

pg 5/16

Use of Calorimetry for End of Charge Determination

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TESTING of AEROSPACE BATTERIES @ BOEING

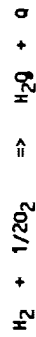
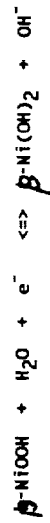
CHEMISTRY	SYMBOL	APPLICATIONS
Nickel Hydrogen	NiH ₂	Future Power Systems
Nickel Cadmium	NiCd	Small Power Subsystems
Nickel Metal Hydride	NiMH	SEDSAT Experiment
Fibrous Nickel Cadmium	F-NiCd	Starter Battery for Boeing 777
Lithium Thionyl Chloride	Li-SOCl ₂	NASA Space Qual
Lithium Bromine Complex	Li-BCX	NASA - EVA suit
Zinc Silver Oxide	Zn-AgO	Boeing - IUS

Application of Heat Flow Measurements on Batteries

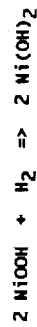
1) ESTABLISH THERMAL NEUTRAL POTENTIAL

PERMITS CALCULATION OF HEAT FLOW FROM VOLTAGE

2) IDENTIFY INEFFICIENT CHARGING



3) UNDERSTAND SELF DISCHARGE MECHANISMS



$$\Delta H = 144.85 \text{ kJ/mole}$$

4) PROVIDE ACCURATE VOLTAGE/TEMP. DATA

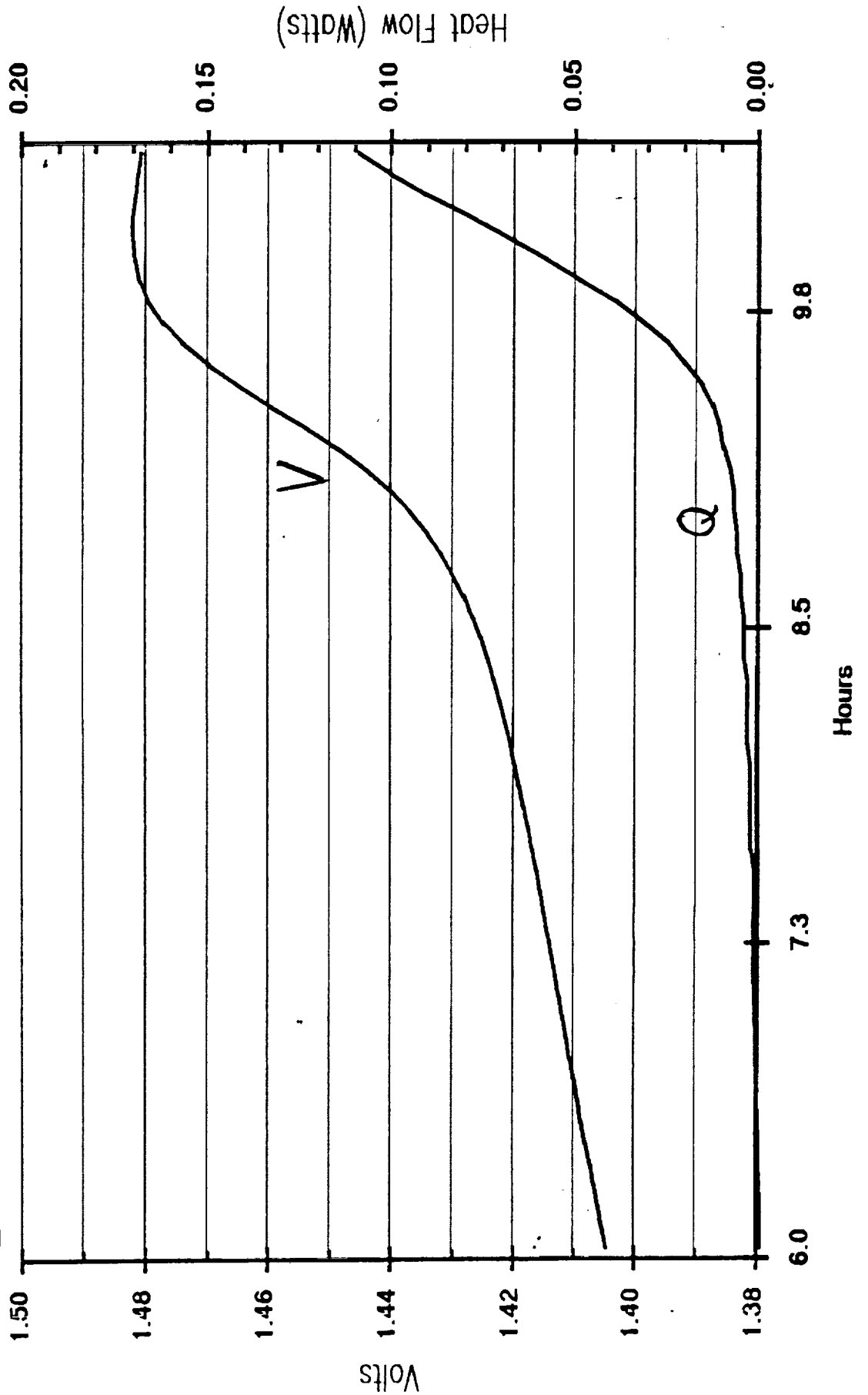
PARAMETRIC DATA NEEDED FOR VT CONTROL

INDICATORS of INEFFICIENT CHARGING

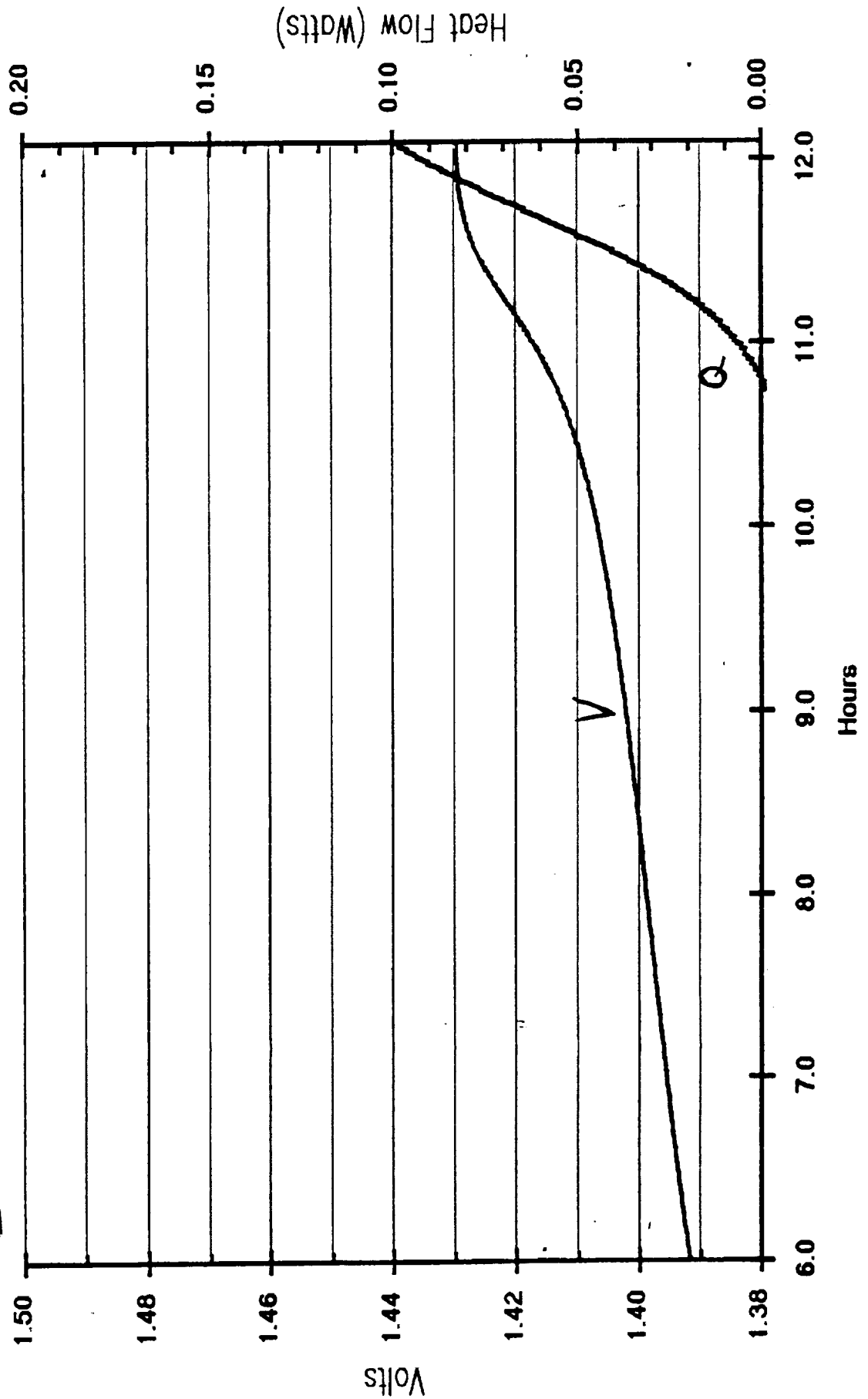
- 1) INCREASED HEAT FLOW FROM $H_2 + O_2$ RECOMBINATION REACTION
- 2) VOLTAGE "ROLL OVER"
- 3) LOSS of LINEAR INCREASE IN PRESSURE on NiH_2 CELLS

N1300 SCRT 1.3Ah Cell Charged at C/10 (0.13A) @ 10C

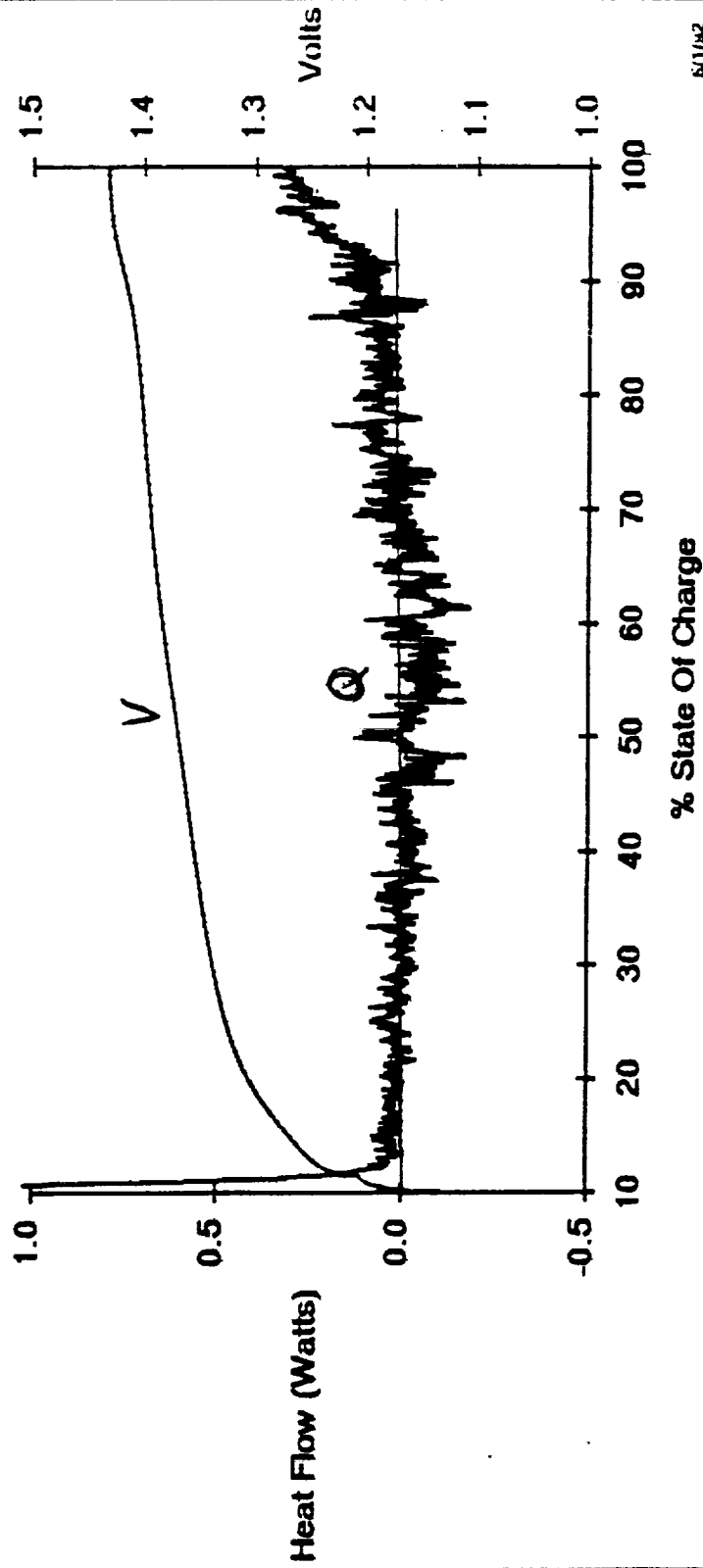
NiCd



N1300 SCRT 1.3Ah Cell Charged at C/10 (0.13A) @ 30C
NiCd

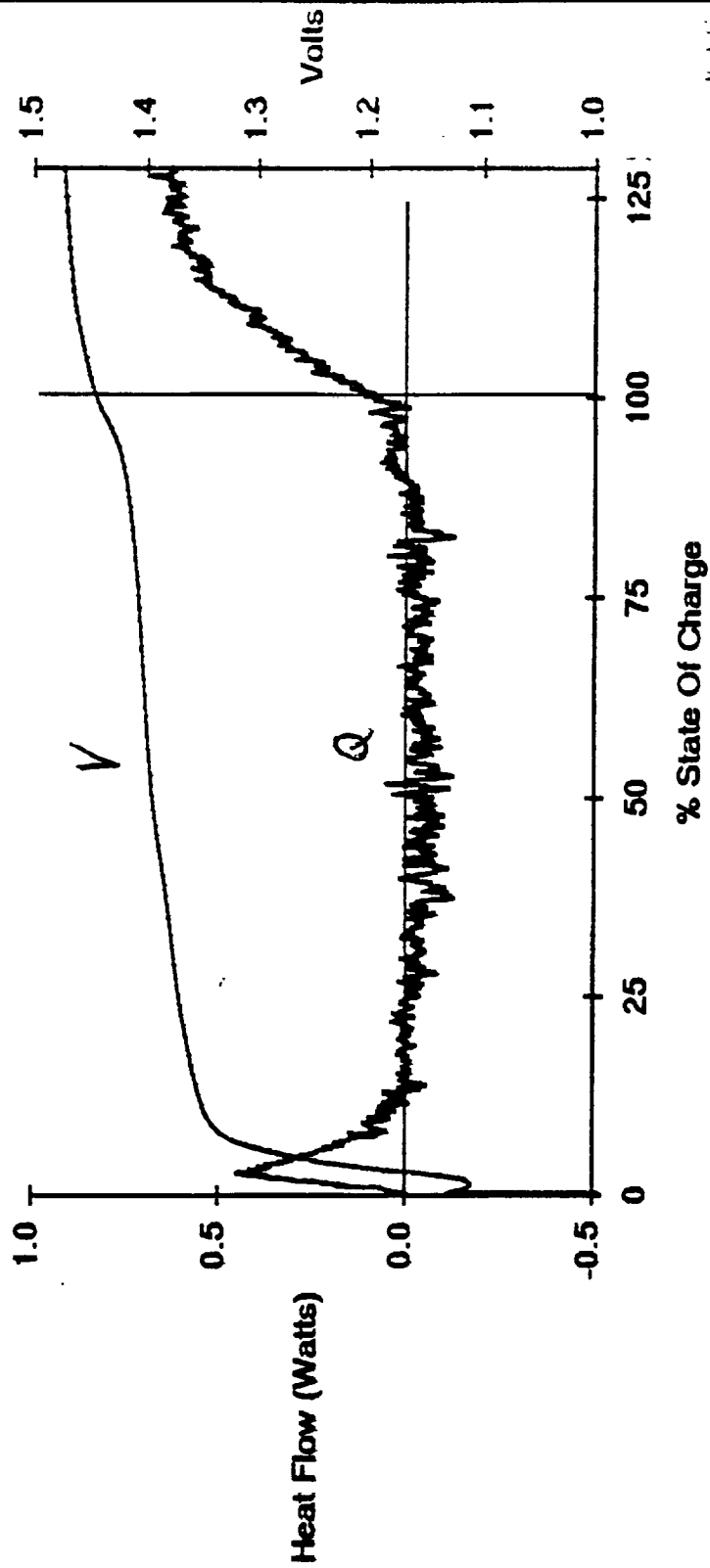


FNC Cell X7S, Charged at C/20 (0.35A), 20 Deg C

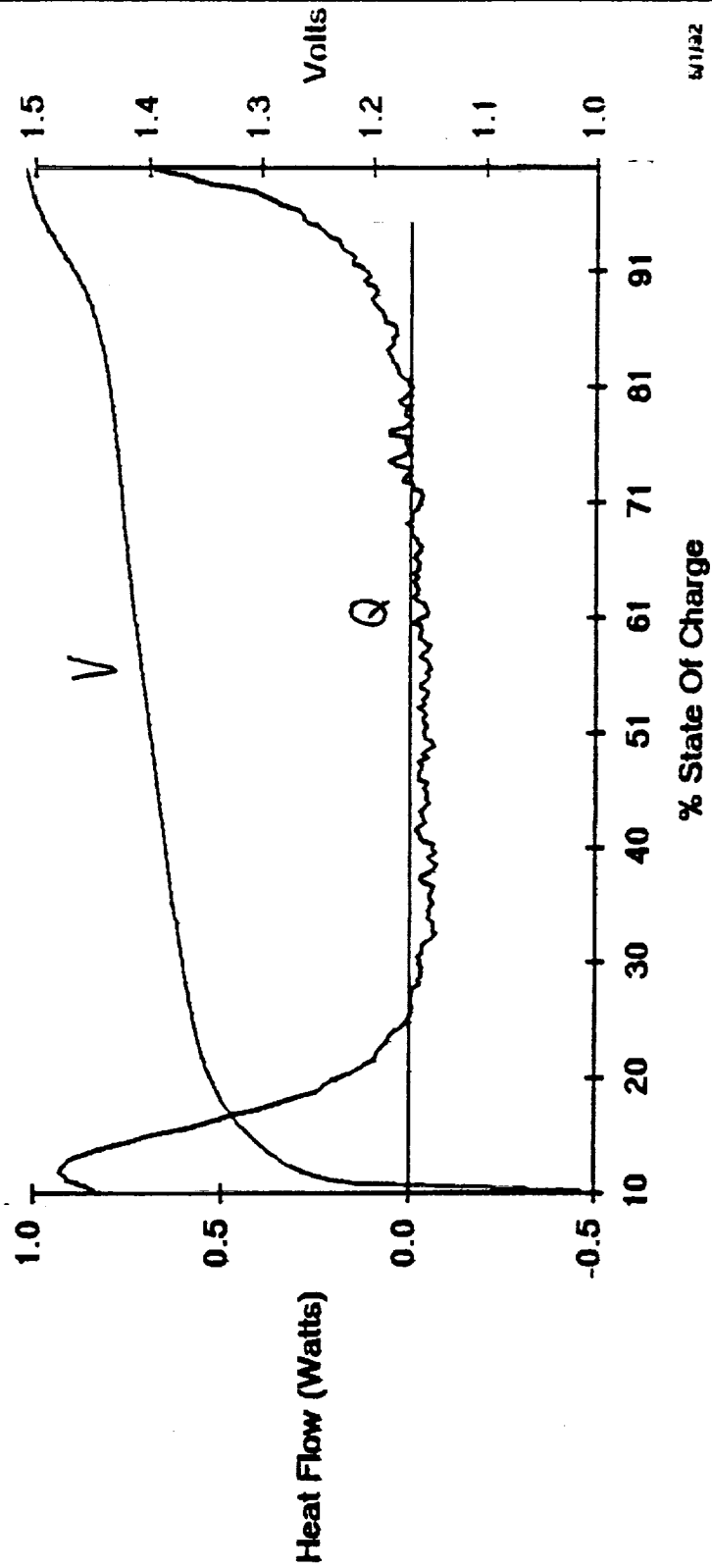


6/1/82

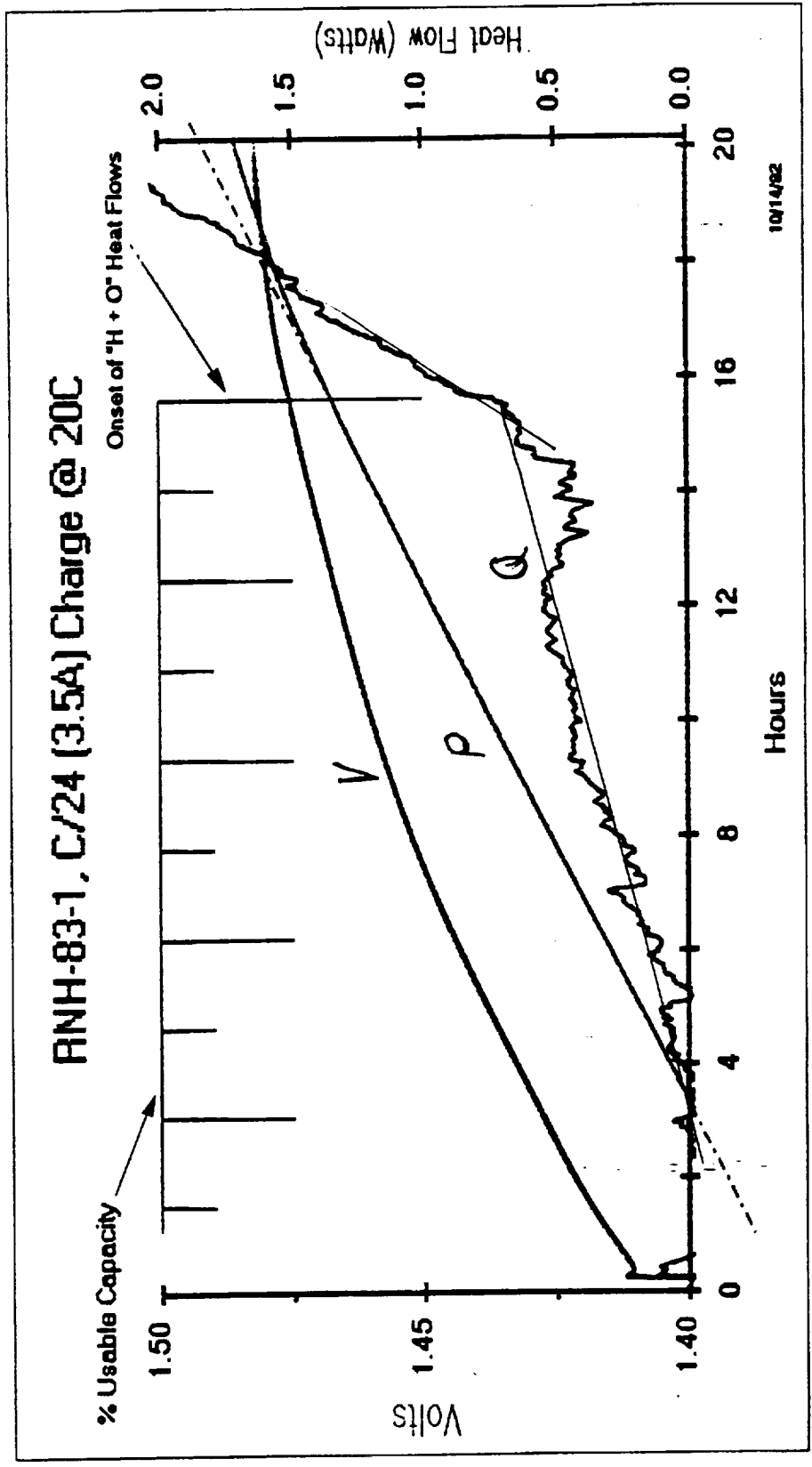
FNC Cell X7S, Charged at C/10 (0.70A), 20 Deg C



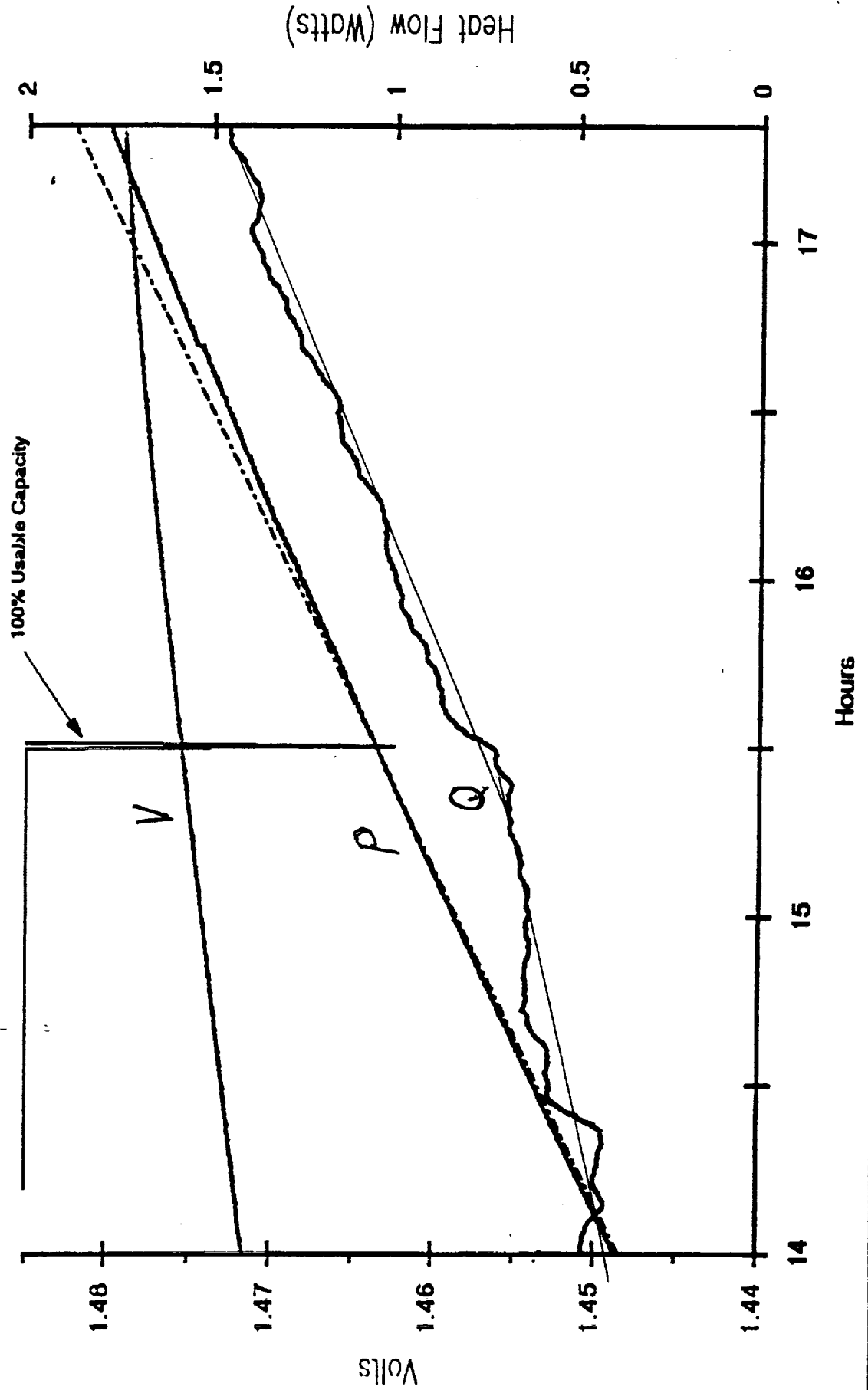
FNC Cell X75, Charged at C/2 (3.50A), 20 Deg C



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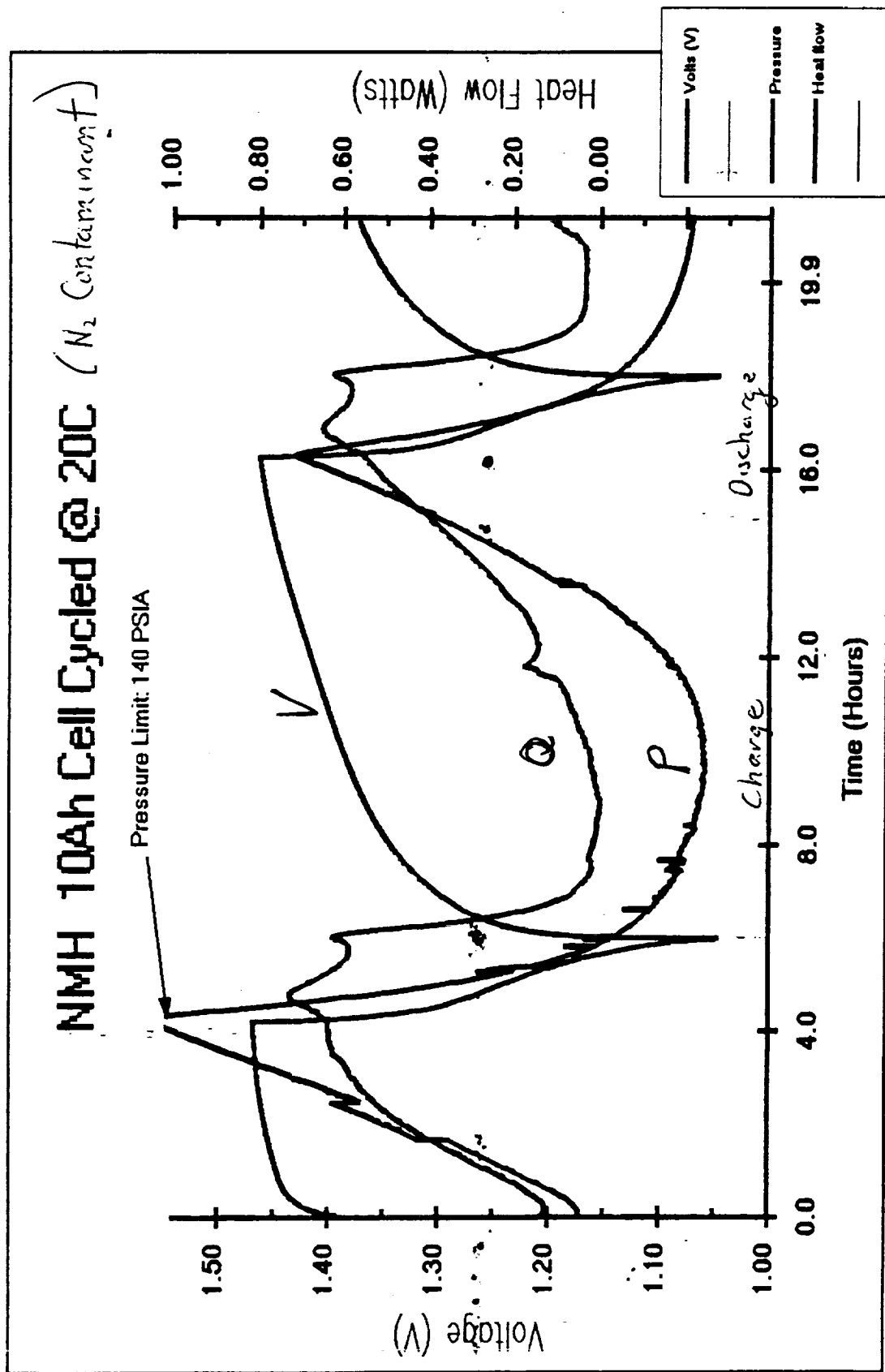


RNH-83-1, C/24 (3.5A) Charge @ 20C (expanded view)



NMH 10Ah Cell Cycled @ 20C (N_2 Containment)

Pressure Limit: 140 PSIA



NIMH Cell Gas Analysis - Preliminary Results Summary

Cell pressure recovers within minutes after sampling

Hydrogen and nitrogen predominant, lesser amounts water, oxygen, others

No evidence for the presence of methane

Significant percentage of oxygen present at 100% charge in one cycle

Oxygen consumed completely during discharge cycle

Explosive mixtures of hydrogen and oxygen are present at some times

Significant gas composition changes occur during storage in a discharged state

SUMMARY

- 1) All Ni - Based Batteries Studied Indicated Increased Q @ End of Charge
- 2) NiH₂ Cells Showed Increase in Q related to Charge Inefficiency
Q Increase & Deviation from Linear Increase in H₂ Pressure synonymous
- 3) Heat Flow (Q) from NiMH was Complicated by Presence of N₂ Contaminant

Advanced Technologies Session

*Session Organizer: Eric Darcy
NASA Johnson Space Center*

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