

**CYCLE LIFE VS DEPTH OF DISCHARGE  
UPDATE ON MODELING STUDIES**

**Lawrence H. Thaller**

**The Aerospace Corporation**

**Presented At**

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## PROCESS INVOLVED

- o COLLECTED DATA FROM VARIOUS SOURCES
  - MARTIN MARIETTA
  - AIR FORCE/CRANE
  - NASA LeRC
    - JOHN SMITHRICK
    - SPACE STATION
  - IECEC PAPERS
- o PLOTTED DATA AGAINST BACKDROP OF SIMPLE WEAROUT MODEL
- o MADE SOME GENERAL STATEMENTS BASED ON AVAILABLE DATA
- o CONSIDERED OTHER DEGRADATION MECHANISMS
- o CONCLUDING REMARKS

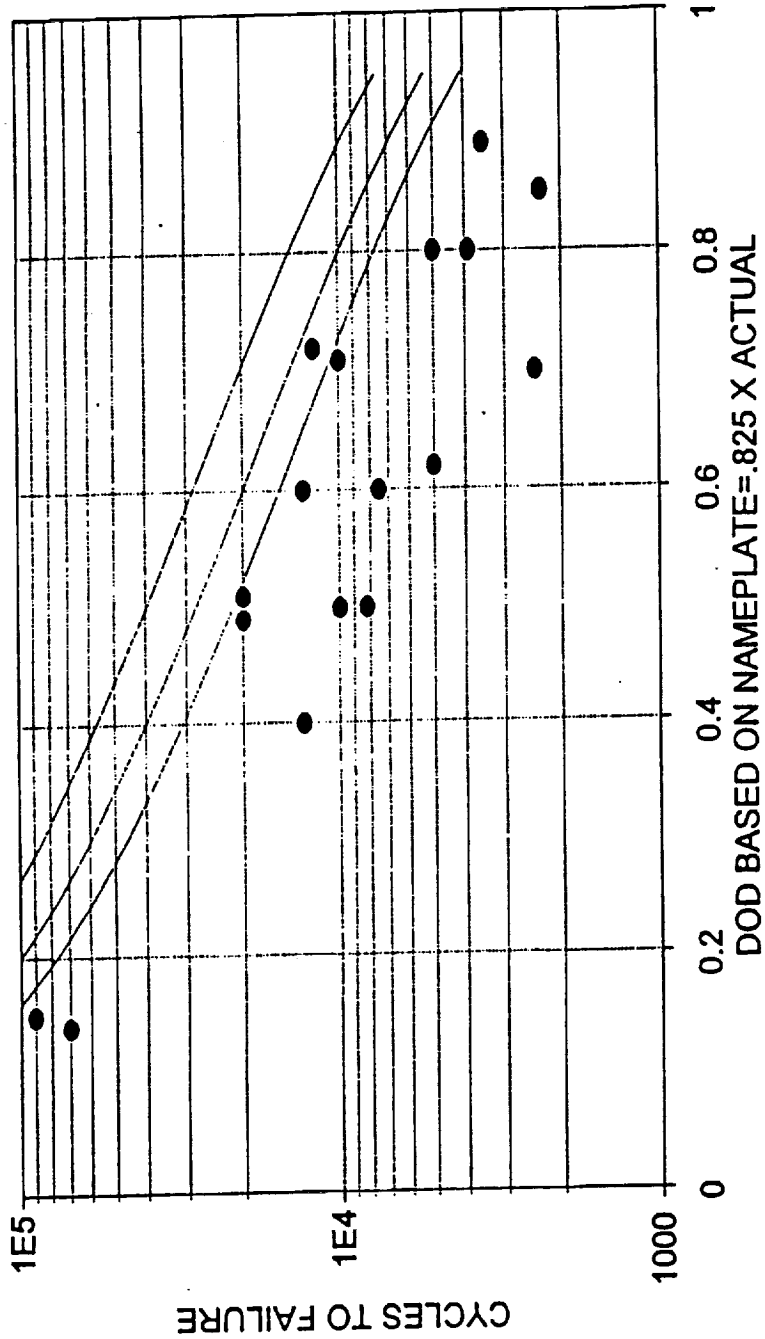
The reader is referred to the 1990 NASA Battery Workshop Paper by L. Thaller for background formulas and information on this topic.

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CYCLE LIFE VS DEPTH OF DISCHARGE  
DATA AS OF THREE YEARS AGO

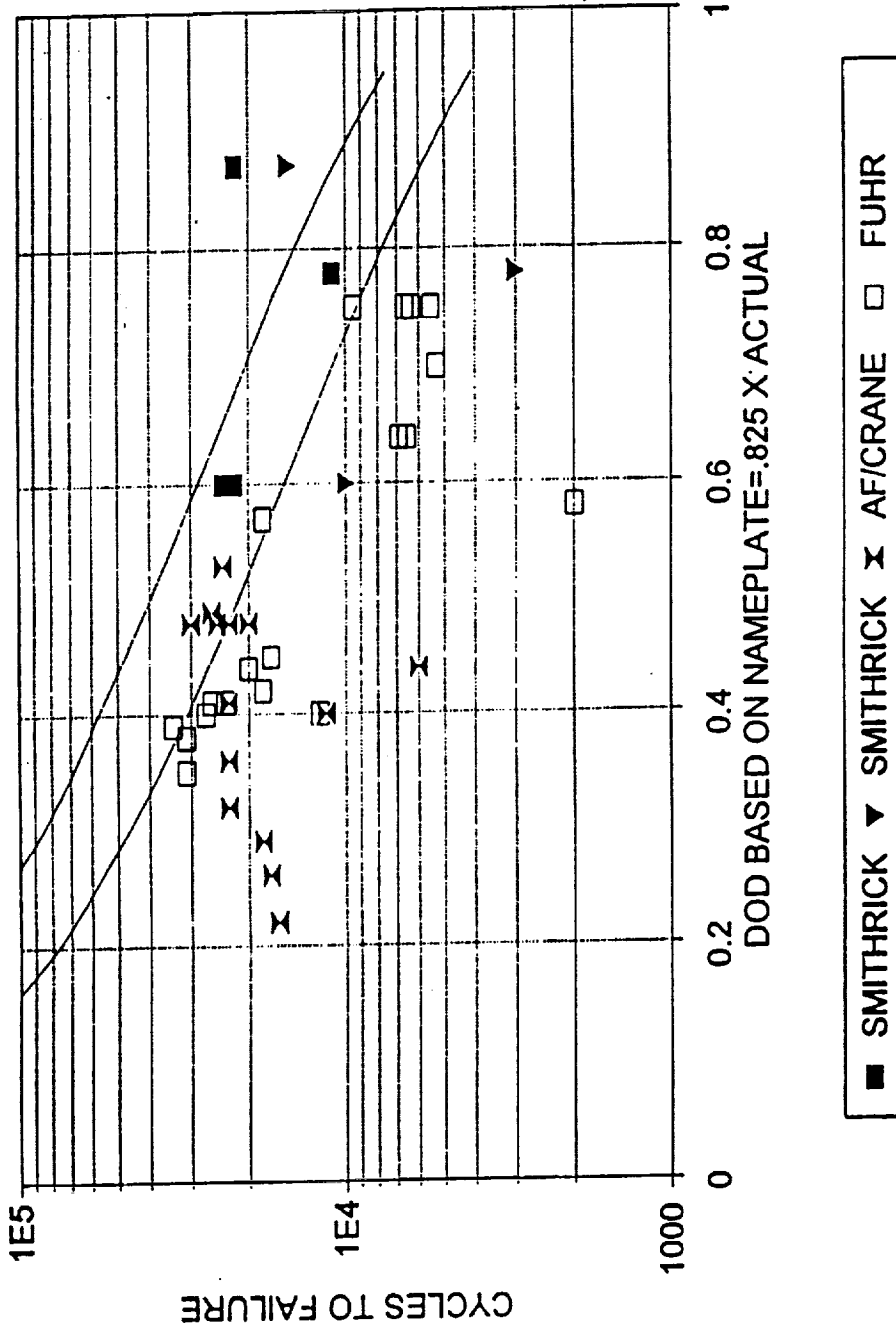


● ALL AVAILABLE DATA

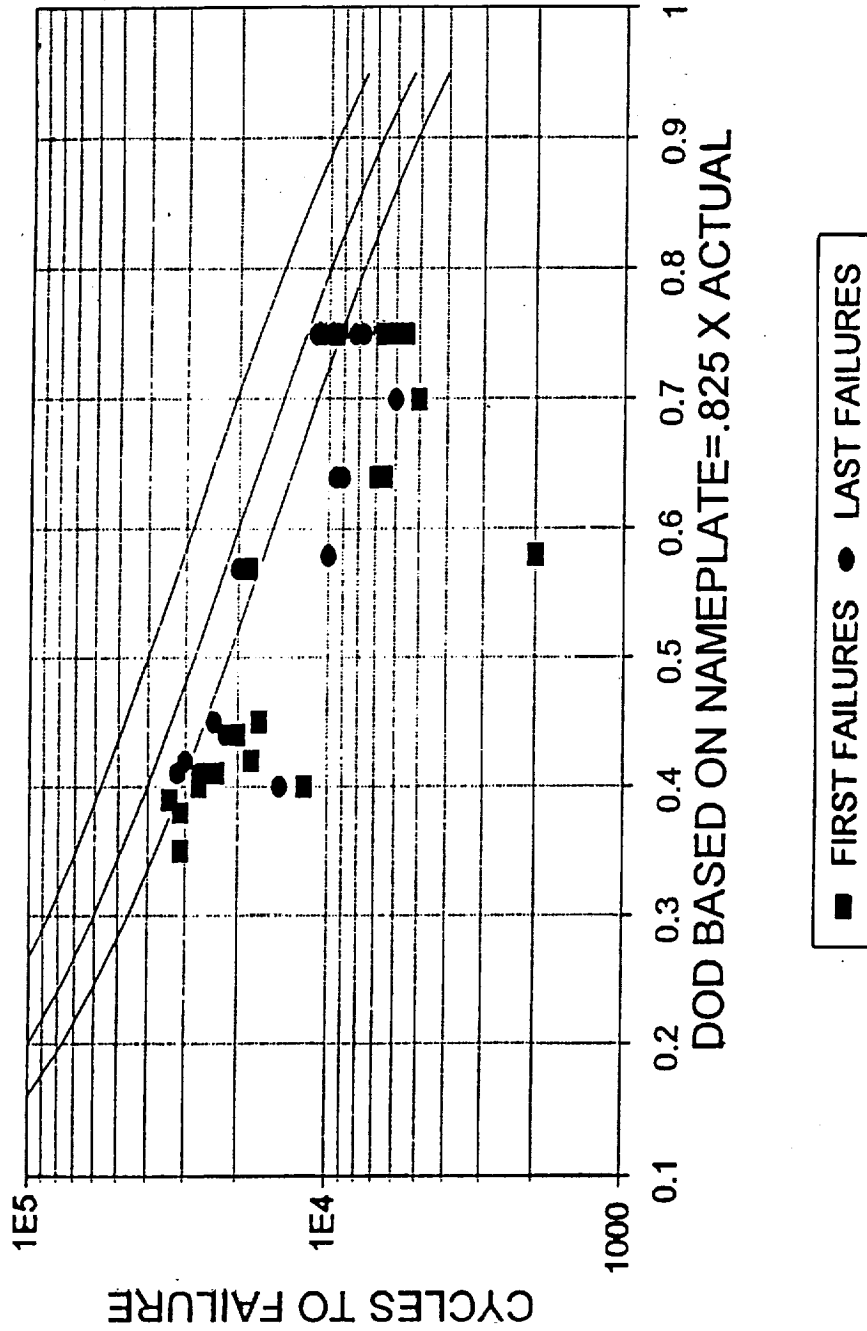


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**CYCLE LIFE VS DEPTH OF DISCHARGE  
AF/CRANE-FUHR-SMITHRICK**



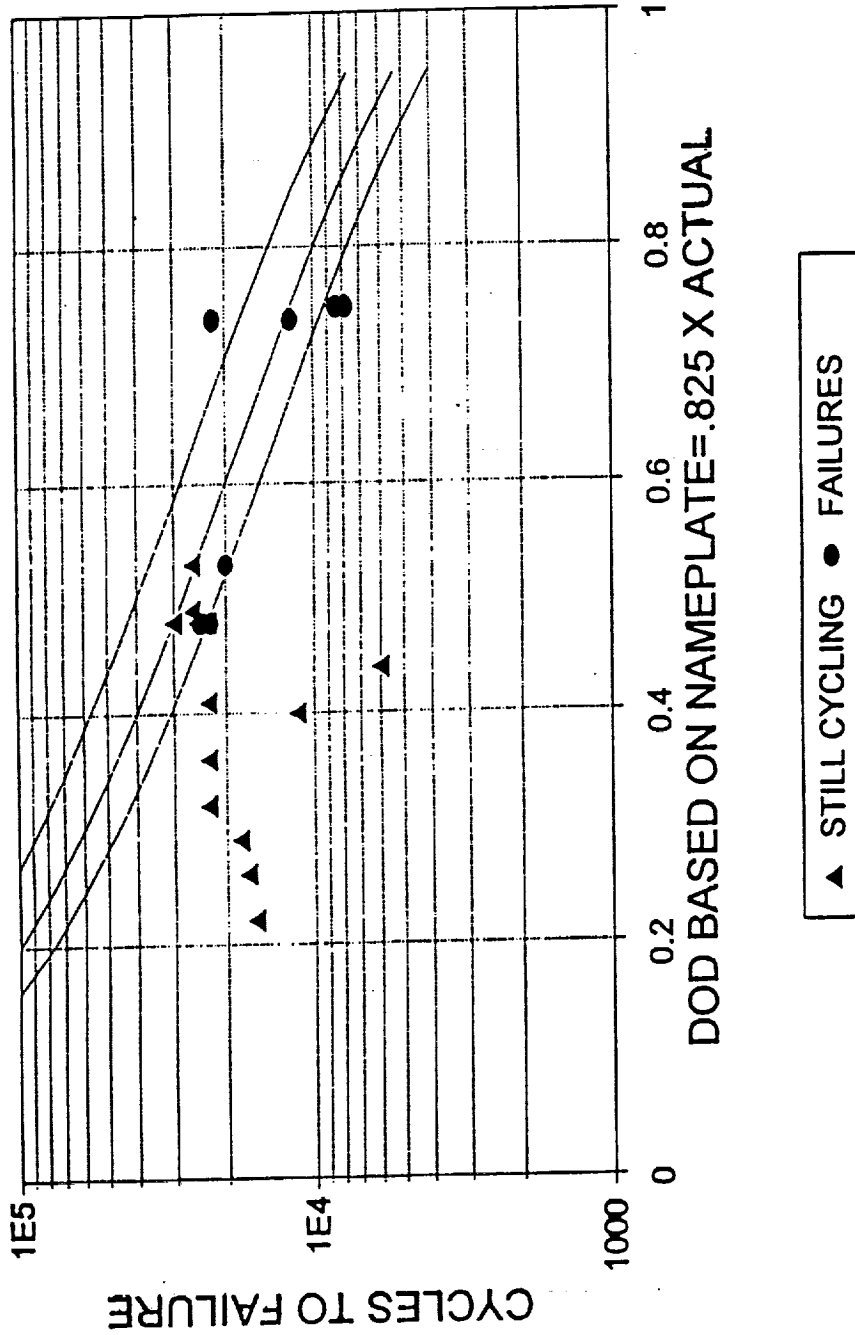
# CYCLE LIFE VS DEPTH OF DISCHARGE KEN FUHR'S DATA



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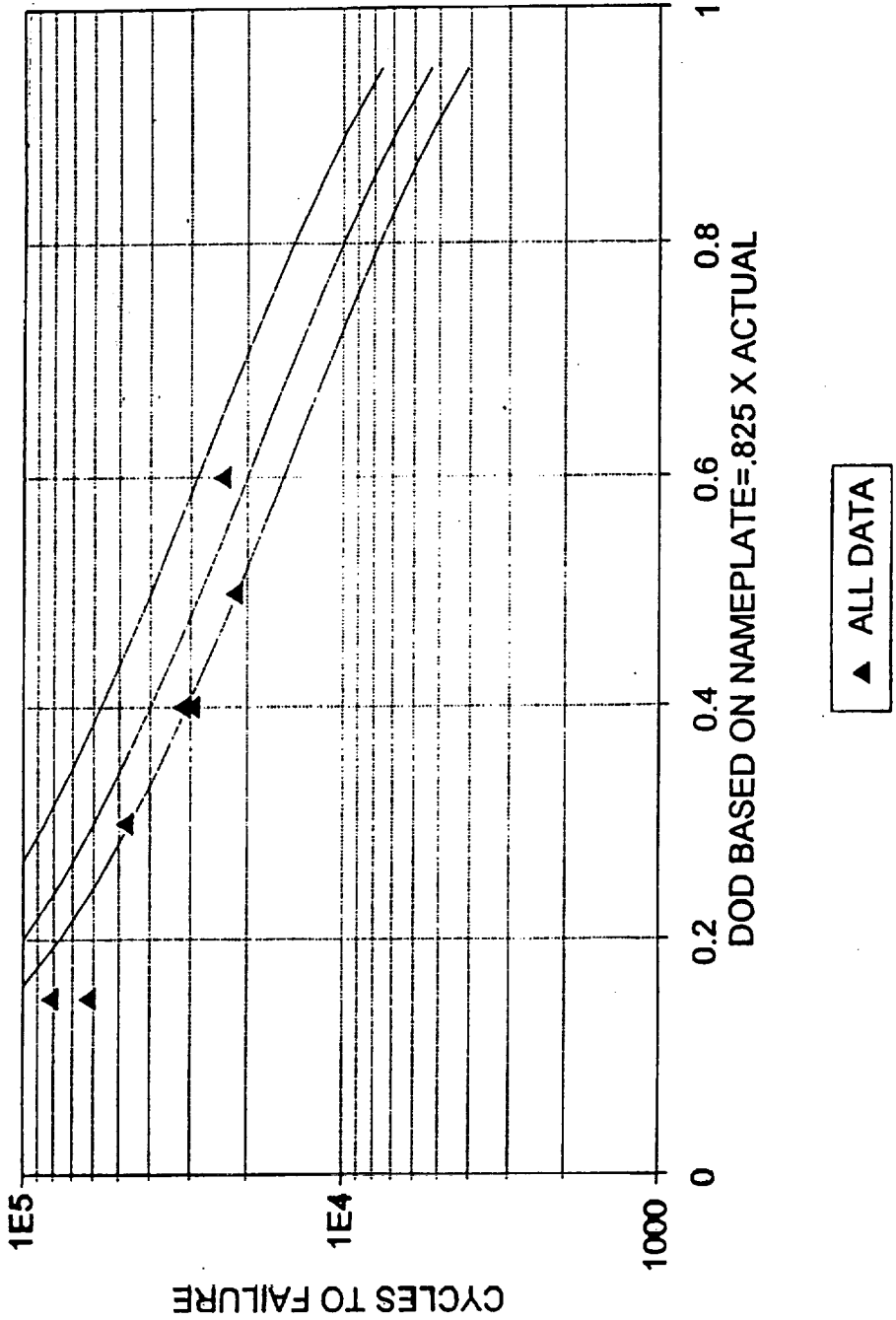
# CYCLE LIFE VS DEPTH OF DISCHARGE AIR FORCE/CRANE DATA



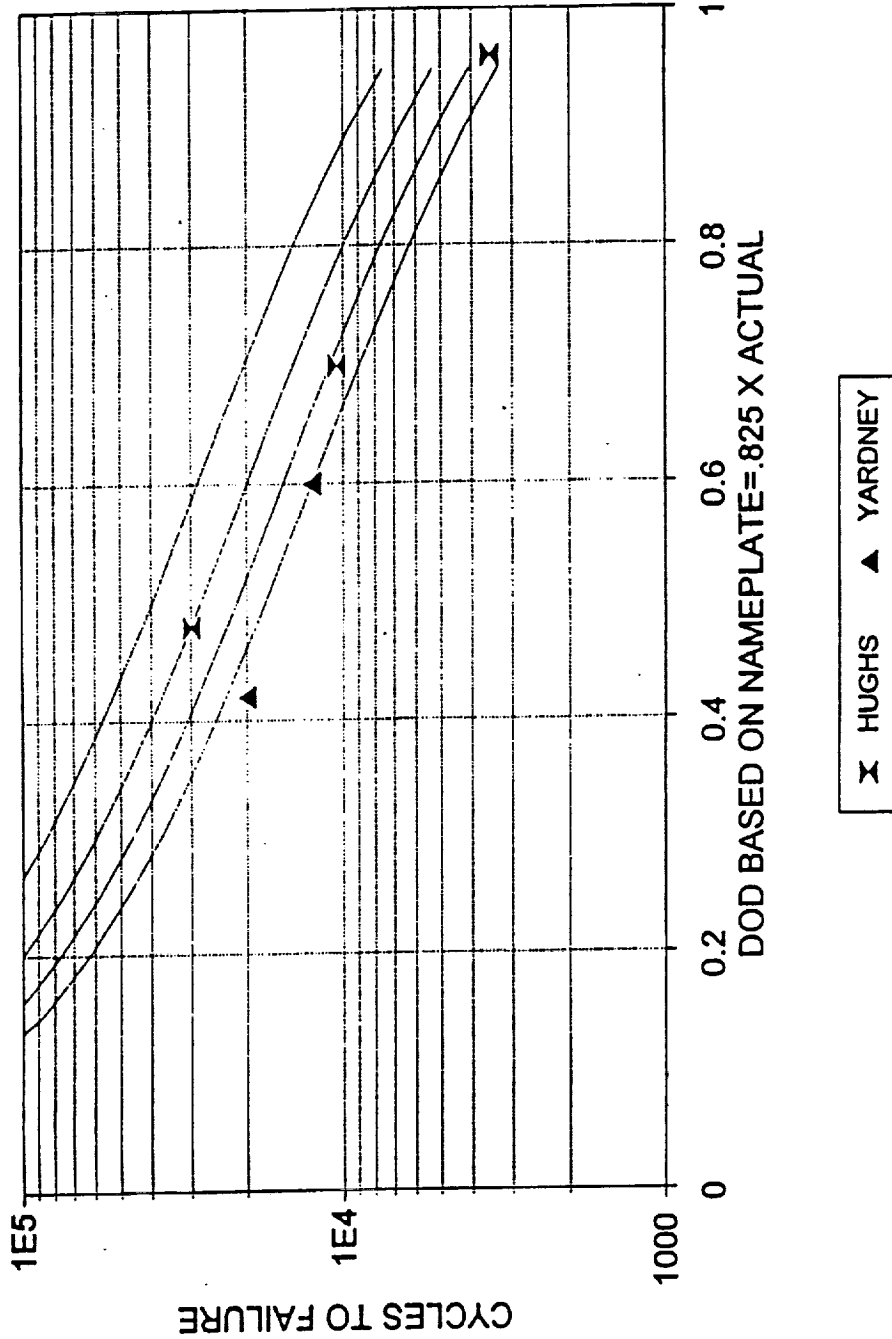
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# CYCLE LIFE VS DEPTH OF DISCHARGE EAGLE-PICHER DATA

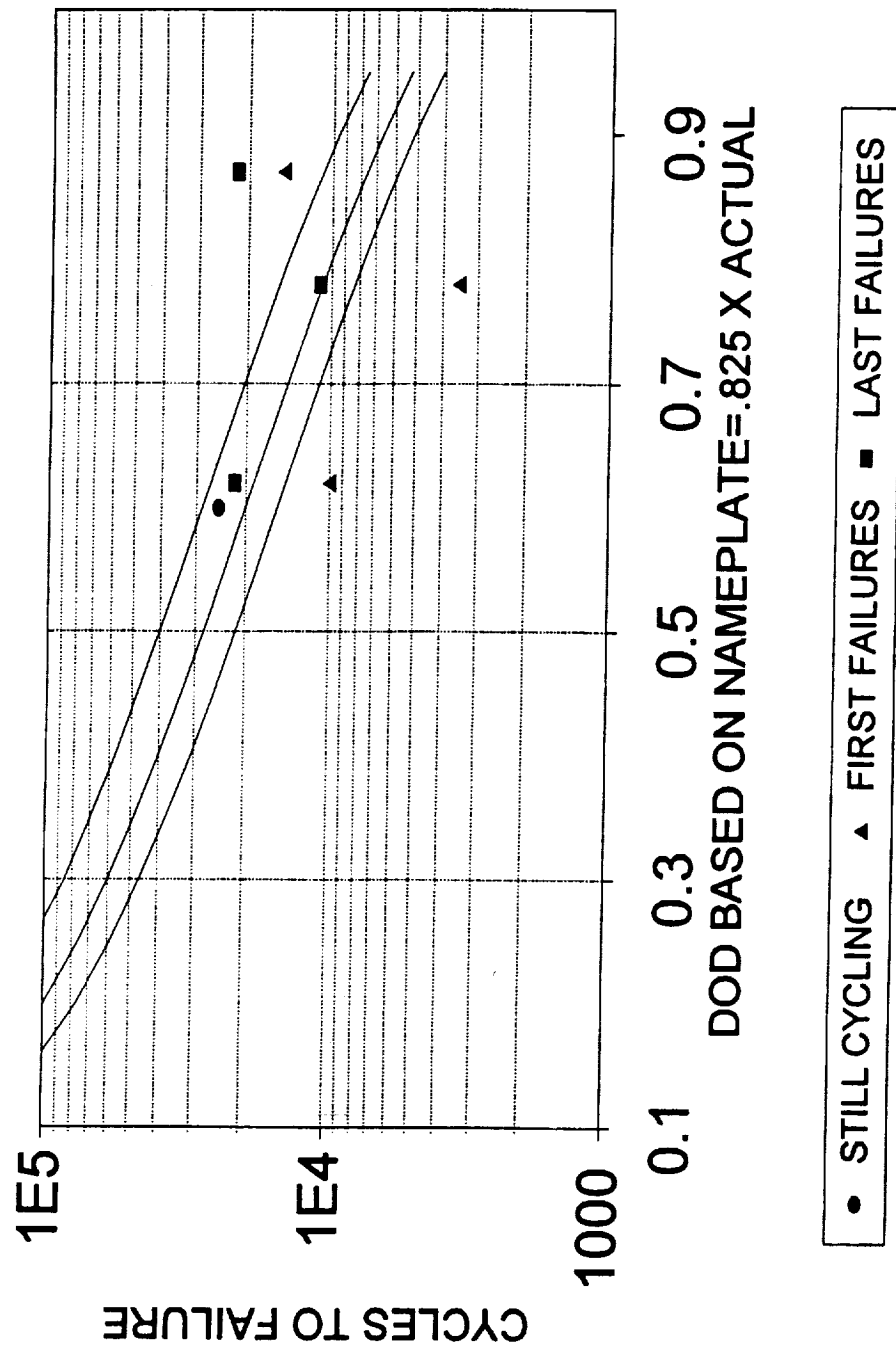


CYCLE LIFE VS DEPTH OF DISCHARGE  
STEVE SCHIFFER'S DATA



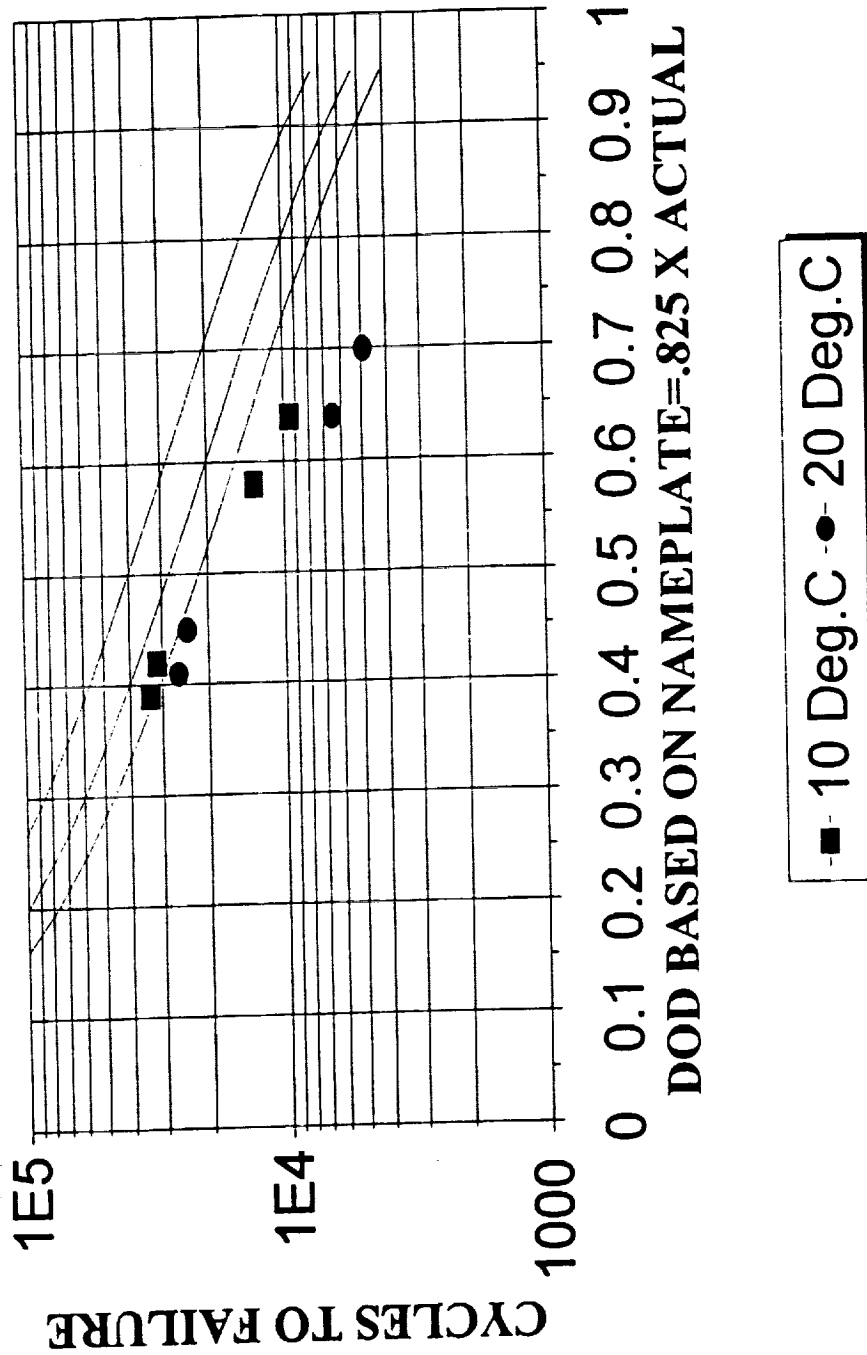


# CYCLE LIFE VS DEPTH OF DISCHARGE JOHN SMITHRICK'S DATA



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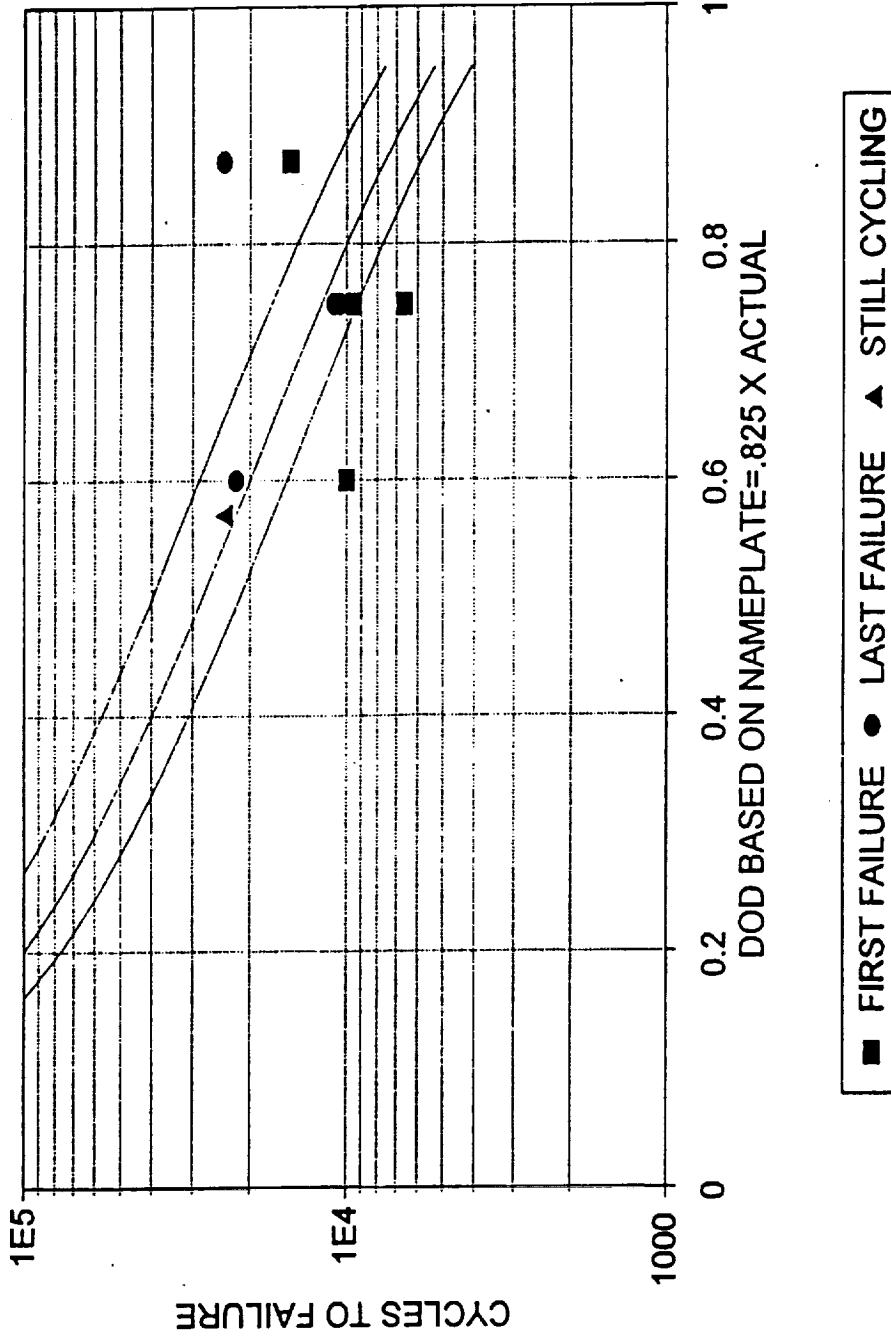
# CYCLE LIFE VS DEPTH OF DISCHARGE TEMPERATURE EFFECTS



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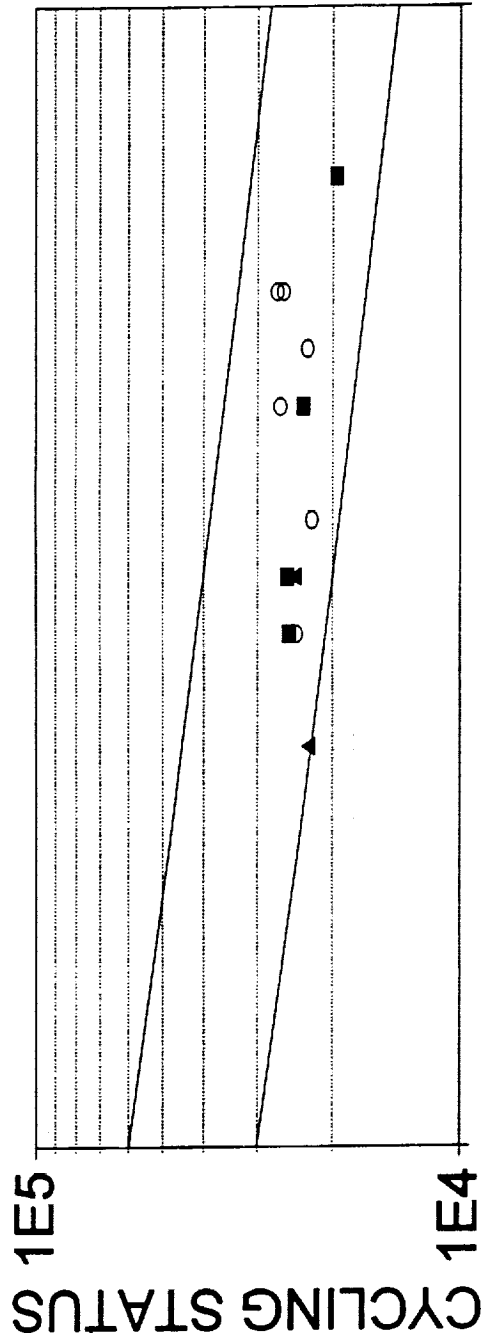


CYCLE LIFE VS DEPTH OF DISCHARGE  
 E-P, YARDNEY, AND HUGHES 26% DATA



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# YARDNEY "SPACE STATION" CELLS NASA LeRC CYCLING TESTS



0.3 0.5  
DOD BASED ON NAMEPLATE = .825 X ACTUAL

- FAILED 31% → 31% KOH-CYCLING
- 26% KOH-CYCLING

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## GENERAL STATEMENTS

- o CYCLING DATA STRONGLY SUGGEST THAT:
  - DROPPING TEMPERATURE INCREASES CYCLE LIFE
  - USING 26% KOH VS. 31% KOH INCREASES CYCLE LIFE
  - CYCLE LIVES AMONG "LIKE" CELLS CAN VARY WIDELY (+/- 50%)
  - CELL FAILURES OCCUR FOLLOWING 25 TO 30% LOSS OF CAPACITY
  - CAPACITY CHECKS PROBABLY DO NOT EFFECT CYCLE LIFE

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## GENERAL OBSERVATIONS

- o CYCLE LIVES GENERALLY IMPROVING - ESPECIALLY AT DEEP DODs
- o NAMEPLATE CAPACITIES SHOULD BE STANDARDIZED
- o SOME CELL DESIGNS MAY NO LONGER BE AVAILABLE



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## GENERAL STATEMENTS

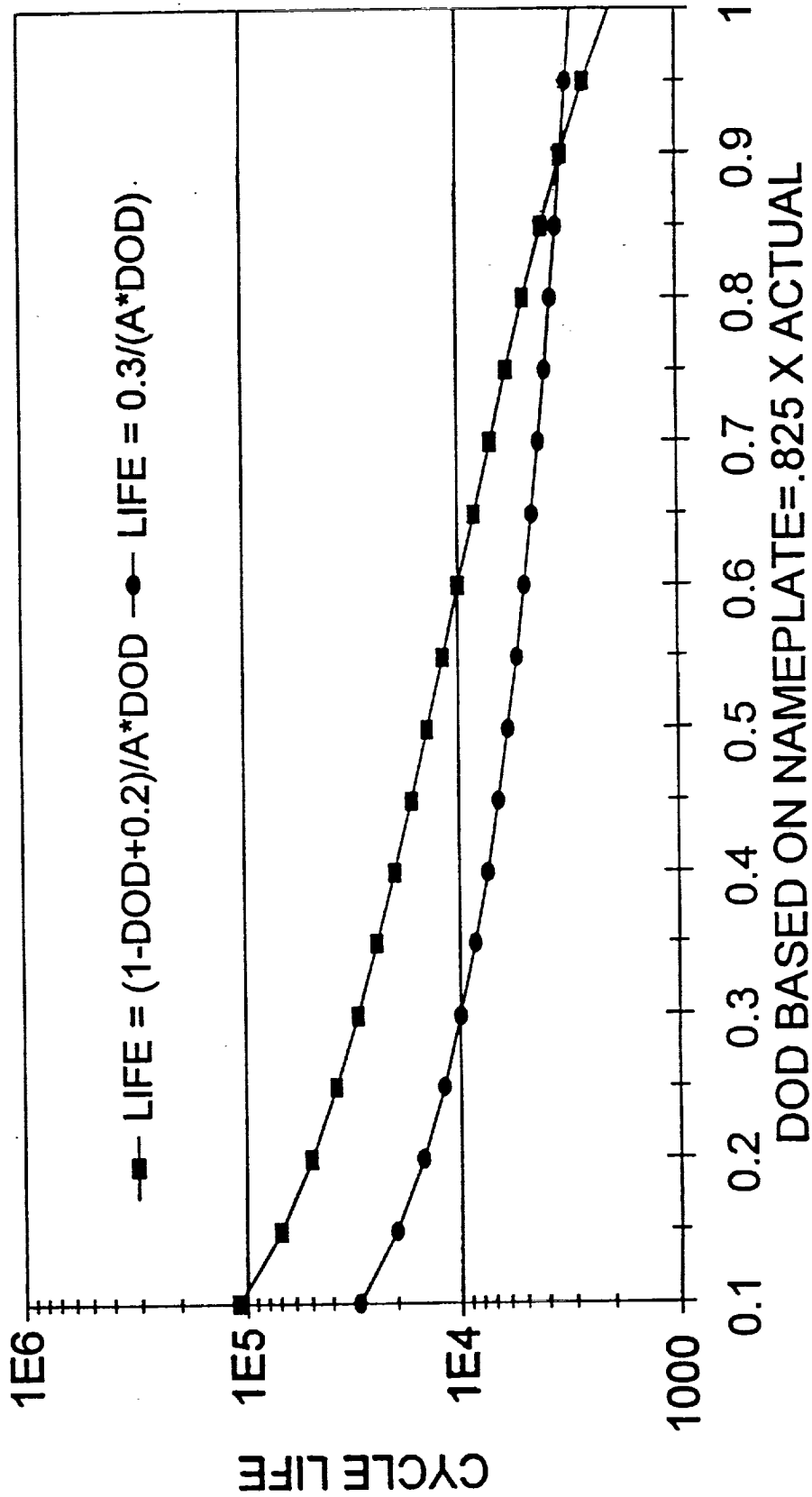
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# CYCLE LIFE VS DEPTH OF DISCHARGE TWO DIFFERENT MODELS





## OTHER DEGRADATION MODES

- o EXCESS ELECTROLYTE
- o CONTAMINANTS (NATURAL) IN ASBESTOS
- o HIGH SURFACE LOADING OF ACTIVE MATERIAL
- o COLD FINGERING OF WATER VAPOR
- o INSUFFICIENT PROVISION FOR STACK EXPANSION

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## SUGGESTED DOs AND DON'Ts

- o DO:
  - USE CELL DESIGNS THAT OVERCOME KNOWN CELL PROBLEMS
  - CONSIDER ELECTROLYTE, THERMAL, AND GAS MANAGEMENT ISSUES
- o DON'T:
  - USE ASBESTOS THAT HAS NOT BEEN PROPERLY REMANUFACTURED
  - USE DESIGNS THAT WERE INTENDED FOR GEO IN LEO

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## CONCLUDING REMARKS

- o CELL DESIGN FACTORS VERY IMPORTANT TO CYCLE LIFE
- o CYCLE LIVES AT DEEP DODs GENERALLY IMPROVING
- o 40,000 TO 50,000 CYCLES AT 40% DOD NOT AN UNREASONABLE GOAL
- o CYCLE LIFE TESTING MUST CONSIDER CYCLING TO 50 TO 70% DOD
- o MECHANICAL DESIGN CHANGES CANCEL OUT ESTABLISHED DATA BASES
- o SIMPLE EQUATIONS DON'T ACCURATELY FIT OBSERVED FAILURES

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