

Practical AC Mains in Semiconductor Fabs: How they differ from ideal AC mains, and what disturbances can be expected

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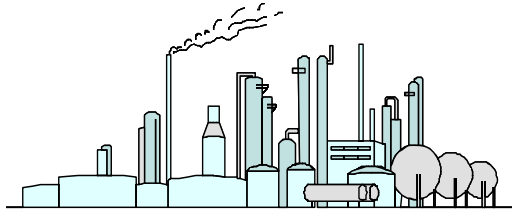
EPRI

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What is a Power Quality (PQ) Problem?

Any occurrence



... manifested in voltage or frequency
deviations

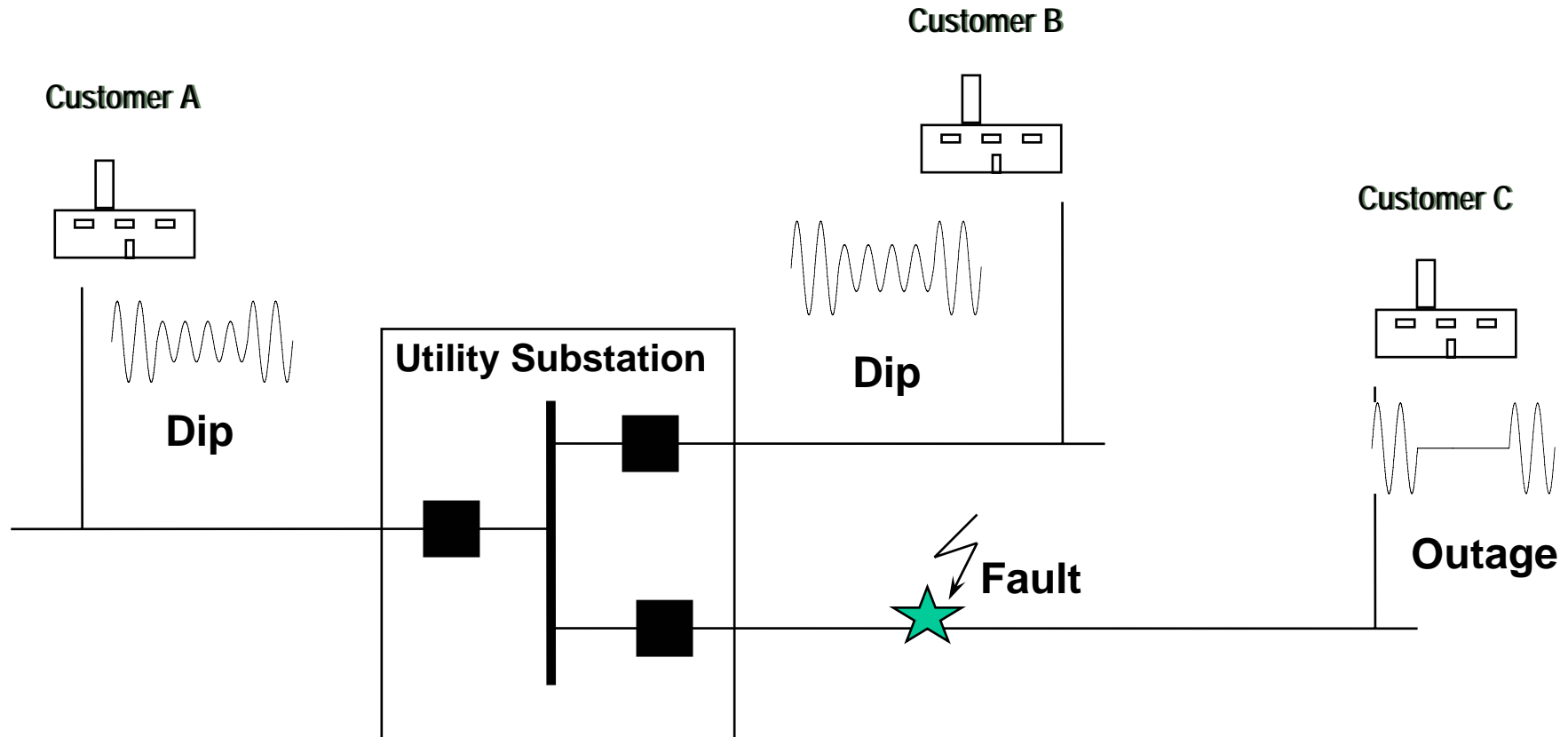


... which results in failure or
misoperation

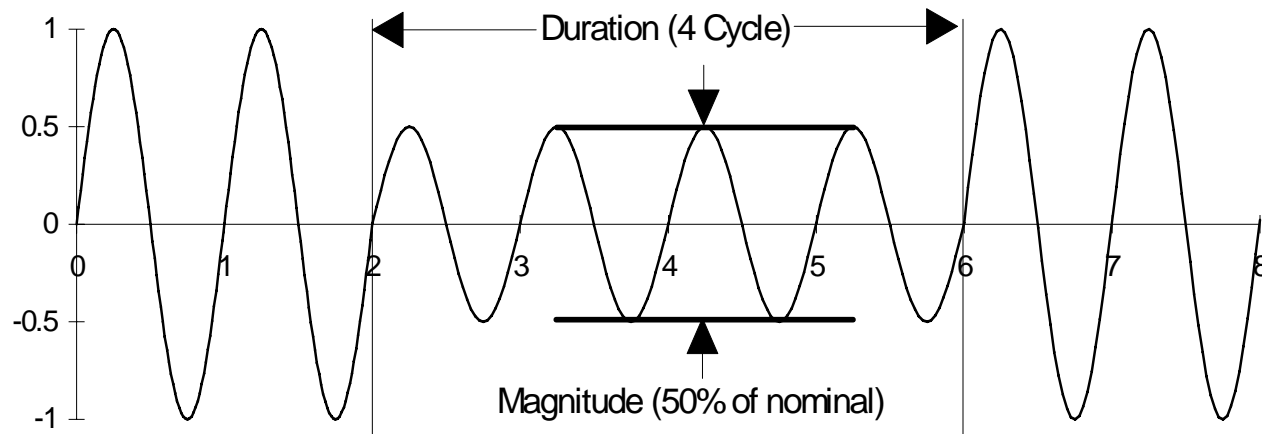
... of customer end-use
equipment



Outage or Dip ?



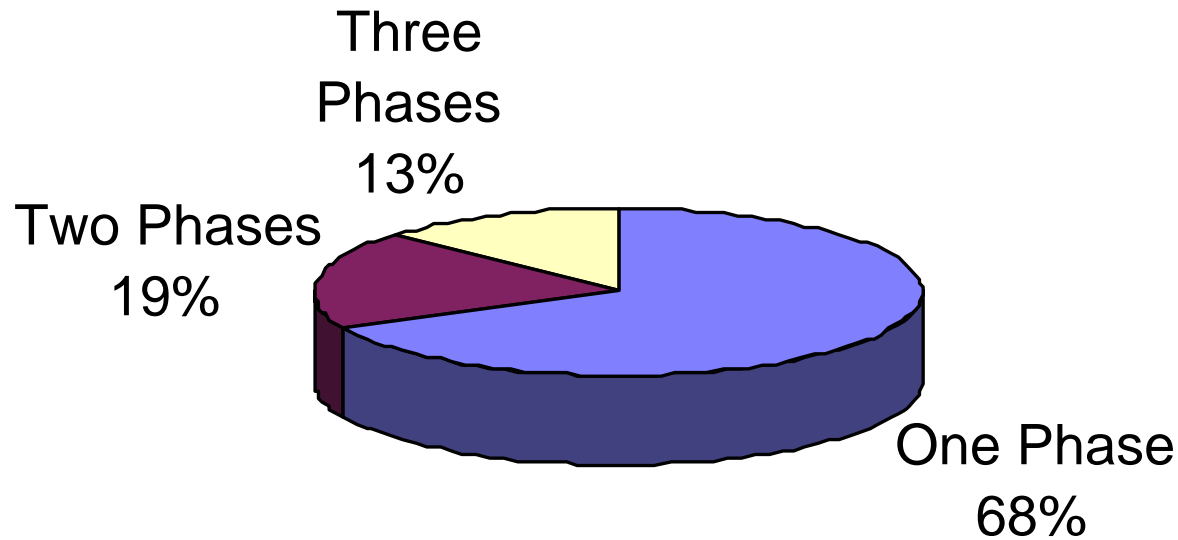
The Voltage Dip (MagDur)



- Lights may or may not flicker
- Tools shutdown or malfunction
- Can result in production downtime an/or product loss



Voltage Dips - How Many Phases Are Affected?



Source: EPRI Distribution Power Quality Study



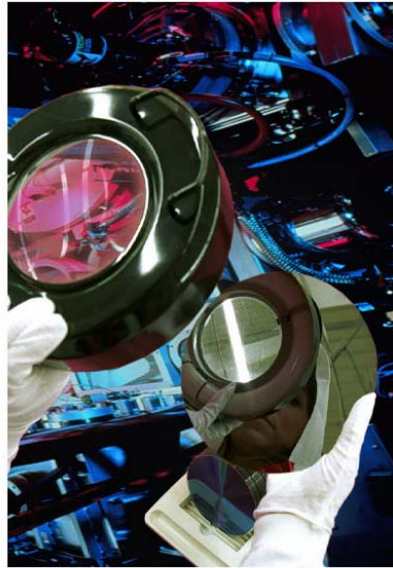
Why Voltage Dips Occur...

Line-to-Ground/Line-to-Line Faults Occur on the Utility System due to:

- Weather
- Trees
- Public Interference
- Internally induced plant events
(starting of large high inrush load)
- Although the utility can reduce the number of events (tree trimming, root cause analysis) it is impossible to eliminate all voltage dips.



Impact on Production



It was the best of times.



It was the worst of times.

Interruptions in semiconductor manufacturing processes can cost as much as \$2 million dollars in revenue per day*. Such interruptions can be due to VOLTAGE Dip events caused by ice storms, floods, hurricanes, lightning, utility power distribution equipment failures or other system anomalies.

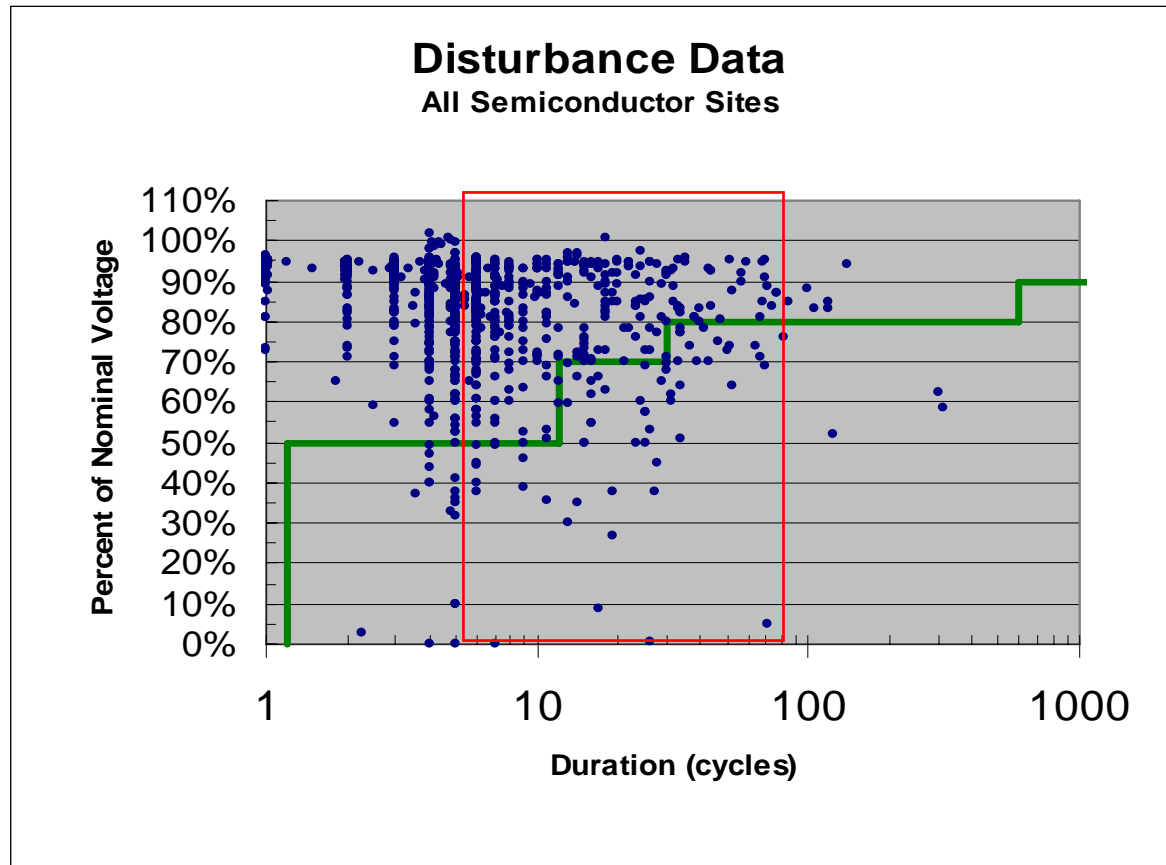
*** Semiconductor Business News, March 30th, 1998.**



PQ Data from the U.S. Semiconductor Facilities



U.S. Semiconductor Site PQ Data With SEMI F47 Overlaid



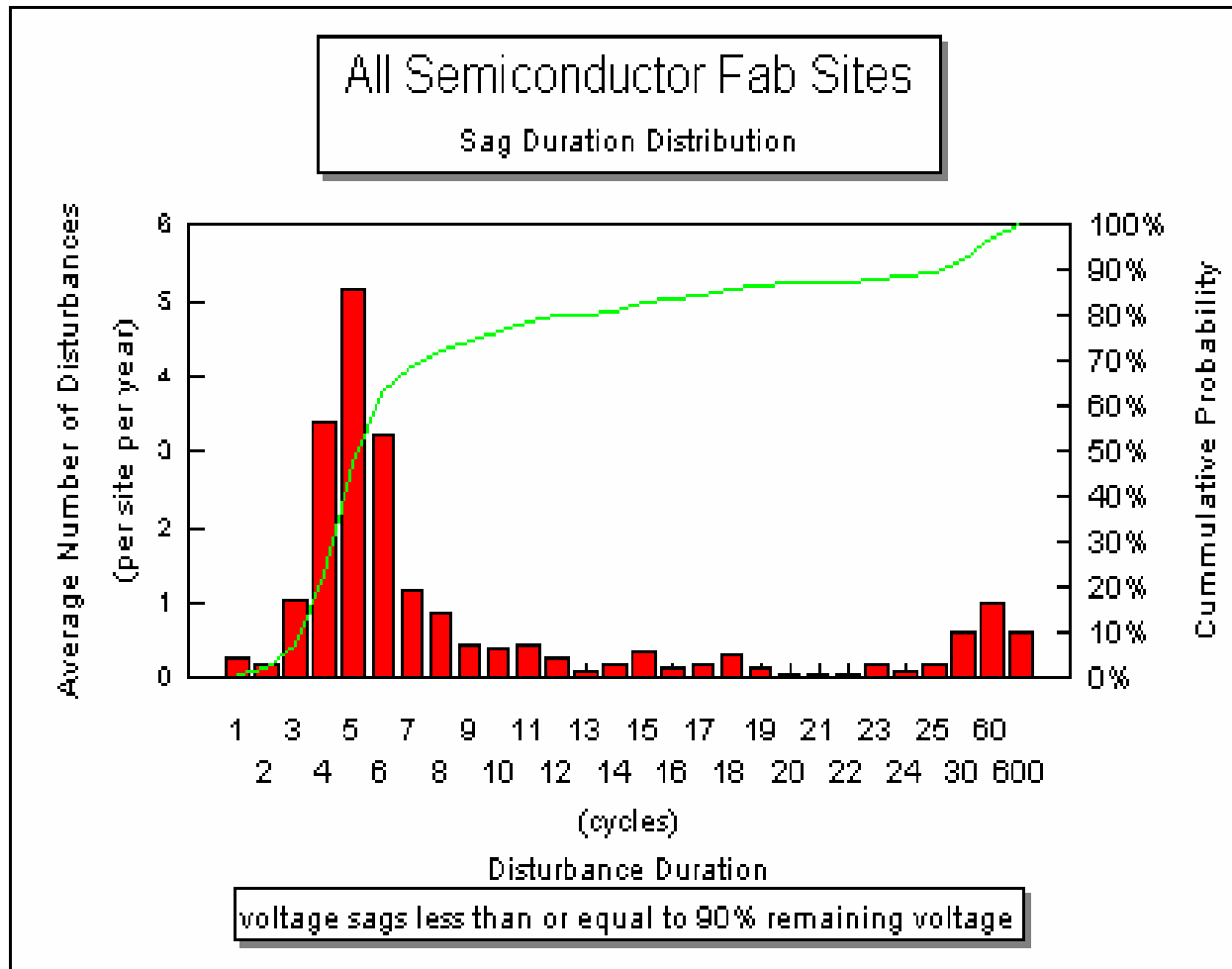
- Relevant Info:**
- 15 Sites
 - 30.5 Monitor years
 - 1076 Disturbances

*All sites but 1
Fed from
Transmission
System*

Source: SEMI Power Quality and Equipment Ride-Through Task Force



Duration of Events

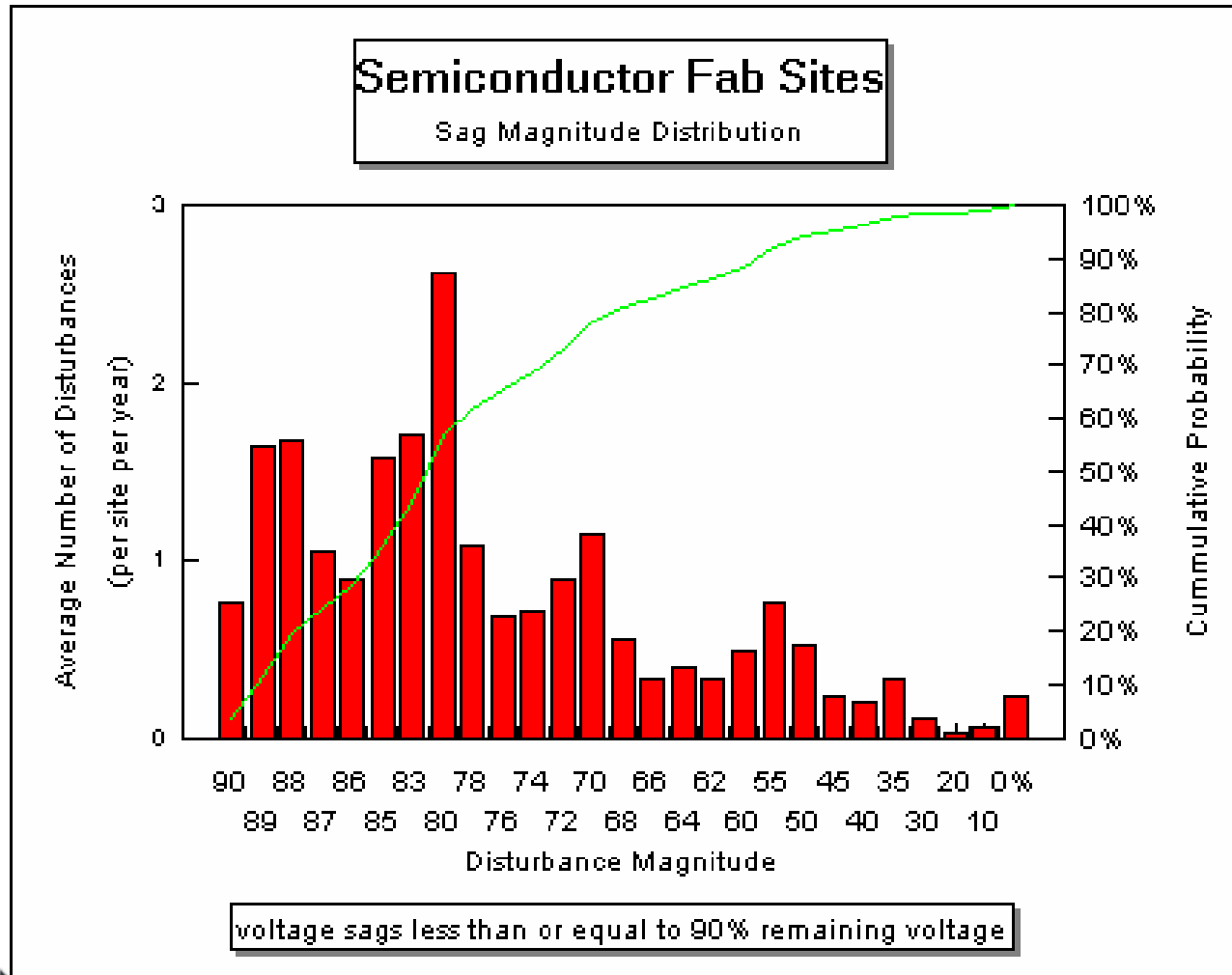


Source: SEMI
Power Quality
and Equipment
Ride-Through
Task Force

Internal
Task Force
Report:
SEMI9804

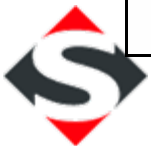


Magnitude of Events



Source: SEMI
Power Quality
and Equipment
Ride-Through
Task Force

Internal
Task Force
Report:
SEMI9804



SEMI Data Bins with SEMI F47 Curve Overlaid

| Percent Dip | Cycles (60Hz) | | | | | | | | | | | | | | | | | | | |
|-------------|---------------|-----|-----|-----|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|
| | 0<2 | 2<4 | 4<6 | 6<8 | 8<10 | 10<12 | 12<14 | 14<16 | 16<18 | 18<20 | 20<22 | 22<24 | 24<26 | 26<28 | 28<30 | 30<32 | 32<40 | 40<50 | 50<60 | |
| 0% | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 4 | 1 | 1 | |
| 10% | 79 | 91 | 135 | 53 | 8 | 12 | 16 | 9 | 7 | 4 | 3 | 5 | 4 | 1 | 1 | 4 | 4 | 3 | 3 | |
| 20% | 7 | 28 | 150 | 76 | 19 | 9 | 3 | 0 | 1 | 9 | 2 | 3 | 4 | 1 | 2 | 1 | 8 | 4 | 2 | |
| 30% | 2 | 10 | 44 | 29 | 8 | 7 | 3 | 9 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 6 | 3 | 2 | |
| 40% | 1 | 1 | 24 | 12 | 5 | 2 | 2 | 1 | 4 | 1 | 0 | 0 | 2 | 0 | 1 | 4 | 1 | 0 | 1 | |
| 50% | 0 | 2 | 10 | 9 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 1 | 3 | 1 | 0 | 0 | 1 | 0 | 0 | |
| 60% | 0 | 0 | 6 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| 70% | 0 | 1 | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| 80% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 90% | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 100% | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |

SEMI F47

Cycles (60Hz)

*All sites but 1
Fed from
Transmission
System*

93% of Events Estimated to be Above SEMI F47

Source: SEMI Power Quality and Equipment Ride-Through Task Force



Conclusions

- **Perfect Power Quality is not attainable.**
- **The Voltage Dip is the most common power quality problem effecting semiconductor facility operation.**
- **The majority of these events are mostly short in duration (less than 200ms) dipping from from 10% to 50%.**
- **EPRI studies show that most events are severe on a single-phase only on utility side.**
- **Power Quality data shows that SEMI F47 compliant equipment will lead to fewer process upsets and equipment shutdowns.**

