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GONDOLA SUPPLY OF EOLE BALLOONS - BALANCE OF POWER CALCULATIONS

Editor: J. Bezaudun

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GONDOLA SUPPLY OF EOLE BALLOONS -
BALANCE OF POWER CALCULATIONS

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ABSTRACT. Daily output, temperature, maximum current and power balance of a battery in the Eole balloon were calculated from August 1, 1971 to March 1, 1972.

This memorandum is in reply to our TA memorandum No. 106/CNES/CST/BA/CG /1* of October 13, 1970.

1 - Calculation Hypotheses

1-1- Genebat Program (m. Hebert in charge)

Calculation of the current delivered by a solar generator as a function of the time for a given date and latitude and for different albedo coefficients (Genebat program) is explained in memorandum No. 71/CT/TA/EB/EOLE B/0.801. Calculations were performed for the following case:

Period: 1 August 1971 through 1 March 1972 inclusive (bi-weekly)

Latitude: 20 - 70° S inclusive (at 10° intervals)

Exterior temperature: - 40° C, - 50° C, - 70° C

*Numbers in the margin indicate the pagination in the original foreign text.

Albedo coefficient: $a = 0,1; 0,35 ; 0,80$

Generator terminal voltage: 15 V

Pressure at balloon altitude: 200 mbar

Angle of inclination of solar cells with respect to the local vertical: 0°

In computing the balance of power, we likewise introduce gondola consumption as indicated in memorandum 106/CNES/CST/BA/CG.

1-2- Milton Program (M. Boutin in charge)

The program allows us to calculate the battery temperature when provided with its cone. Inputs (period, latitude, albedo, external temperature) are the same as in the Genebat program, where -60° C was added for exterior temperature.

2 - Results

2-1- Daily battery output and temperature

The Milton program leads to the following conclusions:

- battery temperature is practically independent of period and latitude. It is constant throughout the day (except at sunrise and sunset).
- It depends solely on external temperature and the albedo coefficient. /2

The following table gives the battery temperature θ as a function of external temperature, on the one hand, and the minor output Q of the battery at the calculated temperature.

2-2- Maximum current delivered by the solar generator

The current delivered by the solar generator depends on:

a / Exterior temperature	0,10	0,35	0,80
- 40° C	θ = - 9° C ρ = 0,79	θ = 7° C ρ = 0,65	θ = 30° C ρ = 0,52
- 50° C	θ = - 12° C ρ = 0,80	θ = 3° C ρ = 0,70	θ = 26° C ρ = 0,55
- 60° C	θ = - 16° C ρ = 0,85	θ = - 3° C ρ = 0,77	θ = 23° C ρ = 0,60
- 70° C	θ = - 20° C ρ = 0,90	θ = - 5° C ρ = 0,85	θ = 19° C ρ = 0,65

- time
- period
- latitude
- albedo coefficient

It is practically independent of exterior temperature, and this is why we did not compute it for an exterior temperature of -60° C. Maximum current delivered by the solar generator is given as a function of latitude and period in the following table. We are dealing with the maximal current, i.e., corresponding to a maximal albedo coefficient, when illumination is most favorable. It is given in mA at 15 V for T = 50° C. Current variations with temperature are on the order of ± 1 mA. It is this maximal current which is important in the charge regulator.

2-3- Power balance /4

It is given in Figures 1 through 18. Each figure shows, for a given

Period \ Latitude	- 20	- 30	- 40	- 50	- 60	- 70
1/8 AUG	68,9	67,6	62,0	55,6	44,2	8,8
15/8 "	68,9	68,5	65,2	58,9	49,5	31,6
1/9 SEP	68,9	68,9	67,5	62,9	55,3	43,7
15/9 "	68,9	68,8	68,6	65,7	59,6	50,6
1/10 OCT	68,6	68,9	68,9	67,9	63,7	56,6
15/10 "	68,3	68,5	68,8	68,8	66,4	60,8
1/11 NOV	68,6	68,7	68,9	68,9	68,2	64,5
15/11 "	68,7	68,7	68,6	68,9	68,8	66,4
1/12 DEC	68,8	68,9	68,8	68,9	68,9	67,6
15/12 "	68,8	68,9	68,8	68,8	68,9	68,0
1/1 JAN	68,8	68,9	68,8	68,8	68,9	68,0
15/1 "	68,8	68,8	68,7	68,9	68,9	67,5
1/2 FEB	68,7	68,7	68,7	68,9	68,7	66,0
15/2 "	68,6	68,4	68,9	68,9	67,9	63,7
1/3 MAR	68,3	68,8	68,8	68,7	66,2	60,4

environment temperature and latitude, the following parameters as a function of period:

- amount of electricity provided by the solar generator (S. G.) for various albedo coefficients
- gondola consumption. Constant for a given latitude.
- amount of electricity required for battery recharging.

We assume that all gondola consumption occurs at night. Battery output is constant at constant external temperatures and albedos (see 2-1).

- The amount of electricity required for battery recharging and charge regulation (B + R). See broken curves in the figures.

For charge regulator consumption, we used:

4 mA during the day

0 at night

The final power balance is given in Figure 19, where the latitude-period space was divided into three zones:

Zone 1: The power balance is never balanced, no matter what the albedo coefficient and environment temperature may be.

Zone 2: The power balance may or may not be balanced, depending on the albedo coefficient and the environment temperature.

Zone 3: The power balance is always excessive.

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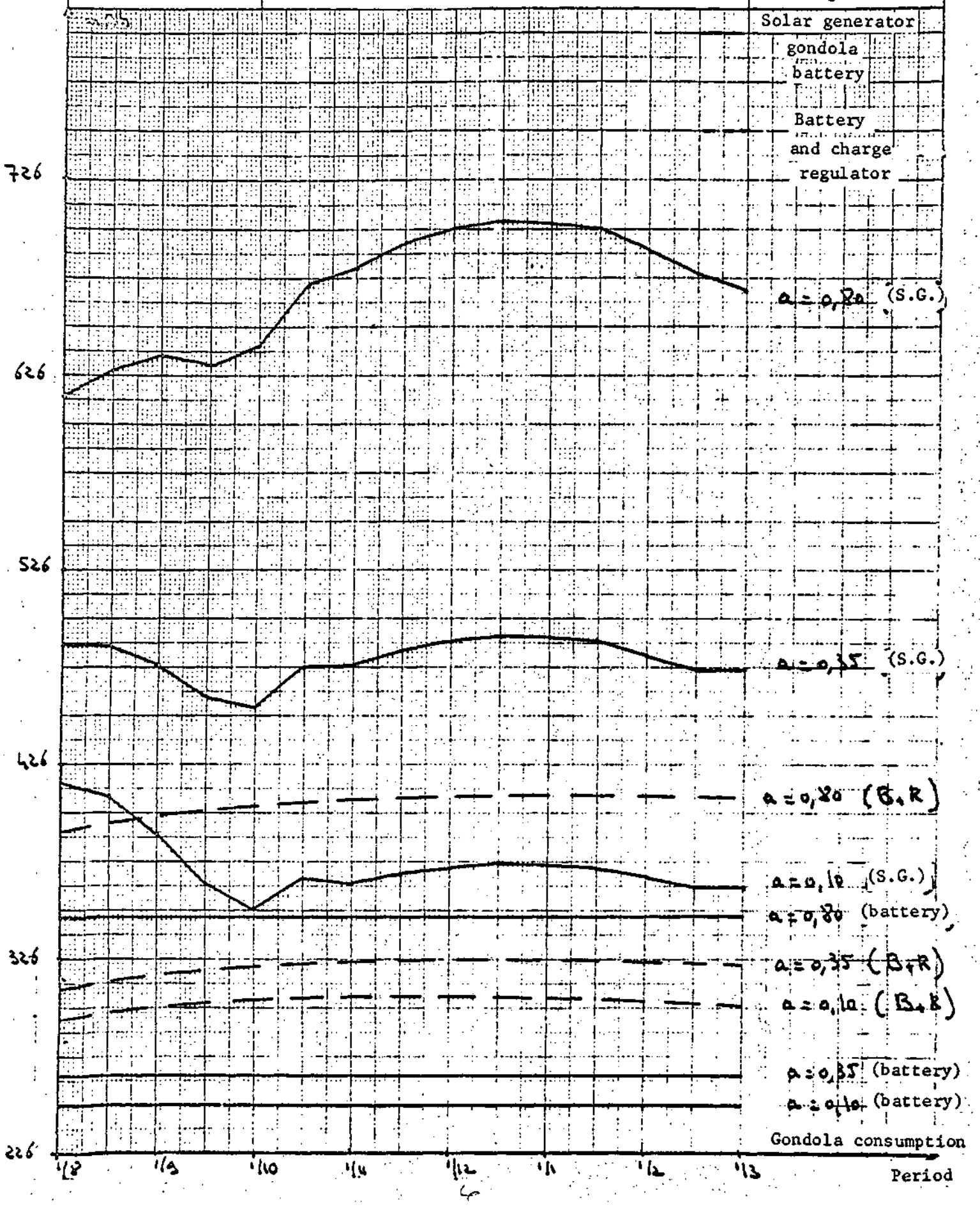
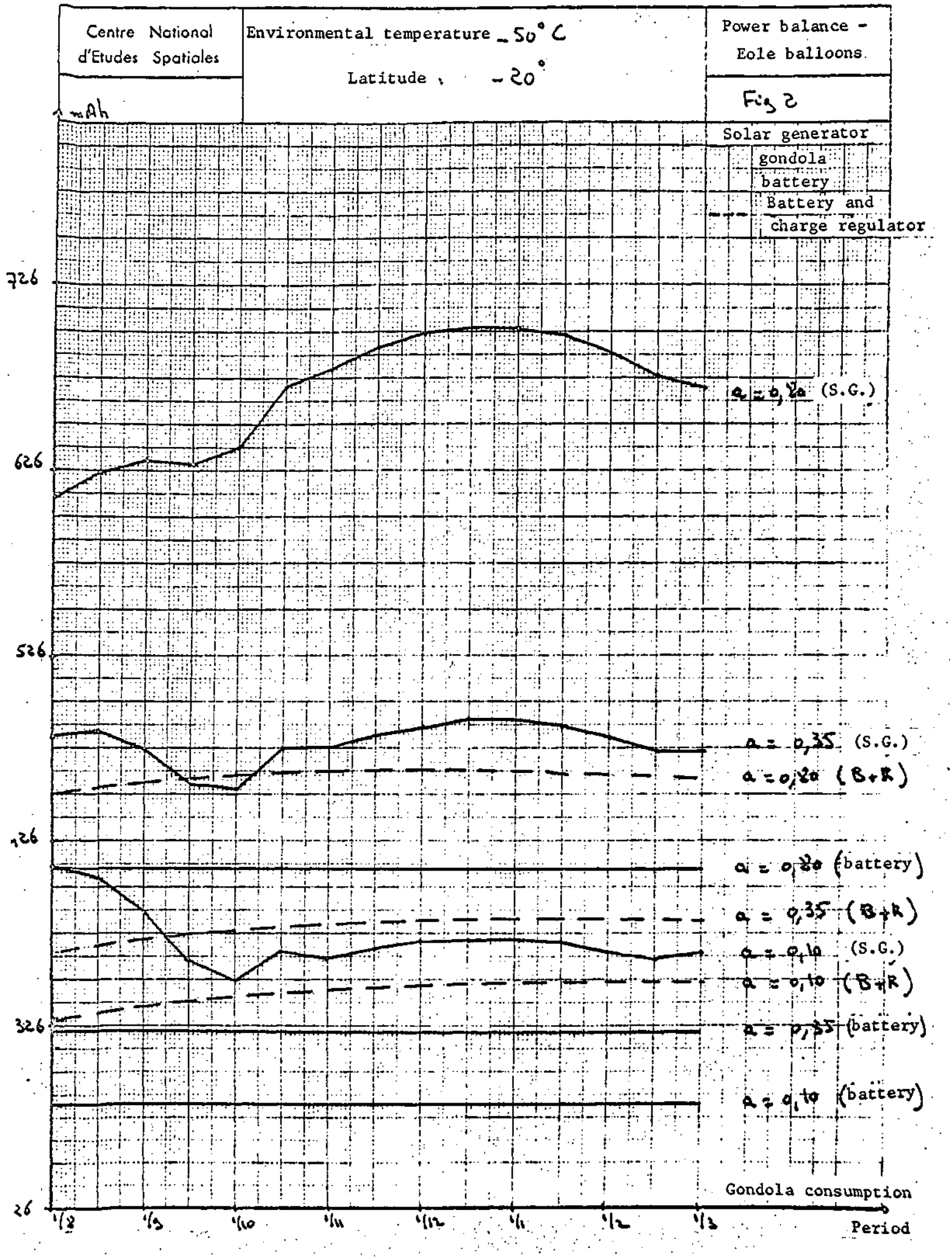
Environmental temperature – 70° C

Latitude : – 20°

Power balance – Eole balloons

Fig 1

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Environmental temperature -50° C
Latitude : -20°
Power balance - Eole balloons
Fig 2
mAh
Solar generator
gondola battery
Battery and charge regulator
726
626
526
426
326
26
a = 0,20 (S.G.)
a = 0,35 (S.G.)
a = 0,20 (B+R)
a = 0,20 (battery)
a = 0,35 (B+R)
a = 0,10 (S.G.)
a = 0,10 (B+R)
a = 0,35 (battery)
a = 0,10 (battery)
Gondola consumption
1/8
1/9
1/10
1/11
1/12
1/1
1/2
1/3
Period

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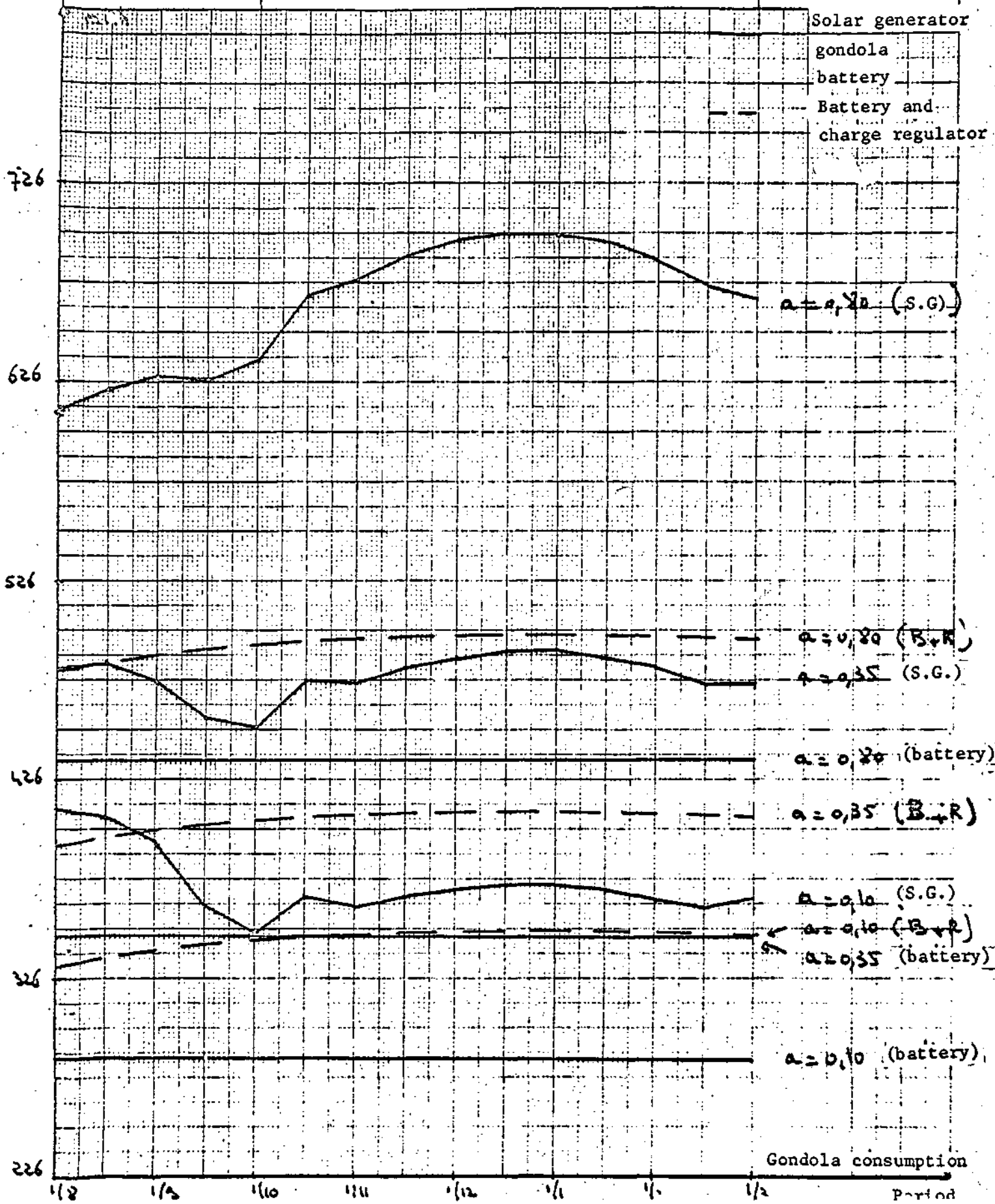
Environmental temperature 40°C

Latitude , -20°

Power balance - Eole balloons

Fig 3



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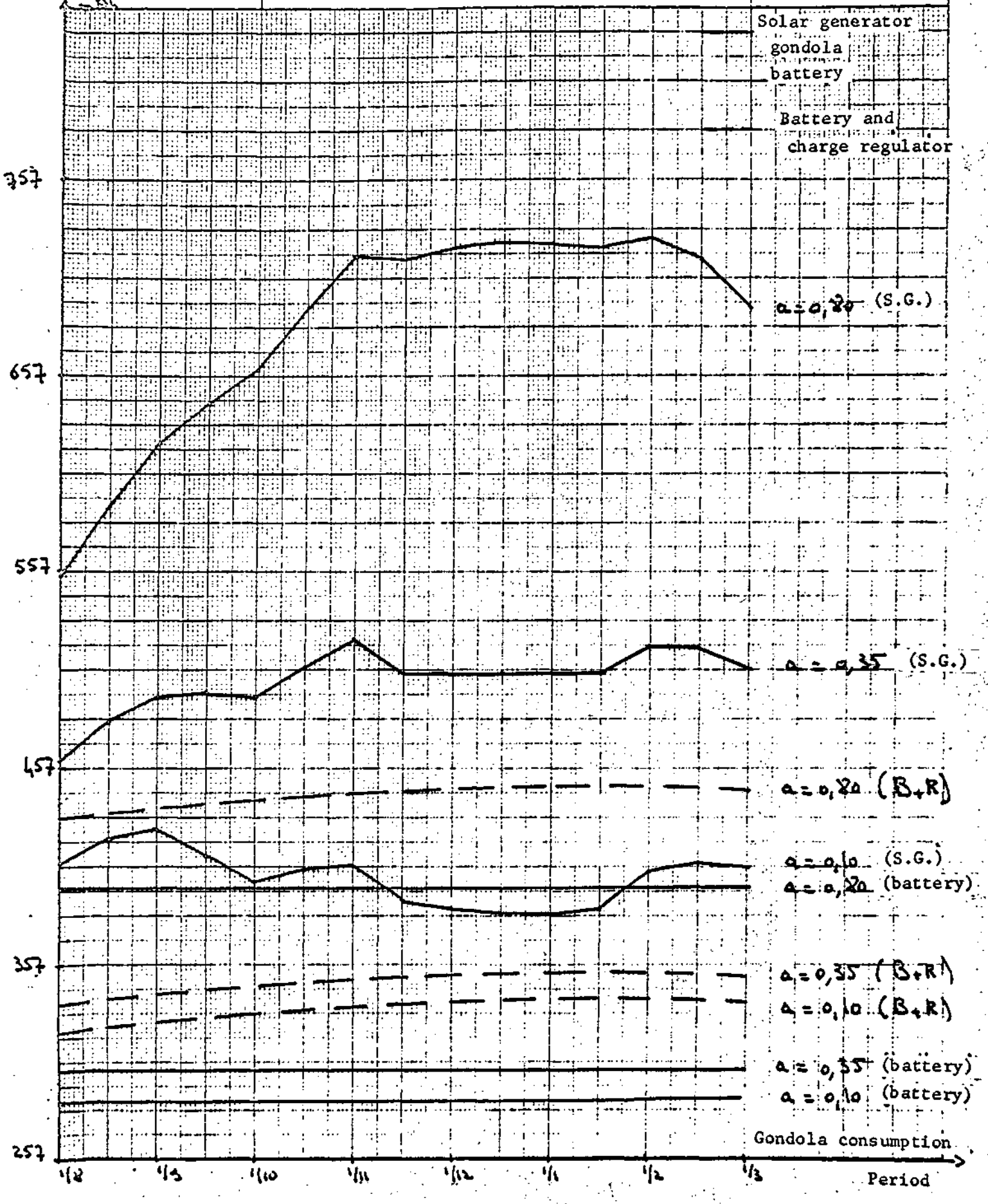
Environmental temperature -70°C

Latitude : -30°

Power balance - Eole balloons

Fig 4



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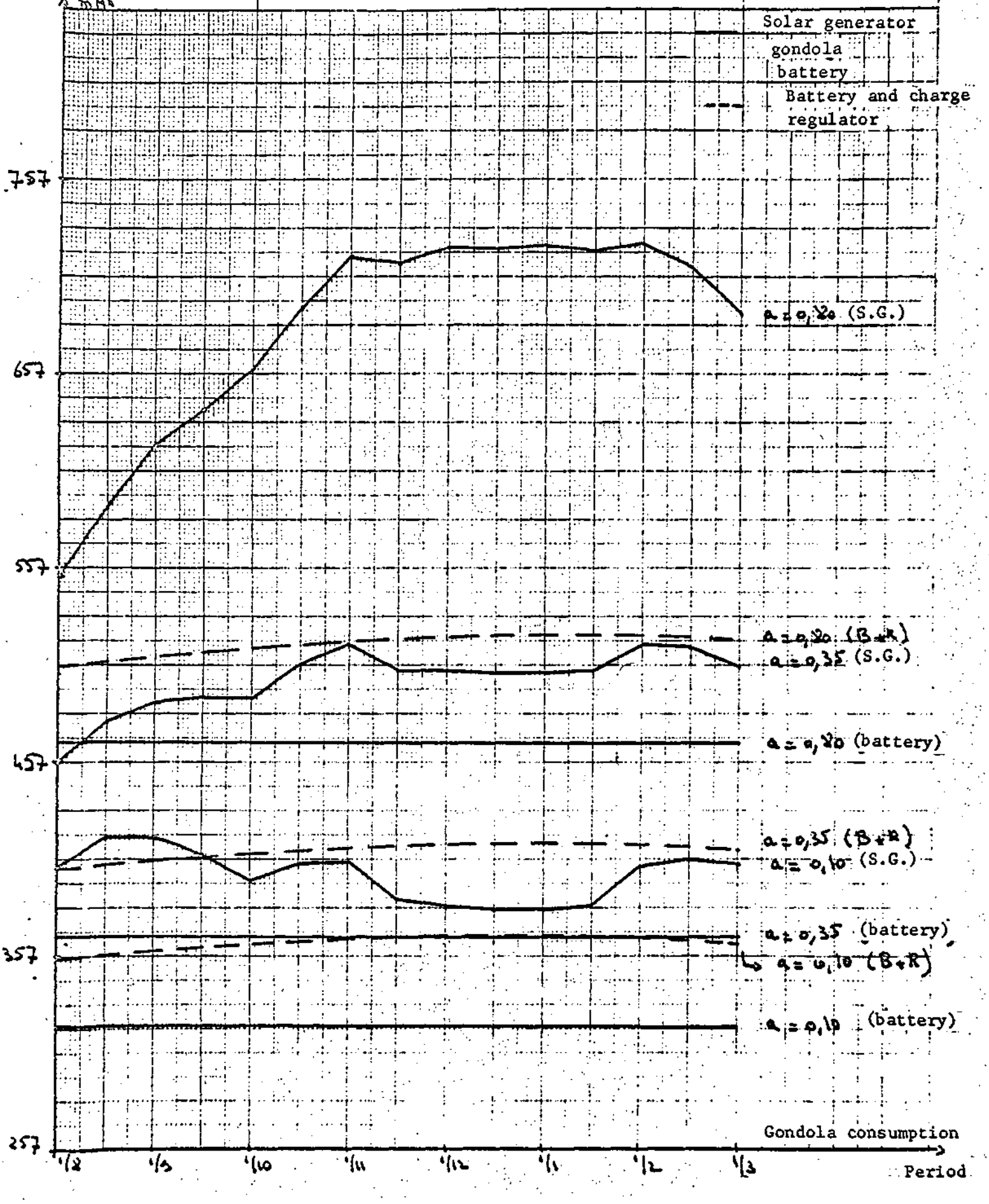
Environmental temperature -50°C

Latitude : -30°

Power balance - Eole balloons

Fig 5



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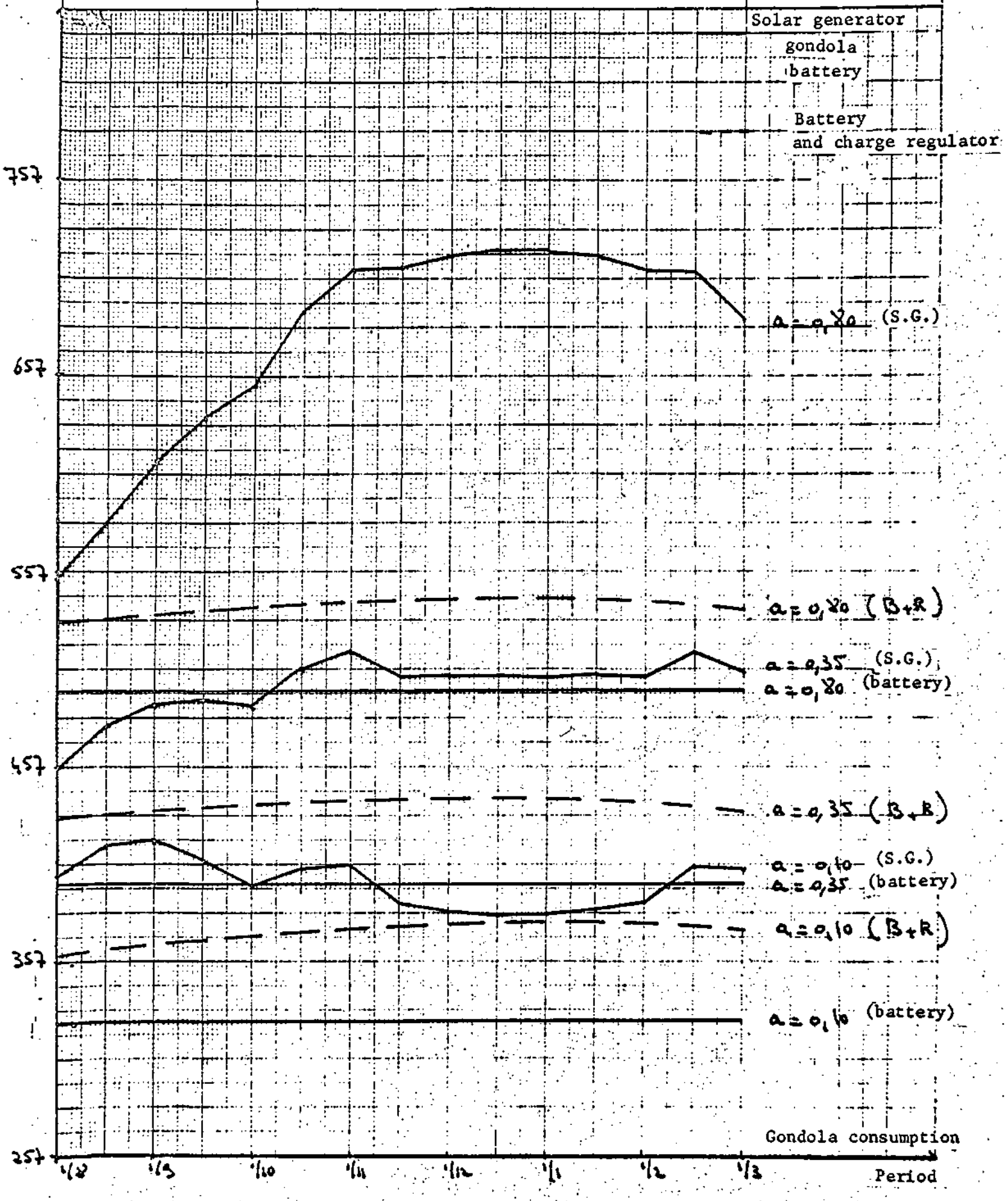
Environmental temperature - 40° C

Latitude : -30°

Power balance - Eole balloons

Fig 6



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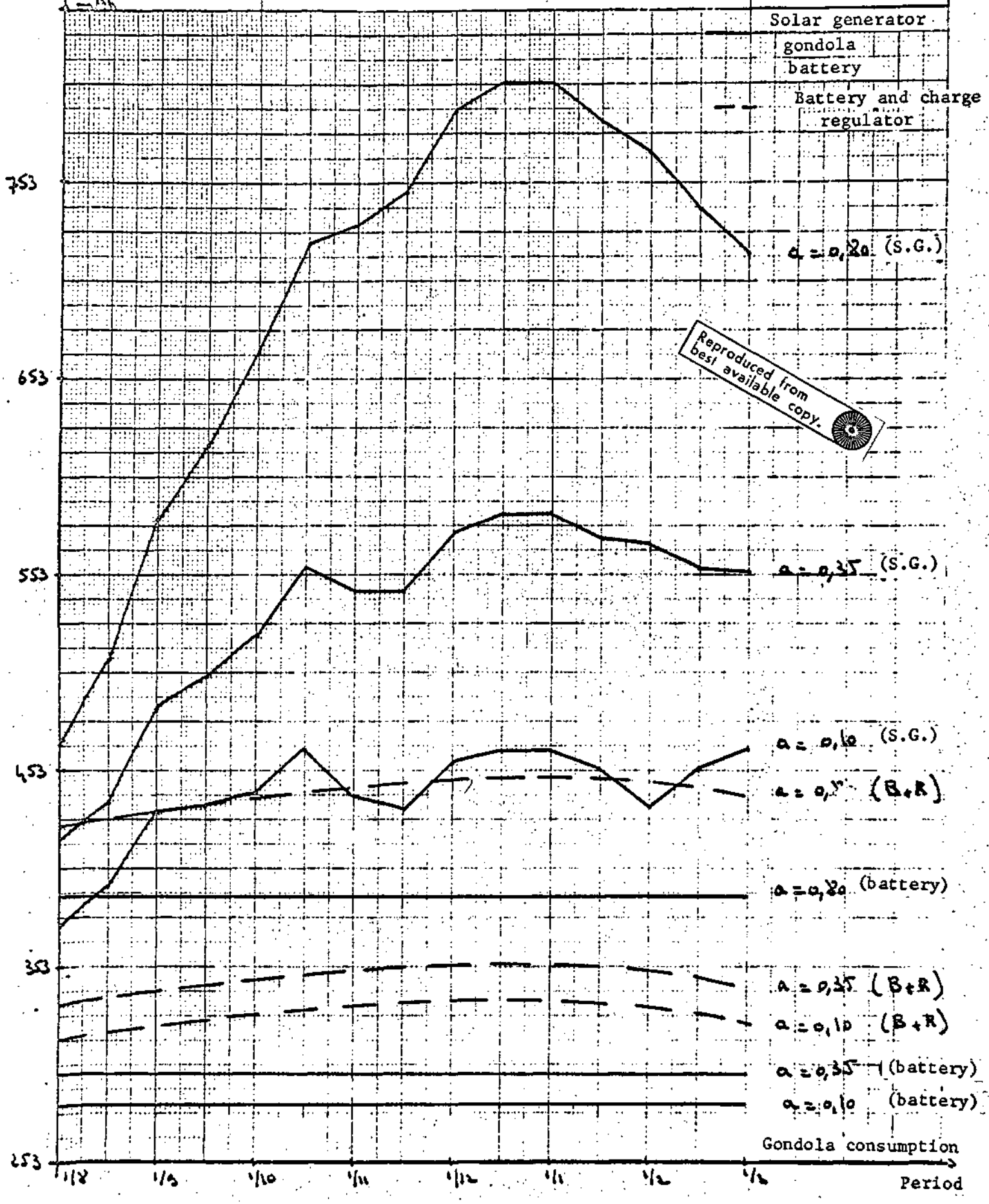
Enivronmental temperature 70°C

Latitude : -40°

Power balance - Eole balloons

Fig 7



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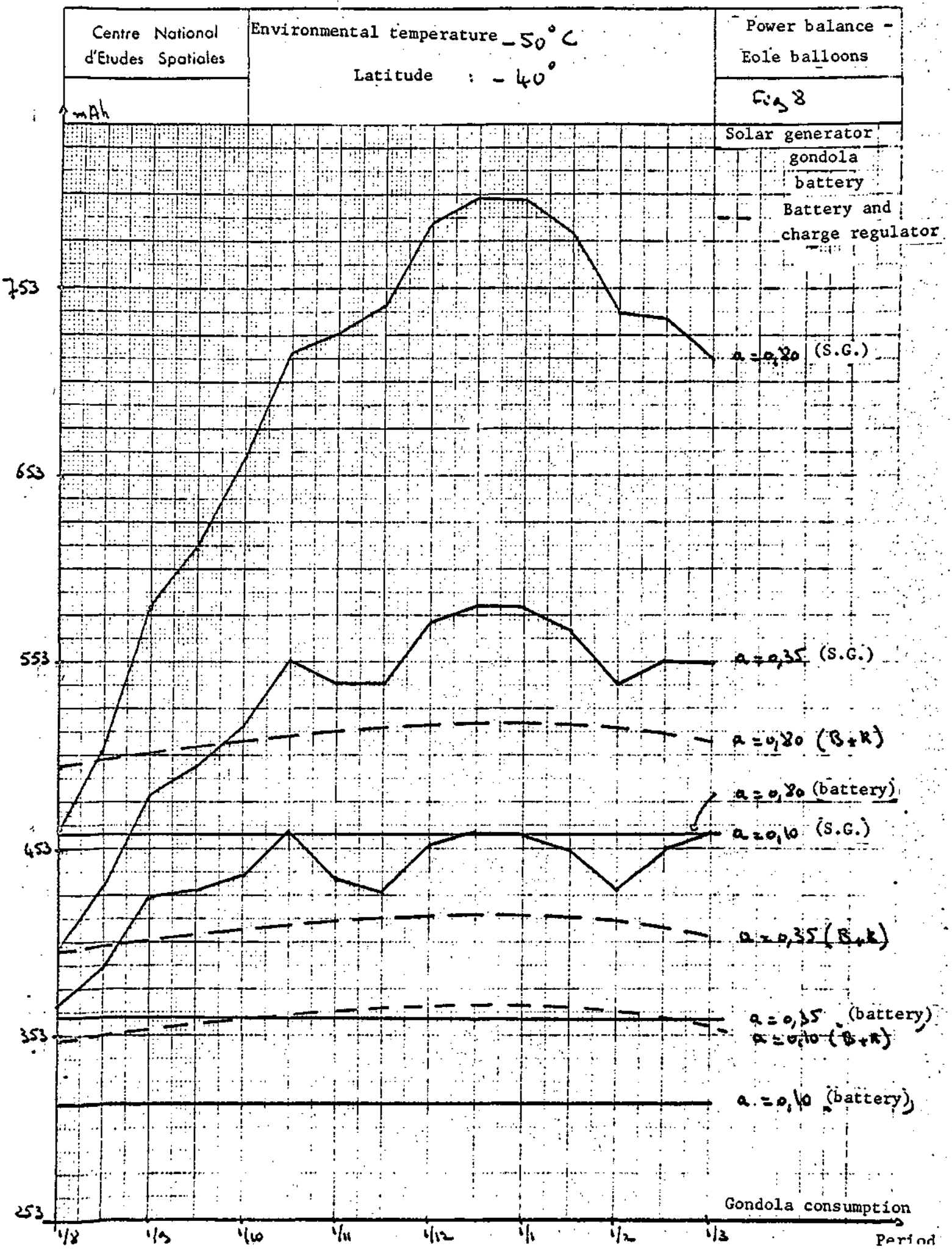
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Environmental temperature -50°C
Latitude : -40°
Power balance - Eole balloons
Fig 8
mAh
Solar generator
gondola
battery
Battery and charge regulator
753
653
553
453
353
253
a = 0,80 (S.G.)
a = 0,35 (S.G.)
a = 0,80 (B+R)
a = 0,80 (battery)
a = 0,10 (S.G.)
a = 0,35 (B+R)
a = 0,35 (battery)
a = 0,10 (B+R)
a = 0,10 (battery)
Gondola consumption
1/8
1/9
1/10
1/11
1/12
1/1
1/2
1/3
Period

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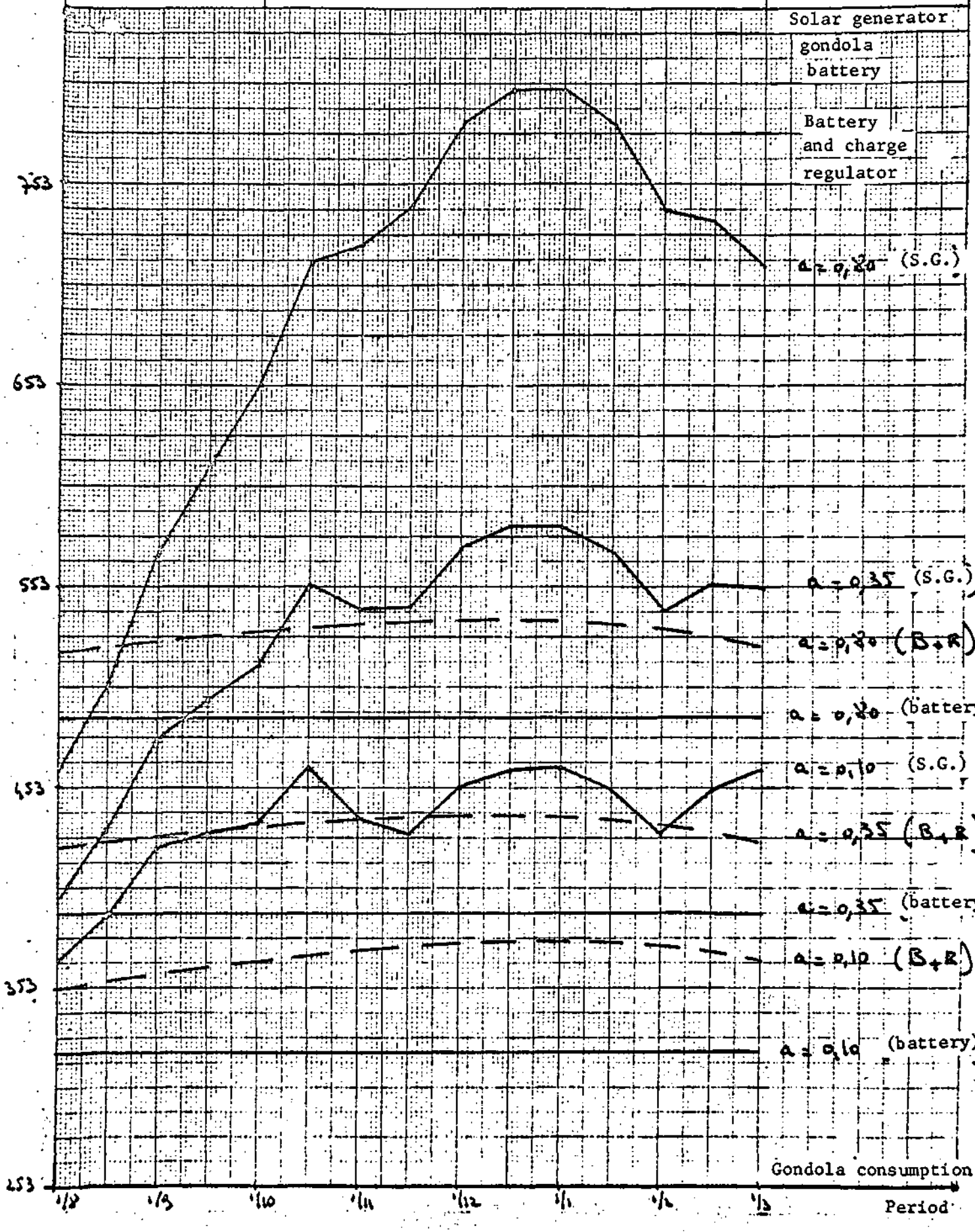
Environmental temperature : -40°C

Latitude : -40°

Power balance - Eole balloons

Fig 3



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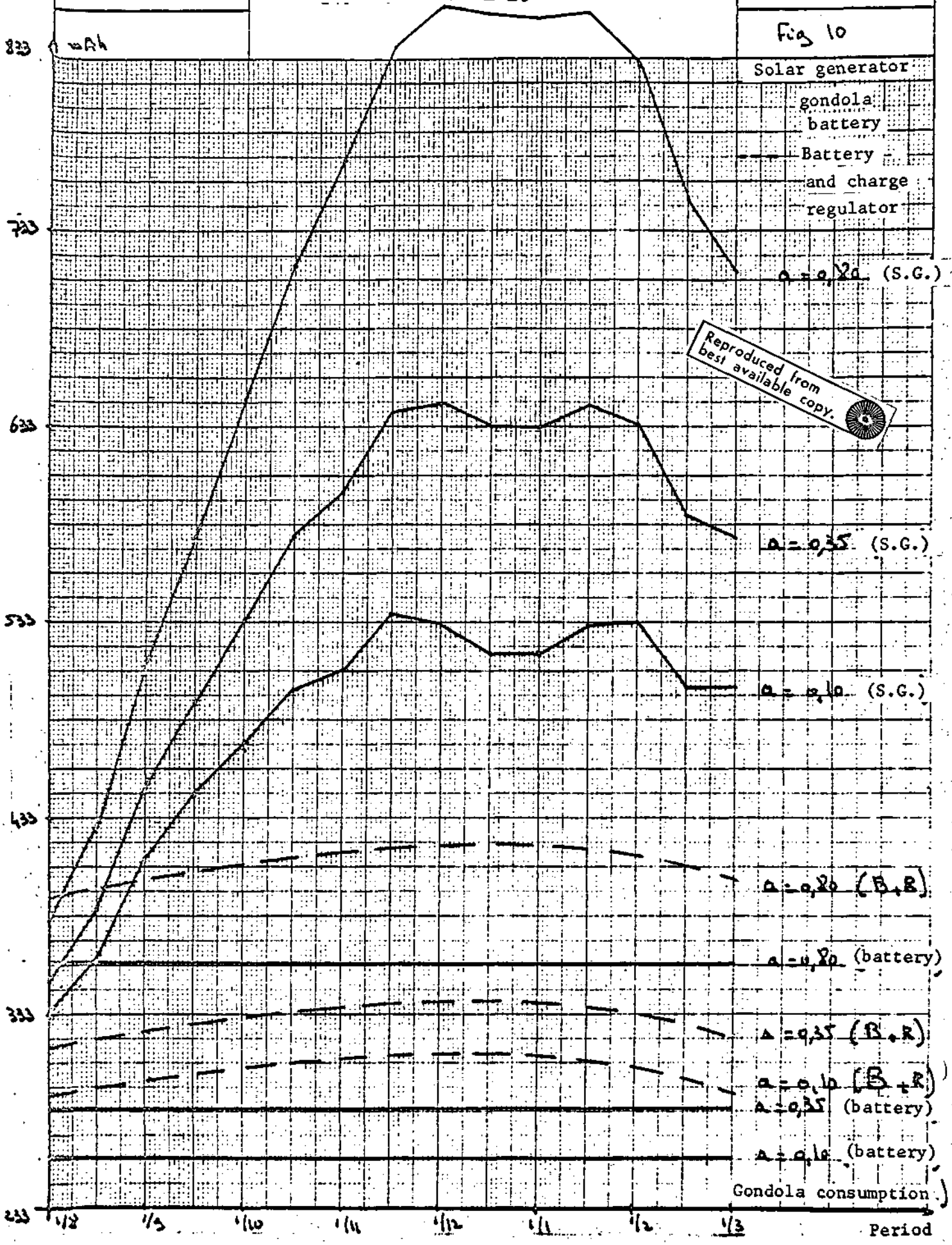
Environmental temperature : -70°C
Latitude : -50°

Power balance - Eole balloons

Fig 10



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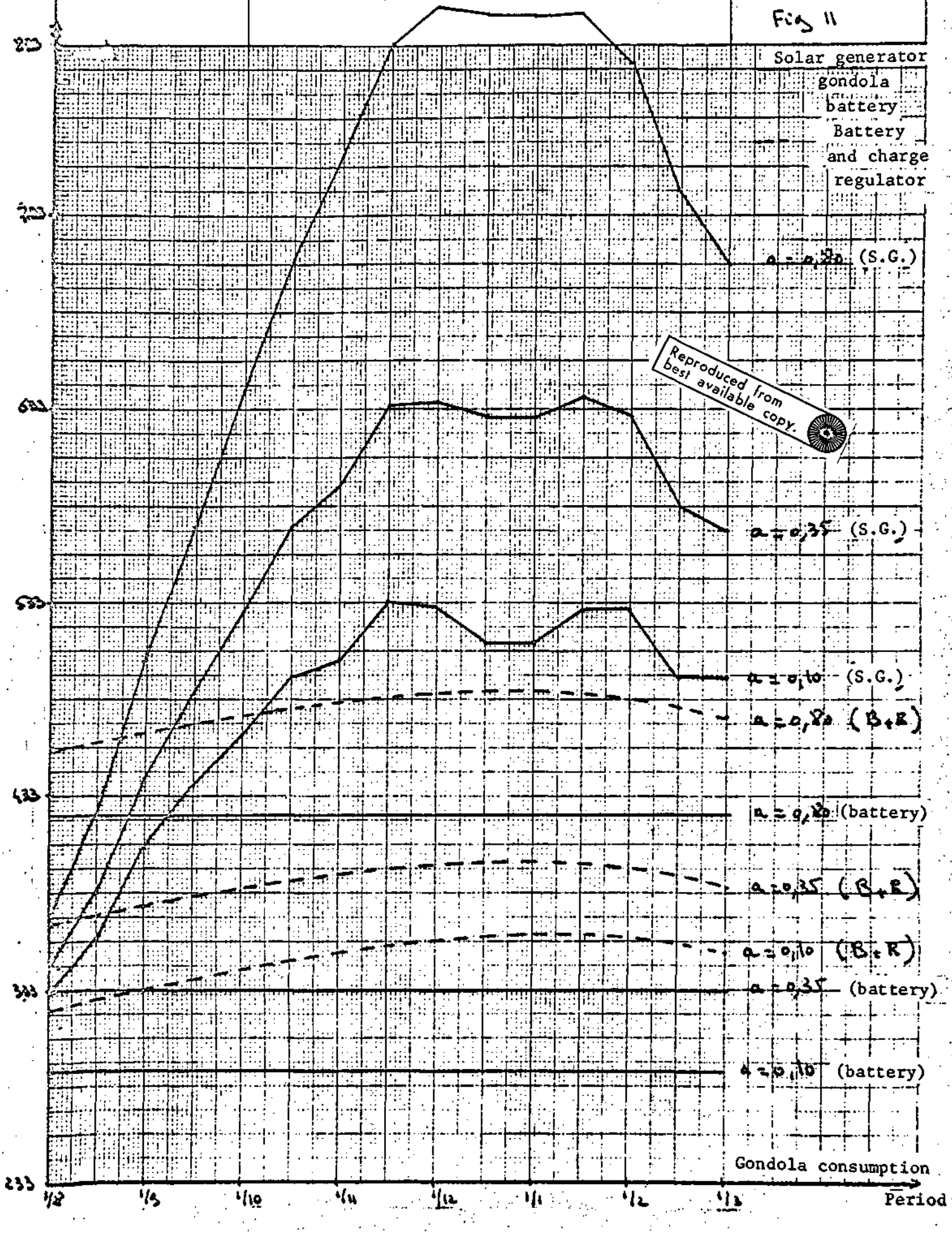
Environmental temperature −50°C

Latitude −50°

Power balance – Eole balloons

Fig 11



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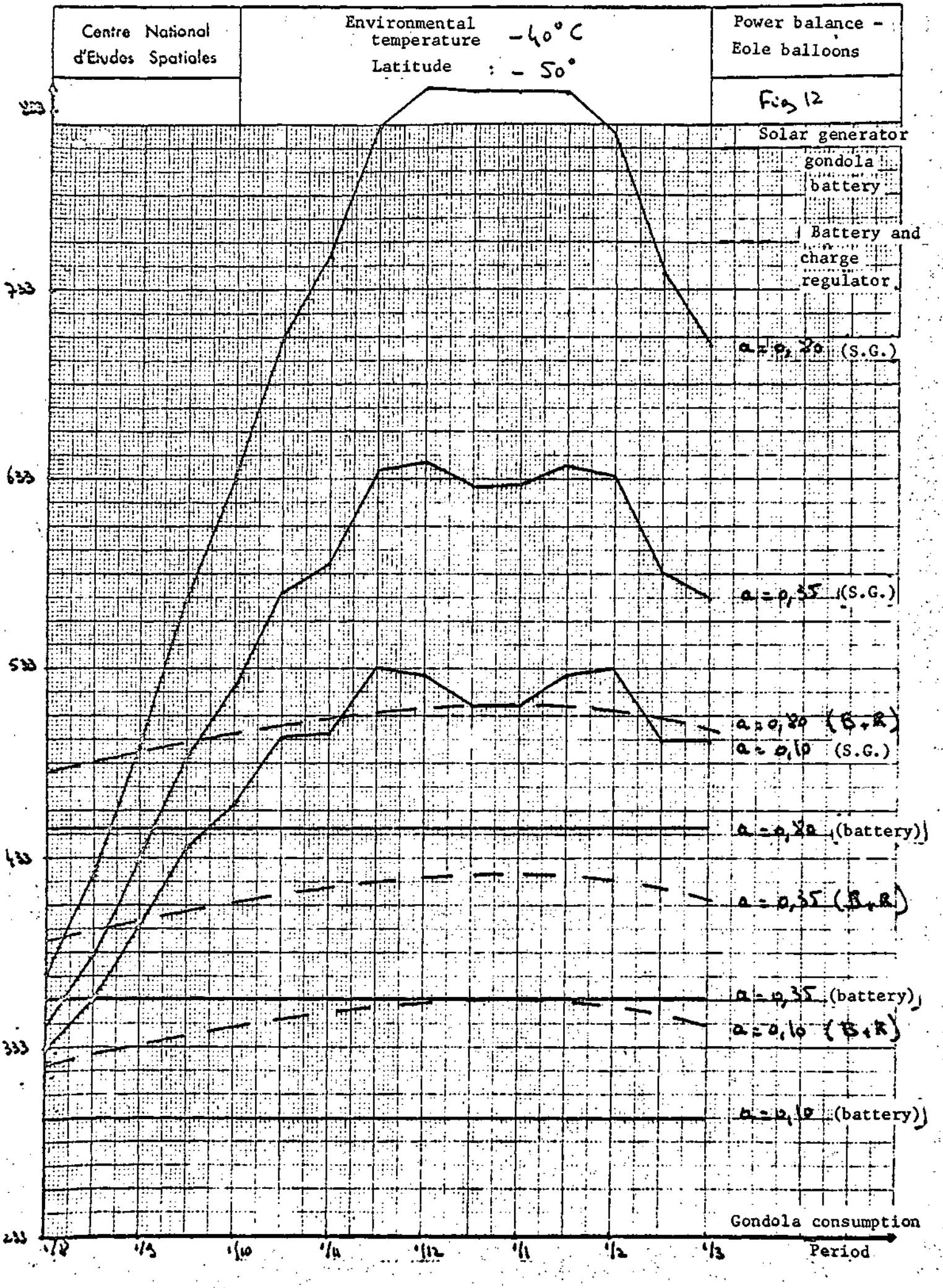
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Environmental temperature -40° C
Latitude : - 50°
Power balance - Eole balloons
Fig 12
Solar generator
gondola
battery
Battery and charge regulator
a = 0,20 (S.G.)
a = 0,35 (S.G.)
a = 0,20 (B+R)
a = 0,10 (S.G.)
a = 0,20 (battery)
a = 0,35 (B+R)
a = 0,35 (battery)
a = 0,10 (B+R)
a = 0,10 (battery)
Gondola consumption
Period
1/8
1/9
1/10
1/11
1/12
1/1
1/2
1/3

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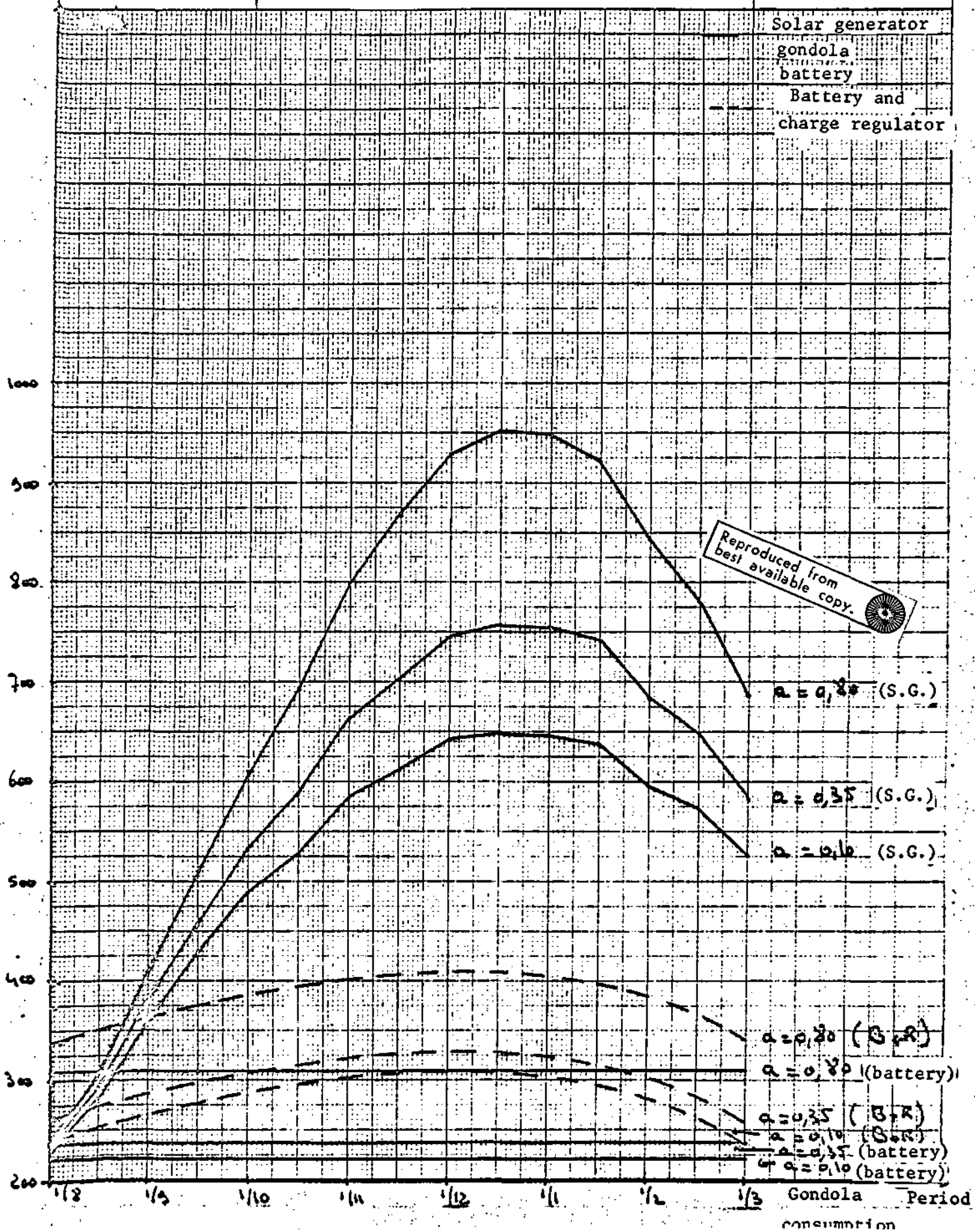

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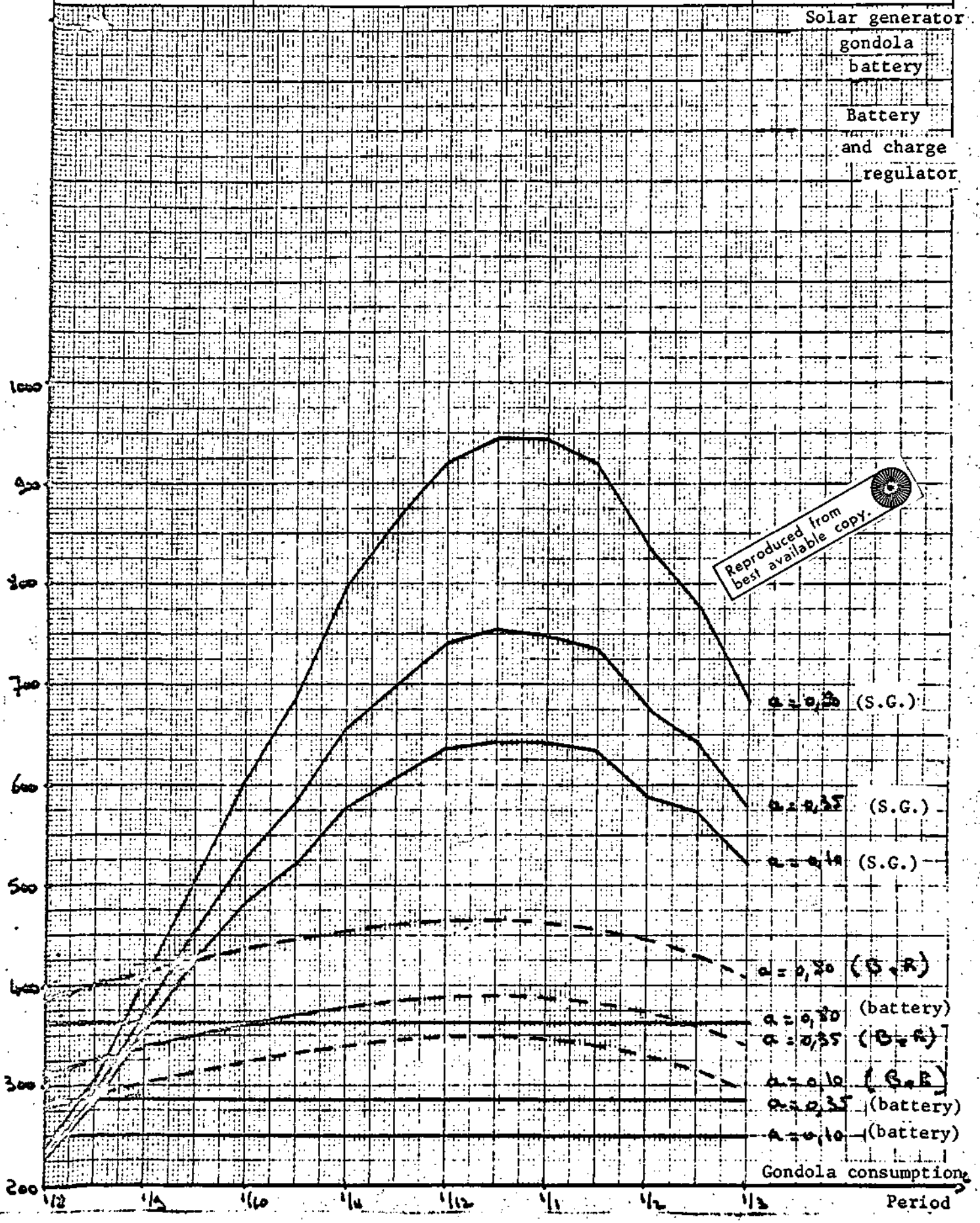

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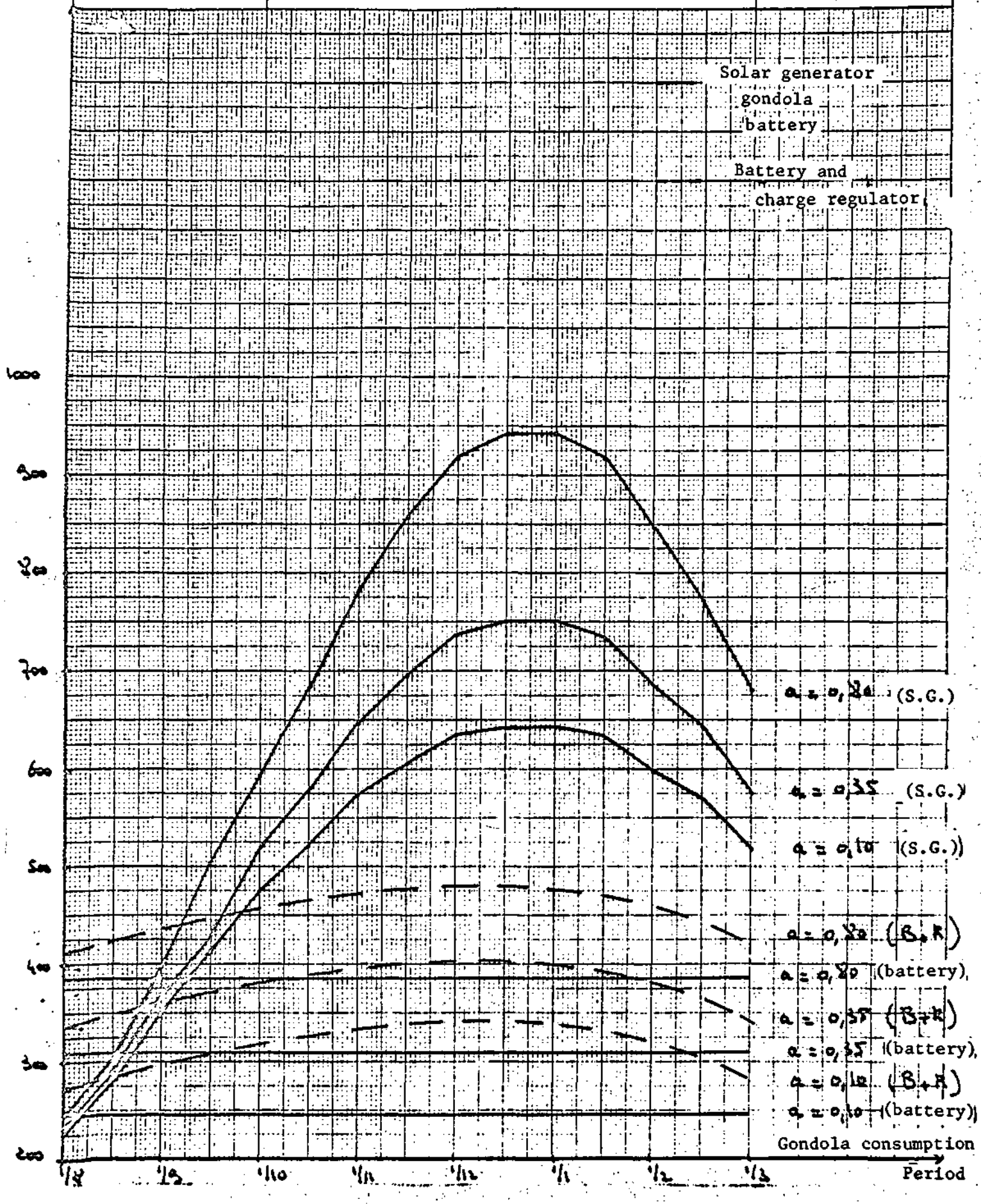
Centre National d'Etudes Spatiales	Environmental temperature : −40°C Latitude : −60°	Power balance - Eole balloons.
		Fig 15



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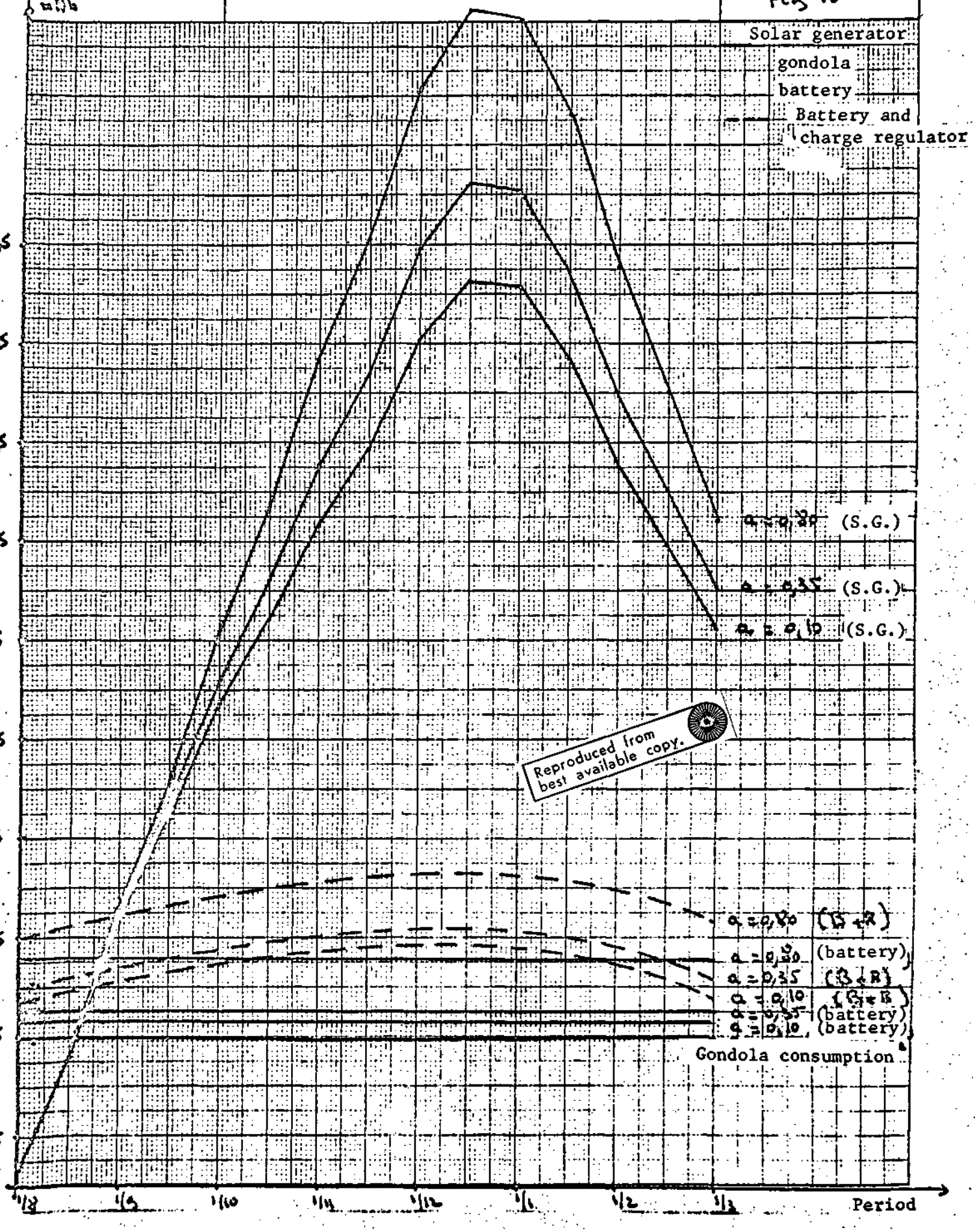
Environmental temperature : -70°C

Latitude : -70°

Power balance - Eole balloons

Fig 16



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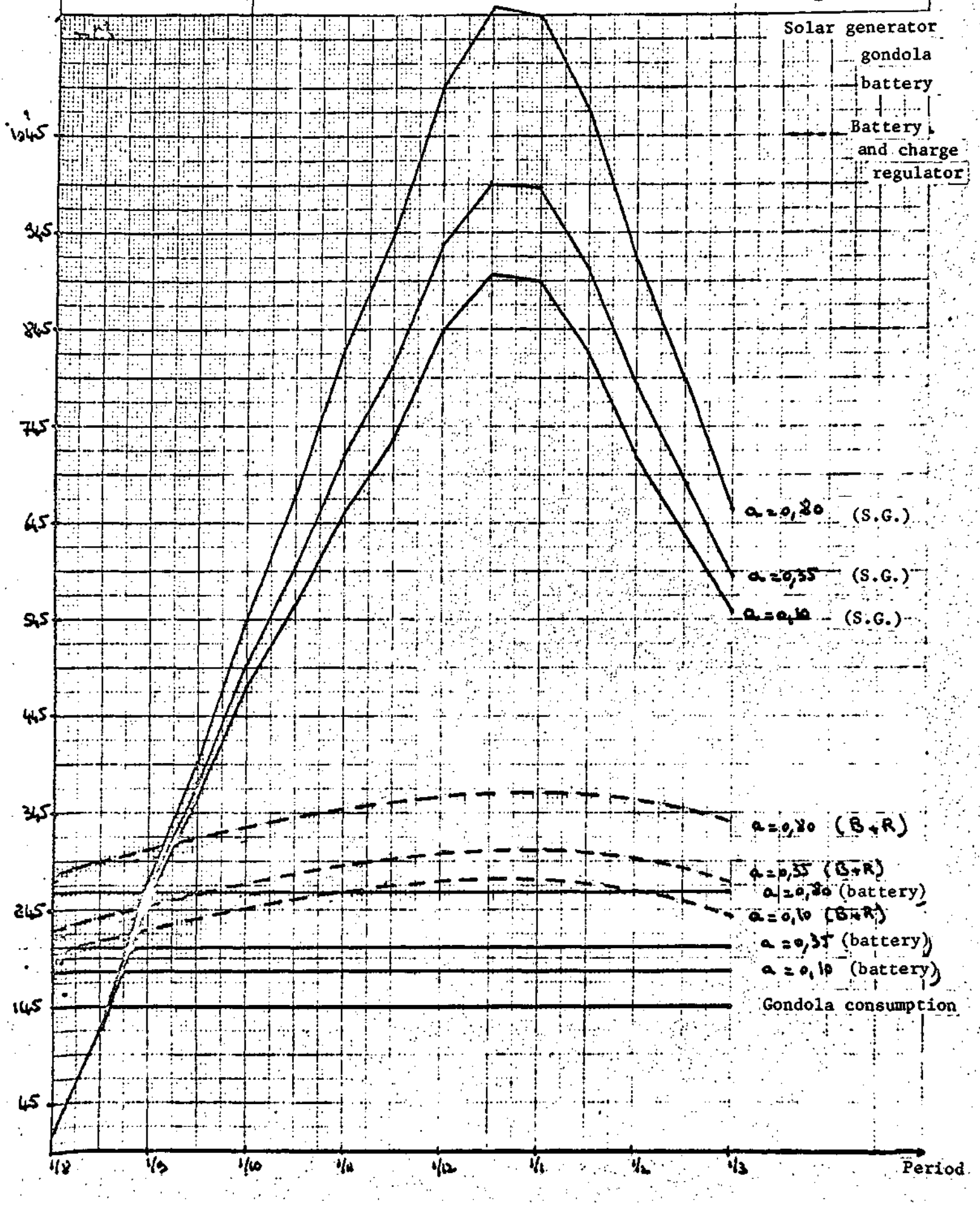
Environmental temperature : -50°C
Latitude : -70°

Power balance - Eole balloons

Fig 17



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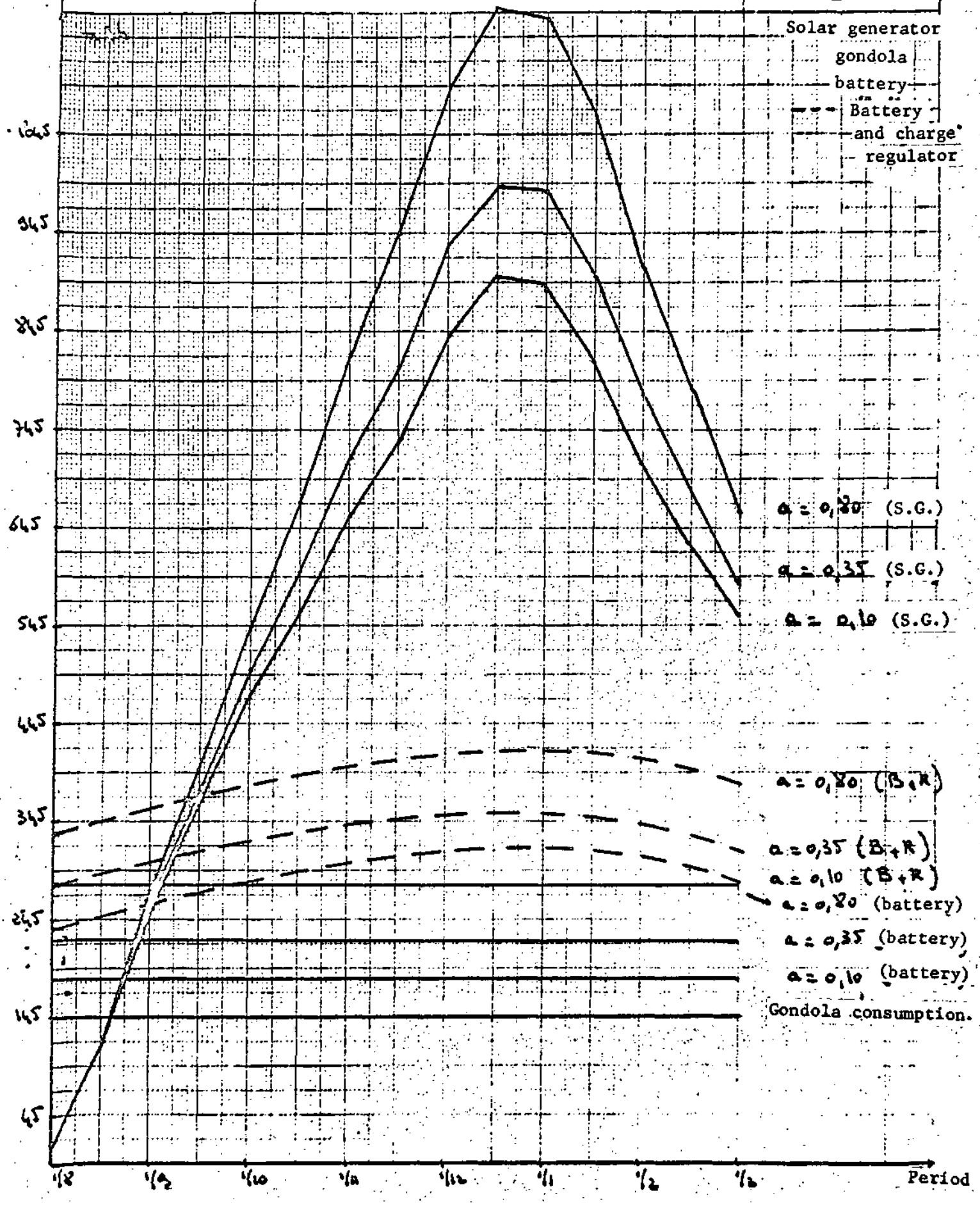
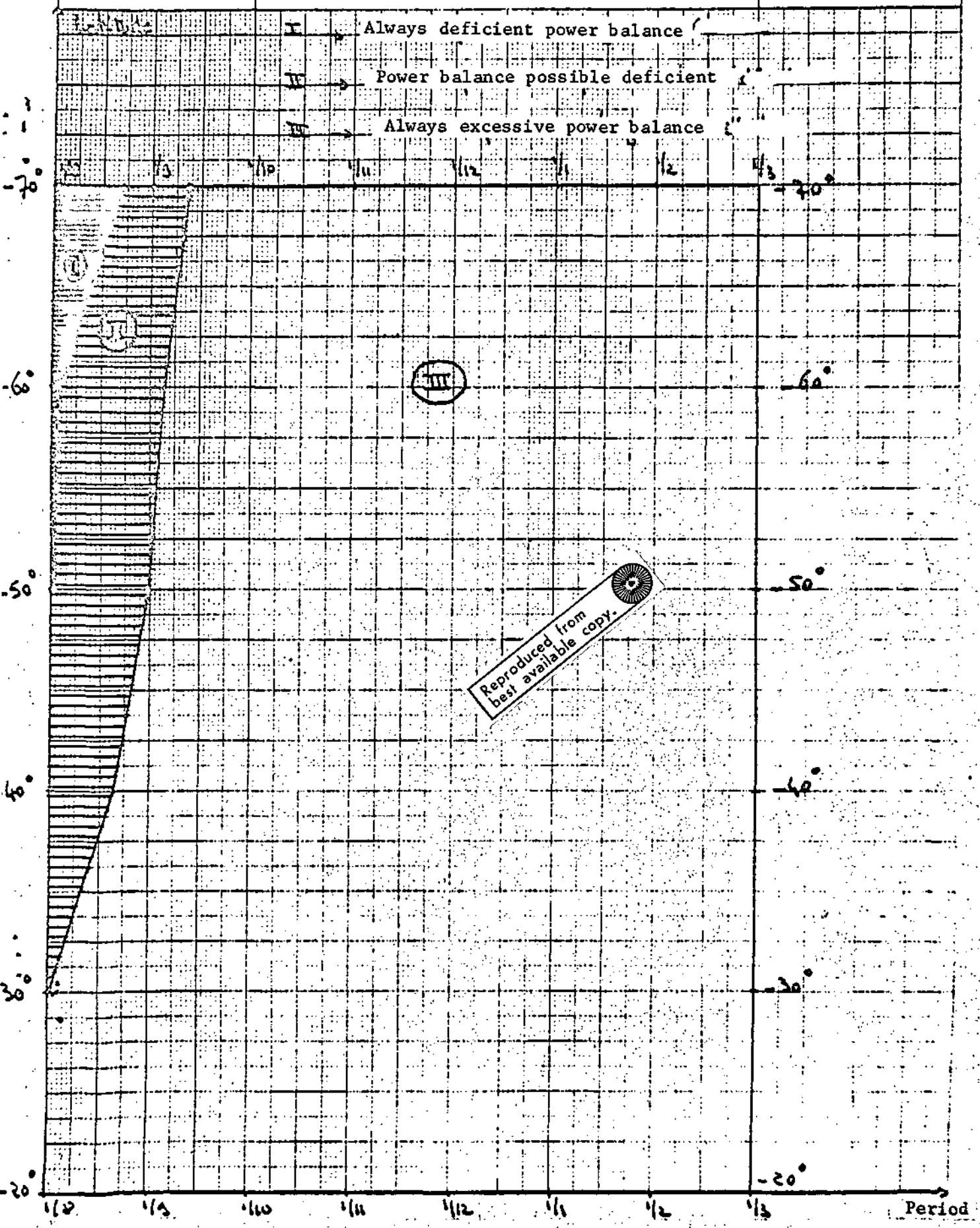
Environmental temperature -40° C
Latitude : -70°

Power balance - Eole balloons

Fig 18



Centre National d'Etudes Spatiales	Equilibrium of power balance as a function of position and time	Power balance - Eole balloons
		Fig 19



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