



Semiconductor Assembly Council - Key Performance Indicators and More

*Presented by: Marla Cooper
SAC VP Technology & Programs*

KGD Workshop - Napa, California

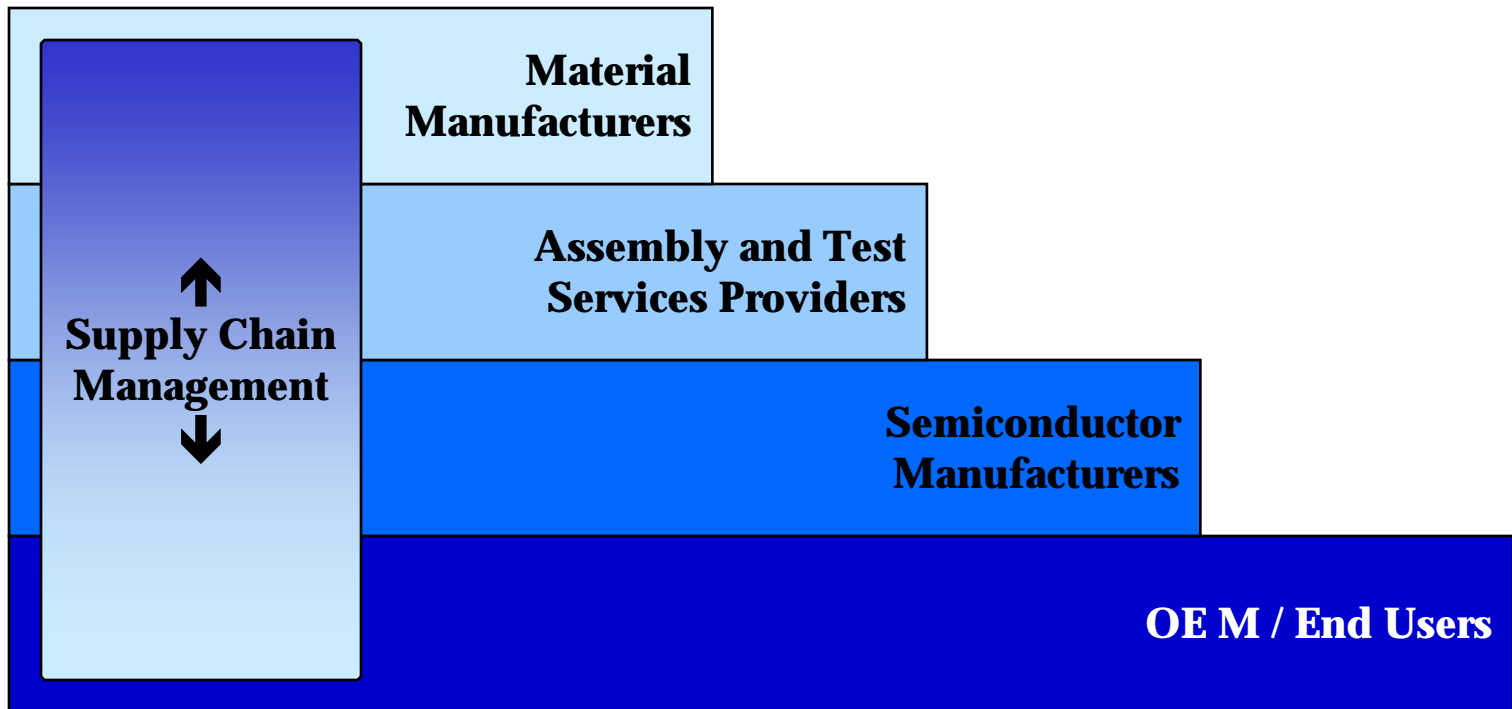
September 9, 2002

Session #2, Future Trends in the Portables World



Who is the Semiconductor Assembly Council?

□ A multi-tiered organization





What is the purpose of SAC?

❑ **What SAC is:**

- **Standardize, certify and improve the quality systems and process controls of assembly & test manufacturing organizations and of their suppliers**
- **Forum for technology exchange and sharing of Best Practices**

❑ **What SAC is not:**

- **Only a standards organization**
- **Only a quality organization**
- **Only an auditing organization**



The SAC Mission Statement

As the preferred standards and certification body for semiconductor assembly and test subcontractors, SAC's mission is to drive continuous improvement throughout the semiconductor manufacturing supply chain.

SAC provides a forum for the exchange of best practices and technical information related to semiconductor manufacturing.



Organization: **Current Members**

End Users (10)

Daimler/Chrysler, Ericsson Microwave, Johnson Electronic, Motorola AIEG, PSA Peugeot Citroen, Qualcomm, Sandia Labs, Sun Microsystems, THALES/TTM, Visteon

Semiconductor Manufacturers (32)

Agilent, Alcatel, Allegro, AMD, Anadigics, Analog Devices, Atmel, Centillum, DelphiDelco, Elmos, Ericsson Microelectronics, Exar, Flextronics, Honeywell, Infineon, IBM, IR, Intersil, LSI Logic, Macronix, Medtronic Microelectronics, Mitel, National, ON Semi, Philips, Robert Bosch, Skyworks, ST Micro, TI, TSMC, Xilinx, Zetex



Organization: **Current Members**

Subcontractors (28)

AIT, Alphatec, Amkor, ASAT, ASAT S.A., ASE, ASE Test, Carsem, ChipPAC, EEMS Italia, Eurasem, Fastech, IDS, King Yuan, Lingsen, Meicer, NSEB, OSE, P*S*i Technologies, Signetics, STATS, Team Pacific, Unisem, UTAC

Material & Service Suppliers (6)

Cookson, Dexter /Loctite, QPL, Reel Service, Sumitomo Plastics, Tessera



Organization: **SAC Officers & Board of Directors**

- | | | |
|--|----------------------------------|--------------------------|
| <input type="checkbox"/> Rick Adams | Visteon | Chair |
| <input type="checkbox"/> Johnny Thomas | Amkor Technologies | |
| <input type="checkbox"/> Niclas Jacobsson | Ericsson Microelectronics | |
| <input type="checkbox"/> Ron Ramos | Philips | |
| <input type="checkbox"/> Bob Martel | Texas Instruments | |
| <input type="checkbox"/> Ed Combs | QPL | |
| <input type="checkbox"/> Wayne Moore | AIT | |
| <input type="checkbox"/> Philippe Briot | | |
| <input type="checkbox"/> Bob Skiba | | |
| <input type="checkbox"/> Doug Pecchenino | Xilinx | Executive Advisor |

STAFF

- | | |
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| <input type="checkbox"/> Bette Cooper | Executive Director |
| <input type="checkbox"/> Marla Cooper | VP Technology & Programs |

Member Benefits – Supply Chain Optimization

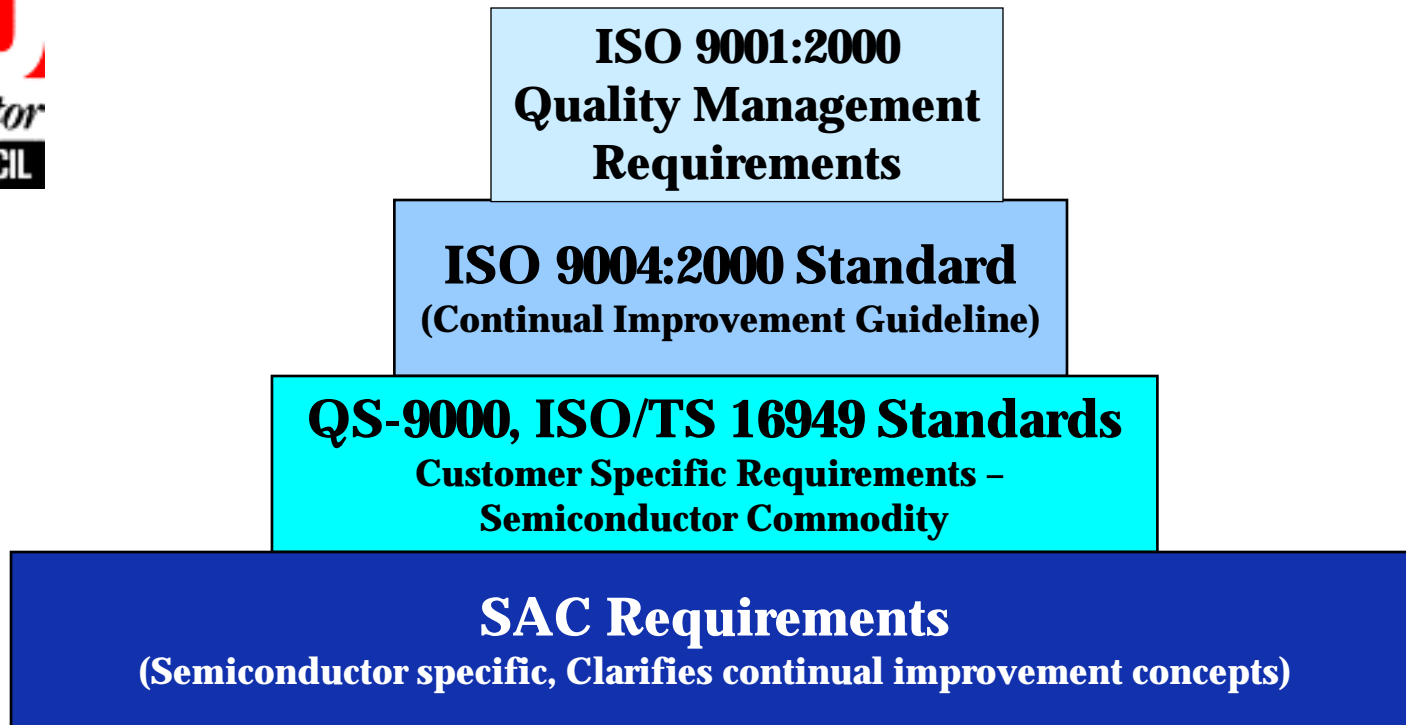
- ❑ **Quality Management Systems Standards**
- ❑ **Reduced Audit/Certification Costs**
- ❑ **Standardized Reports**
- ❑ **Best-in-Class Practices**
- ❑ **Improved Supply Chain Management**
- ❑ **Certified Suppliers**



SAC Standards:

- ❑ **Use Internationally recognized standards (ISO9001/9004:2000, QS-9000 3rd edition, ISO/TS 16949:2002, EIA, JEDEC) and added-value with Semiconductor industry criteria**
- ❑ **Standards are available on the web, and include:**
 - ◆ **SAC-STD-001 Certification Standard**
 - ◆ **SAC-STD-002 Audit Standard**
 - ◆ **SAC-STD-003 Package Qualification Standard**
 - ◆ **SAC-STD-004 Process Control Standard**
 - ◆ **SAC-STD-005 Product / Process Change Notification Standard (on hold)**
 - ◆ **SAC-STD-006 Document Control Standard**
 - ◆ **SAC-STD-007 Quality System Checklists Standard**
 - ◆ **SAC-STD-008 SAC – Registrar Joint Audit Standard**

SAC Certification Standards



- ❑ **Example of differences between standards for Process Control**
 - **ISO 9001 determines if documentation exists, sets minimum requirements**
 - **ISO 9004 provides minimum process control improvement guidelines**
 - **QS-9000 / TS 16949 identifies the minimum and significant process data to be collected and used**
 - **SAC determines if this is the right data and if it is used for continual improvement**

SAC Audit Emphasizes Process Control and Continual Improvement

Para. #	ISO 9001: 1994 Element Title	Number of Shalls in Supplier Requirements		
		ISO 9001 2nd ed. 1994	QS 9000 3rd ed. 3/1998	SAC 007 Rev. A 2000
4.1	Management Responsibility	12		+12 (3)
4.2	Quality System	12		+15 (3)
4.3	Contract Review	6		+ 0
4.4	Design Control	15		+5 (2)
4.5	Document and Data Control	7		+3
4.6	Purchasing	11		+5 (2)
4.7	Control of Customer Supplied Product	2		+2
4.8	Product Identification and Traceability	2		+2
4.9	Process Control	4		+64 (4)
4.10	Inspection and Test	11		+8 (5)
4.11	Control of Inspection, Measuring and test Equipment	12		+8 (2)
4.12	Inspection and Test Status	1		+4
4.13	Control on Non-conforming Product	5		+7 (2)
4.14	Corrective and Preventative Action	11		+6 (2)
4.15	Handling, Storage, Packaging, Preservation and Delivery	6		+11
4.16	Control of Quality Records	3		+2 (1)
4.17	Internal Quality Audits	4		+2
4.18	Training	1		+1
4.19	Servicing	1		+0
4.20	Statistical Techniques	2		+9 (4)
	Total Shalls	128	282	448
			ISO 9000 + 154	QS +166 (+32 CI)

Typical Audit Costs

- ❑ **Supplier Expenses:**
 - **Frequency: About 1 audit every 1-2 months per site**
 - **Duration: 1/2 to 3 days**
 - **Time: 2-12 people taking 16-360 man hours/audit**
- ❑ **Customer Expenses*:**
 - **Frequency: every 1-2 years per supplier**
 - **Air fare: \$1.5k+ (lowest coach fare)**
 - **Food and lodging, misc. expenses: \$300/day minimum**
 - **2 days travel plus audit time**
 - **Usually 2-5 people perform the audit**

***Assumes a North American company auditing an Asian supplier**



SAC Audit/Certification Reduces Overall Costs

- ❑ **Supplier Expenses:**
 - **Frequency: 1 audit every 3 years per site**
 - **Duration: 3 -4 days**
 - **Time: 4-12 people taking 96-360 man hours/audit**

- ❑ **Customer Expenses*:**
 - **Frequency: every 3 years per supplier**
 - **Air fare: \$1.5k+ (lowest coach fare)**
 - **Food and lodging, misc. expenses: \$300/day minimum**
 - **2 days travel plus audit time**
 - **Usually only 1 person per company**

***Assumes a North American company auditing an Asian supplier**



SAC Audit/Certification Strengths

- ❑ Comprehensive and Industry Specific**
- ❑ Auditors are Industry Experts**
 - Provide customer view of issues and concerns**
 - Provide insight to potential problems**
 - Provide direction on solutions**
- ❑ Familiarity with “Best Practices”**
- ❑ Experience with manufacturing problems and solutions**

SAC Audit/Certification Benefits the Supplier:

(Semiconductor Assembly, Test and Material/Service providers)

- ❑ One audit for many customers**
- ❑ No costly registrar QS/TS Registrar (only ISO Registrar)**
 - Only SAC membership fee required (\$1600 per year)**
- ❑ Customers are involved in process**
 - Improves interaction and communication**
- ❑ Single standard and criteria**
- ❑ Proactively learn from other experiences**
- ❑ Identify gaps between “Best Practices” and own processes**
- ❑ Replaces need for separate QS9000 or ISO/TS 16949 certification**
- ❑ Auditors are industry experts**
 - “Free” consultants for continual improvement**

SAC Audit/Certification Benefits the Customer:

- Single industry standard**
- Eliminate need for separate supplier assessments**
- Benefit from other companies experiences**
- Improved interaction and communication**
- Share audit costs with other companies**
- Access to on-going certification surveillance data**
- Opportunity to participate and understand supplier's systems, controls and on-site visibility**
- Understand the supply chain issues and constraints from the supplier perspective**

Standardized Reports

- ❑ **Cpk Reports & CA plan for Cpk's <1.33 or goal**
- ❑ **Continuous Quality Improvement (CQI) Plans**
- ❑ **Internal & External Audit Results**
- ❑ **Management Review**
- ❑ **Key Performance Indicators (KPI)**
- ❑ **Control Plans / Changes**
- ❑ **Benchmark reports**



Standard Cpk Reports

QUARTERLY Cpk REPORT

ASSEMBLER : CPK Assembly Line	LOCATION :#####	REPORT DATE : 02/05/2002
CUSTOMER : ALL	PACKAGE FAMILY : TSOP	PERIOD : 1 Q`tr, 2002

SIGNIFICANT CHARACTERISTICS	GENERIC		AVE Cpk	MIN Cpk	NUMBER OF MACHINES IN EACH Cpk LEVEL					
	DATA*	SPEC LIMITS			< 1.0	1.0-1.33	1.33-1.67	1.67-2.0	> 2.0	TOTAL
Die shear strength	YES	LSL 2.5Kg	2.32	2.24	0	0	1	4	7	12
Wet Epoxy thickness	YES	0.5 -1.0 mil	2.17	1.74	0	0	0	3	5	8
Bond pull strength	YES	LSL 3.0g	2.12	1.99	0	0	13	35	91	139
Ball shear strength	YES	LSL 30g	1.91	1.89	0	0	34	51	69	154
Coplanarity	YES	USL 4.0mil	9.62	8.69	0	0	0	0	16	16
Stand off	YES	2.0~8.0mil	6.26	4.86	0	0	0	0	8	8
Tip To Tip(D)	YES	520~536mil	5.85	4.06	0	0	0	0	6	6
Solder thickness	YES	200~600 "	2.41	2.40	0	0	0	0	20	20
Solder composition	YES	80 ~ 95%	2.82	2.78	0	0	0	0	20	20
COLUMN TOTAL					0	0	48	93	242	383
% OF TOTAL					0.00%	0.00%	12.53%	24.28%	63.19%	100.00%

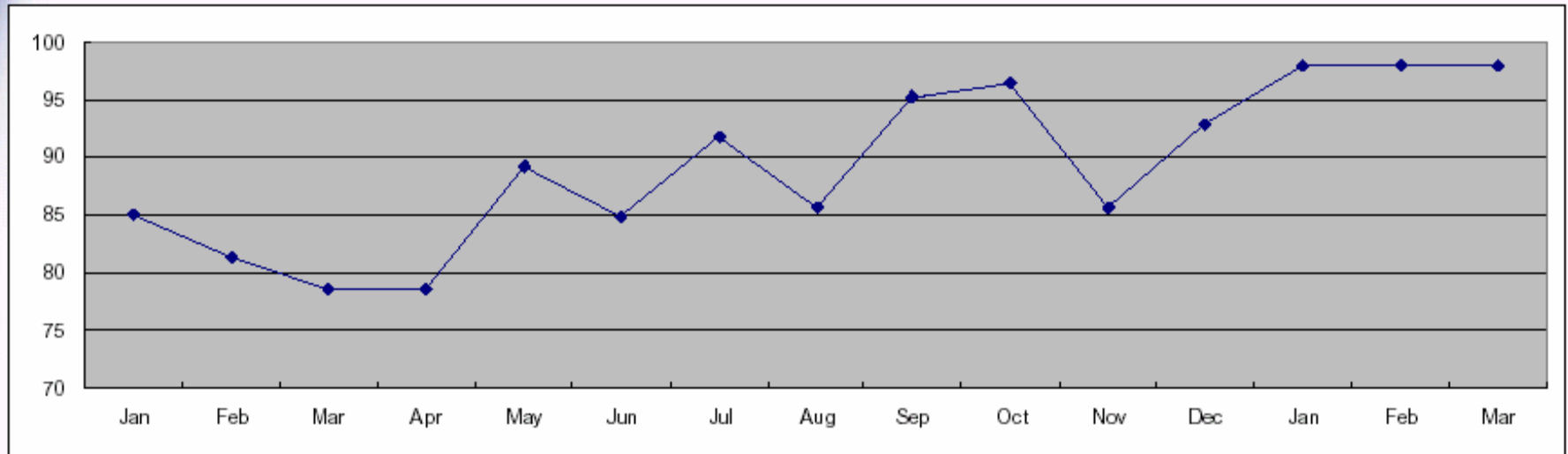
* Check if yes, Data is generic if it is not customer specific.

NOTES : 1) Dry bondline thickness has been correlated to wet thickness and is not being checked.



Standard Key Performance Indicator Reports

% Cpk>2.0



Current Data			
Month	Actual	Goal	B.I.C.
Mar '02	97.8	99.2	99
Feb '02	98.1	99.2	99
Jan '02	98.0	99.2	99

Improvement Project	Team driver	Measure	Start Date	Schedule Date	Completion Date
Check mold die temp balance and tune the temp offset value.	CHS KIM {PBCA}	CpK	WW15'02	WW18'02	WW18'02
Increase the wire bonding heater block vacuum Q'ty in order to fix the circuit tape completely during wire bonding.	NC JUNG {FBCA}	CpK	WW15'02	WW20'02	WW20'02

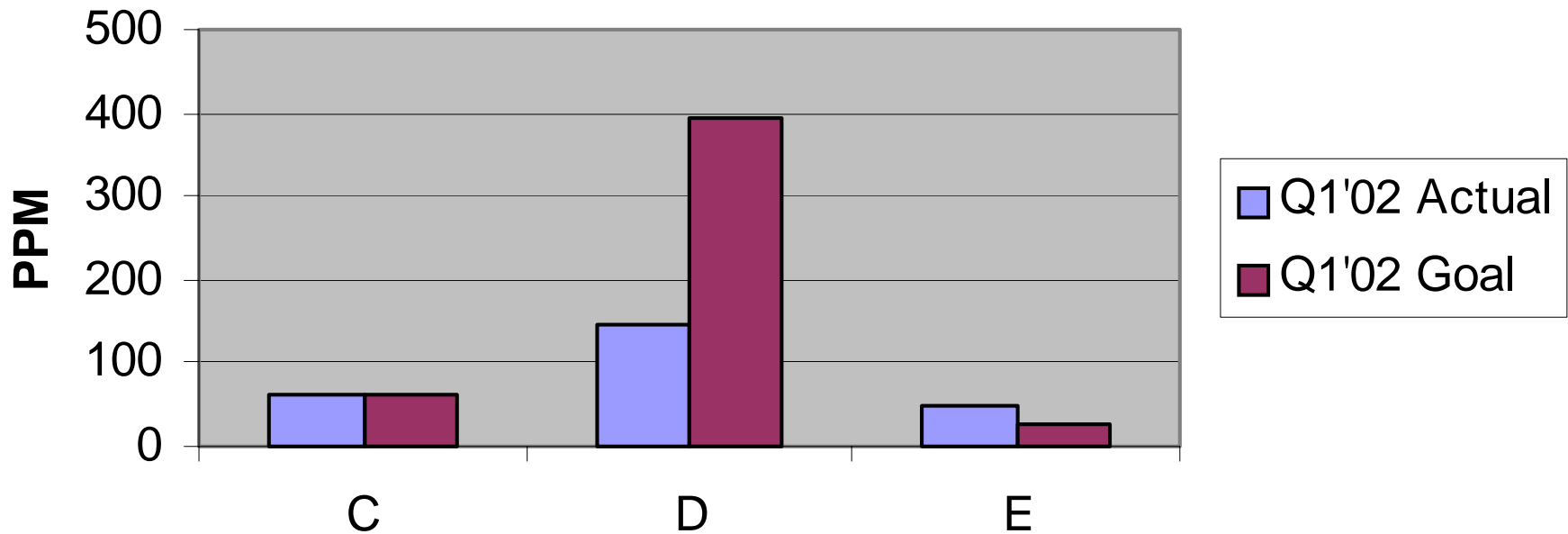
KPI Reports



Q u a r t e r l y S u m m a r y	D e s c r i p t i o n
As s e m b l y P P M	<i>A v e r a g e p e r Q u a r t e r c a l c u l a t e d p e r A N S I - E I A - 5 5 4</i>
T e s t P P M	<i>A v e r a g e p e r Q u a r t e r c a l c u l a t e d p e r A N S I - E I A - 5 5 4</i>
O u t g o i n g / A s s e m b l y + T e s t P P M	<i>A v e r a g e p e r Q u a r t e r c a l c u l a t e d p e r A N S I - E I A - 5 5 4</i>
C y c l e T i m e - A s s e m b l y H o u r s	<i>A v e r a g e p e r Q u a r t e r</i>
C y c l e T i m e - T e s t H o u r s	<i>A v e r a g e p e r Q u a r t e r</i>
C y c l e T i m e O v e r a l l A s s e m b l y + T e s t H o u r s	<i>A v e r a g e p e r Q u a r t e r</i>
O n T i m e D e l i v e r y %	<i>A v e r a g e p e r Q u a r t e r T o F i r s t C o m m i t D a t e</i>
% O n T i m e D e l i v e r y 9 5 %	<i>A v e r a g e p e r Q u a r t e r T o F i r s t C o m m i t D a t e</i>
A s s e m b l y Y i e l d %	<i>A E C - Q 0 0 2</i>
O / S Y i e l d %	<i>A E C - Q 0 0 2</i>
C u s t o m e r C o m p l a i n t (Q T Y)	<i>T o t a l p e r q u a r t e r</i>
C u s t o m e r C o m p l a i n t C y c l e T i m e (D a y s)	<i>A v e r a g e p e r q u a r t e r</i>
% C p k > 1.67	<i>C p k c a l c u l a t e d a n d r e p o r t e d p e r S A C - S T D - 0 0 4</i>
% C p k > 2.0	<i>C p k c a l c u l a t e d a n d r e p o r t e d p e r S A C - S T D - 0 0 4</i>
C y c l e T i m e E n g i n e e r i n g B u i l d s (d a y s)	<i>A v e r a g e p e r Q u a r t e r , a s s e m b l y a n d t e s t</i>

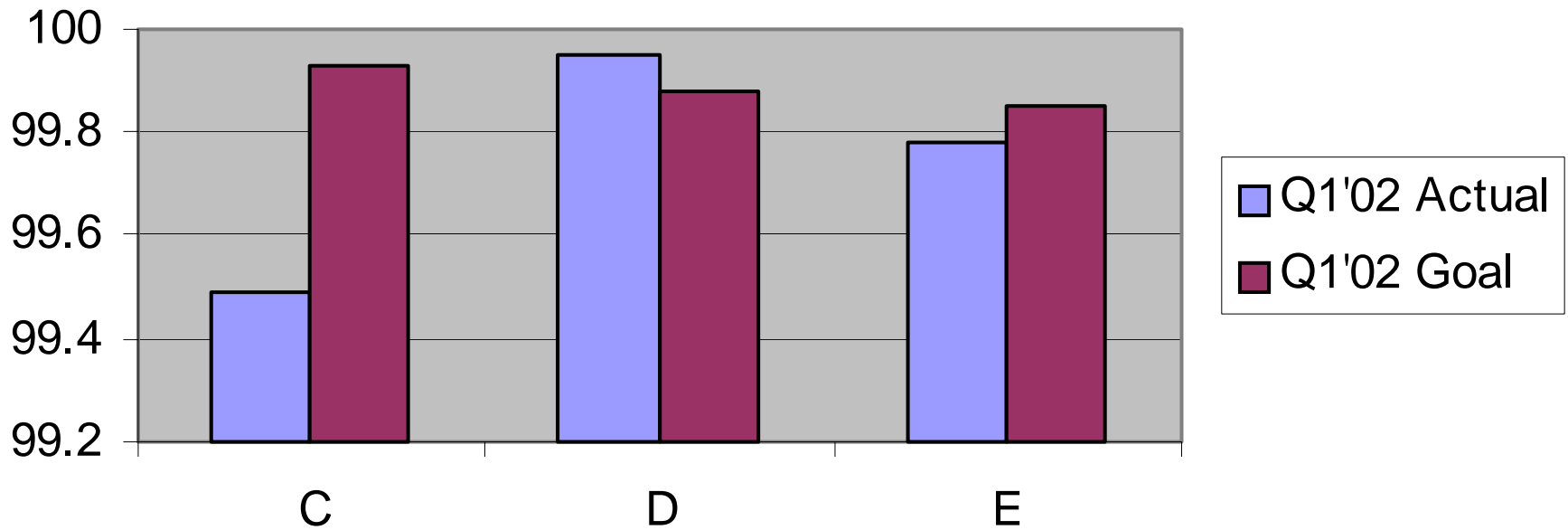
Benchmark Report - Advanced Packages

Advanced Package Assembly PPM

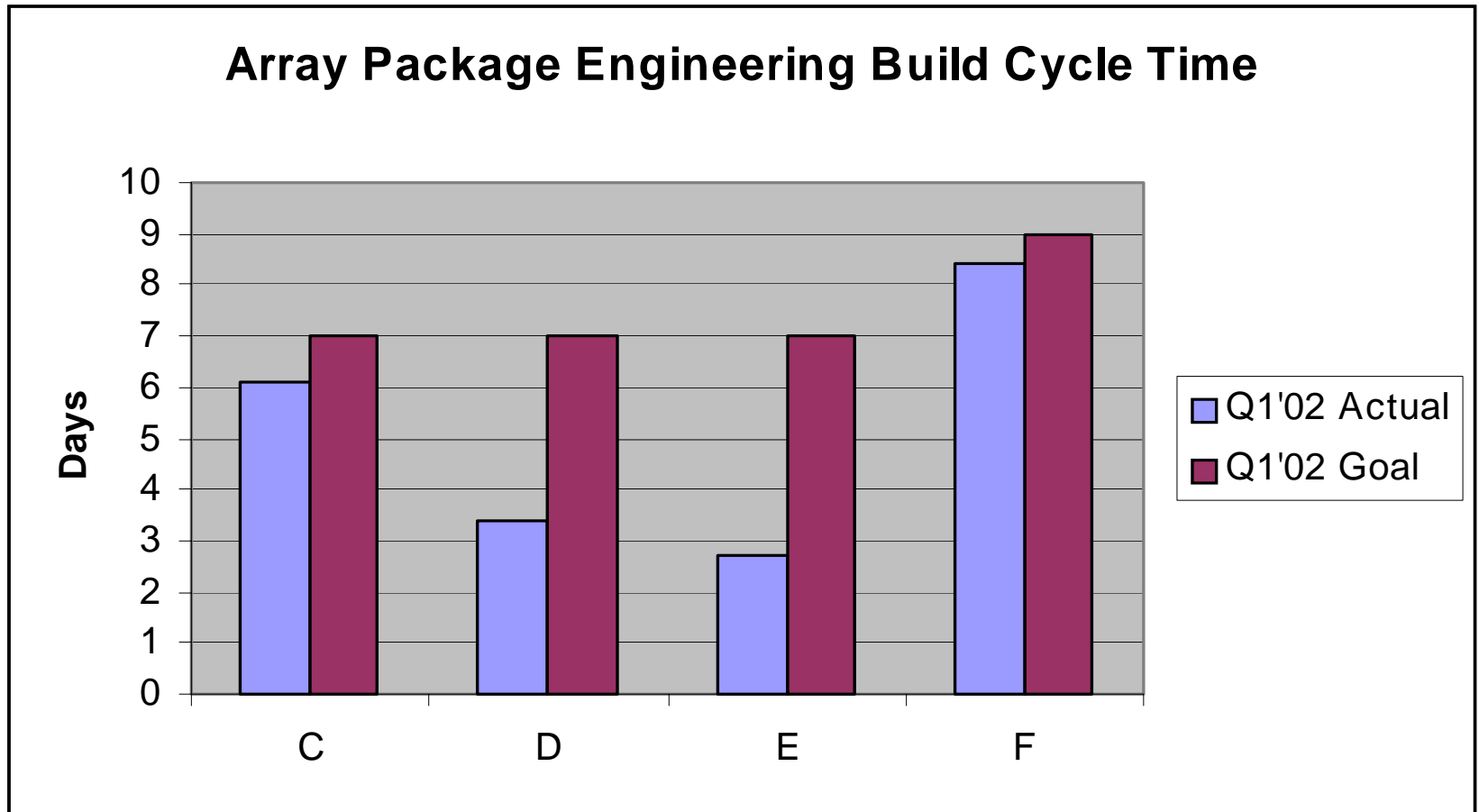


Benchmark Report - Advanced Packages

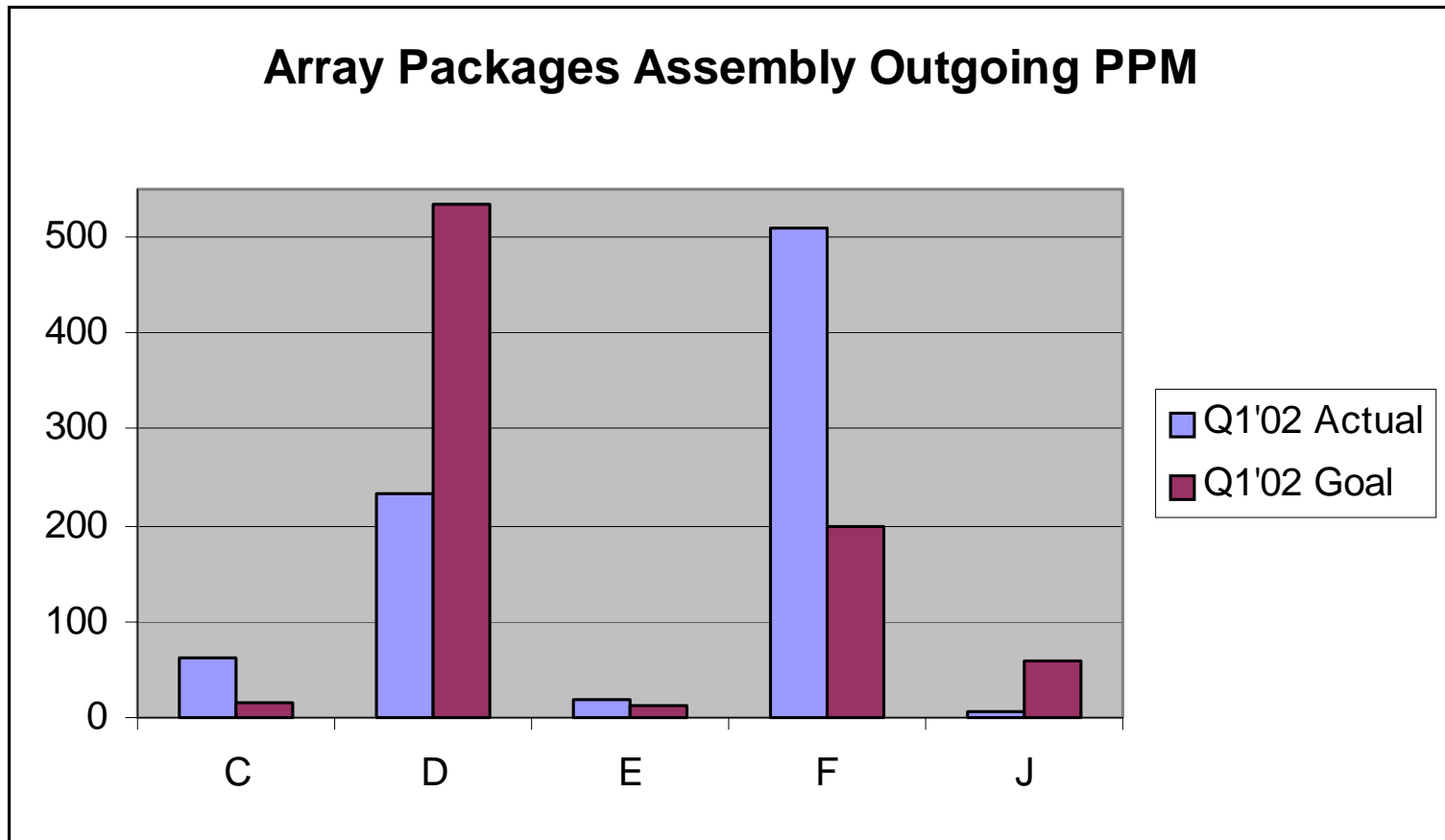
Advanced Packages Assembly Yield



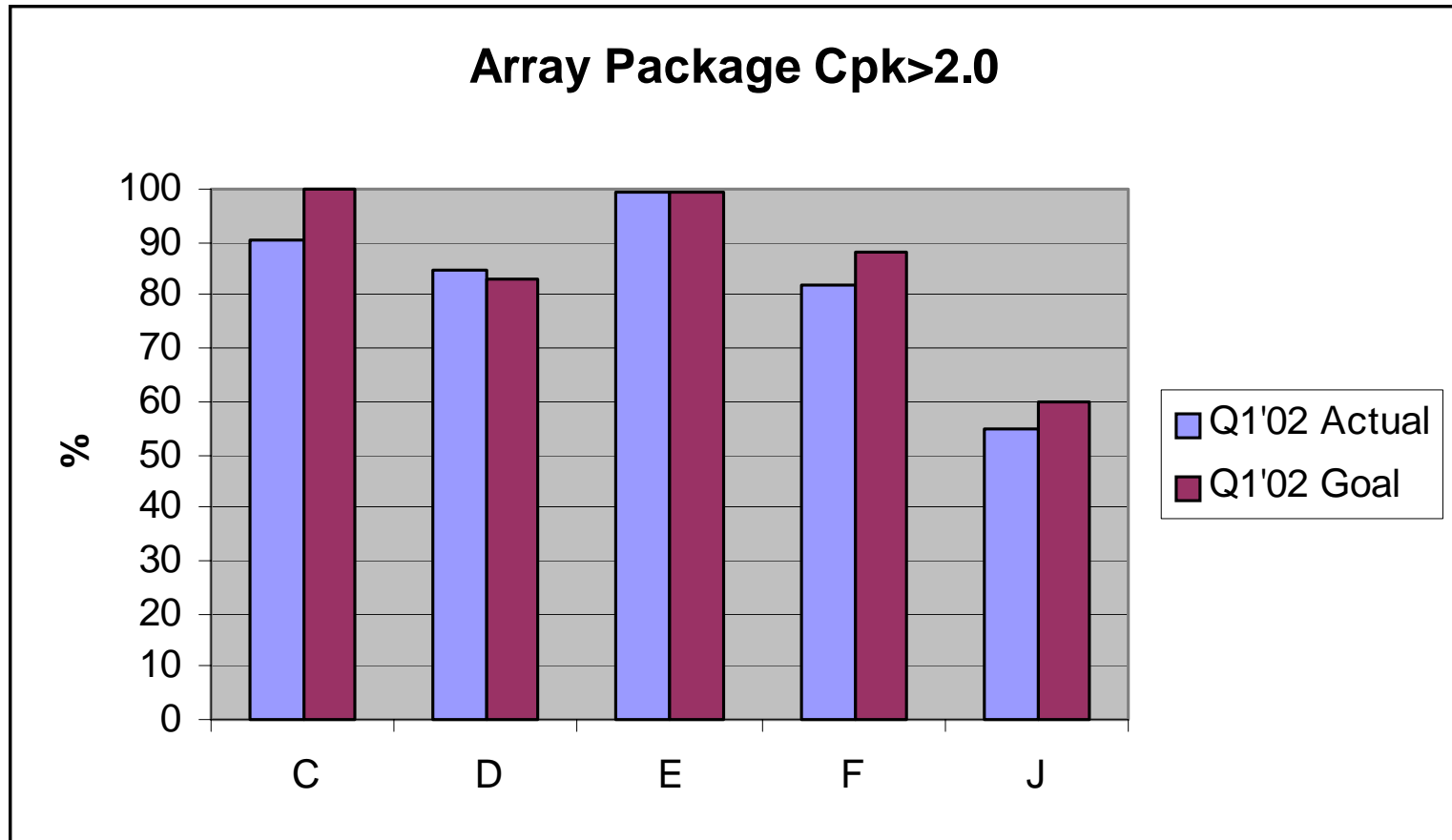
Benchmark Report- Array Packages



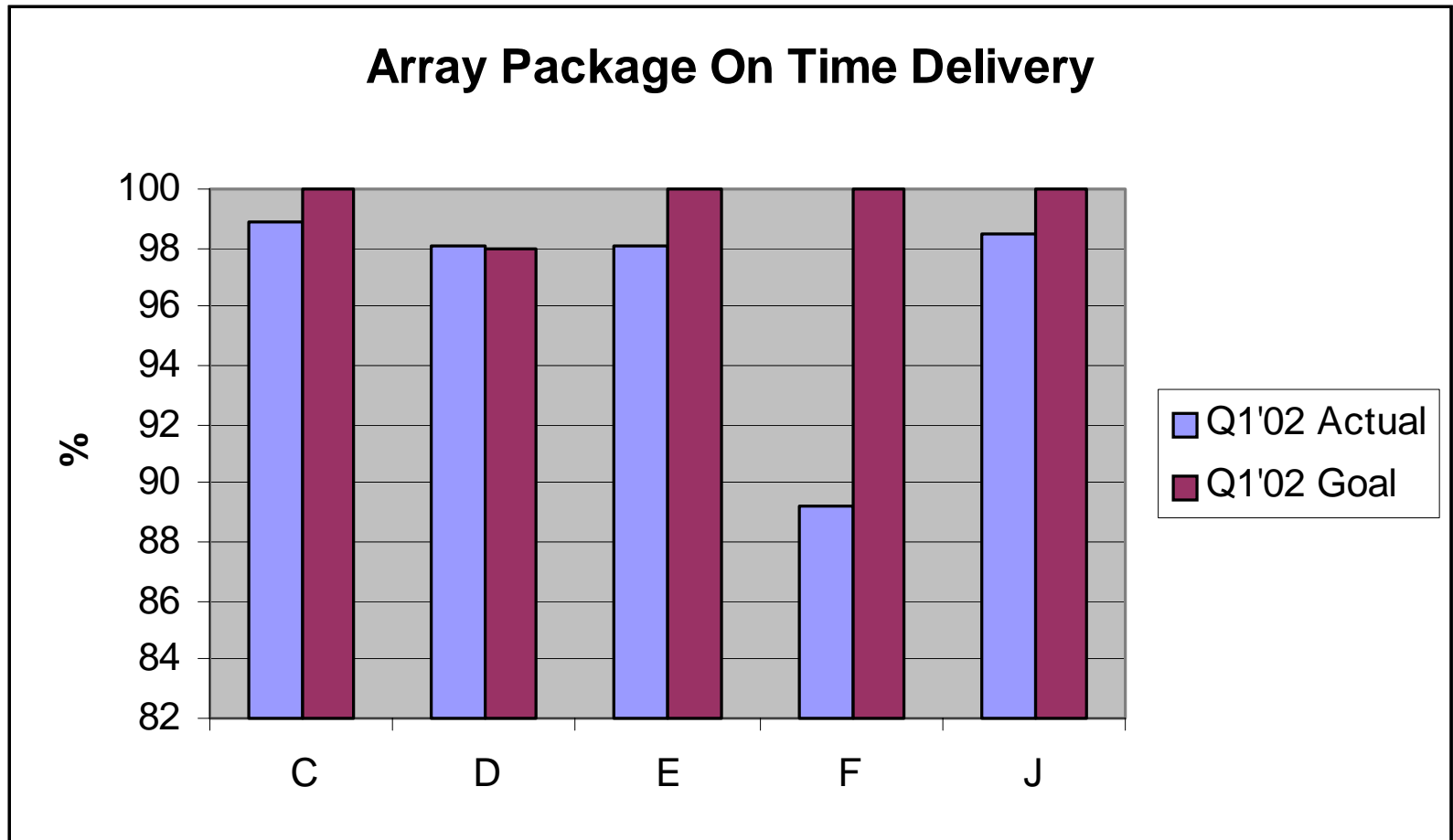
Benchmark Report- Array Packages



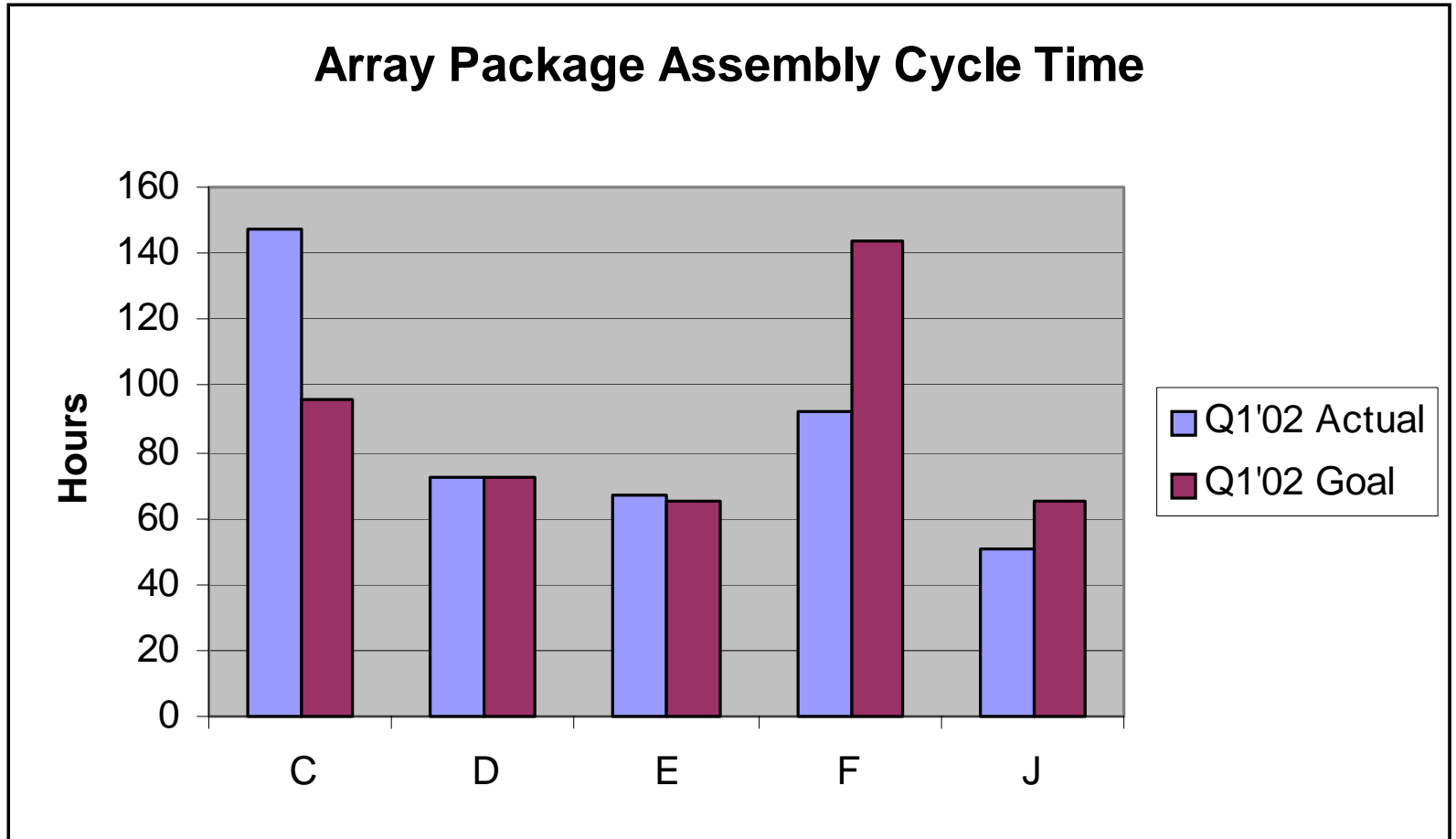
Benchmark Report- Array Packages



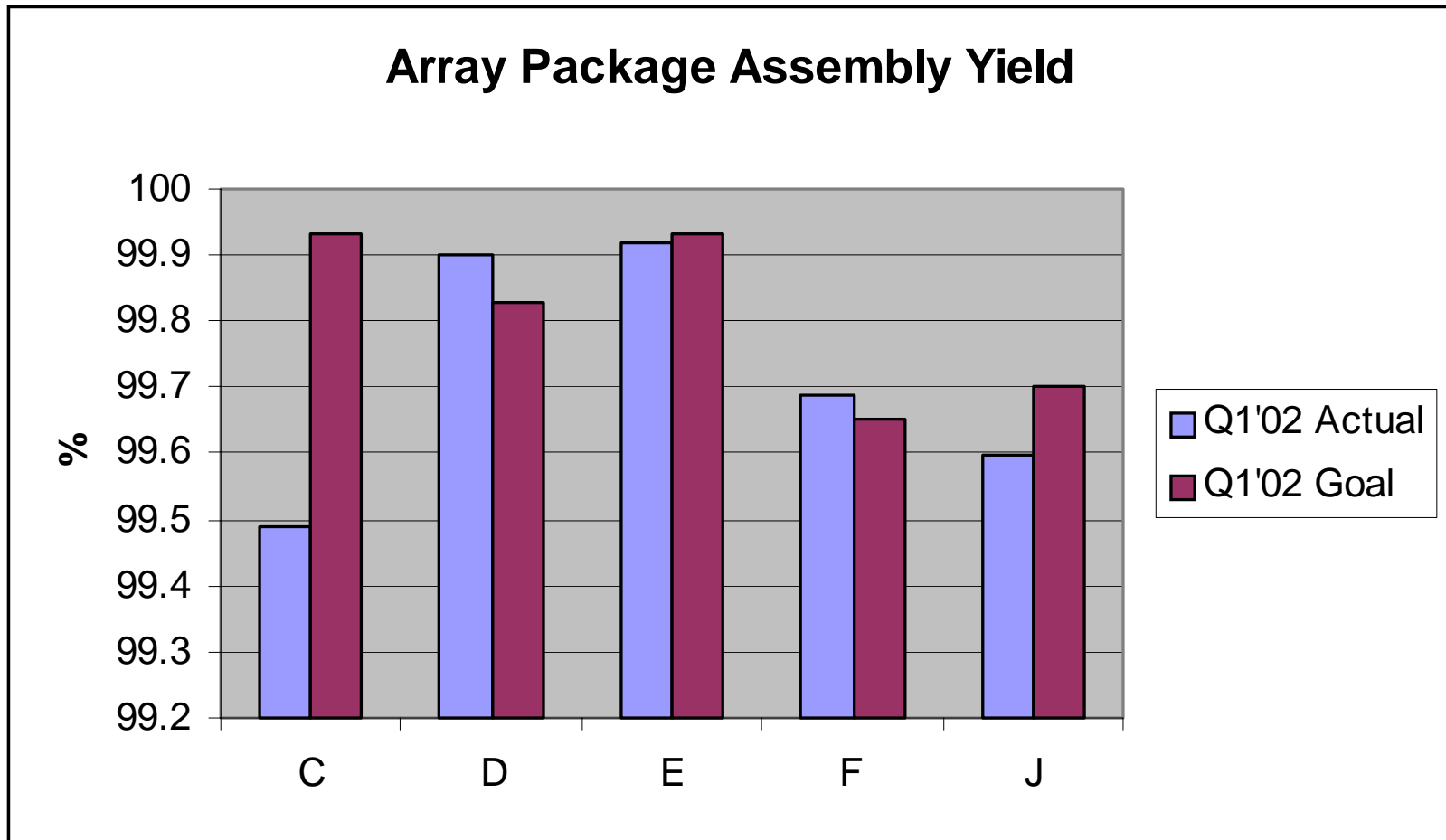
Benchmark Report- Array Packages



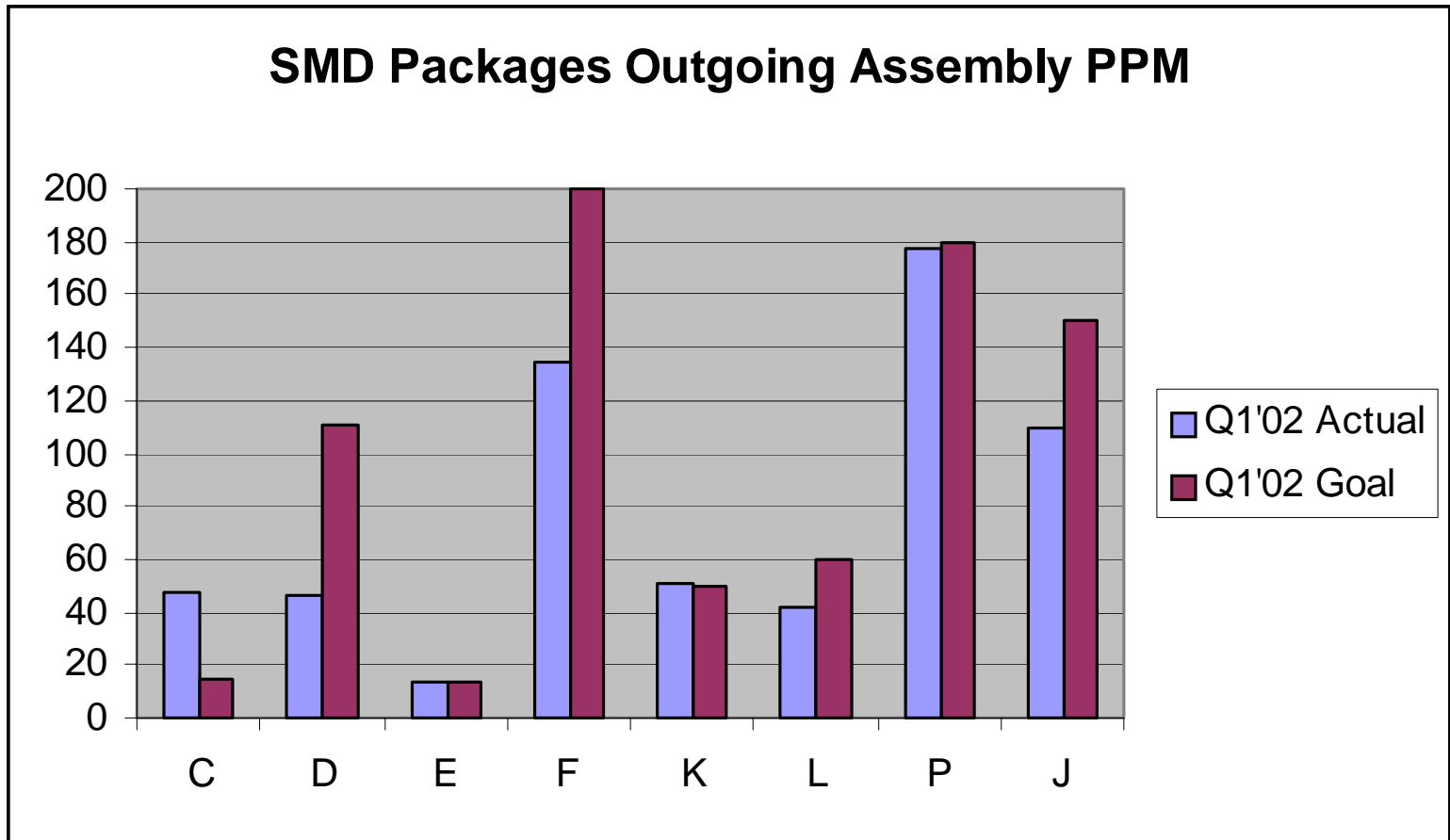
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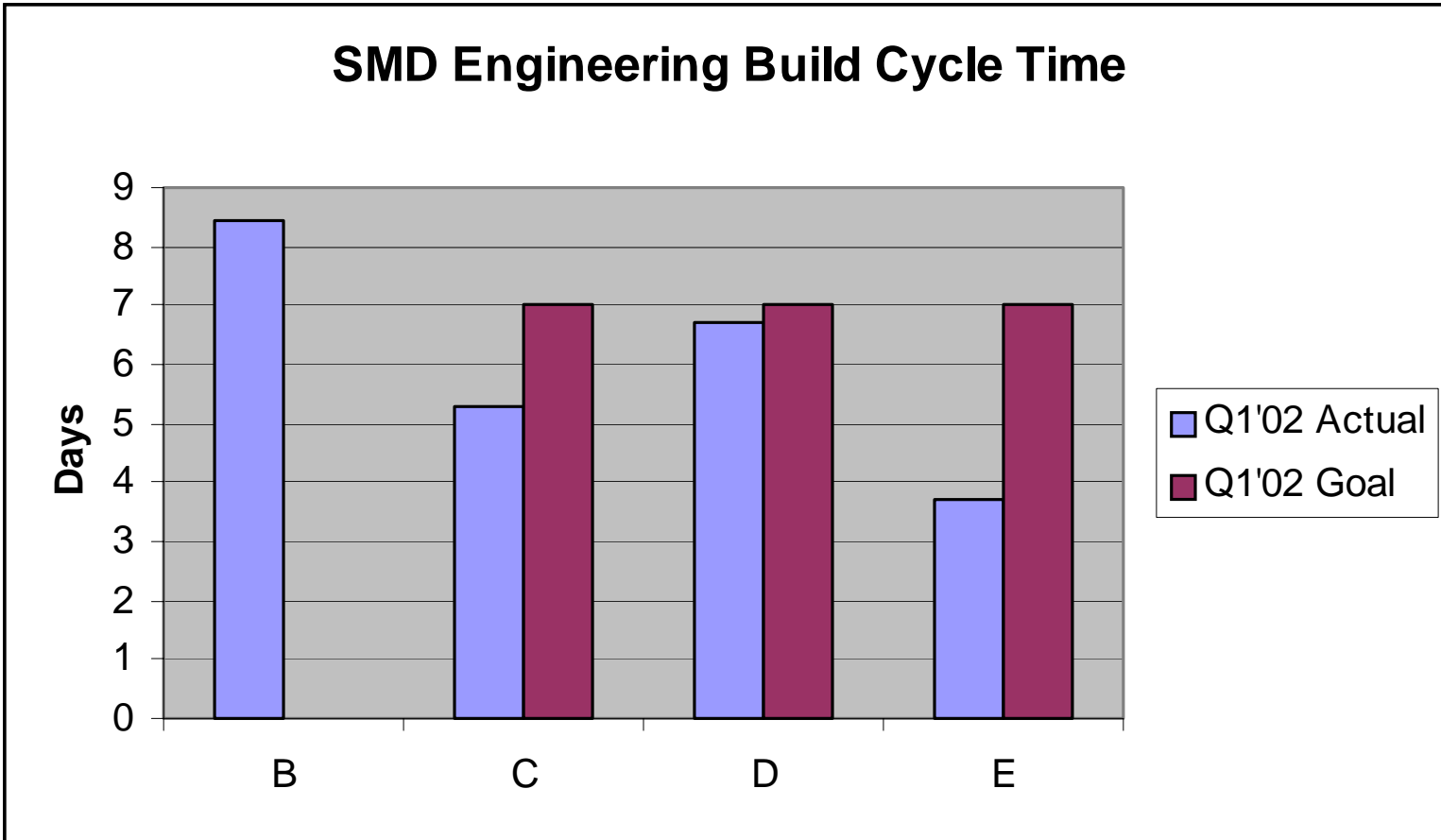
Benchmark Report- Array Packages



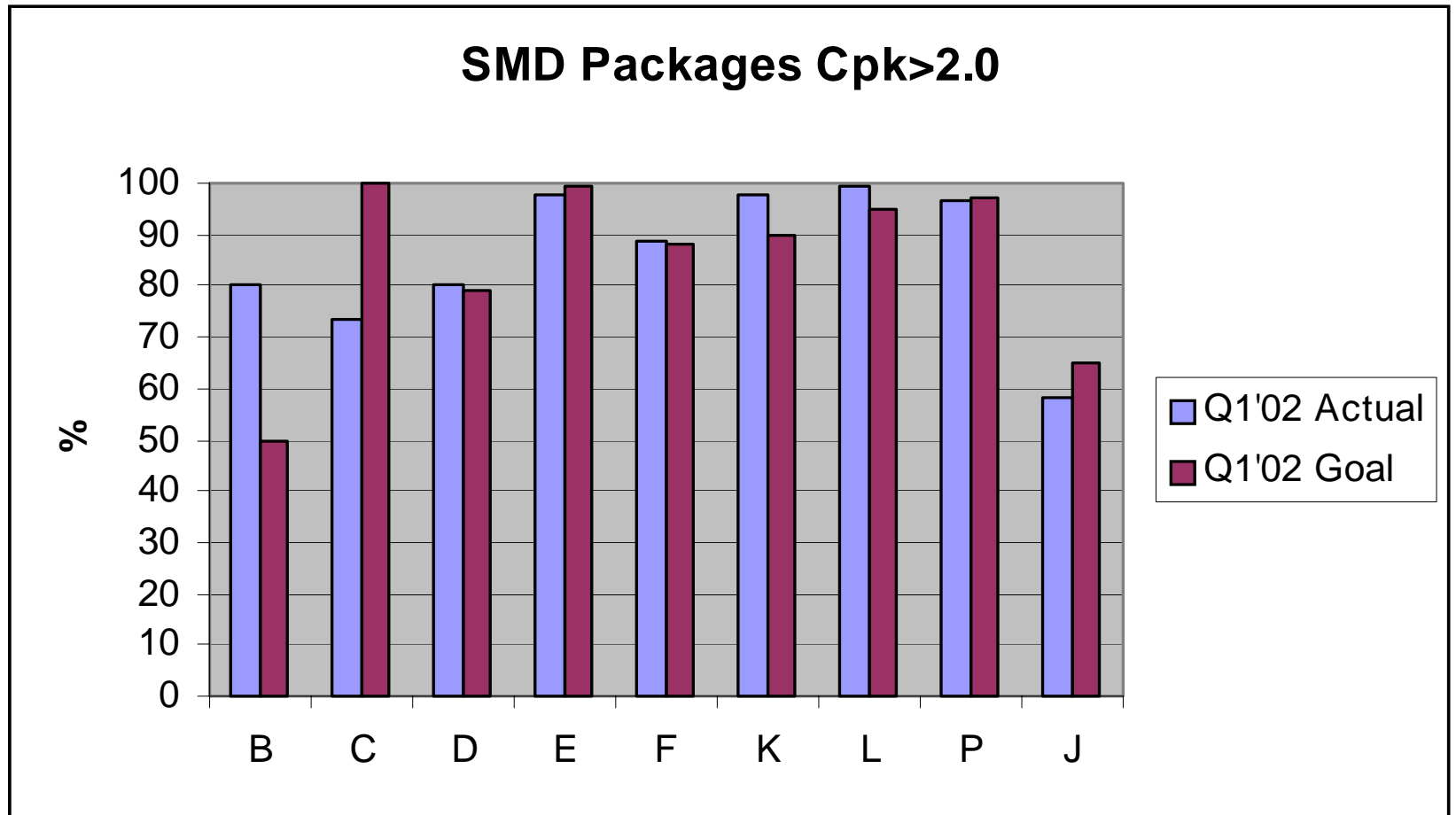
Benchmark Report- Leaded Surface Mount Device Packages



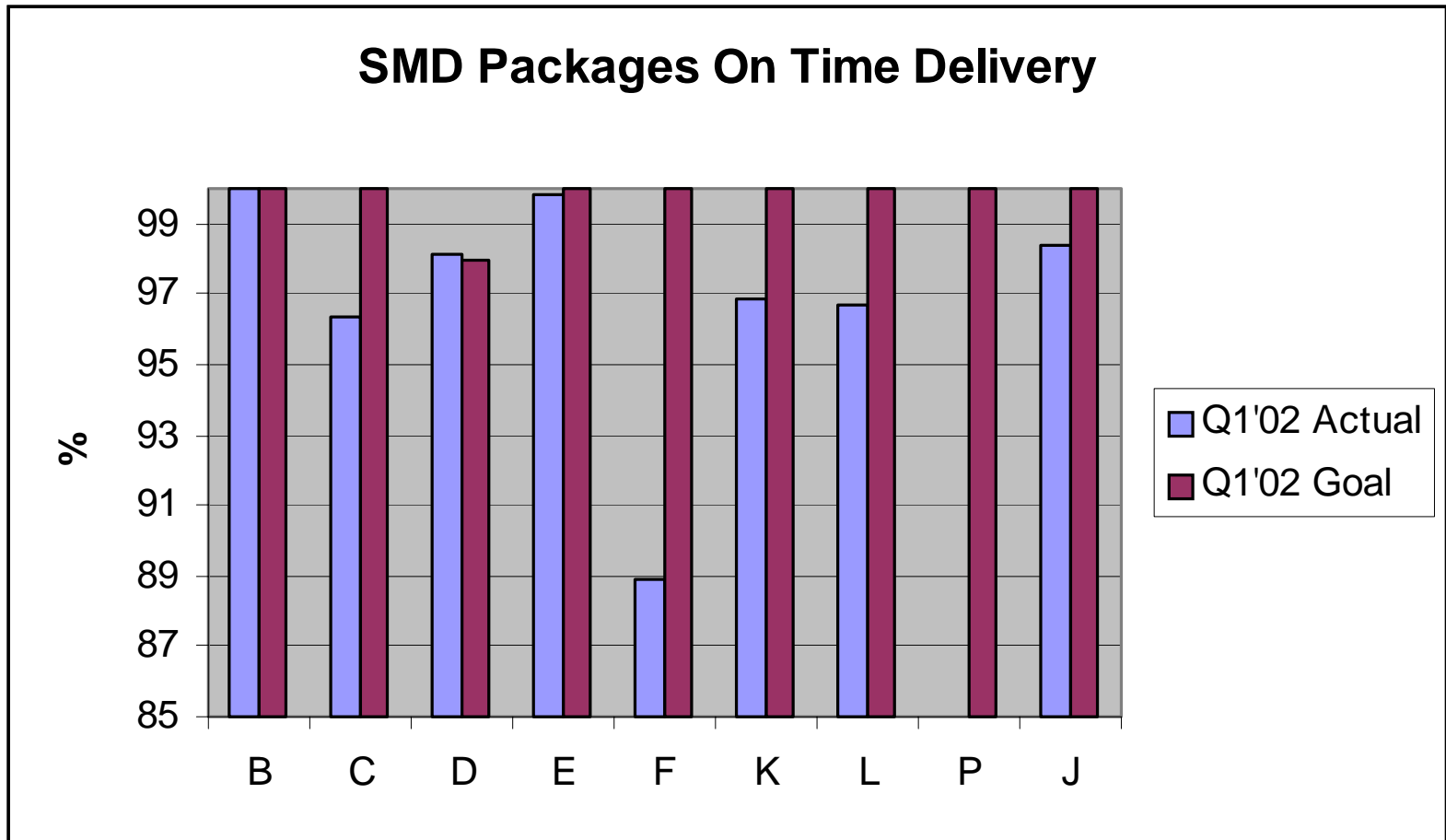
Benchmark Report- Leaded Surface Mount Device Packages



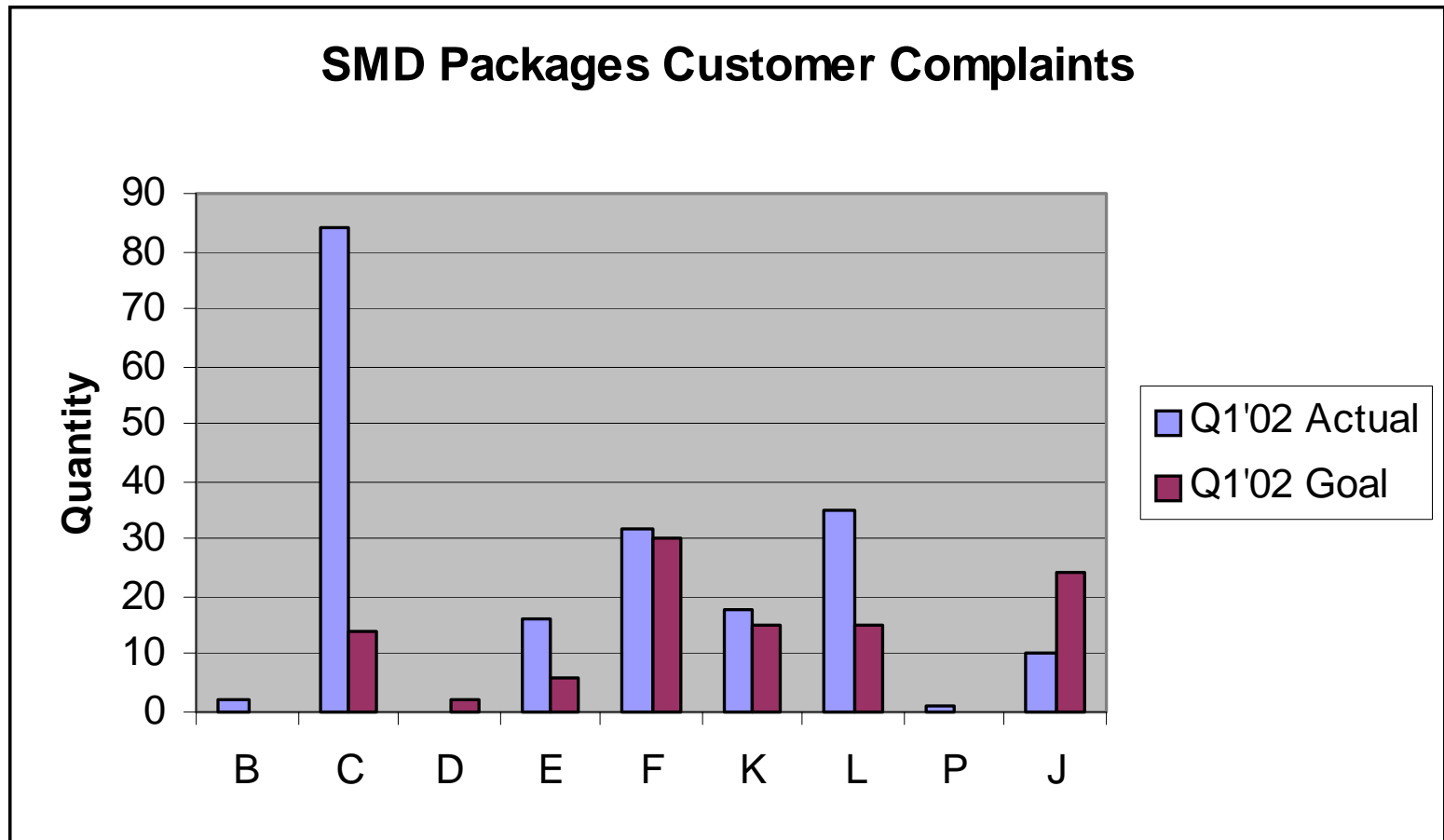
Benchmark Report- Leded Surface Mount Device Packages



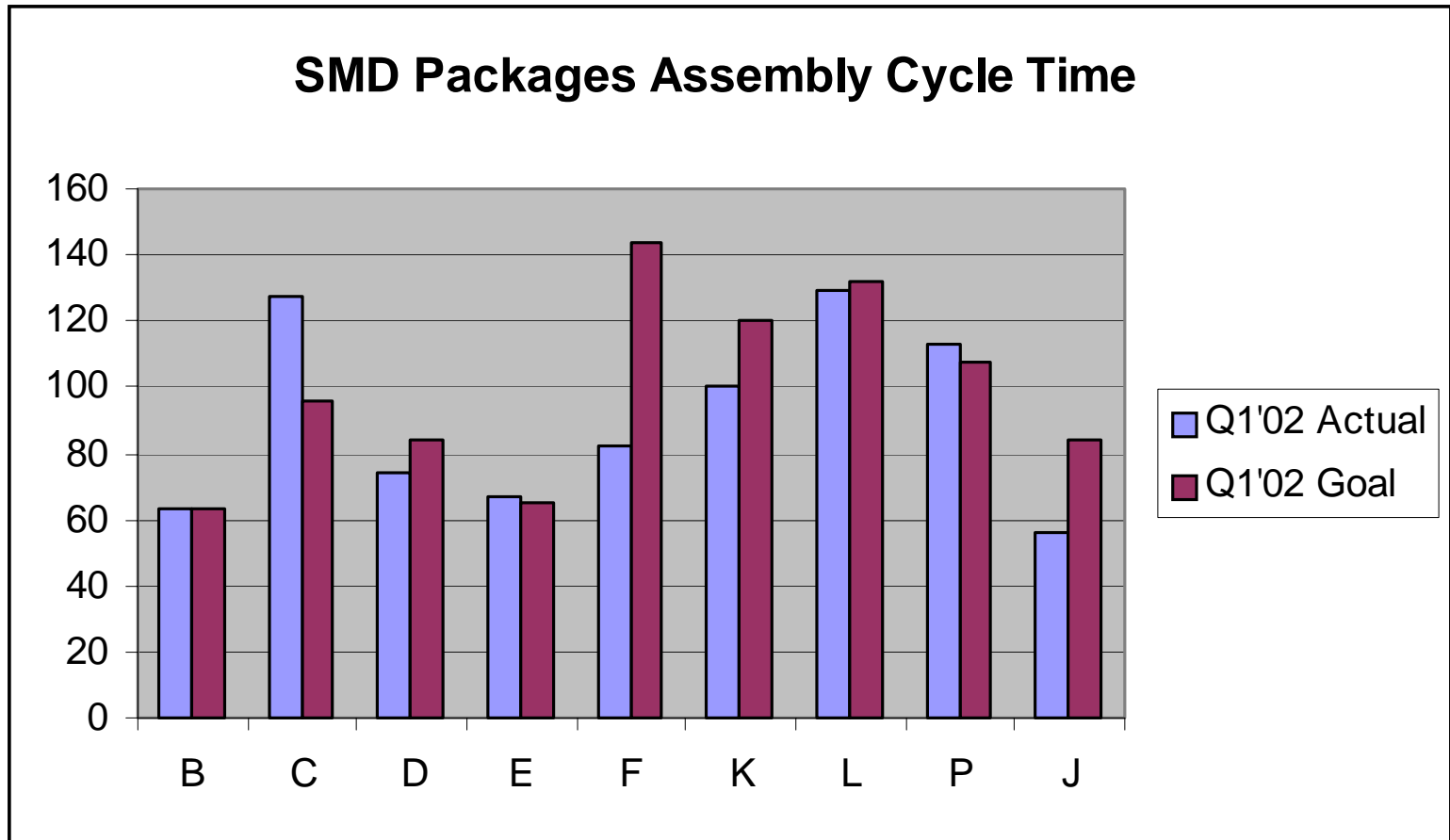
**Benchmark Report- Leaded
Surface Mount Device Packages**



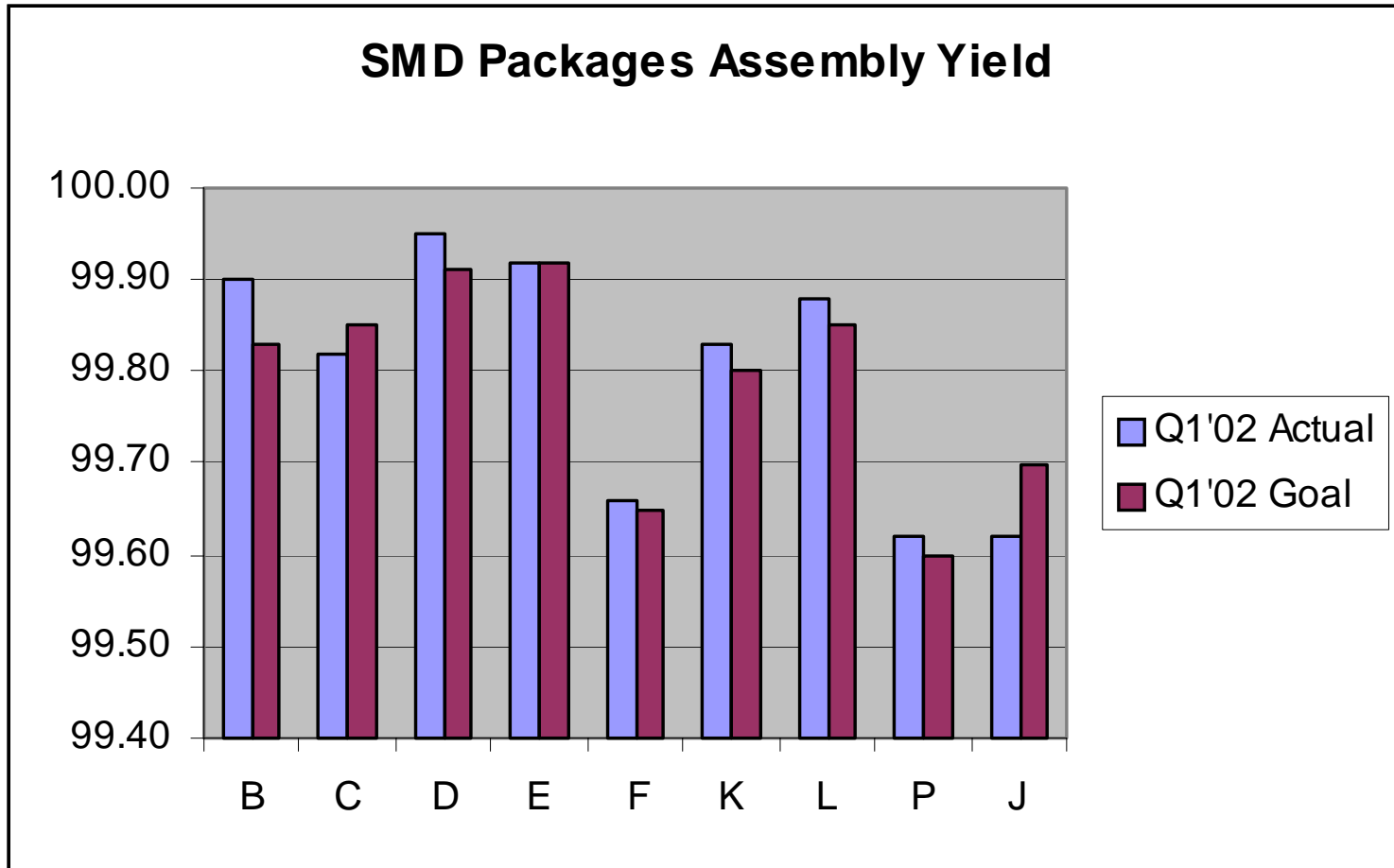
Benchmark Report- Leded Surface Mount Device Packages



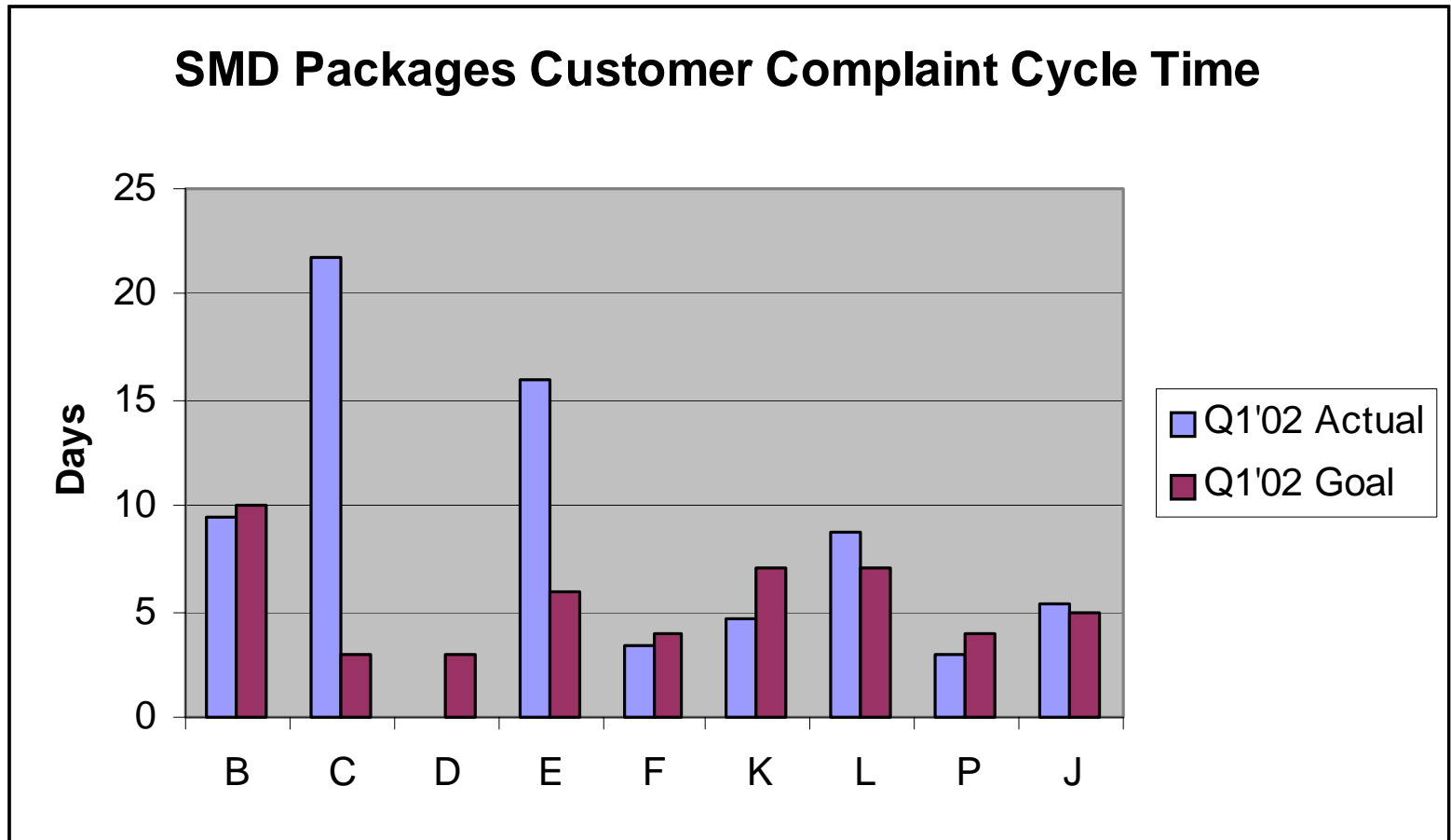
Benchmark Report- Leaded Surface Mount Device Packages



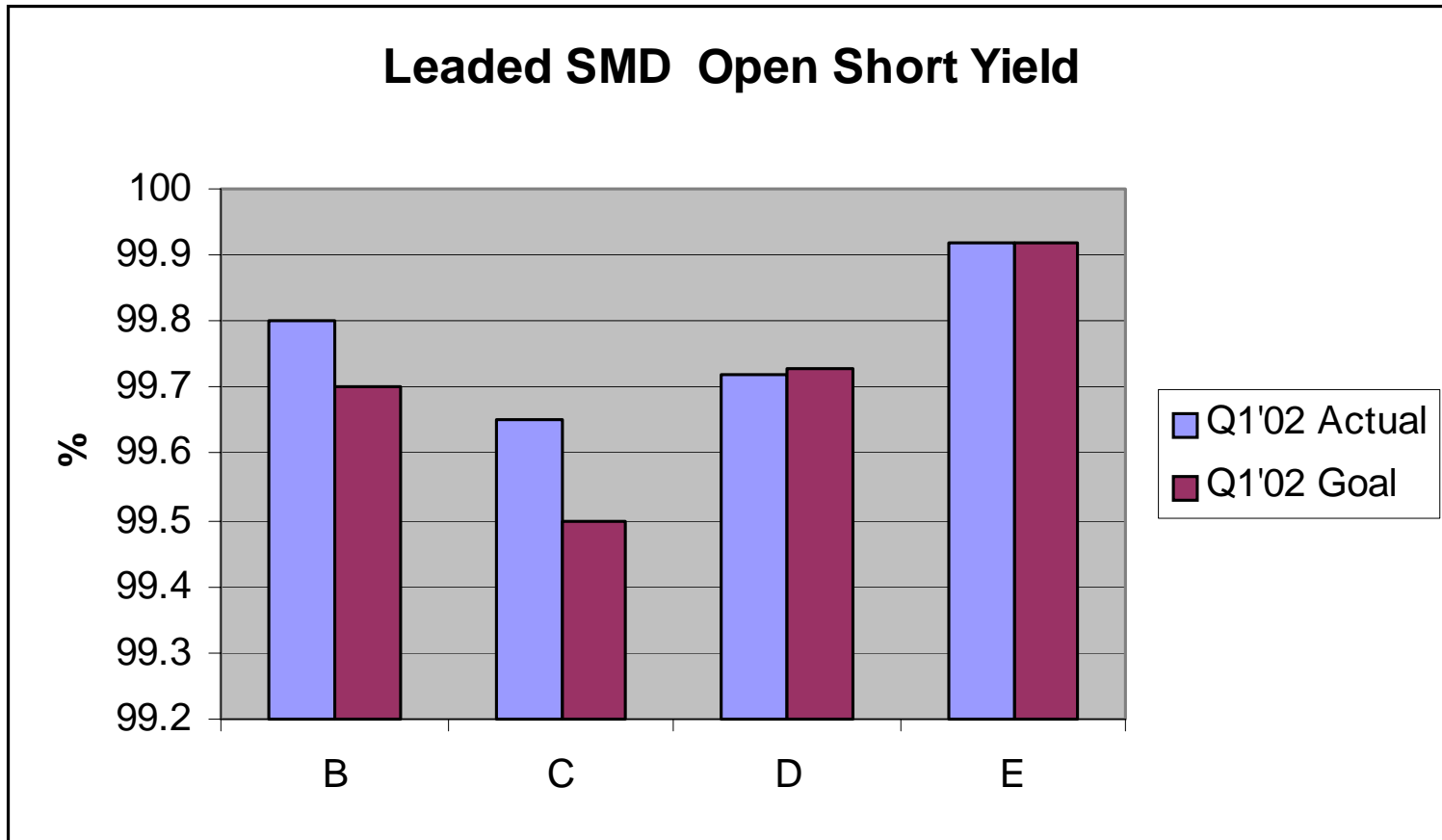
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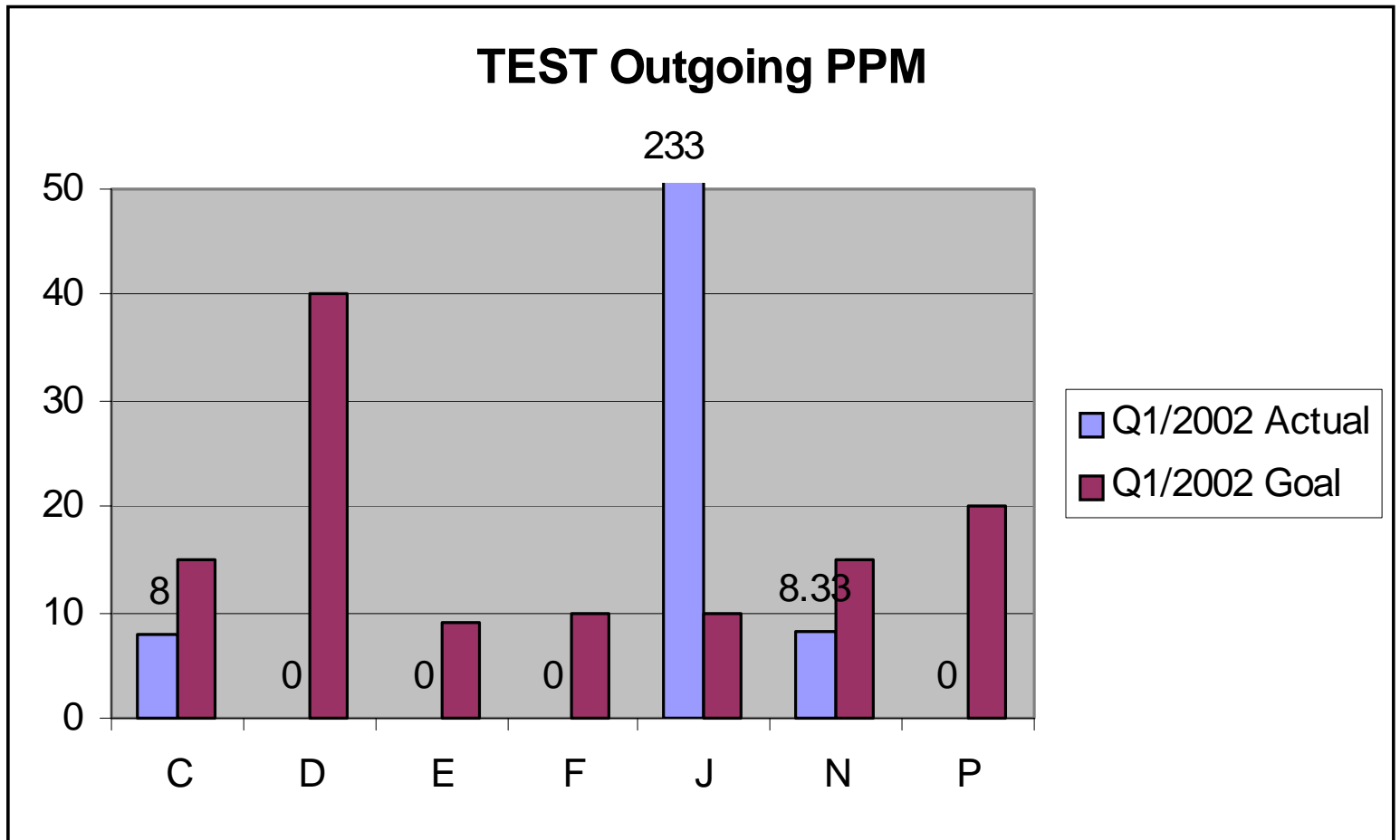
Benchmark Report- Leaded Surface Mount Device Packages



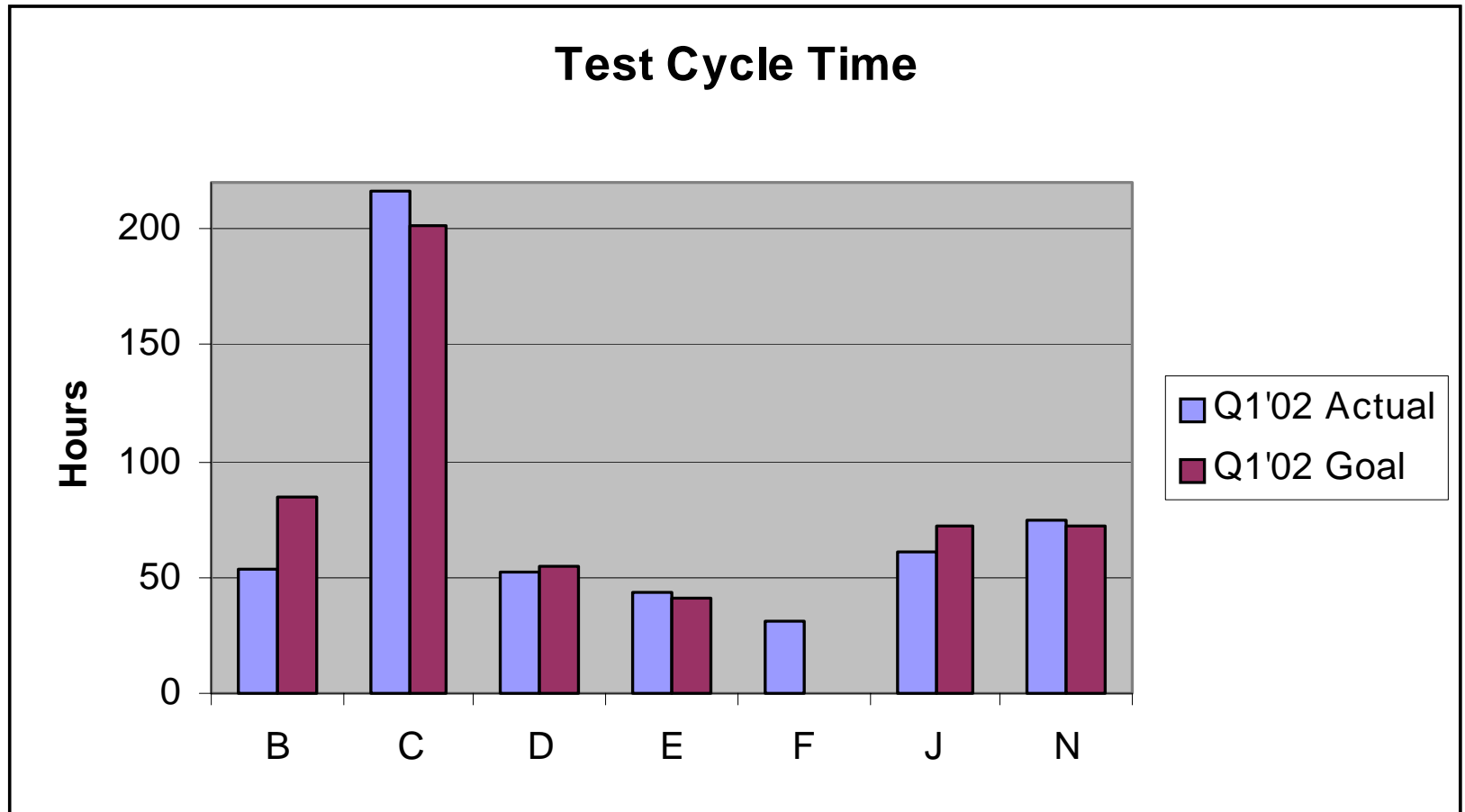
Benchmark Report- Leaded Surface Mount Device Packages



Benchmark Report - Test



Benchmark Report - Test



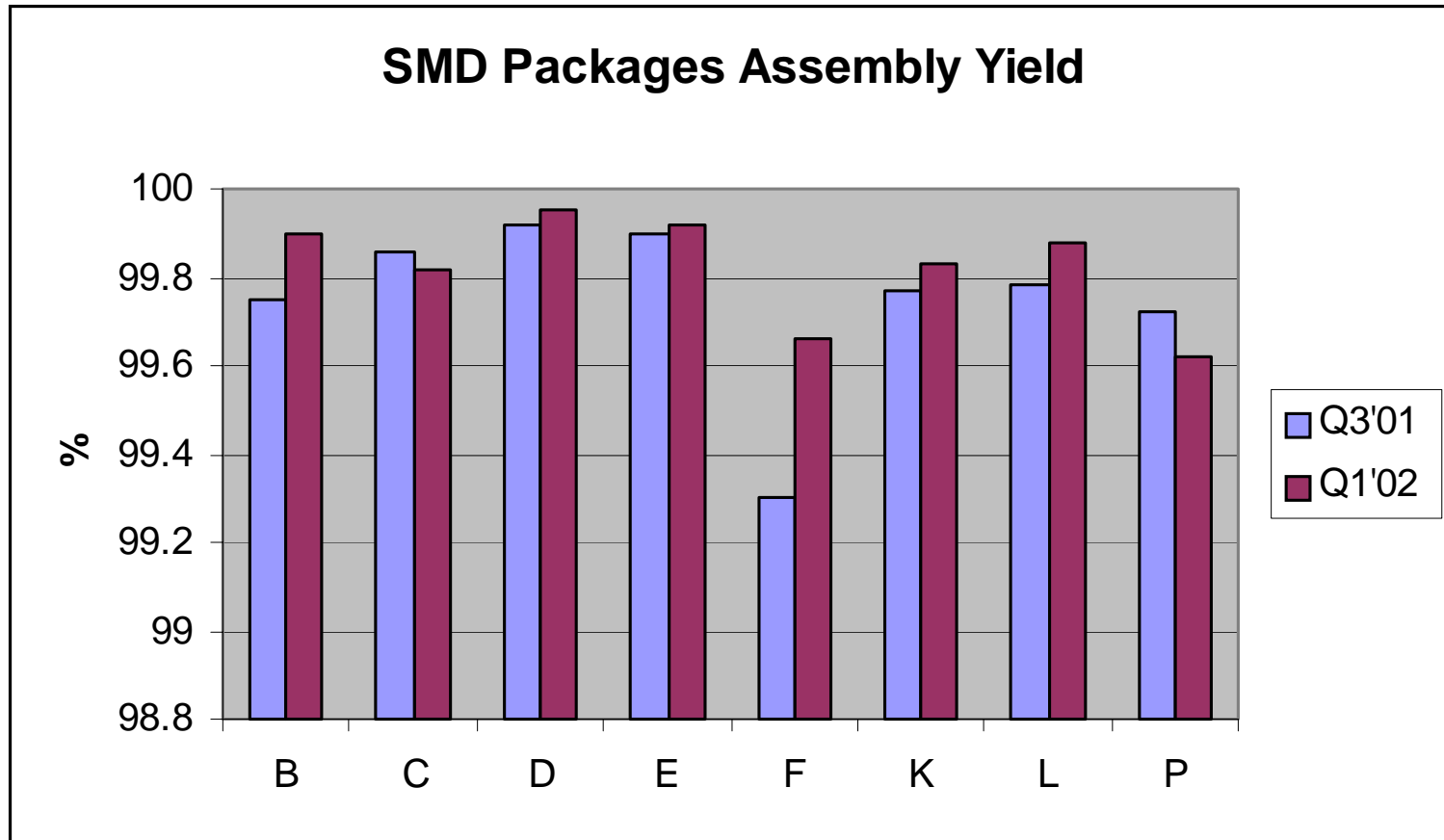


Enhanced Supply Chain Management

SAC adds value to the supply chain by:

- **Unifying Material Manufacturers, Subcontractors, Semiconductor Manufacturers, and End Users**
- **Standardizing Process Control and Quality Management System Requirements**
- **Standardizing Reports**
- **Providing a structure for an effective Supplier Management Program**
- **Reducing the costs for audits and resources**
- **Driving continual improvement**

*Standard Benchmark Reports:
Driving Continual Improvement
Yield Comparison Q3 '01 vs. Q1 '02*





What is the SAC Certification Process?

- 1) Subcontractor / Supplier identifies sponsor, prepares systems to meet requirements**
- 2) Perform pre-assessment audit**
- 3) Submit SAC Certification Petition, propose audit team and schedule**
- 4) Audit Team perform on-site audit & requests response to Non-conformances (NCs) & Opportunities for Improvement (OFIs)**
- 5) Audit report, response to NC & OFI, and Improvement plans are distributed to SAC Certification Committee (Customers, End-Users)**
- 6) Certification Committee Votes**



SAC Certified Subcontractors

<u>Subcontractor</u>	<u>Location</u>	<u>Level</u>	<u>Sponsor</u>	<u>Expires</u>
AIT	Hong Kong	1	LSI Logic	June 2005
Alphatec	Bangkok, Thailand	1	Philips	Nov. 2004
Amkor Technology	Korea	1	Philips	Nov. 2003
Amkor Technology	Philippines	1	Philips	May 2003
ASAT	Hong Kong	1	Philips	May 2004
ASAT S.A.	France	1	Alpha Industries	May 2003
ASE (K)	Kaohsiung, Taiwan	1	AMD & Motorola	Nov. 2003
ASE Test	Kaohsiung, Taiwan	1	Philips	Nov. 2003
Carsem M	Ipoh, Malaysia	1	Allegro & On Semi	Nov. 2003
Carsem S	Ipoh, Malaysia	1	Allegro & On Semi	Nov. 2003



SAC Certified Subcontractors

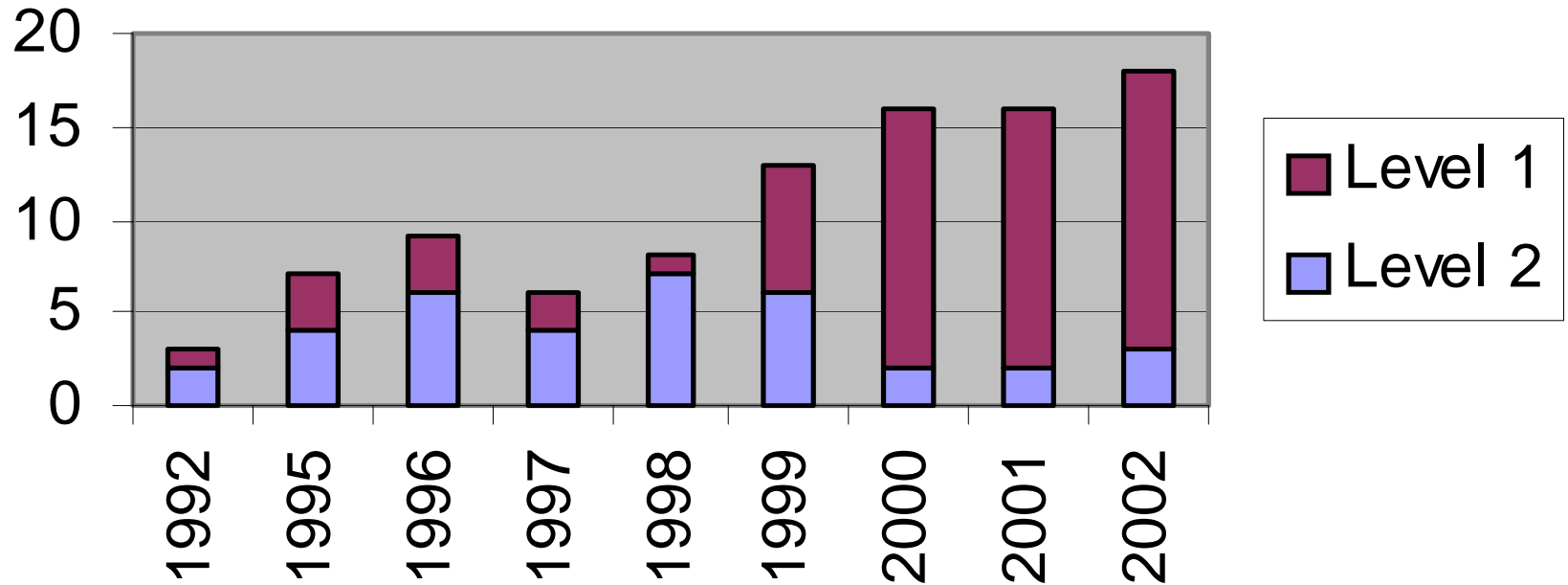
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<u>Subcontractor</u>	<u>Location</u>	<u>Level</u>	<u>Sponsor</u>	<u>Expires</u>
ChipPAC	Korea	1	AMD	Nov. 2002
NSEB	Bangkok, Thailand	1	Philips	Nov. 2004
OSE	Philippines	2	ON Semi	June 2005
ANSAN S3 (Signetics S1)	Seoul, Korea	1	Philips	Nov. 2003
Signetics S2	Paju Korea	1	Philips	June 2005
STATS	Singapore	1	Philips	Nov. 2002
Team Pacific	Philippines	2	National & Delco IC	Nov. 2003
UTAC	Singapore	2	National & Medtronic	Nov. 2004

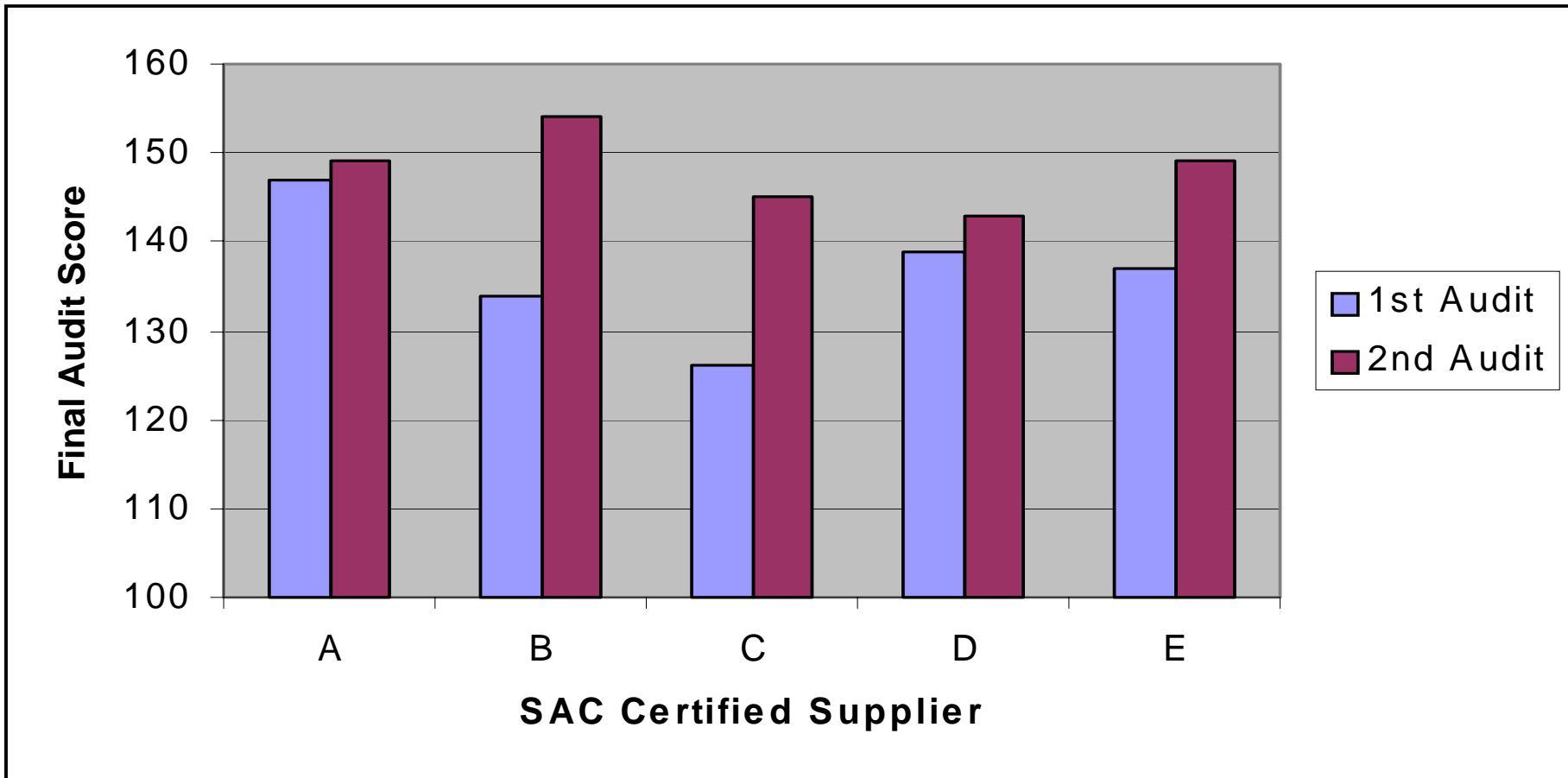
Positive Trends in SAC Certifications

SAC Certified Subcontractors

No. Subcontractors



Driving Continual Improvement: SAC Certification



Minimum Score: Level 1 = 141 Level 2 = 133

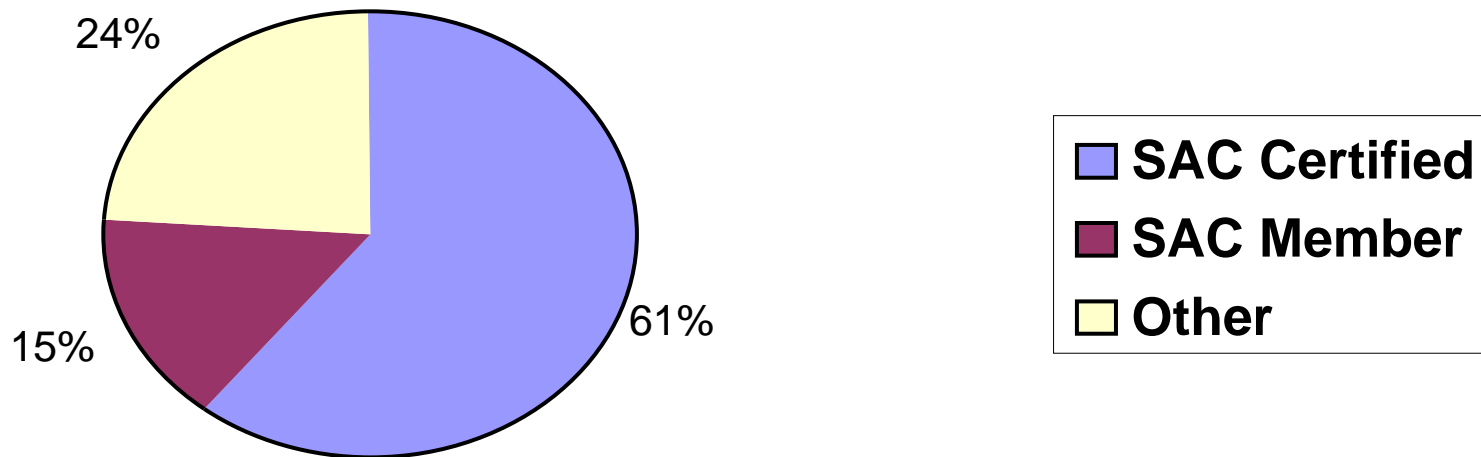


Subcontractors Preparing for SAC Certification

<u>Organization</u>	<u>Location</u>	<u>Plans</u>	<u>Sponsor</u>
STATS	Singapore	Re-Cert August 5-8, 2002	Analog Devices
Amkor Technologies	China	TBD	Texas Instruments
Amkor Technologies	Taiwan	TBD	Texas Instruments
OSE	Taiwan	TBD	Texas Instruments
ChipPAC	Korea	Re-Cert August 21 - 23, 2002	LSI Logic

SAC SATS Members Dominate the Market

2000 Market Share



Source: Gartner report, SATS Industry 2000

Promoting Manufacturing Excellence

- ❑ **Communicate SAC within your organizations**
- ❑ **Communicate SAC to your customers**
- ❑ **Communicate SAC to your suppliers**
- ❑ **Become a Member**
- ❑ **Get Involved**
 - **Participate on Audits**
 - **Participate on Certification Expansion Committees**
 - **Participate on Standards & Audit Committee**
 - **Participate on the Technology Group**



Why Do Companies Join SAC?

- ❑ **SAC promotes a model for effective supply chain management focused on standardization of quality system tools & requirements.**
- ❑ **SAC promotes continual improvement.**
- ❑ **SAC provides members with technology forums, best practices, training and networking opportunities.**
- ❑ **Active participation results in the fanning out of continual improvement philosophies through out the supply chain.**

What's on the SAC Web?

<http://www.sacouncil.org/>

- ❑ **Certification Information**
 - **Certified Subcontractor List**
 - **Audit Schedule**
 - **Auditor List**
 - **Auditor Experience Log**
 - **Audit /Auditor Appraisal Form**
 - **Certification Audit Petition Form**
 - **Surveillance Program Status**
- ❑ **About SAC**
- ❑ **BOD Meeting Minutes**
- ❑ **Meeting Presentations**
- ❑ **Standards & Checklists**
- ❑ **FAQ & Feedback**

