Performance Test Results Of ETS-VI Ni-Cd Cells

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K.Nakatani, Y.Yano, S.Kuwajima* and H.Kusawake*
Sanyo Electric Co.,Ltd.
*National Space Development Agency of Japan

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Background

- Development of 35Ah Ni–Cd cell for ETS–VI was initiated in 1986.
- Cell production of ETS–VI/FM : 1991 to 1992
  - 1st lot : delivered 66 cells to battery manufacturer (MELCO)
  - 2nd lot : delivered 83 cells to battery manufacturer
- ETS–VI uses 4 batteries
  - Each battery consists of 2 packs.
  - 16 series cells per pack
- ETS–VI will be scheduled for launch in 1994.
- ETS–VI/FM Batteries are now storaged at low temperature.
- Same designed cells were delivered to NASA Lewis Research Center for evaluation in this year.

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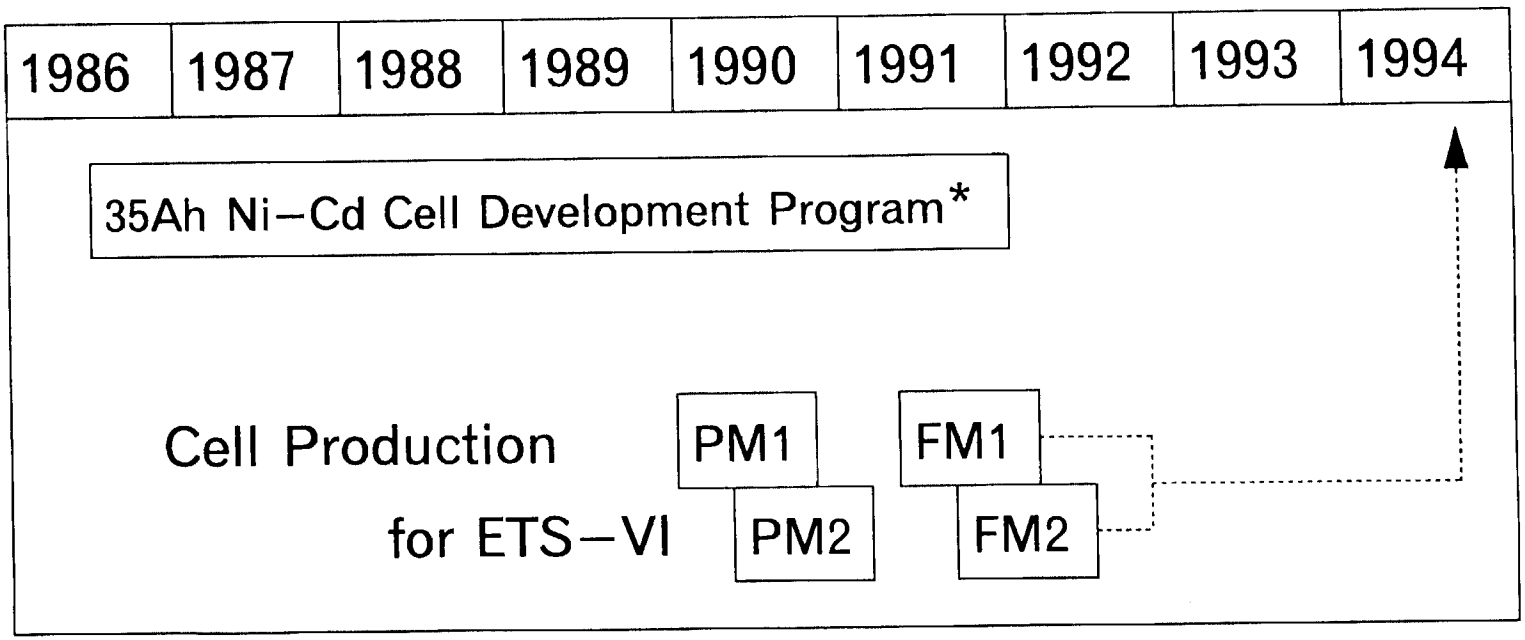
Development Schedule



*Life tests are now continued in NASDA.

PM:Prototype Model Cell FM:Flight Model Cell

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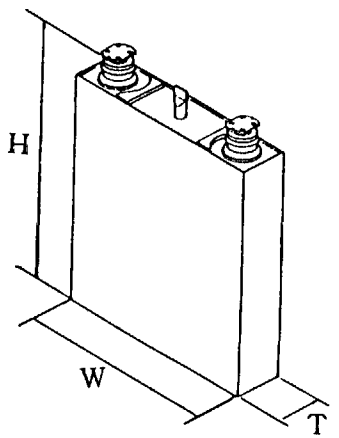
Main Specification

· Model Name : N35S
· Dimension : 107 ^{W} × 25 ^{T} × 127 ^{H} mm
· Weight : max. 1050g
· Nominal Capacity : 35Ah
· Energy Density : 40Wh/kg
· Design Life : 10years in GEO



· Electric Performance

Charge Condition	Charge Volt.	Internal Pressure	Capacity *
0.1C x 24hrs. 20 °C	max. 1.50V	max. 3.5kg/cm^2	min. 35.0Ah
0.1C x 24hrs. 35 °C	max. 1.45V	max. 3.5kg/cm^2	min. 32.0Ah
0.05Cx48hrs. −5 °C	max. 1.55V	max. 3.5kg/cm^2	min. 32.0Ah

* Discharge 0.5C

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Cell Design

	Positive	Negative
Substrate Porosity	Sinter Ni / 85%	Sinter Ni / 86%
Impregnation	Chemical Impreg.	Chemical Impreg.
Additives	Co and Cd	Non
Number of Plate	13	14
Plate Dimension	104 x 100mm	104 x 100mm
Plate Thickness	0.63mm	0.80mm
Loading Level	2.4g/cc−void	3.0g/cc−void
Plate Capacity	42.6Ah	69.7Ah
Capacity Ratio	1.64	
Separator	Nylon Nonwoven Cloth	
Electrolyte	31%KOH 98g	
Design Weight	1040g	
Design Capacity	38.7Ah	

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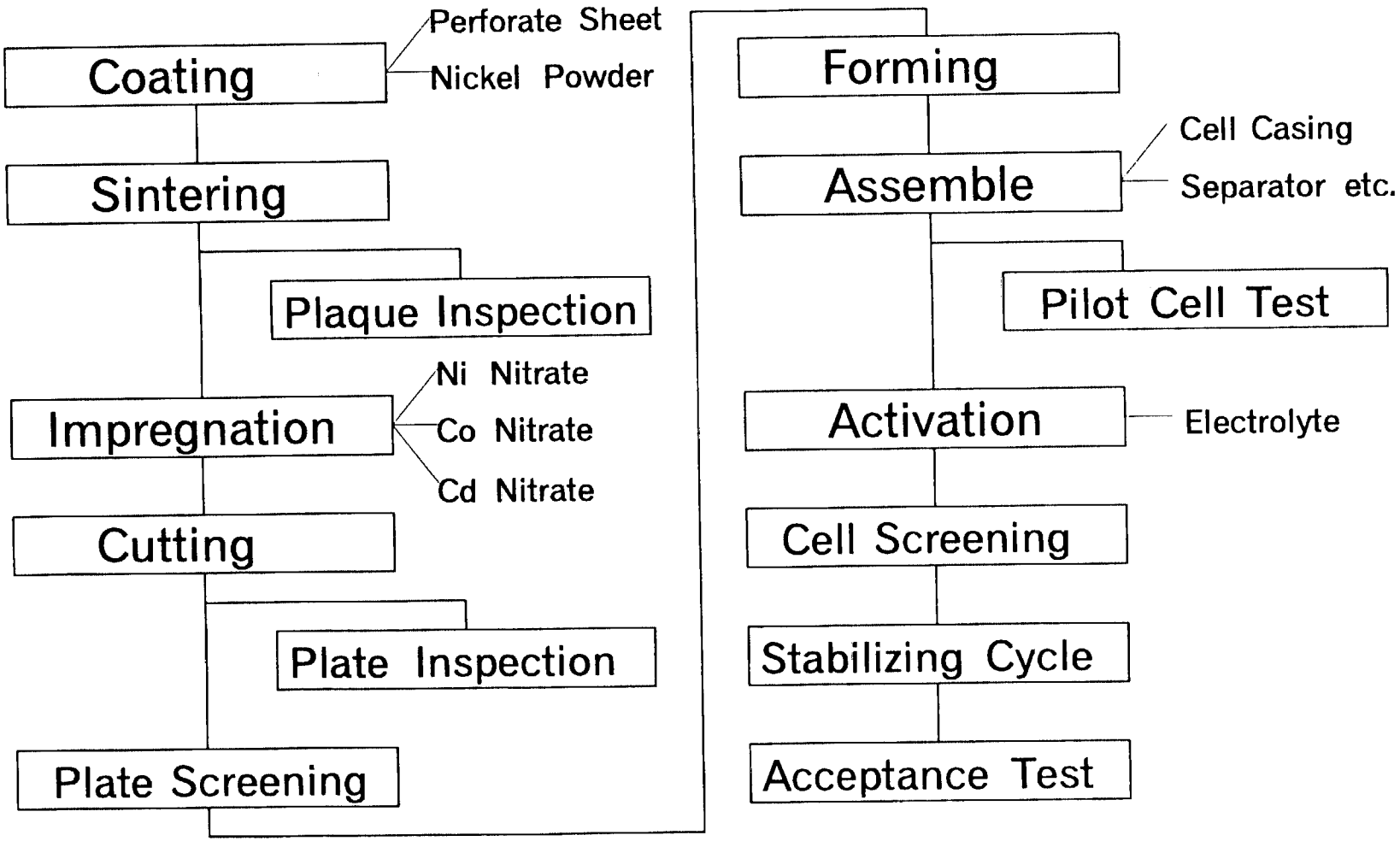
Production Flow



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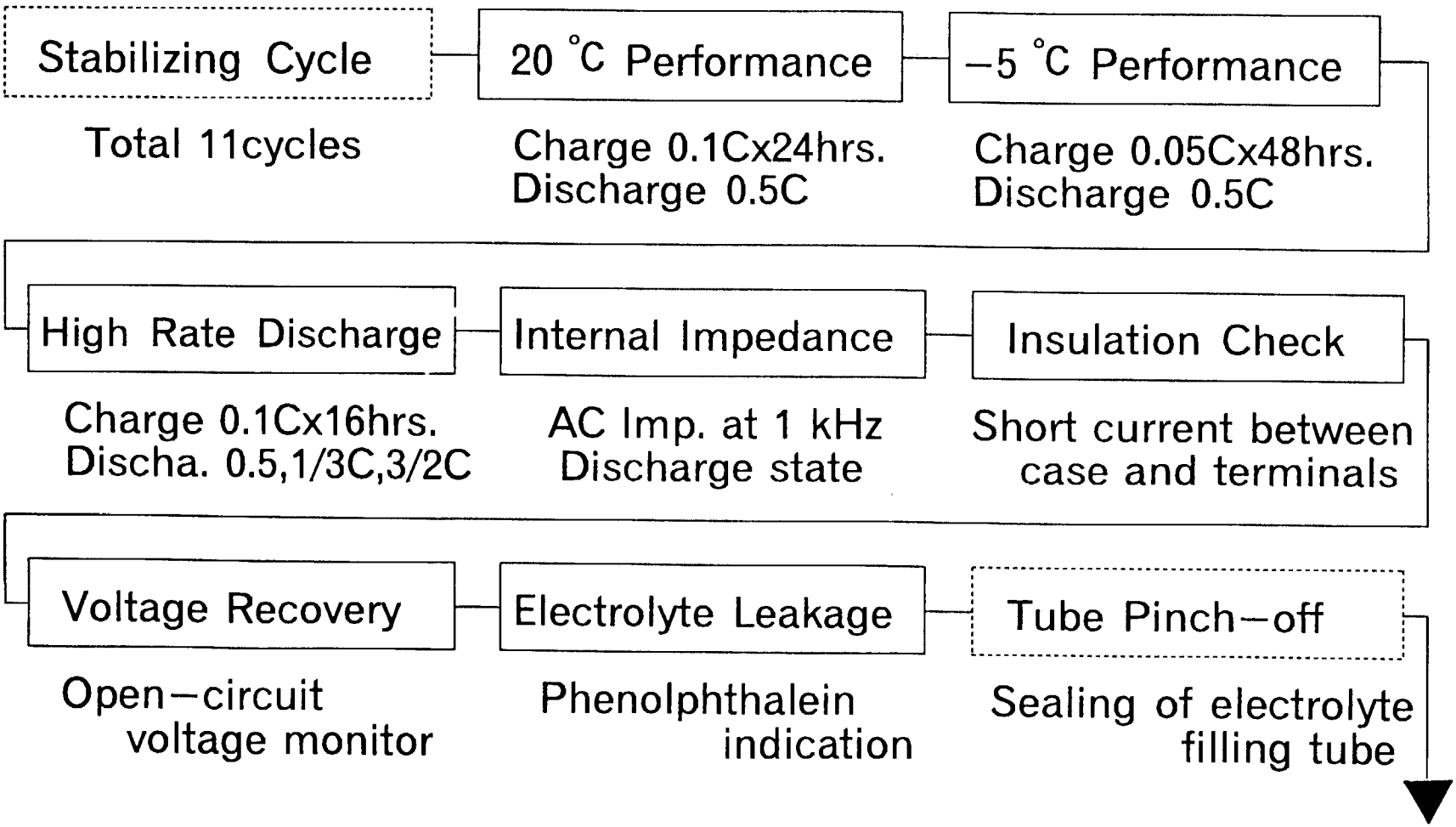
Acceptance Test (1)



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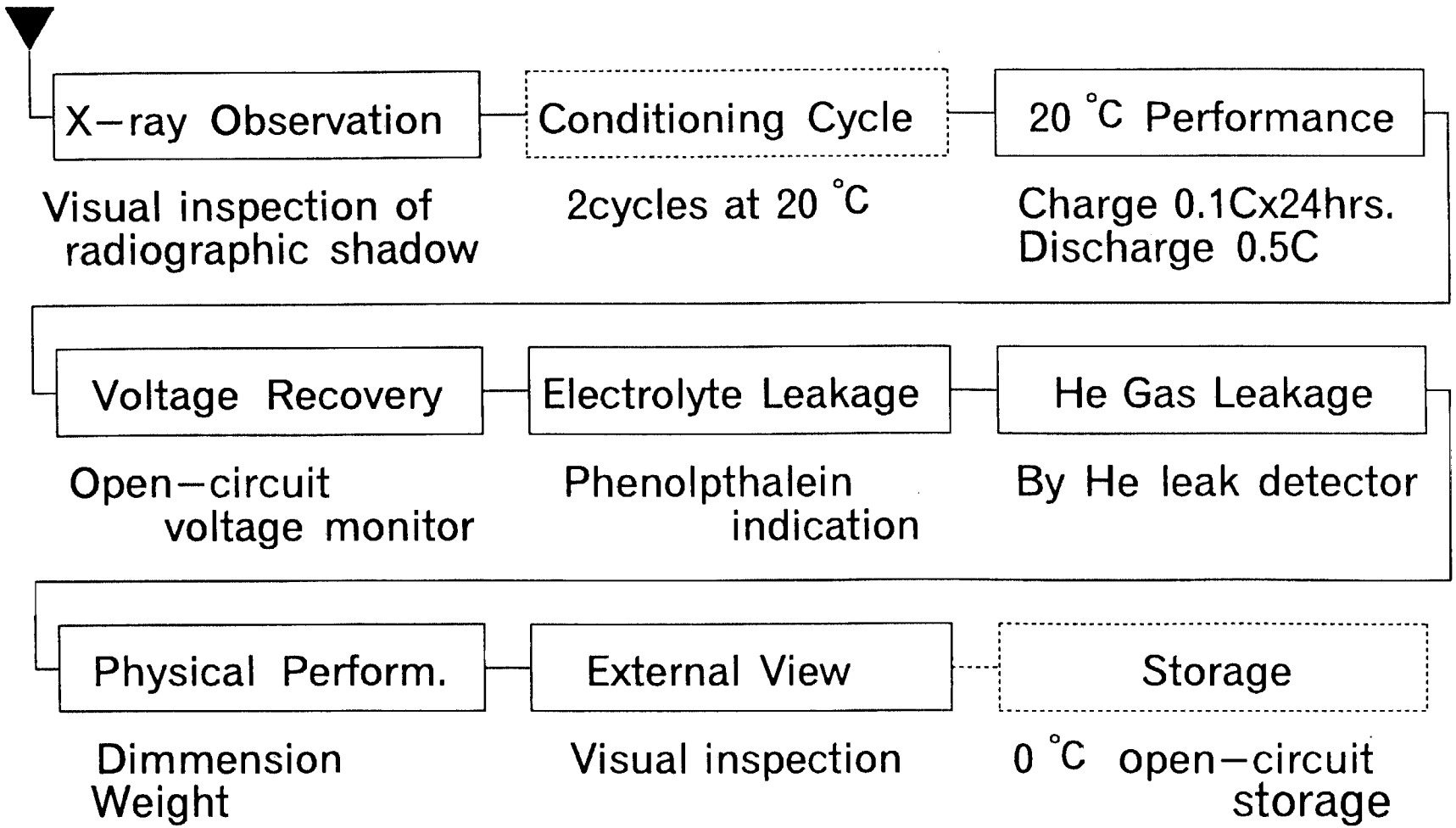
Acceptance Test (2)



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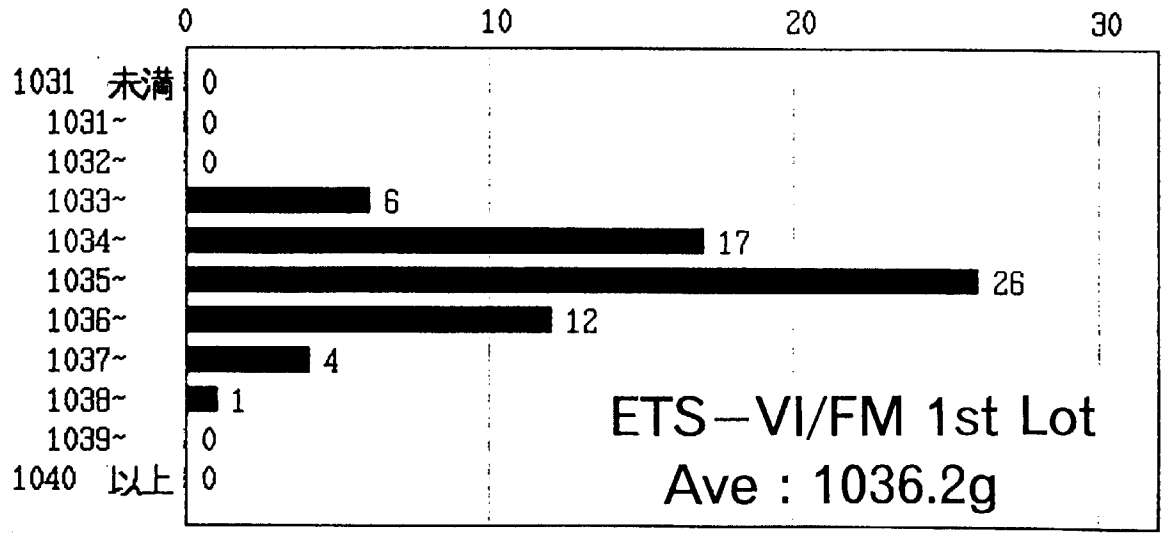
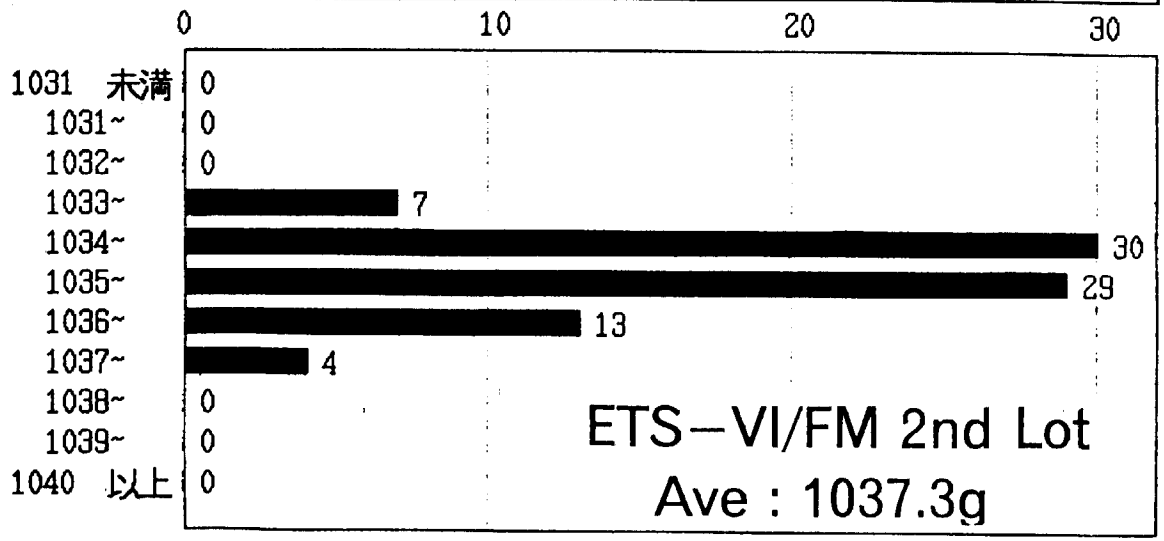
Cell Weight





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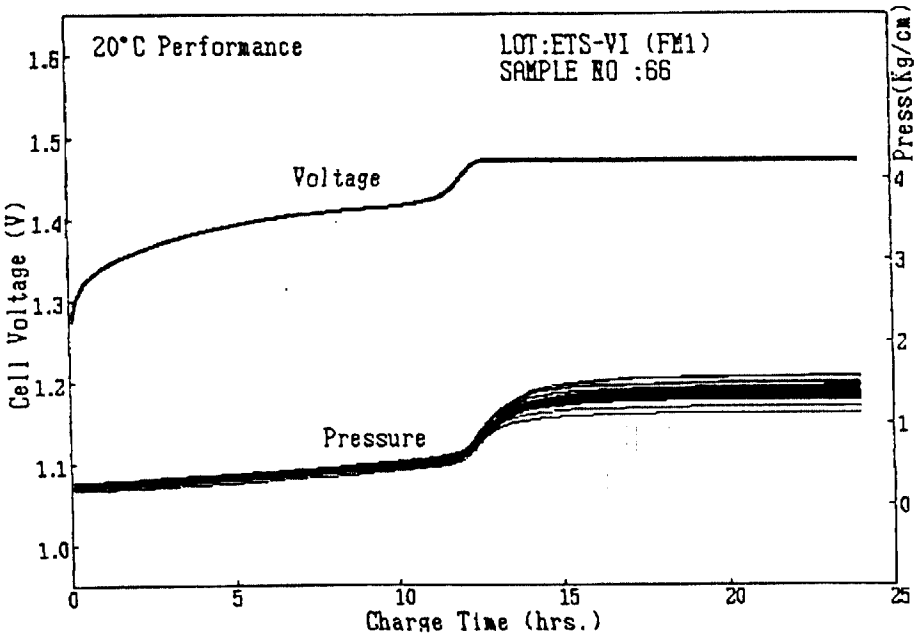
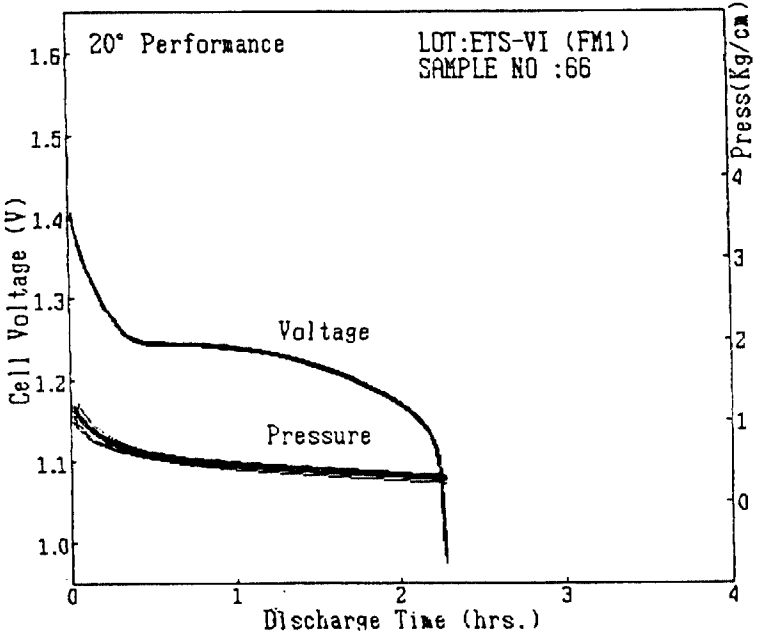
20 °C Performance





Charge 3.5A x 24hrs. Discharge 17.5A Temp. 20 °C

Overplot of 66 Data of ETS−VI/FM 1st Lot

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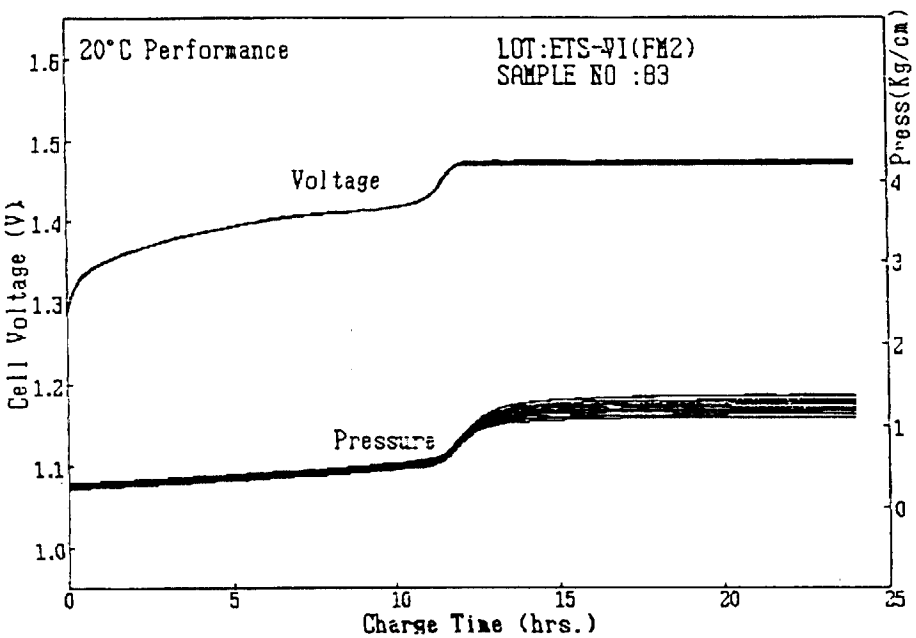
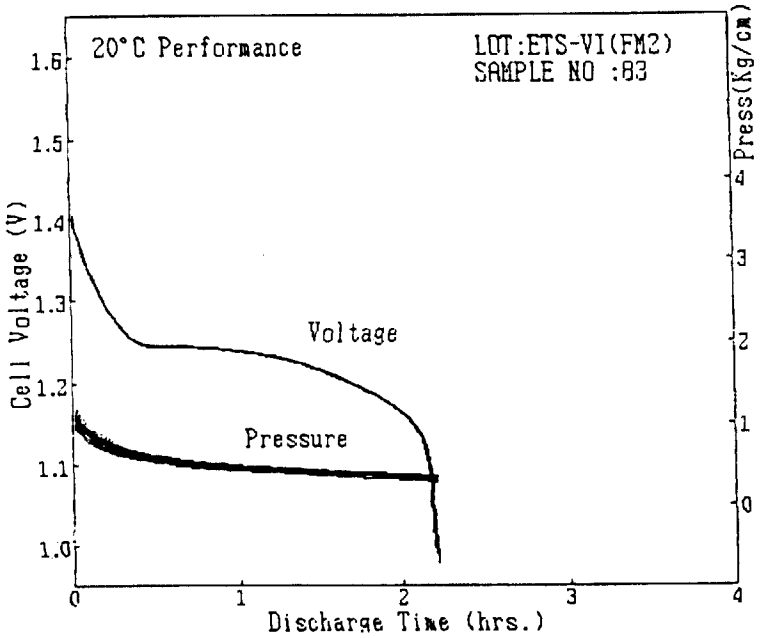
20 °C Performance





Charge 3.5A x 24hrs. Discharge 17.5A Temp. 20 °C

Overplot of 83 Data of ETS–VI/FM 2nd Lot

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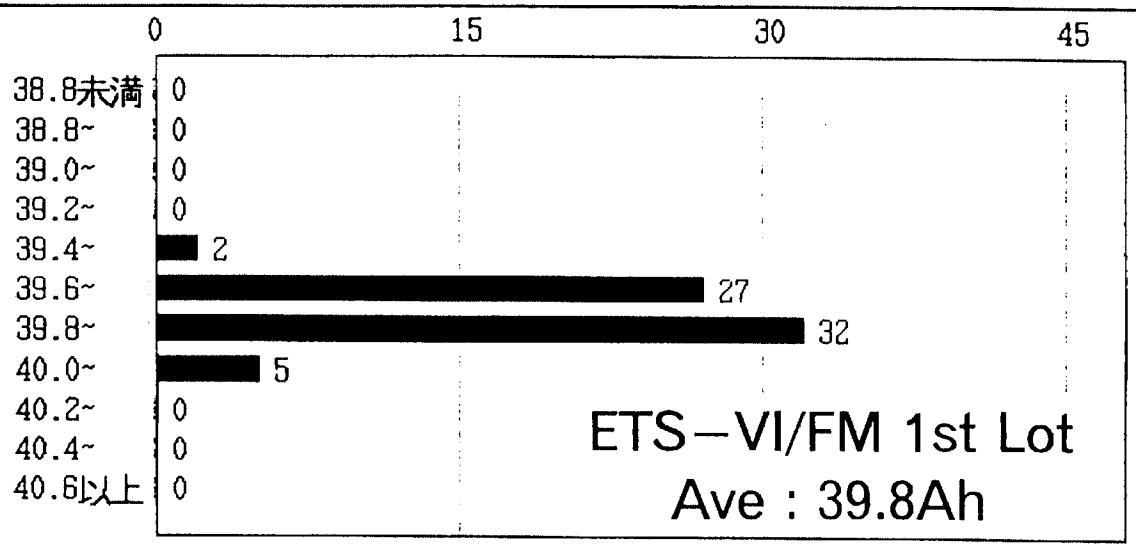
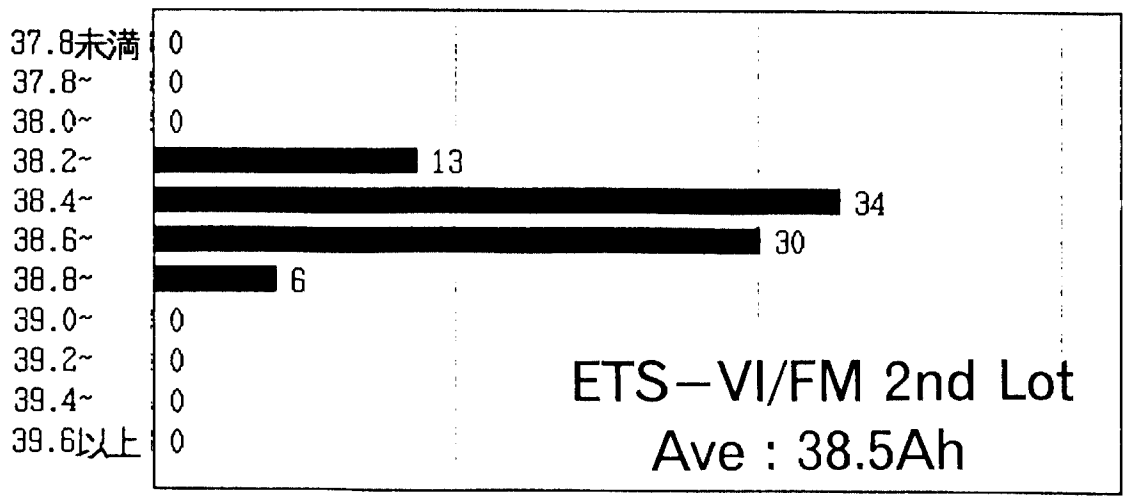
Capacity





Charge 3.5A x 24hrs. at 20 ℃ Discharge 17.5A

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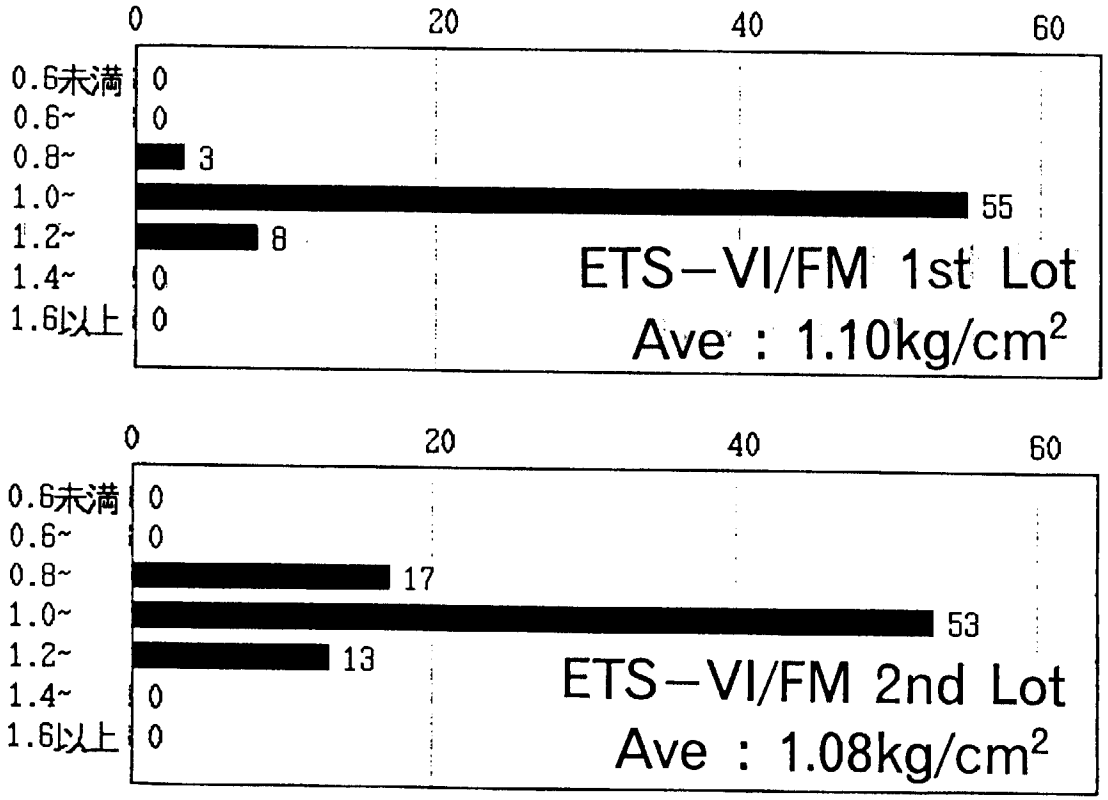
Overcharge Pressure



Charge 3.5A x 24hrs. at 20 ℃

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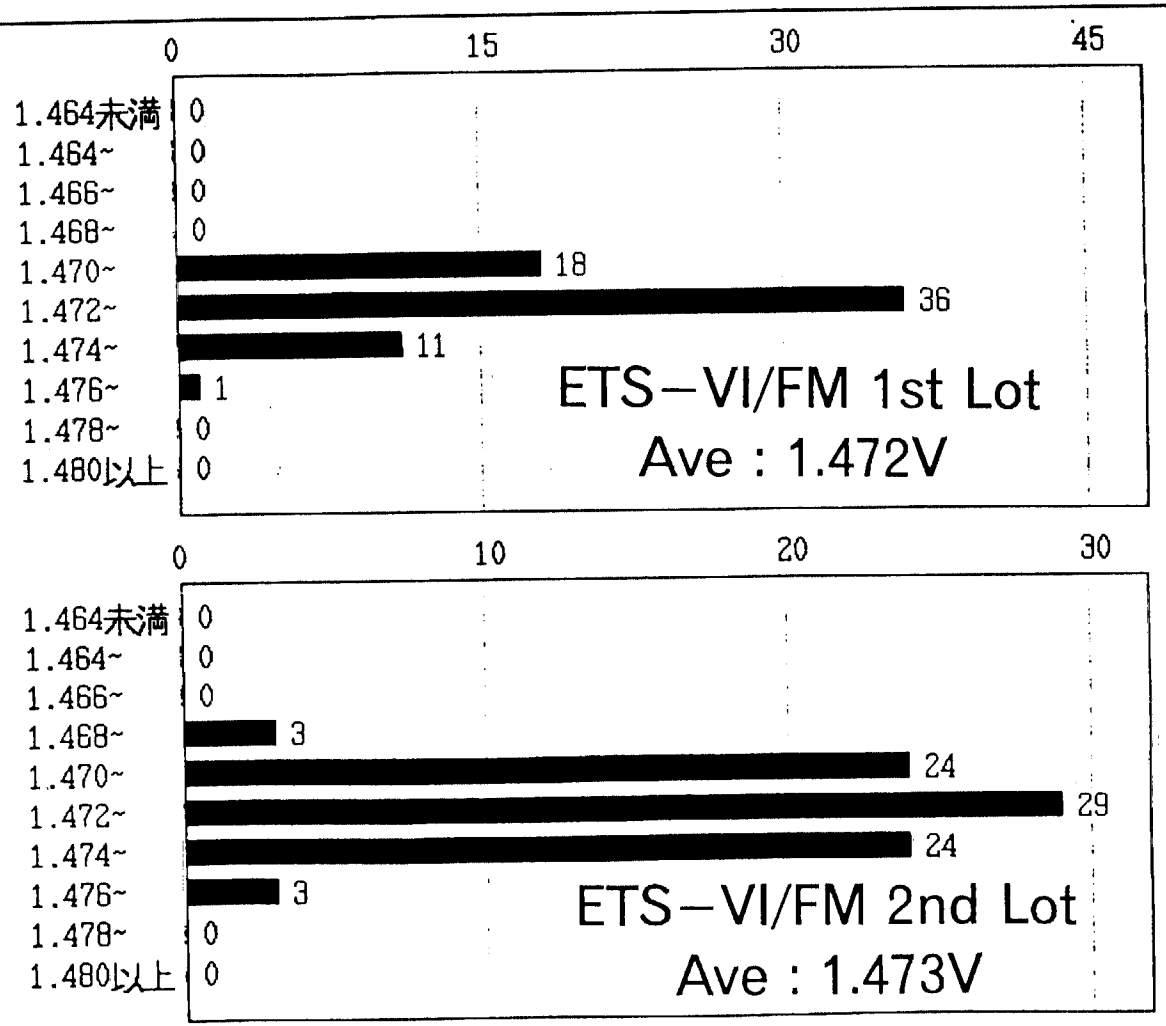
End of Charge Voltage



Charge 3.5A x 24hrs. at 20 °C

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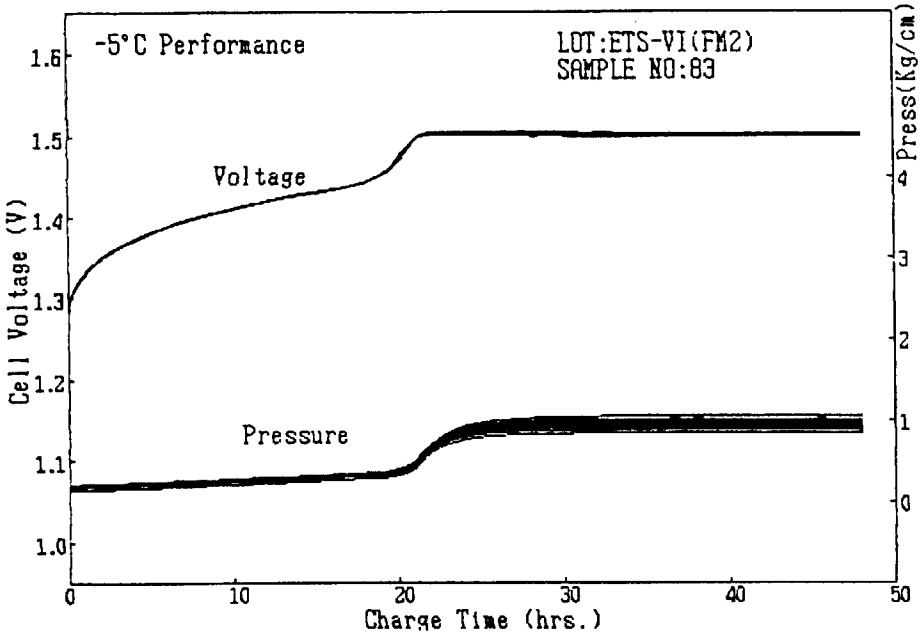
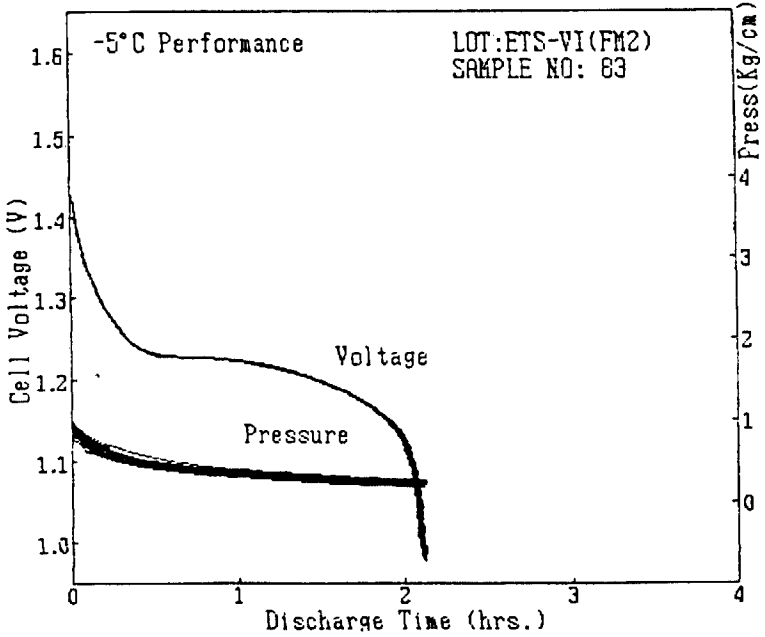
−5 °C Performance





Charge 1.75A x 48hrs. Discharge 17.5A Temp.−5 °C

Overplot of 83 Data of ETS−VI/FM 2nd Lot

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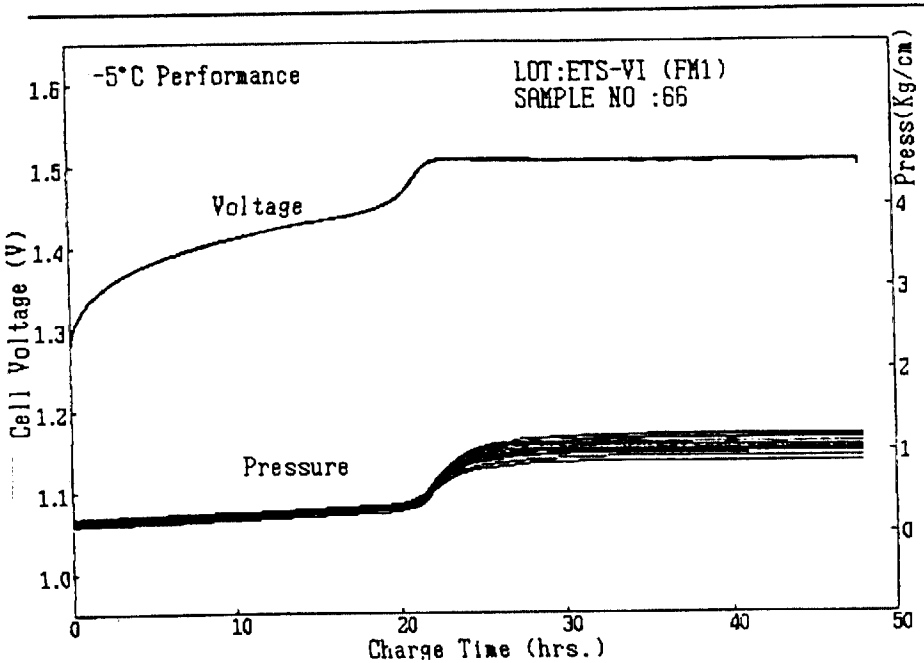
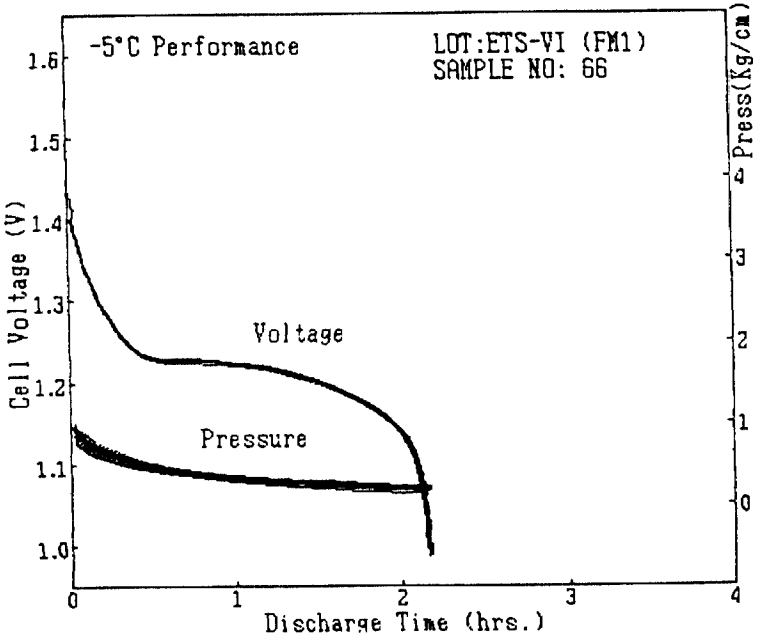
−5 °C Performance





Charge 1.75A x 48hrs. Discharge 17.5A Temp.−5 °C

Overplot of 66 Data of ETS−VI/FM 1st Lot

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ETS-VI Simulation Cycle Test

Sample :

8cells of PM 2nd lot / electrolyte filling in Nov. 1990

Test fascilities :

in NASDA Tsukuba Space Center

Test Status :

Started in Feb. 1991

Continued in 834cycles of 19th season on Nov.1, 1993

Testing Data Summary :

EOCV about 1.45V/cell

8 cells-sample battery has never reached CV mode.

Reconditioning capacities are about 41AH from 5th to 18th season.

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ETS-VI Simulation Cycle Test

Test conditions : from 5th season

Repeat 44cycles

- Charge : (CC 1.5A + CV 12.5V/8cells) x 14hrs.
- Trickle Charge : 0.5A x 8.8hrs.*
- Discharge : 14.6A x 1.2hrs. (DOD 50%)
- Temperature : 10 ℃ **

Reconditioning

- Discharge : 0.66A until any cell falls to 1.0V
- Recovery Charge : (CC1.5A+CV12.5V/8cells) x 35hrs.

*Not applied from 4th to 5th season

**Temperature of 20 ℃ was applied from 1st to 4th season.

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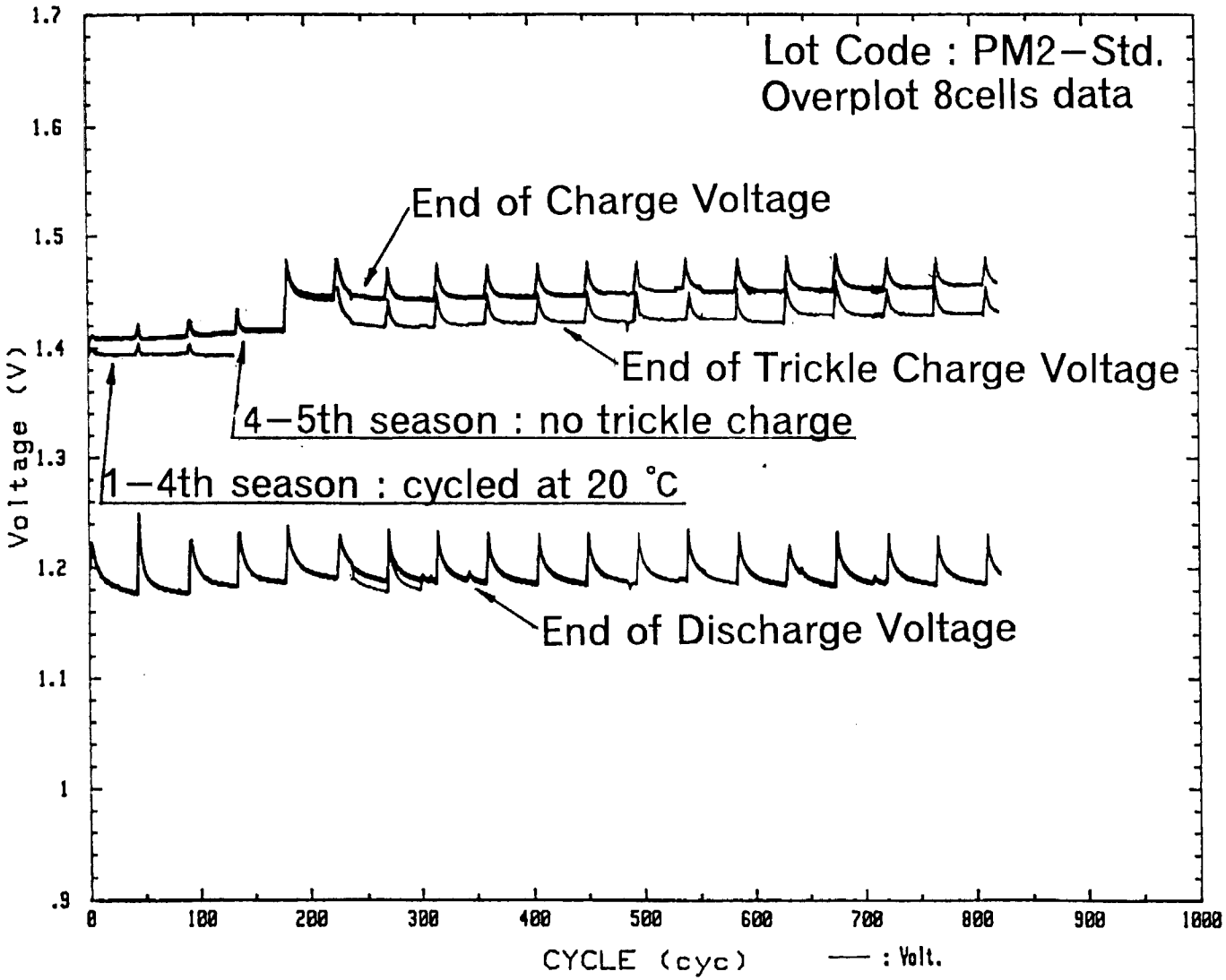
ETS-VI Simulation Cycle Test



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Battery Storage

Storage Condition : Below 0 ℃ , Open circuit condition
Short circuit storage causes a small fading of capacity.

6months Storage Test of ETS-VI/PM Cells

N=11	Short / 0 ℃ before → after	Open / 0 ℃ before → after
End of Charge Volt. [V]	1.471 → 1.471	1.471 → 1.472
Max. Press. [kg/sq.cm]	1.27 → 1.33	1.15 → 1.21
Capacity [Ah]	38.9 → 38.1	38.6 → 38.6

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Conclusion

- 35Ah Ni–Cd cells for ETS–VI/FM showed uniform performance in the initial acceptance test.
- Same designed cells are continuously tested in the simulating cycle mode of ETS–VI in NASDA, and these cells operate in a stable state.
- Our aerospace Ni–Cd cells are surely expected to show good performance in space, and selected by the following succesive program.

  ADEOS to launch in 1996 : now manufacturing FM cells to deliver 176cells

  ETS–VII to be launched in 1998 : will use about 160 cells