

Reliability of Valve-Regulated Lead-Acid Batteries for Stationary Applications

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U.S. DOE ESS Peer Review

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Overview

- + Purpose
- + Program phases
- + Market data
- + Final analysis
- + Conclusions
- + FY02 Plans

Purpose

- ✦ Perform an unbiased evaluation of end-user experience with VRLA cells
- ✦ Identify VRLA operating conditions that will help achieve maximum performance
- ✦ Improve customer understanding of VRLA characteristics
- ✦ Provide an indication of life expectancy for VRLA batteries



Program Phases

- ✚ Manufacturer survey
- ✚ End-user survey
- ✚ Preliminary analysis
- ✚ Interest group workshops
- ✚ Final analysis

Manufacturer Survey

Physical Characteristics	Electrical Characteristics	Performance Characteristics
<ul style="list-style-type: none">✚ Exterior dimensions✚ Electrolyte✚ Separator material✚ Case and post sealing methods✚ Plate geometry✚ Recommended operating temp	<ul style="list-style-type: none">✚ Cell Ah capacity✚ Internal resistance✚ Monthly self-discharge✚ Specific energy	<ul style="list-style-type: none">✚ Application✚ Recommended float voltage✚ Premature failures✚ Causes of premature failures

End-User Survey

Battery Identification	Installation Description	Operation/Monitoring
<ul style="list-style-type: none"># Type of application# Seller/installer# Received installation/operating instructions	<ul style="list-style-type: none"># Make/model of cells# Installation size# Year installed# Location# Temperature control# Ambient temperature	<ul style="list-style-type: none"># Float voltage# Year first cell replaced# Total cells replaced# Monitoring regime# Unusual failures# Root cause of failure

Preliminary Analysis

- ✚ Cross-checked manufacturer and end-user responses
- ✚ Obtained specifications on 62 missing VRLA models
- ✚ Performed analysis on number of installations
- ✚ Focused on utility end users
 - EESAT 2000
 - IPSS 2001
 - Battcon 2001

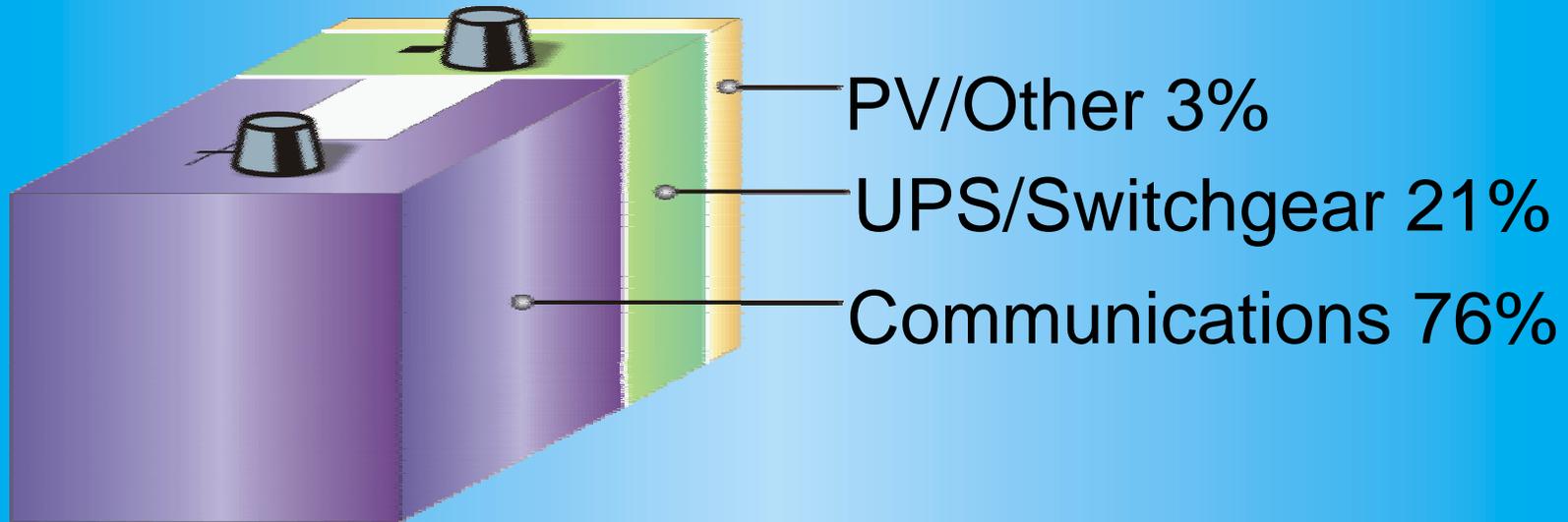
Interest Group Workshops

- ✚ Advanced Lead Acid Battery Consortium members
 - May 2001
 - 30 participants
 - Presented summary findings
 - Facilitated discussions
- ✚ VRLA manufacturers
 - Three manufacturer visits
 - May – June 2001
 - 30 participants total
 - Presented summary findings & manufacturer data
 - Discussions

Market Representation

Calculated from BCI \$ sales data (1993-2000)

11MM total cells

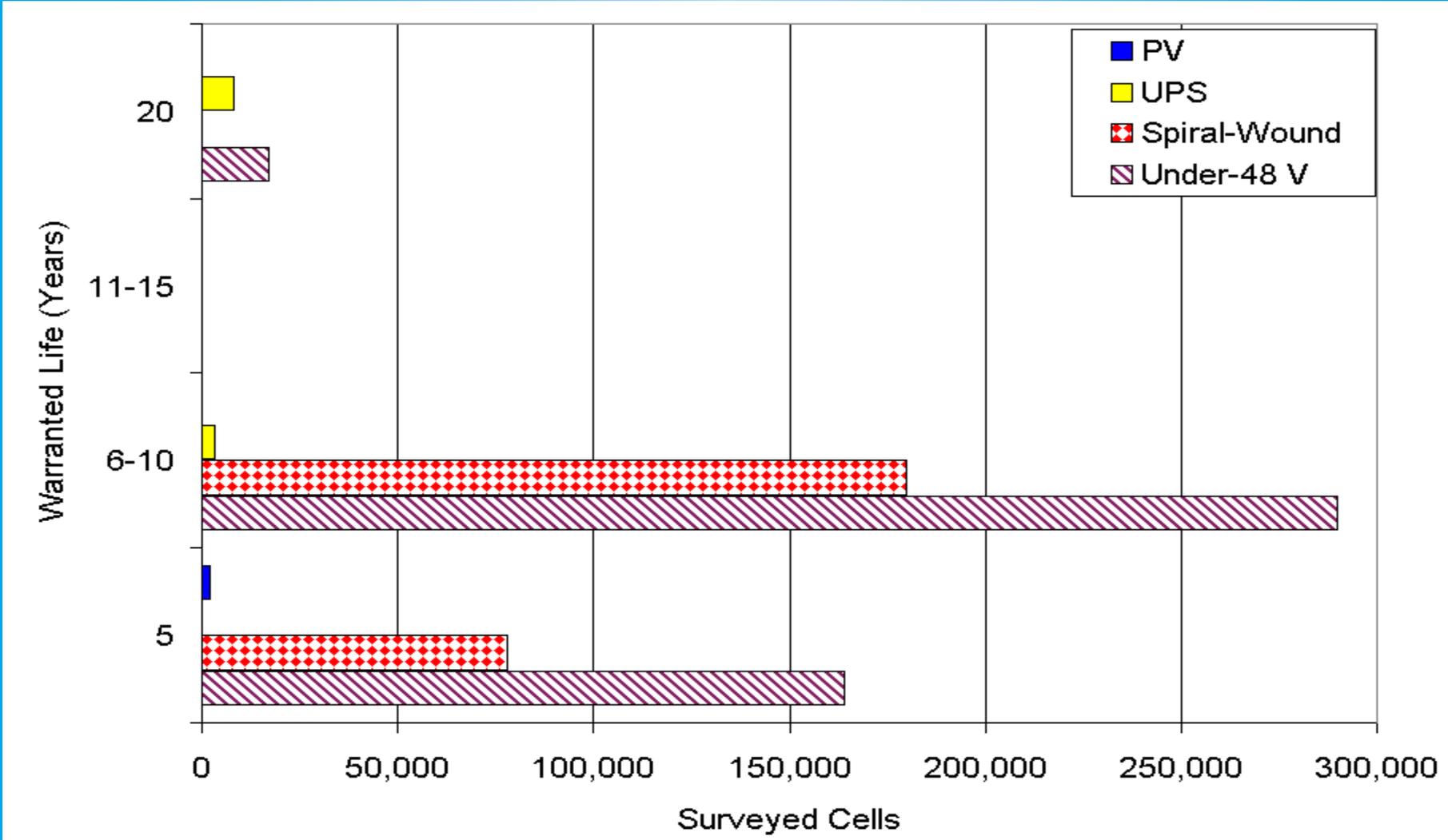


Survey responses from 7% of total cells estimated to be in operation in the U.S.

Summary Statistics of Surveyed VRLA Batteries

Application	Total Cells	Percentage of Total Cells
Under-48 V	470,922	63.4%
Spiral-Wound	258,000	34.7%
UPS	11,553	1.6%
PV	2,112	0.3%
Total	742,587	100%

Warranted Life by Application



End-User Profile Telecommunications

Description	Under-48 V	Spiral-Wound
+ Installed 1980-1989	50%	100%
+ Outdoor	61%	70%
+ Temperature controlled	71%	65%
+ Max temp 30 – 40°C	100%	100%
+ Floated at 2.23 – 2.27 vpc	99%	100%

End-User Profile

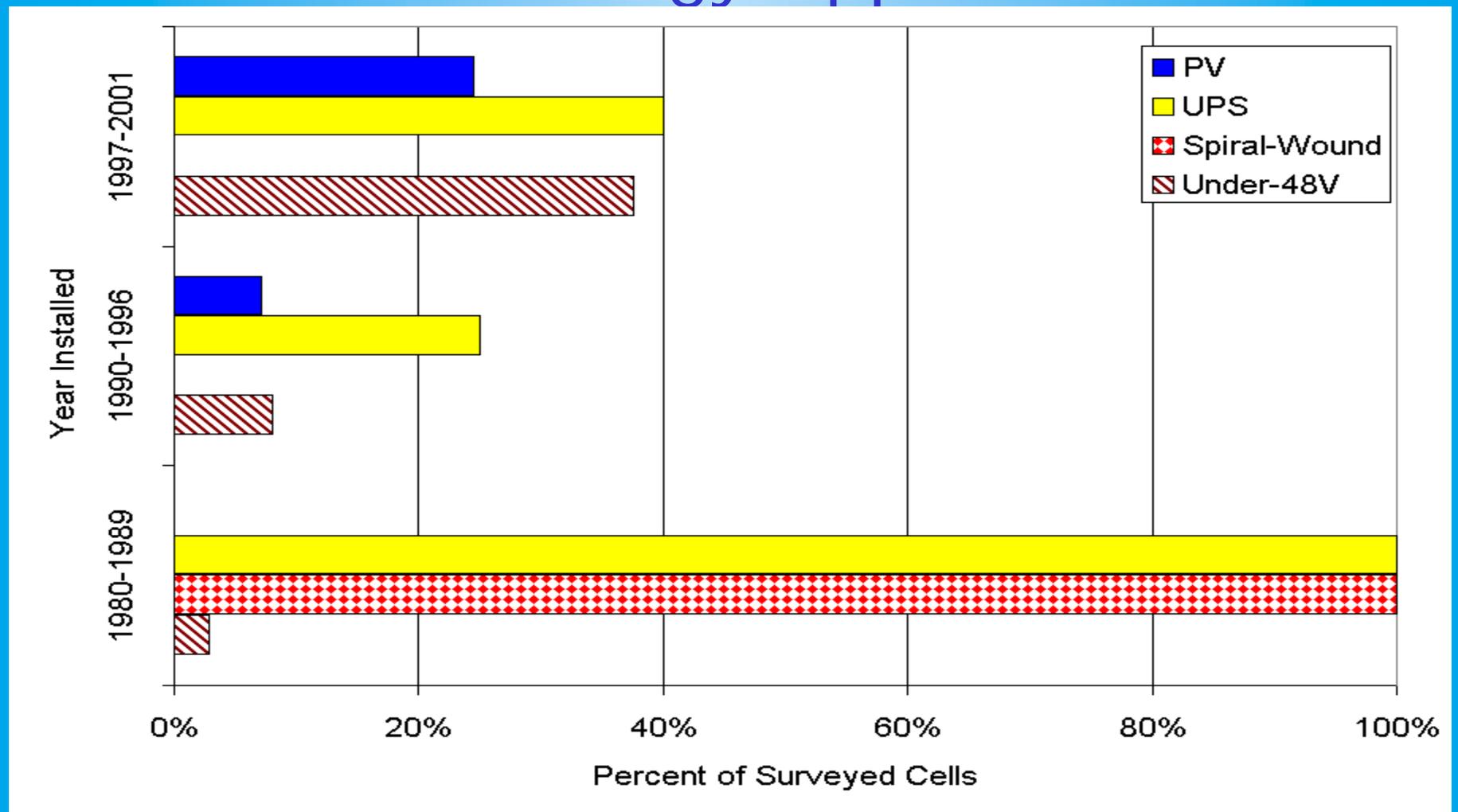
UPS & PV

Description	UPS	PV
✚ Installed 1994 – 1996	41%	72%
✚ Indoor	38%	48%
✚ Temperature controlled	93%	89%
✚ Max temp 20 – 30°C	60%	99%
✚ Floated at 2.23 – 2.27 vpc	90%	1%

Maximum Ambient Temperature of Surveyed Cells by Float Voltage

Float Voltage	<20°C	20-30°C	31-40°C	>40°C	Unknown	Total
<2.23		54				54
2.23-2.27		18,580	471,758	234,000	11,652	735,990
>2.27	24	3,450	1,935			5,409
Not Floated		1,134				1,134
Total	24	23,218	473,693	234,000	11,652	742,587

Percent of Reliable Cells by Year Installed & Technology/Application



Cell Replacement Experience Telecommunications

Under-48 Volt

- ✚ 9% of surveyed cells installed at reliable installations
- ✚ No surveyed cells were replaced within first year of service
- ✚ 7% of surveyed cells were replaced (~34,000) within four years of service
- ✚ 49% of surveyed cells were scheduled replacement (~230,000)

Spiral-Wound

- ✚ 70% of surveyed cells installed at reliable installations (20 years old)
- ✚ No surveyed cells replaced within first four years of service
- ✚ 30% of surveyed cells were scheduled replacement (78,000)

Cell Replacement Experience

UPS & PV

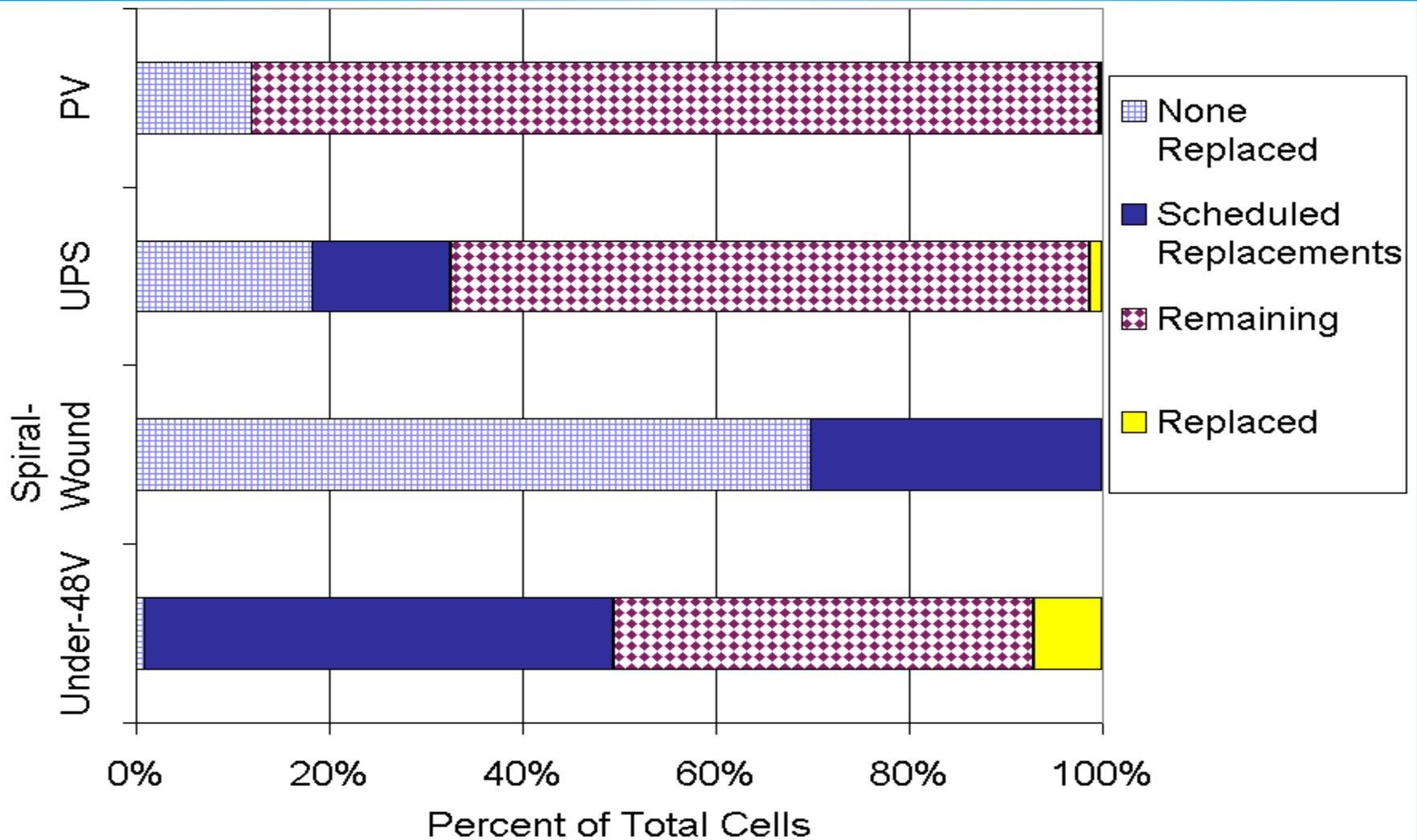
UPS

- ✚ 18% of surveyed cells installed at reliable installations
- ✚ <1% of surveyed cells replaced within first year
- ✚ 1% surveyed cells replaced within the first four years of service
- ✚ 15% surveyed cells were scheduled replacement (~1,700)

PV

- ✚ 12% of surveyed cells installed at reliable installations
- ✚ 0.1% surveyed cells replaced within in first year
- ✚ 0.3% surveyed cells required replacement within the first four years of service

Status of Cells at Time of Survey



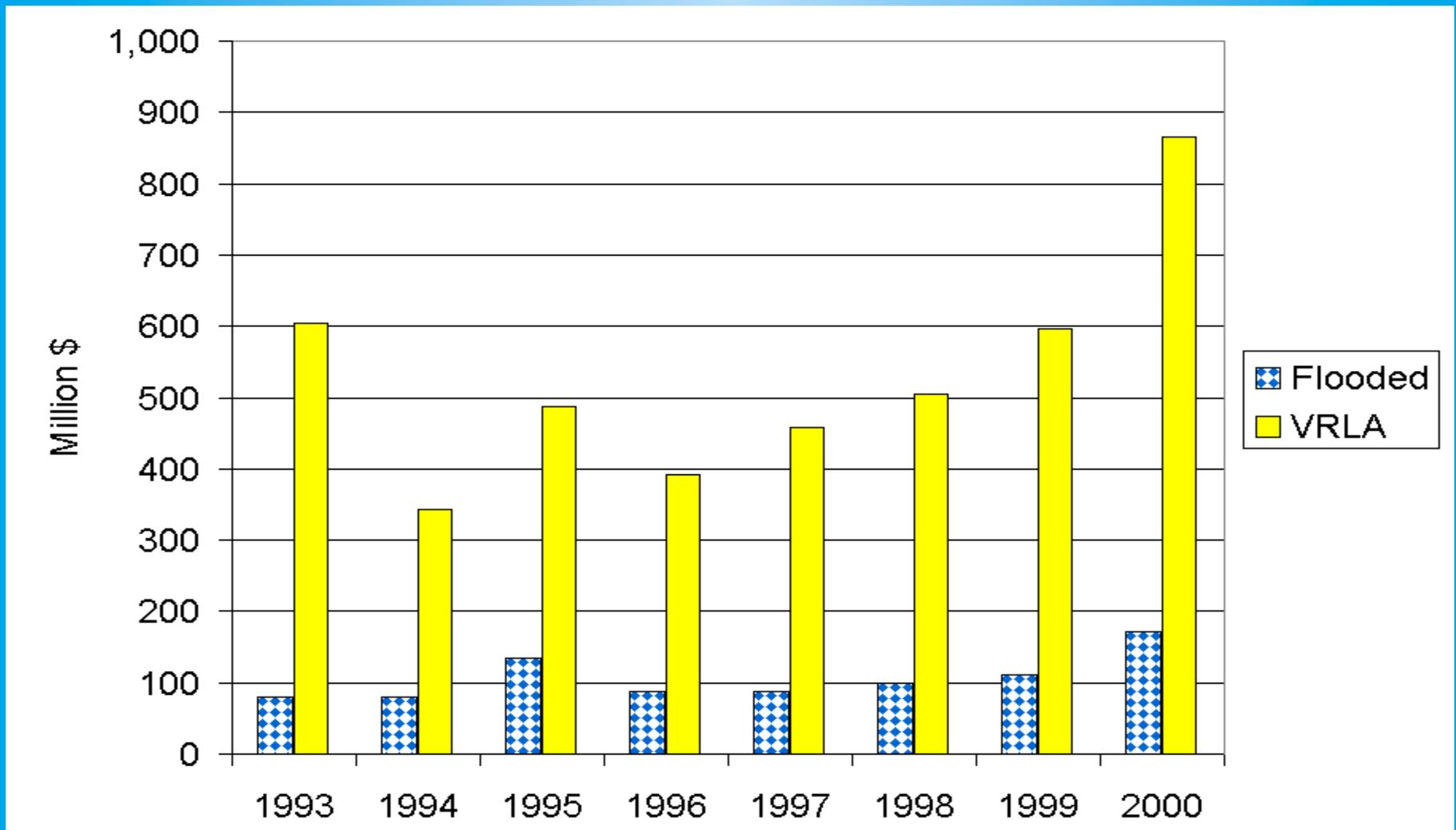
Conclusions

- ✦ 3% of surveyed cells hold a 20-year warranty
- ✦ 99% of surveyed cells floated between 2.23 and 2.27 vpc
- ✦ 67% of surveyed cells operated at maximum temperatures below 40°C
- ✦ 25% of all surveyed cells have never been replaced
- ✦ 42% of all surveyed cells operated five or more years before being scheduled for replacement
- ✦ 33% of surveyed cells were replaced within the first four years of operation

FY 02 Plans

- ✦ Present results at EESAT 2002
- ✦ Present results at INTELEC 2002
- ✦ Pursue further cost-share collaborations
- ✦ Examine proactive cell monitoring performance options

Lead-Acid Battery Annual Sales



Source: BCI