

## UNDERSTANDING ELECTRICAL DESIGN REQUIREMENTS FOR SEMI S2 EVALUATIONS

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## PRESENTING BAD NEWS

NEVER PRESENT DAD NEWS. IT JUST MAKES THE AUDLENCE HATE YOU. EMPHASIZE THE POSITIVE, EVEN IF THERE ISN'T ANY.

















#### Somewhere between electrical <u>CONDUCTORS</u> and <u>INSULATORS</u>

you have:





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# **SEMI-CONDUCTORS**







Somewhere between electrical <u>CONDUCTORS</u> and <u>INSULATORS</u>

## **SEMI-CONDUCTORS**

# COMPUTER CHIPS ARE **SEMICONDUCTORS**





## Semiconductors are made of:







## SILICON

# Hence, **SILICON VALLEY**,

# ...where you are right now !



## It takes very sophisticated and complex equipment to turn sand into computer chips!

## These are known as Semiconductor Tools

# EXAMPLE

12

## Semiconductor Manufacturing Tools



Insert Footer Here

### **HISTORICAL BACKGROUND**



Semiconductor equipment manufacturers have faced many different requirements IBM, Intel, Motorola...

In 1991, the industry established standardized guidelines:



# HISTORICAL BACKGROUND

## 1991 - Industry gave birth to:

SEMI S2 - Environmental, Health and Safety Guideline for Semiconductor Manufacturing Equipment



## **ABOUT SEMI S2**



- A Guideline, NOT a Standard
- □ No "MUSTS", only "*SHOULDS*"
- □ No Certification ... by anybody !
- □ No follow-up program

# Then Why SEMI S2?



Manufacturers will not purchase semiconductor equipment:

- 1) Without a SEMI S2 evaluation
- 2) Without a SEMI S2 report
- 3) Written by a recognized 3rd party

## The SEMI S2 Report is **Essential for SME Sales**

#### SEMI S2 – ENVIRONMENTAL, HEALTH AND SAFETY GUIDELINE FOR SEMICONDUCTOR MANUFACTURING EQUIPMENT



Documents Provided to User	Seismic Protection
Hazard Alert Labels	Automated Material Handlers
Safety Interlock Systems	Environmental Considerations
Emergency Shutdown	Exhaust Ventilation
Electrical Design	Chemicals
Fire Protection	Ionizing Radiation
Process Liquid Heating Systems	Non-Ionizing Radiation and Fields
Ergonomics and Human Factors	Lasers
Hazardous Energy Isolation	Sound Pressure Level
Mechanical Design	

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Fire Protection	
FILE FIOLECTION	Ionizing Radiation
Process Liquid Heating Systems	Ionizing Radiation Non-Ionizing Radiation and Fields
Process Liquid Heating Systems Ergonomics and Human Factors	Ionizing Radiation Non-Ionizing Radiation and Fields Lasers
Process Liquid Heating Systems Ergonomics and Human Factors Hazardous Energy Isolation	Ionizing Radiation Non-Ionizing Radiation and Fields Lasers Sound Pressure Level

## **ELECTRICAL DESIGN TOPICS**



- 1. Types of Electrical Work
- 2. Safety Standards
- 3. Barriers
- 4. Components
- 5. Wiring
- 6. Grounding
- 7. Enclosures
- 8. SCCR

9. Disconnect Switches 10.Breakers / Fuses 11.EMO's 12.SCCR and AIC 13.Nameplates 14.UPS 15.Testing **16.**Flammables

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- 14. Testing
- 15. Flammables

## **13.2 TYPES OF ELECTRICAL WORK**



The following are the four types of electrical work defined by this Safety Guideline:

- *Type 1* Equipment is fully de-energized.
- *Type 2* Equipment is energized. Energized circuits are covered or insulated.
- Type 3 Equipment is energized but accessible voltage is less than 30 V rms (42.4 V peak), 60 volts DC or 240 volt-amps in dry locations.
- Type 4 Equipment is energized and accessible voltages exceed 30 V rms (42.4 V peak), 60 volts DC, or 240 volt-amps in dry locations. RF limits



## **ENERGIZED ELECTRICAL WORK**

Type 4 tasks:

- $\checkmark$  Should be limited
- $\checkmark$  Instructions provided
- ✓ Personal Protective Equipment specified





Equipment should meet product safety requirements:

International	Regional
National	Industry

EN 60204
 SEMI S22
 NFPA 79
 UL 499
 CSA 61010
 IEC 60950



#### **PAST PRACTICE:**

Third-party evaluators would *pick and choose* requirements:

e.g. NFPA 79

- Field Terminals
- Wiring
- Enclosures
- Grounding
- Labeling
  - • •



<u>A BETTER APPROACH</u> to Meeting paragraph 13.4:

**COMPLY** with an appropriate safety standard

Choose One:

- EN 60204 SEMI S22
- NFPA 79
- CSA 61010
- IEC 60950

• UL 499



#### PROBLEMS WITH FULL STANDARD COMPLIANCE

*The Test Environment – a* FAB Cleanroom

- Environmental Pre-Conditioning
- Fault Testing
- Test Equipment (sufficiently large megger)
- Equipment Damage



#### A REALISTIC APPROACH - A Limited Evaluation

Principles of Field Evaluations from NFPA 791

"The electrical testing program should follow the applicable standards as closely as practical, considering the limits of a nonlaboratory setting and <u>the need for</u> <u>the equipment to perform all required functions after the test</u>."

- SEMI S2 Principles
  - "No reasonably foreseeable single-point failure should expose personnel to hazards that could result in death or significant injury"
- Risk Assessment
  - SEMI S10, ISO 12100, etc.



Nonconductive or grounded conductive physical barriers should be provided:

- > Where it is necessary to reach over, under, or around, or in close proximity to hazards.
- > Where dropped objects could cause shorts or arcing.
- Where failure of liquid fittings from any part of the equipment would result in the introduction of liquid into electrical parts.
- > Over the line side of the main disconnect.
- Where maintenance or service tasks on equipment in dry locations are likely to allow inadvertent contact with uninsulated energized parts containing either: potentials greater than 30 volts rms, 42.4 volts peak, or 60 volts DC; or power greater than 240 volt-amps.

#### **COMPONENTS**



Certified by an Accredited Testing Laboratory



## WIRING

(in)

Electrical wiring for power circuits, control circuits, grounding (earthing) and grounded (neutral) conductors should be color coded according to appropriate standard(s) per § 13.4, or labeled for easy identification at both ends of the wire.

Where color is used for identification, it is acceptable to wrap conductor ends with appropriate colored tape or sleeving; the tape or sleeving should be reliably secured to the conductor.

EXCEPTION 1: Internal wiring on individual components (e.g., motors, transformers, meters, solenoid valves, power supplies).

**EXCEPTION 2:** Flexible cords.

EXCEPTION 3: Nonhazardous voltage multiconductor cables (e.g., ribbon cables).

EXCEPTION 4: When proper color is not available for conductors designed for special application (e.g., high temperature conductors used for furnaces and ovens).



#### GROUNDING



Grounding (earthing) conductors and connectors should be sized to be compatible in current rating with their associated ungrounded conductors according to appropriate standard(s) per § 13.4.





#### **ENCLOSURES**

Electrical enclosures should be suitable for the environment in which they are intended to be used.

Enclosure openings should safeguard against personnel access to un-insulated parts energized to a hazardous voltage or hazardous electrical power.

Top covers of electrical enclosures should be designed and constructed to significantly reduce the risk of objects falling into the enclosure.

Compliance to this criteria should be demonstrated by compliance to the enclosure opening criteria in SEMI S22.





## FACILITY ELECTRICAL FEED CIRCUITS



Equipment should be designed to receive incoming electrical power from the facility to a single feed location that terminates at the main disconnect specified in § 13.4.10.

This disconnect, when opened, should remove all incoming electrical power in the equipment from the load side of the disconnect.

The disconnect should also have the energy isolation ('lockout') capabilities specified in § 17.





## FACILITY ELECTRICAL FEED CIRCUITS



#### **EXCEPTION 1:**

Equipment with more than one feed should be provided with provisions for energy isolation (lockout) for each feed and be marked with the following text or the equivalent at each disconnect:

"WARNING: Risk of Electric Shock or Burn. Disconnect all [number of feed locations] sources of supply prior to servicing."

It is preferred that all of the disconnects for the equipment be grouped in one location.



## FACILITY ELECTRICAL FEED CIRCUITS



#### EXCEPTION 2:

Multiple units mounted separately with no shared hazards and without interconnecting circuits with hazardous voltages, energy levels or other potentially hazardous conditions may have:

- 1. separate sources of power and separate supply circuit disconnect means, if they are clearly identified; or
- 2. separate EMO circuits, if they are clearly identified.

#### **MAINS DISCONNECT SWITCH**





## LOCK-OUT / TAG-OUT







The equipment should have an 'emergency off' (EMO) circuit. The EMO actuator (e.g., button), when activated, should place the equipment into a safe shutdown condition, without generating any additional hazard to personnel or the facility.





#### EMO'S

- ✓ All EMO circuits should be fault-tolerant.
- $\checkmark~$  Resetting the EMO switch should not re-energize
- $\checkmark$  The EMO circuit should shut down the equipment by de-energizing
- ✓ The EMO circuit should require manual resetting
- ✓ The EMO should be:
  - Red, mushroom shaped, and self-latching w/ a yellow background
  - Labeled as 'EMO,' 'Emergency Off,'
  - Guarded







# EMO

# The EMO should be No more than 3 Meters from Users or Maintenance Personnel



Products need to be designed to handle short circuits and other faults.

The Available Fault Current is the maximum amount of current that will flow in the event of a dead short fault.

Semiconductor equipment must be rated to handle these faults.



**SCCR - Short circuit current rating** – defined as the amount of fault current that <u>equipment</u>, <u>industrial control panels</u> or **passive components** can tolerate and remain safe.

AIC – Ampere Interrupting Capacity – defined as the maximum amount of fault current an overcurrent protective device (*fuse or breaker*) can safely *interrupt* 

## **SCCR & AIC**



The equipment should be provided with:

- main overcurrent protection devices and
- > main disconnect devices

Each rated for at least 10,000 Amperes Interrupting Capacity (AIC)

https://www.youtube.com/watch?v=qu-ssfQRRJg

## NAMEPLATE RATING



A permanent nameplate listing:

- manufacturer's name
- machine serial number
- supply voltage
- number of phases
- Frequency
- short circuit current rating
- full-load current



Uninterruptable Power Supplies (UPSs) — (outputs greater than: 30 v rms, 42.4 v peak...)

Power from the UPS should be interrupted when any of the following events occur:

- the emergency off actuator (button) is pushed; or
- the main equipment disconnect is opened; or
- the main circuit breaker is opened.

EXCEPTION: Upon EMO activation, the UPS may supply power to the EMO circuit, safety related devices, and data/alarm logging computer systems as described in the exception clauses of § 12.2.

## **ELECTRICAL SAFETY TESTS**

(in)

Electrical safety tests:

- ✓ Leakage current for Cord-and-Plug Equipment (3.5 mA)
- ✓ Earthing Continuity (0.1 ohms)

SEMI S22 methods are specified

## **OTHER CAUTIONS**



Equipment in which flammable liquids or gases are used should be assessed to determine if additional precautions (e.g., purging) in the electrical design are necessary. NOTE 53: NFPA 497 and EN 1127-1 provide methods for making this assessment.



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## **Additional Slides**

## **ENERGIZED ELECTRICAL WORK**



The supplier should design the equipment to minimize the need to calibrate, modify, repair, test, adjust, or maintain equipment while it is energized, and to minimize work that must be performed on components near exposed energized circuits.

The supplier should move as many tasks as practical from category Type 4 to Types 1, 2, or 3.



## **BRANCH CIRCUIT VS SUPPLEMENTARY PROTECTION**





Figure 2: Graphic explanation of Step 1: Determination of the SCCR for individual power circuit components





SCCR of the individual components.

Ratings are either from the nameplate or for unmarked components from Table SB4.1 UL508A

High Fault/Capacity Short Circuit Current

Ratings are based on Combination Tests, certified by UL and documented in a UL Certificate of Compliance.

www.usa.siemens.com/sccr



Figure 3.1: Graphic explanation / example of Step 2: Use of current limiting transformers in the feeder circuit





Figure 3.2: Graphic explanation / example of Step 2: Use of current limiting fuses in the feeder circuit



Figure 3.3: Graphic explanation / example of Step 2: Use of circuit breaker marked as "current limiting" in the feeder circuit





## **UNINTERRUPTIBLE POWER SUPPLIES (UPS)**



The UPS may be physically located within the footprint of the equipment provided that the UPS is within its own enclosure and is clearly identified.

The UPS should be certified by an accredited testing laboratory and be suitable for its intended environment (e.g., damp location, exposure to corrosives).

The UPS wiring should be identified as 'UPS Supply Output' or equivalent at each termination point where the UPS wiring can be disconnected.



## **ELECTRICAL SAFETY TESTS**



Equipment protective grounding circuits should have a measured resistance of one-tenth (0.1) ohm or less as determined by testing in accordance with 'Earthing Continuity and Continuity of the Protective Bonding Circuit Test' in SEMI S22.







Figure 7 Ground Bond test (GB)