clothing.

4. The clothing worn by members of the party varied a great deal according to personal preferences. The clothing must be able to withstand wind and low temperatures. Wind is by far the most troublesome factor in summertime ice-cap operations. During windy weather every man wore a windproof jacket in addition to the windproof field pants which were worn at all times.

Footgear is a very important item. The type of work carried on by Crystal made it necessary for members of the party to stand in cold snow without much foot movement for long periods of time (working in study pits or surveying). It was necessary to have changes of socks and boots available. Surface melting during part of the season made the footwear problem more pronounced. The VaBar rubber insulated boots are excellent for use under conditions where dampness is expected. Canvas covered mukluks (with wool and felt socks for liners) are very good for continuous work in cold, dry snow. Canvas mukluks, however, become wet and unsatisfactory whenever worn while any melting is taking place; they are also unsatisfactory for combined indoor and outdoor wear unless greater care is exercised by their users than has been common in the past.

The following list represents the clothing requirements of a single individual. The exact

selection of items and the quantities involved will inevitably be subject to personal preference; however, some things are absolutely essential, such as woolen underwear (two sets), windproof outer clothing, and adequate footgear.

a. Footgear

1 pr. VaBar rubber insulated boots
2 pr. Mukluks, cold dry (rubber-bottom type)
3 pr. Felt socks for mukluks
1 pr. Felt boots ("Bunny Boots")
8 pr. Felt inner soles
8 pr. Wool ski socks (heavy)
10 pr. Cotton cushion-sole socks

b. Hand gear

2 pr. Arctic mittens, outer shell (convenient size for working, such as chopper's mittens)
3 pr. Woolen mittens
3 pr. Woolen gloves
2 pr. Nylon gloves
2 pr. Leather gloves (flexible for instrument work)
1 pr. Leather work gloves

c. General clothing

1 Pile-lined field cap
1 Lightweight field cap w/sun visor
1 Wool stocking cap
1 Field jacket w/liner and hood
1 Parka shell w/liner
2 pr. Field pants w/liner
1 pr. Wool pants
2 Wool shirts
1 Flannel or cotton work shirt
2 Undershirts, woolen (Navy type preferred by writer)
2 Underdrawers, wool
1 Muffler, woolen
1 Vest, pile-lined or sheepskin
1 Sweater, wool
1 or 2 pr. Sunglasses, plastic undesirable because of scratching

Scientific equipment.

5. The scientific equipment for Party Crystal was furnished by SIPRE. The major items of equipment are listed below.

General pit equipment:

*2 Shovels, scoop 2x D-handle
1 20-ft ladder, wood #2

* Listed also under trail equipment

General pit equipment (Continued):

1	Saw, pruning, 24 in., with leather sheath
1	Tape, steel whiteface, 15 m
2	Tape, steel whiteface, 2 m
2	Meter sticks (wood)
*1	Ice chisel, 2 section w/guard
1	Machete, 18-in. knife w/leather case
1	Trowel
1	Forty-Niner pickhammer
1	Scriber, steel
200	Aluminum tags, numbered 1-200
1 roll	Nylon fish line, 50 yd
36 yd	Cloth, red and white, 14 in. wide (weather treated or plastic)
	Bamboo trail-marking poles for marking pit sites and accumulation markers

Equipment for temperature measurement:

12	Thermometers, Weston dial, -50 C to +25 C, in wood case #1
4	Probes, thermometer, wood handle
2	Probes, thermometer, metal disk handle
2	Cork sheaths for thermometers (for use in core hole)
1	Thermometer, Weston, maximum -40 to +120 F
2	Thermometers, alcohol, -50 to +50 C, w/eye on end, 12 in.
2	Thermometers, alcohol, -50 to +30 C, small size, 6 in.
1	Rammsonde temperature probe, SIPRE Shop Job #290, consisting of:
	(a) 1 ea. Rammsonde head specially prepared for use with thermocouple
	(b) 1 ea. Thermocouple sealed in plastic tube (20-ft leads)
	(c) 2 ea. Thermos bottles, 1 qt, wide mouth (for 0 C temperature baths)
	(d) 1 ea. Weston galvanometer

Equipment for density measurements:

60	Snow-sampling tubes with rubber caps, in wooden field boxes
	1 30-tube box
	3 10-tube boxes
12	Spare snow tubes
27	Spare rubber caps for snow tubes
8	Snow cutters, aluminum cutting plates
3	Snow cutters, stainless steel
1	Snow-tube driver
2	Balances, triple beam (1600-g capacity), in wooden case
1	Mandrel, for snow tubes
1	Auger, core, 5-1/2 x 8 x 41 in., in wooden field case
16	Drill rods, extension 3 in. long
1	Tee handle for auger
1	Brace handle for auger
1	Remover for drill cuttings, SIPRE Shop Job #281
1	File, second-cut, flat, 10 in.
1	File, second-cut, flat, 6 in.
1	Miter box for cutting drill core samples

* Listed also under trail equipment.

Equipment for hardness measurements:

2 sets	Penetrometer, Rammsonde, complete w/2 canvas carrying cases
1 set	Canadian hardness gages

Equipment for snow-permeability measurements:

12	Snow tubes, polished, #f/1079 to 1090
2	Boxes for shipping snow tubes
1	Micromanometer, Trimount S/N B6240, w/case
1	Permeability tank, SIPRE Shop Job #319
1	Reservoir, for permeability apparatus
2 gal	Prestone antifreeze
50 ft	Tubing, rubber, pure gum, 3/8-in. ID
2	Caps, brass, for snow tubes
1 lb	Dow Corning liquid, AA 2053, 1CS
1	Hand press, for permeability work, w/wood case, SIPRE Shop Job #214
2	Permeability standards, brass
2	Snow-tube holders, rubber, w/clamps
1	Snow-tube holder, w/pressure outlet
1	Adaptor snow tube, brass
1	Snow tamper, wood
1	Snow-tube rule
1	Hose clamp
1	Level, 9-in. straight, bubble
1 pr.	Pliers, long-nose, side-cutting #5332
3 rolls	Wire, soft copper
1	Lantern, headlight, electric
1	Slide rule, K&E #N4083-55 log log duplex vector, w/case
1	Stop watch

Equipment for snow viscosity and dead-weight tests:

2	Dead-weight apparatuses, complete with wts
7	Dial indicators, #25-F 1 in., jewel-bearing, reading 0-100, grad. .001-in.
6	Combination utility & burret clamps
6	Support stands, for dead-weight apparatus, with 6 aluminum screw rods

Equipment for shear-strength tests:

1	Double shear apparatus
6	Spring scales, 2, 5, 10, 20, 40, and 60 lb, full scale
1	Canadian shear-strength apparatus

Equipment for photography (macro- and microphotos):

1	Praktiflex 35-mm single-lens reflex camera
1 set	Brass clips for meter stick
1	Microscope, Spencer, w/case
1	Microphotographic equipment, Wetzler #8095
1	Focusing cloth, 36 x 48 in.
2	Glass slides with 2-mm divisions etched
1	Changing bag, Rexo #5 (portable darkroom), 35 x 44 in.

Equipment for photography (macro- and microphotos) (Continued):

1	Changing bag, plastic w/zipper
1	Developing tank, model CF-48
12	Film hangers, 3-1/4 x 4-1/4 in., stainless steel
1	Timer, clock, interval
1	Film-developing tank for 35-mm film, stainless steel
1	Funnel, polyethylene (small)
5	Film plate holders, 3-1/4 x 5-1/4 in., w/plastic bags
10 rolls	Film, Kodachrome, 36 exp K-135, daylight
10 rolls	Film, Kodak Plus X, 36 exp PX-135
24 boxes	Film, Kodak Super XX panchromatic, 3-1/2- x 4-1/2-in. sheet (25 exp to box)
18 boxes	Acid fixer, 1/2-gal size
18 cans	Developer, D-76, 1/2-gal size
3	Bottles, polyethylene, screw-cap (1-gal size)
1	Beaker, polyethylene, 8 oz.

Equipment for grain-size analysis:

1	10x Hand Lens, B&L Hastings triplet
1	Microscope, Spencer, with 2-mm grid etched on glass slides
12	Sieves, U. S. Std, testing, size #6, 8, 10, 12,14, 16, 18, 20, 25, 35, 45, and 60
1	Cover, brass, for U. S. Sieves
2	Pans, brass, for U. S. Sieves
1	Paintbrush, 3 in.
1	Paintbrush, 2 in.
1	Paintbrush, drawing, small
2	Grain-size disks (flat plate with concentric circles spaced 1 mm apart)

Equipment for surveying:

1	Gurley transit
1	Stadia rod #6278A
1	Altimeter, microsurveying, American Paulin system model M-2
1	Tape, steel, K&E surveying, 100 ft

Equipment for meteorological measurements:

2	Thermometers, max -38 to +50 C
2	Thermometers, min -50 to +50 C
1	Velometer, Alnor w/leather case
1	Aneroid barometer

Equipment for drawing:

1	Drawing board w/case
1	Rule, plastic, metric
1	Triangle 45°
1	Triangle 30°-60°
1	Bow pen
12	Pencils, #2

Equipment for drawing (Continued):

12	Pencils, #4H
12	Pencils, #2H
4	Pencils, red
4	Pencils, blue
2	Erasers, rubber, "pink pearl"
200 shts	Graph paper, 341 D-M, 11 x 16-1/2 in.

Materials for recording and storing data:

6	Field books, level book Bruning #739F
	Data forms:
	Profile data sheets
	Rammsonde data sheets
	Drill-core data sheets
	Descriptive stratigraphy sheets
1	File, favorite index A to Z, 10 x 15 in. (elastic), #V-9119-N
1	Partition wallet, 9-1/2 x 14-3/4 in., 3-1/2-in. expansion, 4 pockets, #5335
100	File folders, manila, third cut, 9-1/2 x 11-3/4 in.
1	File, clipboard, legal
1 box	Paper clips
1	Wooden file box

Miscellaneous equipment:

2	Coleman lanterns, w/spare mantles and globes
1	Scoop, metal sugar-scoop type for filling water cans and buckets with snow
1	Tin funnel, small
2	Laundry cases, aluminum
1	Coping saw, w/blades

Rations.

6. The listing of rations carried by Crystal includes the weight of cans and packing boxes. The type of rations used is not satisfactory for such a small group. The average amount of weight involved, per man per day, was 7.4 lb. Thus, during the period when Crystal consisted of six men, an average of 44.4 lb of cargo weight per day were needed to feed the group.

Type of rations used: The ordinary daily ration for one man provided by the 5-in-1 or the C-ration is not sufficient for men who are working on an ice-cap party. In planning the food supply of Party Crystal, each man was allowed 1.5 rations per day.

Approximately two-thirds of the total diet was derived from the 5-in-1 rations. The remainder was made up of food stuffs from the commissary and C-rations. Fresh meats and fruits were also included in the diet.

The party received its initial supply of rations from Thule on 25 May and was resupplied with rations carried onto the ice cap by Poleax.

Total cargo weight of food: The total cargo weight of rations used to feed Crystal during the field season was 3,450 lb. The over-all cargo weight of foodstuff carried in the field was 3,700 lb, of which 800 lb was returned to Thule. This leaves, then, a net figure of 2,900 cargo lb carried by Crystal. The remaining 550 lb are accounted for in meals eaten at Transportation and Engineer Corps stations on the ice cap.

The 3,700 lb of food cargo is broken down as follows:

a. 2,000 lb taken on at Thule, 25 May
b. 1,500 lb taken on at 1-0, 13 June
c. 200 lb taken on at 2-0, 23 June
d. 800 lb returned to Thule, 21 August

Detailed breakdown of food cargo:

a. Initial supply of rations received at Thule on 25 May

Item	Unit	Quantity	Weight (lb)
5-in-1 rations	case	15	420
C-rations	case	9	342
eggs (fresh)	doz	30	65
apples (fresh)	lb	42	42
oranges (fresh)	lb	50	50
beef, cut	lb	50	50
ham (canned)	lb	12.5	12.5
bacon (canned)	24-oz can	24	36
luncheon meat	6-lb can	2	12
butter	lb	20	20
bread	loaf	24	36
soup	8-oz can	96	64
rice	lb	10	10
beans, without pork	#3 can	12	24
corn, cream style	#2-1/2 can	24	48
asparagus	#2-1/2 can	12	24
tomatoes	#10 can	6	48
fruit cocktail	#10 can	12	96
peaches	#10 can	12	96
pears	#10 can	6	48
dehydrated apricots	1-1/2 lb	5	7.5
dehydrated peaches	1-1/2 lb	6	9
raisins	#10 can	2	12
pineapple juice	8-oz can	96	100
orange juice	46-oz can	24	96
blended juice	46-oz can	24	96
tomato juice	46-oz can	24	96
sugar, salt, black pepper, cinnamon, chili powder, hot sauce, bouillon cubes			
coffee	20-lb can	1	20
tea	5-lb can	1	5

b. Resupply at 1-0 on 13 June

Item	Unit	Quantity	Weight (lb)
5-in-1 rations	case	11	308
C-rations	case	9	342
ham, canned	case (4 hams)	1	60
beef, cut (moist heat)	lb	50	50
beef, cut (dry heat)	lb	50	50
eggs	doz	30	65
oranges	lb	50	50
apples	lb	42	42
lettuce	lb	33	33
bread	loaf	40	60
butter	lb	46	46
chicken	lb	40	40
beans, without pork	#3 can	24	48
pears	#10 can	6	48
apricots	#10 can	6	48
grapefruit juice	46-oz can	24	96
pineapple juice	46-oz can	12	48
shortening	5.5-lb can	1	5.5

c. Resupply at 2-0 on 23 June

Item	Unit	Quantity	Weight (lb)
green beans	#2-1/2 can	24	48
corn, cream style	#2-1/2 can	24	48
fruit juice	46-oz can	24	96

d. Rations returned to Tuto on 21 August

Item	Unit	Quantity	Weight (lb)
5-in-1 rations	case	12	336
C-rations	case	6	228
soup	8-oz can	48	32
fruit	#10 can	12	96
vegetables	#3 can	24	48
fruit juice	46-oz can	12	48

Crystal had originally planned to pick up more than 200 lb of food cargo at 2-0. The large number of meals eaten at temporary stations on the ice cap reduced the amount required.

Meals from outside sources: The total number of meals eaten by Crystal personnel at ice-cap stations was 224.

A daily ration per man is composed of 3 meals; therefore, the 224 meals are equivalent to 75 rations. This is equivalent to 15 cases of 5-in-1 rations, if each man is allowed 1 ration per day, or 20 cases of 5-in-1's and 2 cases of C-rations, if each man is allowed 1.5 rations per day.

Thus, the amount of food consumed by Crystal from supplies other than its own was between 420 and 636 lb. The actual figure is placed at 550 lb.

Average consumption of food cargo per day: It is difficult to arrive at an over-all average figure for the daily amount of food-cargo consumption for the party, since the number of personnel varied considerably throughout the season. However, the total number of man-day rations and the total amount of food cargo used is known. From this information, we get the figure of 7.4 cargo lb per man-day ration. Variations in the number of party members and the rate of food-cargo consumption are shown in Table I.

Table I

Field Party Members	Period	Total Days	Man-day Rations for Period (lb)	Cargo lb of Rations for Period	Crystal's Average Food-cargo Consumption Per Day (lb)
6	25 May-8 July	45	270	1,990	44.4
5	9 July-2 Aug	25	125	930	37.0
4	2 Aug-21 Aug	18	72	530	29.6
	Totals	88	467	3,450	

The figure of 7.4 cargo lb per man-day is equivalent to 1.1 rations per man-day based on the cargo weight of C-rations, or 1.3 rations per man-day based on the cargo weight of 5-in-1 rations.

Since a great amount of class A and B rations were consumed, it is difficult to evaluate exactly the number of rations consumed per man per day. The figure of 1.5 rations per man-day is good for people who are working; for persons engaged in limited physical exertion, this figure can be lower. The main meal provided by the 5-in-1 ration was very easily consumed by three men.

Fuels and lubricants.

7. Quantities of fuels and lubricants used were as follows:

Total quantities used by Crystal in the field:

gasoline (mo gas)	1,614 gal
white gas (for stoves)	77 gal
oil, SAE 10	20 gal
G.O. 75 (gear oil)	10 gal
grease	25 lb
antifreeze	8 gal
denatured alcohol	5 gal

Analysis of gasoline consumption during the season:

Total distance traveled by the four weasels	3,089 mi
Total amount of gasoline consumed by the vehicles	1,614 gal
Amount of gasoline used for actual travel*	1,314 gal

* Traveling on the ice cap with the weasels pulling sleds from one point to another is counted as "actual travel" use of the weasels. Operation of the vehicles for other purposes includes: driving without sleds in the work program (especially while surveying); warming up weasel engines; running weasel engines for personnel heat; and running the radio weasel as a power plant for the radio transmitter.

Analysis of gasoline consumption during the season (Continued):

Amount of gasoline used for work on the expedition	300 gal
Average over-all mileage per vehicle, including travel and work during the entire trip	1.91 mi/gal
Average mileage per vehicle for actual travel	2.14 mi/gal
Average amount of gasoline used per day by Crystal	18.4 gal/day

Gasoline consumption of individual weasels: The operational records for the individual vehicles are shown in Table II.

TABLE II. Vehicle Performance Records

Weasel No.	Total Miles Traveled	Miles with Sled (actual travel)	Miles Without Sled	Over-all Total Mileage (mi/gal)	Mileage on 4-day Straight Travel Run	Total Gal Used on Trip	Gal Used for Travel w/sleds	Gal Used for Purposes Other than Travel
16	737	647	100	1.98	2.15	378	301	77
17	734	731	33	1.87	2.07	392	353	39
19*	793	768	25	1.71	2.49	464	308	156
20	815	768	47	2.14	2.18	380	352	28
Average	772	728	51	1.92	2.22	404	329	75
Average without #19 data*					2.14	383	335	48

Each weasel departed from Thule with a full fuel tank. The tanks were refilled to "full" on return to Thule. Excluding the radio weasel, the average amount of gasoline used per vehicle was 383 gal. The maximum deviation from the average was 2%. The radio weasel, which was run several times each day of the season, used 21% more gasoline than any of the other vehicles. The fuel consumption of each weasel is illustrated in Figure 1, which shows the date and amount of refueling for each weasel.

Comparison of gasoline consumption of Ice-Cap Parties Solo, 1953, and Crystal, 1954:

	Solo 1953	Crystal 1954
Weasels in party	7	4
Days in field	48	88
Total distance traveled by party vehicles (mi)	4,879	3,089
Total amount of gasoline consumed (gal)	2,710	1,614
Amount of gasoline used for actual travel (gal)	2,230	1,314
Amount of gasoline used for work other than actual travel (gal)	480	300

* Weasel No. 19 was the radio weasel. It was in the best condition of all of the weasels on the party and its gasoline mileage was exceptionally good. The average travel mileage computed without the data from No. 19 is more representative of past results. The large amount of gasoline used by Weasel No. 19 for nontravel use resulted from running the engine in connection with the radio transmitter.

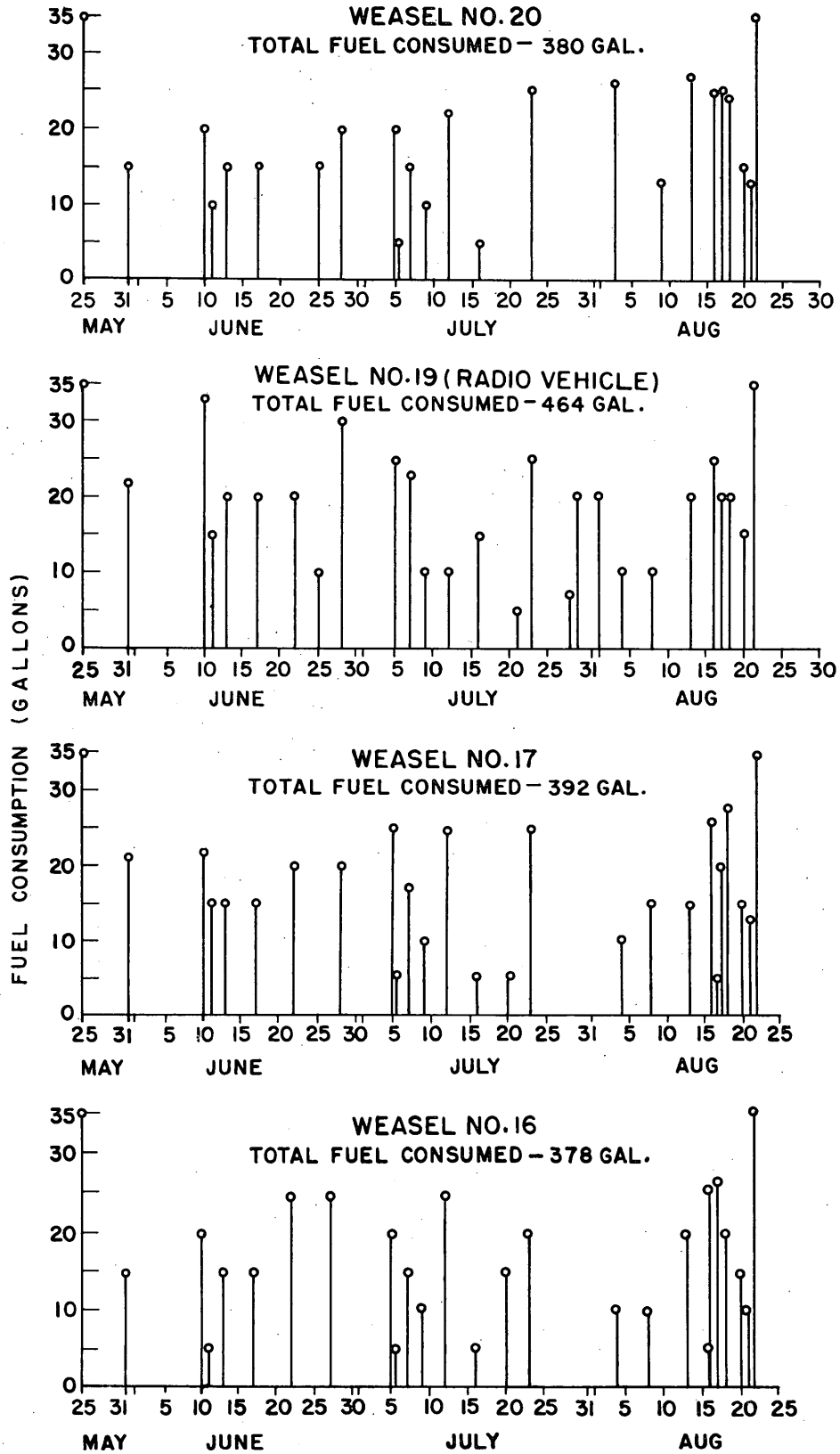

Figure 1. Record of fuel consumption for individual weasels.

Comparison of gasoline consumption of Ice-Cap Parties Solo, 1953, and Crystal, 1954 (Continued):

	Solo 1953	Crystal 1954
Average overall mileage per vehicle including travel and work during the entire trip (mi/gal)	1.80*	1.91*
Average mileage per vehicle for actual travel (mi/gal)	2.18	2.14
Average amount of gasoline used by party (gal/day)	30.8	18.4
Total number of work days with no travel time	21	46
Total number of work days with less than 3 hr travel time	21	79

Oil and lubrication record: The over-all oil consumption for the expedition was 215 mi/qt. This breaks down as follows:

a. Weasel #16

Date	Quarts of oil added	
10 June	1	
13 June	1	
20 July	1	
13 August	1	
17 August	1	
18 August	1	Total 9 qt of oil (SAE 10)
19 August	1	Oil change and complete lubrication on 6 July
20 August	1	Average 83 mi/qt
21 August	1	

b. Weasel #17

Date	Quarts of oil added	
13 June	1	Total 3 qt of oil (SAE 10)
8 August	1	Oil change and complete lubrication on 6 July
10 August	1	Average 244 mi/qt

c. Weasel #19

Date	Quarts of oil added	
1 August	1	Total 2 qt of oil (SAE 10)
18 August	1	Oil change and complete lubrication on 6 July
		Average 396 mi/qt

* Preliminary analysis of the data shows that fuel consumption on 1955 ice-cap expedition, Project Jello, was 1.6 mi/gal. The increased fuel requirements resulted from operation at higher elevations (over 10,000 ft) and with heavier loads.

d. Weasel #20

Date	Quarts of oil added	
10 June	1	
17 June	1	Total 6 qt of oil (SAE 10)
19 July	1	Oil change and complete lubrication on 13 Aug
18 August	1	Average 136 mi/qt
21 August	2	

IV. MAINTENANCE

8. It is important that the expedition mechanic is afforded the time to work on his vehicles prior to the start of the expedition and become familiar with them. Crystal's mechanic had such an opportunity and as a result the weasels were in proper working order before the party went into the field. The main trouble in the field came from the fuel and ignition systems. The transmissions, tracks, and track suspensions held up very well; however, they had been carefully checked in Thule and new parts installed where needed.

Breakdown of maintenance work.

9. (a) *Ignition system.* New spark plugs, ignition points, and condensers were installed in each vehicle prior to departure. New plugs, points, and a condenser were installed in weasel 19 on 7 July. The points were cleaned and reset in weasel 20 on 10 June.

(b) *Fuel system.* The carburetors in all vehicles were cleaned and adjusted and a carburetor kit was installed in No. 20 before departure. Carburetor trouble developed in the field in weasels 19 and 20. The fuel filter in weasel 19 was clogged completely and broken during repair. Since no new filter was available, the weasel ran without a fuel filter from 5-10 July (90 mi). The damaged filter was rebuilt in the field and installed on 10 July. The air vent in the gas cap of weasel 16 was faulty and created a fuel vapor lock; this also happened in the other weasels but not to the same extreme.

(c) *Transmissions.* A new transmission was installed in weasel 16 at the shop in Thule before the field season. No spare transmissions were available when Crystal departed from Thule.

(d) *Thermostats.* Troubles developed with the thermostats in weasels 17 and 19. The weasels were run without thermostats during most of the trip. All weasels are equipped with adjustable trap doors over the fan wells, which make the thermostats relatively unnecessary.

Special measures taken to safeguard transmissions, tracks, and track suspensions.

10. Weasel expeditions in the past have included extra tracks and transmissions. Crystal did not carry a spare track because of the weight and bulk involved; also, the resupply potentials for Crystal were unusually good as compared with those of previous weasel expeditions. A spare transmission was not carried because there were none available in Thule at the time of departure.

The pulling of heavy sleds by weasels on the ice cap is a major cause of the frequent failure of transmissions; also, care exercised by the driver is of great importance in preventing

failure. The sleds and wannigans used on Party Crystal were the lightest ones available. Heavier wannigans were offered since they provide more luxury in the field, but they were not used because of the anticipated strain on the weasels.

Even with the light sleds, it was sometimes necessary to exercise extreme precautions to prevent excessive pull on the weasels. The greatest troubles of this nature occurred during the warm spell of 11 to 15 July. The top 3 in. of snow was moist and sticky, with colder snow below. The snow packed in the runner braces and stuck to the runner bottoms to the extent that one weasel could not pull its sled. It was necessary to hook the heaviest and the lightest sled together and use two weasels in tandem to move them. This arrangement allowed the combination of weasels and sleds to move at its normal rate of speed (5 mph) and was used for 5 mi on 12 July. Special straight-bar sled tongues were taken from Thule and carried as spares for this specific purpose, since with the triangular-shaped tongues there is no way to hook sleds in tandem. At some of the stops, the runners of the sleds and the weasel tracks and track suspension systems became frozen down or jammed with wind-blown snow. Considerable time was spent in cleaning the sled runners and the weasel tracks and roller assemblies before moving. This was done to avoid trouble with the weasel tracks and prevent excessive starting loads on the transmissions. In some instances, two weasels were hooked together in tandem for breaking sleds loose and for pulling the sleds when heavy icing fouled up the bottoms of the runners; after the abrasive action of the snow cleaned the runners, it was possible for one weasel to pull the sled again.

V. SAFETY

11. Fire presents the greatest of all hazards to an arctic expedition. Throughout the field season, fire extinguishers were carried on each weasel (the standard CCl_4 weasel fire extinguisher) and one large 15-lb CO_2-type extinguisher was carried for each wannigan. A large extinguisher was placed directly outside or inside of each wannigan at all stops.

A five-man arctic tent was carried in one of the cargo sleds for use as an emergency shelter in case one of the wannigans burned. The clothing of party members was spread throughout the caravan in such a way that there would have been no complete loss for any individuals if one vehicle or wannigan burned. It is advisable that any small expedition should have a duffle bag full of emergency clothes cached in a cargo sled.

Each vehicle carried one case of C-rations in its rear pontoon as an emergency supply. This case of rations was not calculated as part of the food-cargo load and was to be used only in case of extreme emergency.

Arrangements were made with the Air Rescue Squadron in Thule prior to departure. In the event of a 36-hr period with no radio contact from Crystal, an overhead check flight was to be made and in case of emergency, a ski-landing was scheduled.

VI. CONCLUSIONS AND RECOMMENDATIONS

Sleds.

12. The sleds used by Party Crystal were part of the original supply brought to Thule in 1952. The runners on these sleds are too narrow for efficient use and the runner braces are inadequate. The braces give support only at points along the runner length rather than continuously

along the runner. This results in a warping of the runners with use. The braces also act as traps for snow and at times the entire brace system is full of snow. Over 300 lb of snow can pack in the runner braces on one side of the sled, if 0.5 g/cm^3 is assumed as the packed-snow density. Therefore, the total weight of snow carried by the runners on a cargo sled or wannigan can easily run between 500 and 600 lb.

The wannigans were originally designed to have a canvas cover stretched over metal braces as the only form of shelter. This is inadequate for a party which is to remain on the ice cap at high elevations. The wannigans used by Crystal were first braced with wood and then a complete cardboard and celotex lining was built before the canvas was put on. The lining provided insulation and protection from the wind. It is undesirable to have wannigans or sleds heavier than the ones used by Crystal during 1954. Some heavier wannigans were available but were not used because of the strain they would put on the vehicles.

An attempt was made to keep the maximum load at 1,000 lb for each weasel and 2,500 lb for each cargo sled. Personal equipment was carried in the weasels and wannigans. The major portion of the SIPRE test equipment was carried in one weasel and wannigan (weasel #20, wannigan #13). At maximum load, each cargo sled carried 1,800 lb of gasoline cargo-load (1,650 lb of gasoline, 250 lb of cans) and approximately 1,000 lb of food cargo. The heaviest sled load hauled during the trip was 3,000 lb and was pulled by the radio weasel.

Sled tongues, tow bars, and clevices.

13. The standard triangular sled tongue has worked satisfactorily. The straight tow bars are weaker and less desirable for towing a sled behind a weasel, but several should be carried in case it is necessary to tow two sleds in tandem with one weasel (Fig. 2).

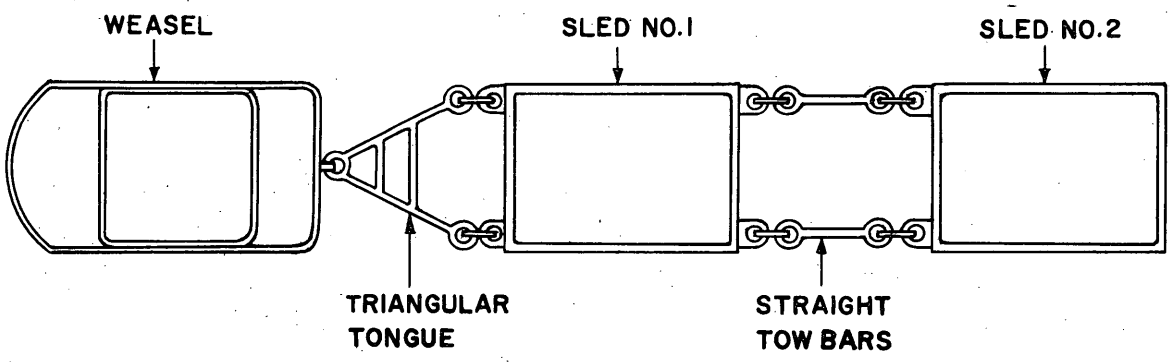

Figure 2. Tandem hookup of weasel and sleds.

It is important that the proper type of clevices be used. The rounded U-shaped clevice (Fig. 3) works very well whereas a "homemade" variety (Fig. 4) found in Thule is very poor. Many of the latter type pulled apart completely during the field season. A spare set of clevices should be allowed for each sled.

Weasels.

14. The weasel is a good vehicle for over-snow transportation with small sleds. However, if it is to be used as an expedition vehicle on the interior ice cap, it should be modified for this specific purpose. Some of the design features were incorporated for use in water and are detrimental to ice-cap work. The bilge sections and the pontoons are examples of this.

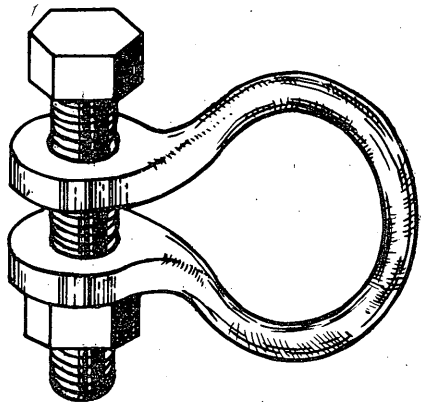

Figure 3. Proper type of clevice.

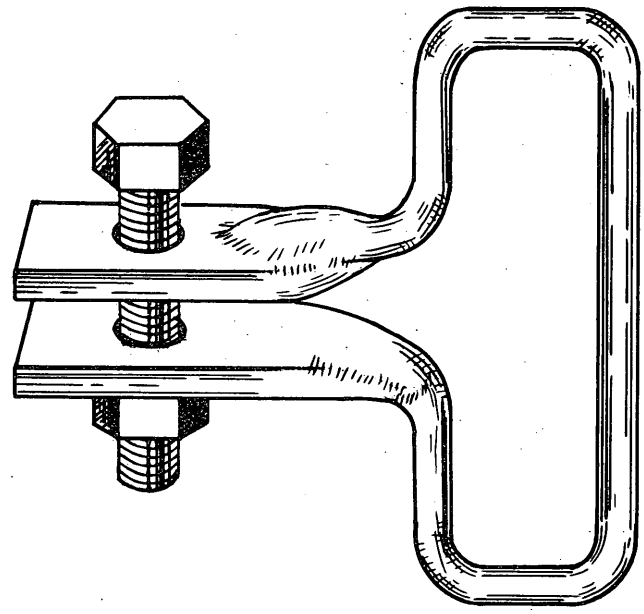

Figure 4. Wrong type of clevice.

The general utilization of space in a weasel is inefficient. The total amount of usable interior space could be increased by extending the cab over the rear pontoon. This was suggested in 1952 and the cab was extended over the right half of the rear pontoon with the personnel heater seated on the left. If the personnel heater was put on the roof (as suggested by Jorgen Busch in 1952), the entire area of the rear pontoon could be enclosed. Also the top of the pontoon could be cut away for easy access to cargo space.

The pontoons, at present, are useful for carrying some cargo, but their usefulness would be increased if the hatches were made larger. If the pontoons are not to be utilized as cargo space, they should be removed. The combined weight of the pontoons is more than the weight of a full 55-gal drum of gasoline.

A major defect in the weasels at present is the manner in which the exhaust gases and heat are discharged. The exhaust pipe runs under the passenger portion of the vehicle, in an enclosed section (the bilges), and has its outlet on the right side at the level of the passenger's head. The heat from below the rear floor, in combination with the fumes which sometimes come in from the right rear corner, often makes the weasel extremely uncomfortable. The exhaust gases could be channeled out through the front portion of the vehicle with the vent above roof level. It is also conceivable that the exhaust heat could be utilized for melting snow (the only source of water) while the weasels are in operation. This would be very economical, since a large quantity of fuel is burned on every expedition for the sole purpose of obtaining water.

The excessive heat within the weasel was utilized to obtain water by placing snow-filled water cans inside while moving from one station to the next. It was also used for drying clothes.

Temporary shelters.

15. The use of tents and other temporary shelter areas should be developed for small ice-cap parties. In 1953 the SIPRE work on Party Solo was partly carried on in a 5-man arctic tent, while Solo was at high elevations. The amount of living space is always a critical item for a small party. It is difficult to carry ready-made space such as in wannigans because of the weight involved. Sleds should be utilized for cargo. Tents increase the amount of shelter-covered floor space at a small expense of cargo weight. The weasel party of the British North Greenland Expedition used tents for living quarters while on the trail.

Two wannigans, or one wannigan and one cargo sled, could be made into a temporary shelter by having a tarp mounted on one, which could be stretched across and fastened to the other when the two are parked side by side. Canvas or plywood could be utilized as temporary wall materials. The advantage of temporary one-day shelters would be primarily in supplying sleeping space and allowing the wannigans to be used exclusively for working and cooking.

When the party was stopped at a test station, the weasels and sleds were lined up facing into the wind. This put most of the large drifts to the rear of the vehicles in the event of a storm.

The wannigan which contained the glaciological equipment was used in connection with the snow pits at each of the extended stops. It was pulled up broadside to the wind with the lee-runner on one edge of the pit-cover tarp. The tarp could then be rolled up alongside of the runner or spread across a timber framework over the pit, according to the dictates of the local meteorology. Once the pit was dug and properly covered, it provided a comfortable place for work even during the worst blizzards encountered.

Rations.

16. In planning future operations, several points with respect to rations are worth careful consideration. The rations eaten on Party Crystal were more than adequate. The tremendous figure of 7.4 lb of cargo weight to feed one man for one day must be cut down*. Weight is important when the men must carry their own food on their backs or in sleds. The majority of the food was packed in 1-gal cans. This is fine for large groups, but is very inconvenient and tends to be wasteful when only two or three men are cooking and eating by themselves.

Special trail rations, such as were brought to Thule by the USGS in 1953, should be procured for small parties. Dehydrated foods and frozen and dried meats should be utilized rather than trying to pack "home-cooked" meals in cans. One defect of the standard 5-in-1 or C-ration for arctic work is the lack of fats. In planning for small groups, where the group members are to be engaged in physical work, 1.3 or 1.5 rations per man day should be allowed, if 5-in-1 and C-rations are to be eaten.

Fruits and fruit juices are very important items to include on an ice-cap expedition. Members of Party Solo and Party Crystal noticed that their desire for, and consumption of, fruits and juices was much greater while in the field. A partial cause of this may be the aridity of the region. The juices and the liquid in the fruits tend to quench thirst. The small cans of frozen juice concentrate should be excellent for an ice-cap expedition—there will be no refrigeration problem once the group is on the ice cap. The 50-lb cartons of frozen meat which have been used in the past are very fine rations, being almost all net weight.

The most extravagant packaging is found in the bread-type units. The ratio of net weight to cargo weight is very small in these units. The starchy portion of the daily diet is the easiest to obtain in dehydrated form and an effort should be made to have as much of this material in dehydrated packs as possible.

Fuel consumption.

17. The gasoline required by Party Crystal was estimated prior to the field season to within 3% of the actual amount used. In calculating gasoline requirements, the figure of 1.8 mi/gal

* During the 1955 ice-cap expedition, special emphasis was placed on dehydrated and frozen foods. This reduced the amount of food cargo weight per man per day to approximately 4.9 lb per man per day.

is satisfactory*. This figure was arrived at by Robert Guillard of "Expedition Polaires Francaises" and was found to apply to Party Solo and Party Crystal, both out of Thule.

In estimating fuel requirements for a long expedition, it is well first to estimate the amount of gasoline required for normal operation, and then include a safety factor for loss due to breakage and unforeseen developments. The figure of 1.5 mi/gal should give a safe maximum requirement. Thus the amount of gasoline required for four weasels to go 1,000 mi is between 2,222 and 2,667 gal.

The weight of gasoline is taken as 6.2 lb/gal, thus the corresponding fuel load in pounds would be 13,776 and 16,535 lb. The weight of the fuel drums must be counted in addition to the gasoline weight; in this case it would be 2,881 and 3,484 lb.**

During the course of a field season, the actual number of miles traveled by any one weasel is always more than the number of actual trail miles. This extra mileage can come about in part from wandering on the course, extra travel in lining vehicles and sleds into the wind, movement for refueling, etc. From the data of Solo and Crystal, it appears that the order of magnitude is 4 to 5 extra miles for every 50 trail miles. In calculating the distance to be covered by a party going into a certain region, 10% should be added to the total number of trail miles. This 10% is to be included in the figure for actual travel use of the vehicles, not including project work.

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* Preliminary analysis of the data from the 1955 ice-cap expedition, Project Jello, shows the fuel consumption to be 1.6 mi/gal. The increased fuel requirements resulted from operation at higher elevations (over 10,000 ft) and with heavier loads.

** The weight of fuel drums varies. There is a light-gage drum which weighs 50 lb and a heavy gage which weighs 67 lb. The light-gage drum will not survive an air drop; therefore, the figure 67 lb per drum must be used. The capacity of a fuel drum is 55 gal. However, they are only filled to 52 gal. The figure 52 gal per drum is used in the above calculations.