

Protection Survey



Fire Protection Solutions
668 N. Coast Highway, Suite 518
Laguna Beach, CA 92651
(866) 777-FIRE

Location Surveyed

Global Integrated Chip Solutions

Survey By: **John Doe**
12503 Honor Park Drive
Houston, TX 77065
Phone: 832-237-9646
Fax: 832-237-9647

Mill Street

Billville, WY 81274

Conferred With

Benny Goodman, Plant Manager
Lionel Hampton, Production Manager
Teddy Wilson, Security and Fire Systems Manager

Survey: **May 15, 2002**

Recent Changes and Comments

The hazardous materials storage facility on the south side of B-1 is complete and being used for liquids storages. A new high-current ion implanter has been installed in the same room as the existing so there are now two high current units. During the next 60 days, a feasibility study is being conducted for adding another fab to B-2.

Construction

Total Building Area: 187,100 ft²
Percentage Sprinklered: 98%
Percent Needing Sprinklers: 2%

- B-1 is 45,800 ft², built-up roofing on plywood deck on wood joists and purlins on wood glu-lam beams on steel 6" pipe columns roof, and concrete tilt-up walls with poured pilasters. The building is fully sprinklered except for the 4,000 ft² air handlers room
- B-2 has a 38,000 ft² basement of 100% reinforced concrete construction, fully sprinklered. There is a 30,100 ft² first floor with a non-combustible roofing system on metal deck on fire-protected steel beams and columns roof and concrete block walls, with a non-combustible drop ceiling, sprinklered both above and below the drop ceiling.
- B-3 is a single story 58,200 ft² building with prestressed concrete panels on fire-protected steel beams and columns roof, poured concrete walls, and concrete slab on grade floor.
- Hazardous Materials Storage building is 3,000 ft² of 100% poured concrete construction, raised 4' above grade. It is fully sprinklered.
- The office is 12,000 ft² with tar and gravel on plywood deck on wood joists on wood beams on steel pipe columns roof, concrete block walls, and a concrete slab on grade floor, fully sprinklered.

Occupancy

Raw Materials: 4" silicon disks, purchased masks, photoresist, acids (mostly hydrofluoric), gases (hydrogen, helium, argon, oxygen, freon 14, freon 116, silane, phosphine, dichlorosilane, nitrous oxide, anhydrous ammonia).

Finished Product: Unassembled 4" wafers with completed circuits.

Hours of Operation: Continuous for all areas including the offices.

Process:

All production is done in the single Fab, the south-east quarter of B-1. This facility uses the photolithographic process (photoresist coat, pattern exposure, photoresist develop, etch, photoresist strip, clean) along with diffusion furnaces, ion implanters, metalization & oxidation, to produce the circuits. The areas in which these process steps are done are all class 10,000 to 1,000 clean rooms (exception: class 10 room at north end of Photo-II) which are arranged in bays separated by service chases (see layout attached). The wafers travel from bay to

[Fire Protection Solutions 668 N. Coast Highway Ste 518, Laguna Beach, CA 92651](#)

This report is intended to assist you in reducing the potential for property damage resulting from fire and related perils. The recommendations are not intended to replace any responsibility you may have to maintain a safe workplace, operation, or product. The report does not imply that all other hazards or conditions not mentioned in the report are acceptably arranged or meet the requirements of any local, state, or national standard or code. This report is only advisory and the final decisions must be made by you.

Occupancy

bay after each process step and will visit different rooms multiple times, depending upon the number of masking levels needed to produce the finished circuits. Processing here uses from seven to twenty-two masking levels.

After a wafer has been completed, it is sent to the finished product storage room (NW corner of B-1). The wafers are then sent to overseas assembly plants. After assembly, the product returns to the finished product storage room. Then it goes to "pre-test assembly" where it is staged for the final testing which is done in "Final Test" in B-2. After final testing (computerized circuit testing), the product returns to the finished product storage room for storage and eventual shipping to the customer. Some customers prefer the assembled circuits to be mounted on tape reels so this product proceeds from the finished product storage room to "tape & reel" in B-1 prior to shipping.

The following are comments on some of the wafer fab process rooms, the equipment present, and the process steps being accomplished (refer to layout drawing):

- Preliminary marking with a laser scribe is done in "Metal". Wafers also return to this room for metalization using vacuum deposition equipment.
- Photoresist (light sensitive flammable-liquid-based emulsion) is applied in stand-alone (no connected developer, etcher, etc) trackers. There are three trackers in Photo-II in the class 1,000 portion. There is also a combined coater/developer unit in the class 10 portion of Photo-II.
- Exposure is done in Photo-III. There are six projection aligners (expose the coated wafer so that part of the photo-resist will cure, to permit removal of the unexposed resist) in Photo-III and two developers (removes the unexposed resist utilizing isopropyl & acetone). There are also two steppers (accomplishing the same as the projection aligners) and a coater/developer (combined tracker & developer unit) in the class 10 portion of Photo-II.
- Wet etch uses hydrofluoric acid in non-heated wet benches. Dry etch uses various fluoridated gases and is done to wafers contained within an evacuated bell jar. The wet and dry etch bays are separate.
- Diffusion has seven electric furnaces with a total of 40 tubes. This process step introduces dopants (impurities) into the exposed portions of the wafer, and thus occurs after the photolithography process has been completed (for the particular masking level). This area also has a heated plastic wet bench using phosphorus for cleaning. There is also a "spin-on-glass" (SOG) unit which is a contained piece of equipment that drops very small droplets of a flammable passivation coating onto the spinning wafer and also uses isopropyl for line cleaning. There are nine non-heated wet benches throughout this module.
- The class 10,000 Implant area has two low current implanters using boron trifluoride (inert) to place atoms of this dopant into the crystalline structure of the exposed silicone. An implanter aims a controlled high-energy beam of ions at the wafer; the beam can be focused to specific regions. The class 1,000 Implant area has two high current implanters using arsenic (highly toxic). All implanters have the vacuum pumps and dopant contained within the cabinet of the machine.
- The utility chase areas surrounding the Fab clean room bays contain support equipment for the production equipment in the clean rooms. This support includes gases supply and photoresist supply. The gases are in individual 55 ft³ cylinders in individual gas cabinets against the west, north, and south walls. The photoresist is in 10 gallon pressurized pots adjacent to the east & west sides of Photo-II bay. The clean rooms are at positive pressure relative to the surrounding utilities area. Chillers, air-conditioning units, electric switchgear, hot water boilers, and service pumps are all in the separate "equipment rooms" area north of the Fab, in the NE corner of B-1. Bulk hydrogen, oxygen, argon & nitrogen are in the yard north of RB-I, as are the waste water neutralization system and the ultra-pure water treatment plant.
- Combustible loading in the clean rooms varies by bay. Some bays have substantial amounts of combustible equipment in the form of polypropylene work benches (wet etch, lift-off, metal, back-end, AME, diffusion). Other bays have low loading, containing only equipment with metal enclosures (ion implanters, Photo-II, Photo-III). Combustible loading in the surrounding utility chases is low and broken up. There are various pieces of equipment enclosed in plastic (acrylic & polypropylene) cabinets. Many pieces of equipment have substantial quantities of plastic tubing and wiring within them, as well as power supplies and other full voltage wiring.

Remaining Occupancies: (Refer to layouts)

The west third of B-1 has the finished product storage room at the north end. This room has 7 ft. high metal shelf storage of finished wafers in plastic cases. There are also finished dies (the terminology for wafers that have had all circuit testing done). Finally, there is finished product, which is the individual circuits sealed in a thermoset plastic lead package slid into a polyethylene tube packed in cardboard cartons.

[Fire Protection Solutions 668 N. Coast Highway Ste 518, Laguna Beach, CA 92651](#)

This report is intended to assist you in reducing the potential for property damage resulting from fire and related perils. The recommendations are not intended to replace any responsibility you may have to maintain a safe workplace, operation, or product. The report does not imply that all other hazards or conditions not mentioned in the report are acceptably arranged or meet the requirements of any local, state, or national standard or code. This report is only advisory and the final decisions must be made by you.

Occupancy

There is a gold room at the south end in which the finished wafers have a very thin film of gold applied by vacuum deposition in a single vacuum deposition unit. This room also has a stainless steel bench which is used for cleaning the wafers prior to deposition: protection tape is removed from wafers by immersing them in open unheated containers of acetone. Remaining rooms are facilities utilities monitoring room, mail room, scanning electron microscope room, tape & reel, and the locker/suit-up area for the fab. All rooms in this portion of the building are separated by full height gypsum/metal stud partition walls.

The Office projecting south of B-1 has a cafeteria/kitchen at the west end, offices in the center portion, and the main computer room at the east end.

B-2 was built originally to assemble the dies (completed & tested wafer circuits broken apart). The first floor has some raised floor areas used for assembly and testing. The assembly areas (north wall) are idle but the equipment remains in-place (includes the wave solder room). The testing areas (center) are for testing all finished assembled product which returns here from the overseas assembly plants. This testing is done using high value automated computerized testing equipment (equipment acquisition costs are about \$16,000,000). The south portion of the first floor has a research/quality assurance lab (no raised floor), an electronics repair shop, locker room, test equipment stockroom, and engineering lab (all with raised floor).

B-2 basement has stores (equipment, clothing, raw materials of a non-chemical nature including the silicon wafers), paper records archival storage, a fitness center, some air handlers and associated equipment room, an uninterrupted power supply arrangement which supplies power to the fab ventilation systems (battery room & transfer switch) and nine environmental testing "burn-in ovens".

B-3 is an office building. The west end of the first floor is empty.

Protection

Private Protection

- Sprinkler systems are all wet-pipe, hydraulic design, using 165°F, ½" orifice sprinklers. Fab areas have the systems designed to 0.20 gpm/ft² over 3000 ft² and office and other non-fab areas are designed to 0.19/2000 gpm/ft²/ft². Control valves are exterior for each system, detached 40' from the buildings.
- Sprinklers in the wafer fab are arranged as a sidewall system along each bay.
- An air-sampling smoke detection system is provided throughout the wafer fab, with signals transmitted to the proprietary alarm system.

Public Protection

- The plant is served by an ISO class 3 public fire department with less than a 2 minute response. Public hydrants surround the site, all fed from 12" water mains.

Exposure

There are no buildings within 200' in any direction. There are public streets on the north and east side of the site, and an empty lot on the west side. There's a single story concrete tilt-up sprinklered building 250' to the south, used for light metal products manufacturing.

Surveillance

Surveillance: Proprietary

Surveillance Adequate? Yes

- All sprinkler systems are supervised for water flow and control valve status, with signals transmitted to the site security post, which is constantly occupied. Signals are automatically recorded. The alarm system also covers pump running, pump controller status, and pump problems, as well as water tank level. All doors have card-key access that records identity and time of entry, as well as camera surveillance.

Other Perils Flood, tornado, hurricane, earthquake, leakage, vehicle damage, vandalism, riot, settling, collapse. No comment indicates no exposure.

[Fire Protection Solutions 668 N. Coast Highway Ste 518, Laguna Beach, CA 92651](#)

This report is intended to assist you in reducing the potential for property damage resulting from fire and related perils. The recommendations are not intended to replace any responsibility you may have to maintain a safe workplace, operation, or product. The report does not imply that all other hazards or conditions not mentioned in the report are acceptably arranged or meet the requirements of any local, state, or national standard or code. This report is only advisory and the final decisions must be made by you.

Survey Testing

Each sprinkler system water flow alarm was actuated and reception of alarm signals at the proprietary alarm panel was verified. All post valves were exercised and all other valves visually checked. All systems were drain tested using the 2 inch drain. A full flow test of the fire pump was witnessed. The south-west hydrant was flow tested and sectional control valves were exercised during this test to clean them and verify their function (what portion of the piping they control). A site loop test was conducted during the December 1994 shut-down.

Plant Loss Control Programs

Fire protection equipment inspection frequencies are currently exceeding national standards and structured to accommodate corporate testing periods. These frequencies include:

- On a weekly basis, visual valve inspections, visual checks of dry pipe system air pressures, and churn testing of each fire pump.
- On a monthly basis, water flow alarms using inspectors test valves are tested and visual checks of plant fire hoses extinguishers and fire doors are made.
- On a quarterly basis, two inch drain tests are flowed and isolation valves exercised and lubricated.
- On an annual basis, full flow fire pump testing is conducted, trip testing of dry pipe sprinkler systems and functional testing of special extinguishing systems are preformed.

Weekly visual fire door inspection and reporting is in place with an emphasis along the areas exposed by the Bag Mill (not managed by SSCC). Due to the size of this facility, weekly visual inspection of fire extinguishers and the increased "spring testing" (or actual exercise) of all sectional and main control valves are being done quarterly as opposed to monthly. Because of good historical record keeping and spot checking strategies, these two frequencies are tentatively acceptable to Corporate Risk Management and Fire Protection Solutions (FPS).

Flood Exposure

Flood Zone: NIFP Flood Elevation: _____ Plant Elevation: 179.8 Flood PML: _____ \$0

It should be noted that the Jackson County does not participate in the National Flood Program and does not have FIRM or FEMA flood survey maps available. Elevations and geographical bench marks information was obtained to best reflect current conditions. The northeast corner of the No. 5 Paper Machine building has a finished floor elevation of 182 ft. and basement elevation at 169 ft. (MSL). The No. 2 Power Boiler located within the power house and located in the central portion of the mill has a finished floor elevation of 192 ft. This part of the mill is considered the highest point of the premises while the southern end, where the Lime Kilns are, is the lowest with a grade of 175 ft. (MSL). The reclaim ponds located 3/4 mile south of the Kilns define the 100 year flood plain level with an average elevation of 92 ft.(MSL & surveyed marker), which is 100' below the main plant. No flooding has occurred beyond the reclaim ponds and no history of business interruption has been reported dealing with access to the premises.

Windstorm Exposure

Wind PML: _____ \$1,000,000

The facility is subject to 75 mph wind speeds and 2 to 5 tornadoes per year according national weather maps and FM Datasheet 1-7. Should high winds in excess of structural designs (> 90 mph) or tornado(s) directly hit machinery or significant structures, then total (PD & BI) damage is estimated at less than to \$1,000,000 per occurrence. A CAT 4 Hurricane in the Gulf of Mexico could spin tornadoes this far north; however, wind speeds would be reduced to those mentioned in the average annual wind speed for the area. A direct tornado hit to outlying buildings occurred on 11/26/01, causing \$87,000 of building damage.

[Fire Protection Solutions 668 N. Coast Highway Ste 518, Laguna Beach, CA 92651](#)

This report is intended to assist you in reducing the potential for property damage resulting from fire and related perils. The recommendations are not intended to replace any responsibility you may have to maintain a safe workplace, operation, or product. The report does not imply that all other hazards or conditions not mentioned in the report are acceptably arranged or meet the requirements of any local, state, or national standard or code. This report is only advisory and the final decisions must be made by you.

Special Hazards

Wafer Fab

Location: B-1, South-east quarter

Description:

CONSTRUCTION Semiconductor circuits manufacturing in a 166 x 112 ft. concrete tilt-up building with wood frame roof, sheathed below with gypsum board. The clean room areas are framed with either gypsum on metal studs (original portions) or "Plascor" on unistruts, a light-weight metal stud. "Plascor" is a one-quarter inch thick aluminum faced panel with aluminum honeycomb core. For the gypsum construction walls, the gypsum is coated on the clean room face with a .028" to .040" thick plastic for cleaning purposes. The plastic (either "Kydex" by Ridout Plastics or "Baltaron 4333" by Gencorp) is applied using a water base adhesive.

VENTILATION The clean room areas are predominantly class 1000 & 10,000, though there is a small class 10 area. HEPA filters are arranged in the T-bar ceilings with air flow down from the filter, through the room, out the bottom of the surrounding walls, into the utility chase area, and back to the remote air handler via metal ducts. Many benches in the clean rooms have laminar flow hoods (which block overhead sprinkler protection) that take air from ceiling level and recirculate it through the bench and the room. The principal ventilation systems are arranged in eight groups feeding the individual production bays: ACU-1 (Photo-III, Lift-off), ACU-2 (Diffusion), ACU-3 (Photo-II), ACU-4 (Implant, Dry & Wet Etch), ACU-5 (Photo-I), & ACU-6 (Nova, Backend, Metal), ACU-7 (AME) and ACU-SUN (ASM). ACU-1 through 4 are in a single room which is a plenum receiving fresh air from outside through penthouses directly above. ACU-5 & 6 have the same arrangement in a separate room. ACU-7 & SUN are on the roof. Thus, all systems take fresh air from above RB-1 roof. Each air handler discharge is hard ducted to the module of use. Once the air leaves the module (through the bottom of the walls) and enters the chase, it then mingles with all the other returning air (the chase is a return air plenum at lower pressure than the clean rooms). The air handlers have ducts that have pick-up points near the chase north wall at roof level. Some 25% of all fab air returns to the air handlers via these ducts to be recirculated. The other 75% is exhausted through the scrubber systems (systems 1, 2 & 4--see "FRP Ducts"). To complicate the arrangement, there are several additional fan units in the chase that take air from the chase and discharge into specific modules. The class 1000 "NOVA" implant area east of the high energy implanter has ceiling mounted fan powered HEPA filters taking 50% from the chase and 50% from ACU-6. The "backend" module has two fan units near chase roof level taking from ACU-6. The east end of the common access corridor has a dedicated exhaust fan to outside atmosphere. All told, the air handler units move 131,000 cfm into the wafer fab while the fume scrubbers, solvent exhausts and dedicated exhausts remove about 95,000 cfm. Thus, 73% of the air is fresh and 27% is recirculated.

The air is conditioned by a single chill water system supplied from 4 chillers and a single hot water system fed from two boilers. These systems supply coils in the discharge ducts of the air handlers.

OTHER SPECIAL HAZARDS There are two electric-strip-heated polypropylene wet-benches using non-flammable liquids, three trackers and one "coater/developer" using combustible photoresist with flammable edge bead remover, one spin-on-glass unit using isopropyl alcohol, five cylinders of silane (pyrophoric gas), a cylinder of dichlorosilane (pyrophoric & toxic), five hydrogen-fired burn-boxes, eight electric-heated diffusion furnaces, substantial runs of resin ducting (FRP), and use of isopropyl alcohol throughout for spot cleaning. These hazards are dealt with individually.

Protection:

- Wet pipe automatic sprinklers (ordinary hazard pipe schedule) at the roof level, clean room ceiling level, and clean room mid-wall height (sidewall sprinklers below laminar hood obstructions). The sidewall sprinklers have their own shutoff valve. Roof level sprinklers can provide at least 0.17/3000 (determined by hydraulic analysis).

[Fire Protection Solutions 668 N. Coast Highway Ste 518, Laguna Beach, CA 92651](#)

Special Hazards

Wafer Fab

- The plastic facings used on the inside walls of gypsum are either Baltaron 4333 or Kydex. Both are a PVC/acrylic alloy with a flame spread of 15 and smoke developed rating of 15 for .028", 60 for .040", and 200 for .060" (the latter isn't used here). This is a class A, UL listed interior finish material; class I under BOCA.
- Ventilation systems are interlocked to smoke detection in the supply and return ducts to shutdown the room recirculating systems. There are also manual shutdown stations at the exterior of each module within the chase and at the exits from the chase. The stations at the exits of each module shut down the air handler for that module only; the stations at the exits of the chase shut down either the entire north side or the entire south side (depending upon which is activated) of the fab air handlers. All shutdowns also include the laminar flow hoods. The solvent ventilation systems and fume scrubbers are not interlocked to shutdown; instead, they are provided with uninterrupted power supply to remain running. The diameter & height of the scrubber and solvent exhausts were calculated to make sure that exhausts would disperse and not feed ventilation intakes based upon computer-generated wind analyses.
- Each work station and piece of equipment that uses any toxic gas or solvent has an atmosphere monitor which reports the parts per million of the particular material being used to a central monitoring panel that reports to the proprietary alarm system. This atmospherical monitoring uses three different systems. ICAMS (Industrial Central Atmospheric Monitoring System) works using mass spectrometry (a molecular scale of detection); this system works well with most of the chemicals present here. Thus, there are 50 monitoring points each capable of detecting 25 different chemicals. The MDA Monitor uses chemical sensitive tapes to detect the organic hydrides (silane, dichlorosilane) and hydrofluoric acid. Finally, the Gas-Tech system uses sensors at specific tools and sources to detect hydrochloric acid and chlorine. These systems permit identification of potential releases well before they could reach any human threshold levels. (A human threshold level is defined by the American Conference of Governmental Industrial Hygienists (ACGIH) as "the time weighted concentration for a normal 8 hour work day and 40 hour work week to which nearly all workers may be repeatedly exposed, day after day, without adverse health affects.") Thus, TLV detection is detecting at a level thousands of times lower than any fire or smoke detection system. In general, the gas monitoring alarms are set at one half TLV for low alarm indications and TLV for high alarm indications. A low alarm indication produces an individually annunciated trouble signal at the proprietary alarm panel. A high alarm indication produces both a trouble signal at the proprietary panel and a shutdown at the supply of the gas detected.
- There is a VESDA smoke detection (air sampling type of smoke detection) covering all areas of the utility chases, which is where clean room air goes. This system is capable of detecting products of combustion well before any sustained oxidation reaction could take place. This system is also supervised at the proprietary alarm station with three levels of response. The top level of response automatically shuts down major fab equipment and evacuates the building.
- Only CO2 extinguishers & extinguishing systems (see specific hazards) are used inside the clean room.

- Deficiencies:** This is a very well protected operation. The major weaknesses are the combustible building construction (main building wood roof), the location of pyrophoric gas cabinets in the same building, and the use of recirculating ventilation systems. The combustible building construction has been mitigated by complete underside sheathing with type "X" gypsum board. The location of the gas cabinets is somewhat mitigated by the provision of proper supply interlocks (see "Pyrophoric Gases") and the multiple ultra-sensitive gas and smoke detection systems; however, a long range improvement plan would be to move all such cabinets to a fire resistive cut-off building. The new (south) hazardous materials bunkers are available for this purpose but funding is not available at present.
- The recirculating ventilation systems should be eliminated. Air should be 100% fresh. In order to accomplish this, motorized pressure relief air dampers are needed on the roof. These

[Fire Protection Solutions 668 N. Coast Highway Ste 518, Laguna Beach, CA 92651](#)

Special Hazards

Wafer Fab

dampers would be arranged to keep chase pressure slightly above atmospheric when all return air dampers have shut while the supply air handlers continue to run. This will keep the individual clean room modules at positive pressure to the chase AND exhaust all of the air from the chase instead of recirculating it, thus preventing cross contamination between modules. This response should be automatic upon detection of sprinkler waterflow in the fab or upon detection of smoke in the chase plenum. An alternative to this would be to provide a separate smoke removal system for each module equal to the air input of the room. The exposure at present is the potential of spreading contaminants (from a fire or even from a dopant release) through all the fab clean room modules, with resultant loss to all product in process and a large interruption during cleaning of the entire fab, a very expensive and lengthy process.

- The sidewall sprinklers throughout the clean room are positioned out of reach of normal activity; however, equipment rearrangement or other similar activity could possibly result in a head being hit. Physical guards of sufficient strength would be impractical. It would be cost effective to convert this mid-height sprinkler system to a pre-action system (single interlock type), since it has its own valve and supply piping and since smoke detection systems and control panels are already in-place. It would be nice if the entire wafer fab were preaction given the water damage potential of this occupancy.

Fiberglass/Resin Ducting

Location: B-1, South-east quarter

Description: There are substantial runs of 6 to 48 inch FRP ducting and a good quantity of 8 inch PVC ducting. Runs manifold into four systems that go to four different scrubbers, also FRP construction. Total CFM exhausted from the fab by these scrubbers and smaller incidental exhaust systems (such as the two solvent bench exhausts and the five silane cabinet exhausts) is 95,000 CFM.

- System 1 scrubber is in the equipment room and has PH control. It serves all acid-using processes (etch). These individual drops from each piece of equipment drop down into the tunnel that runs under the Fab.
- System 2 is a 50,000 CFM double scrubber system located north of B-1 northwest of the shipping pad [photo 6]. This is a large system with 4' diameter FRP ducting running on the roof of B-1 and down the north wall of the building to the scrubber. It exhausts wet benches (non-acid) and general Fab exhaust.
- System 3 scrubber is adjacent to scrubber 2 and is for wave solder operations in B-2; it is scheduled for removal July 2002.
- System 4 scrubber is dedicated to the high current implanter which uses arsenic. The scrubber is on a pad south of B-1 in the hazardous materials yard [photo 10].
- 6" & 8" diameter PVC ducts ventilate numerous pieces of equipment and are tied-in to the FRP duct systems.

Protection:

- Building sprinklers (wet ordinary hazard pipe schedule with 0.17/3000 available). Duct sprinklers have been provided on all ducting that is not FM listed for use without sprinklers. Non-sprinklered ducting is "ATS Products, Plastiweave FX, Mark VIII," which is FM listed for use without interior sprinkler protection. This includes all of the 4 ft. diameter ducts on the roof. These ducts have no interior interrupters which would prevent exhaust from continuing under fire conditions, which makes them acceptable and also allows them to meet the provisions of the UBC for H-6 (semiconductor manufacturing) occupancies. Sprinklered ducting is ATS Mark V. Sprinklers are designed to provide 20 gpm minimum flow to 5 to 8 heads (a 100 foot section of duct).
- The PVC ducting is of small diameter and has wall thickness less than 1/4 inch. It would collapse if exposed to elevated temperature and thus prevent fire spread through the duct.

[Fire Protection Solutions 668 N. Coast Highway Ste 518, Laguna Beach, CA 92651](#)

Special Hazards

Fiberglass/Resin Ducting

- No ducts are handling any flammable or combustible atmospheres.

Deficiencies: None

Photoresist Supply and Waste

Location: B-I, Wafer Fab, Photo-II bay.

- Description:**
- Photoresist and edge bead remover are supplied to trackers which drop 6 cubic centimeter quantities onto spinning wafers to coat the wafer with photoresist. The photoresist, AZ-1515, a positive resist with 119°F flash point, comes in "nowpacks", 4 liter plastic (HDPE) bottles, which are placed in a polypropylene containment cabinet and feed the tracker inside the clean room by vacuum feed through small teflon tubing. To change the bottle, it is necessary only to remove an adaptor from the top of the bottle that leaves the top of the bottle in place. There are 2 bottles/tool and 3 tools.
 - The edge bead remover (AZ-EBR-100) is a flammable liquid (73°F est. FP, class IB) that is received in 1 gallon glass jars. The jars are poured inside the south flammable liquids room into a 25 gallon atmospheric pressure stainless steel fill pot with side sight glass. The operator then connects the discharge ¼ inch plastic tube from the fill pot to a 10 gallon stainless steel tool pot sitting on a scale. A house nitrogen supply is connected via ¼ inch plastic tube to the fill pot and then manually regulated to 10 to 15 psi to pressurize the fill pot. The operator then fills the tool pot by opening a ball valve on the fill pot discharge. The entire purpose of the fill pot is to filter the product to ensure it's not contaminated. The operator stops filling the tool pot when the proper weight is observed. The tool pot is then disconnected, closed, and wheeled on a special dolly to the fab utility chase at the exterior of Photo II module and secured to a station. The tool pot is connected to house nitrogen using ¼ inch plastic tubing and pressurized to 10 psi using house nitrogen. The ¼ inch plastic discharge tube from the fill pot [photo 14] is connected to the wafer trackers inside the clean room.
 - The waste from the tracker, which includes AZ-1515, AZ-EBR-100 & acetone used for cleaning the tubing, drips from the coating chamber of the unit into a small sealed chamber that has three drainage ports emptying into sealed 2 inch ABS piping [photo 13]. The piping leads to an air driven small capacity diaphragm type pump that is situated in a concrete containment pit nearby in the utility chase. The pump can develop 9 psi maximum. The pump is in an acrylic box in the containment pit. The liquid is pumped from here through a 1 inch welded stainless steel pipe within a 2 inch welded stainless containment pipe. This pipe goes directly up through the wood roof and runs over the roof along the west parapet to the north wall of the building, then over to the north flammable liquids room, where the pipe drops into the room and connects to a 55 gallon drum. The waste stream is thus pumped only up to the top of the roof, from which point it gravity flows to the 55 gallon drum. The piping is not full of liquid due to the small quantities being applied at the trackers; it takes over a week to fill the 55 gallon drum. There are two 55 gallon drums.

- Protection:**
- Building sprinklers (wet ordinary hazard pipe schedule with 0.17/3000 gpm/ft²/ft² available at the roof), VESDA smoke detection system, ICAMS atmosphere detection system, all connected to proprietary alarm system.
 - The waste pump has a liquid level detector in the pump containment box and in the containment pit. Should a release occur, the accumulated liquid should shut off the pump and annunciate at the proprietary panel. There is a high level probe in the waste 55 gallon drum that is interlocked to shut off the pump (in the Fab). Should this probe fail, there is an automatic selector valve that diverts the waste stream to the second 55 gallon drum which also has a high level probe. High level detection in the drums or the pump pit is interlocked to shut off the trackers. Both drums are connected to the flammables room ventilation through closed tubing.

[Fire Protection Solutions 668 N. Coast Highway Ste 518, Laguna Beach, CA 92651](#)

Special Hazards

Photoresist Supply and Waste

Both the filling operation and the waste drums are located in a cut-off flammable liquids room (see separate description). There is an annual PM procedure for testing the integrity of the double-wall transfer pipe (from the fab to the waste drums) by pressurizing the annular space and observing pressure drop.

- Operators have specific procedures detailing step-by-step how the filling and transfer process is to occur and they receive training in these procedures.

Deficiencies: The 10 gal. EBR supply pot needs to be put into a metal containment cabinet and braced more substantially. An interlock is needed between pot pressure and the nitrogen supply and the power to the tool so that if pressure suddenly gets high (regulator failure), nitrogen and the tool will shut down. Tubing from the pot to the tool should be metal jacketed. Cabinets have been made and are being fitted for installation during August to September, 1995. The 10 gallon pot will be replaced with sealed "now-packs".

Hydrogen

Location: Bulk storage at far north end of north yard. Use in Wafer Fab.

Description: Liquid hydrogen is kept in a horizontal 7500 gal tank. Welded 3/8 inch stainless tubing goes through the concrete block wall that separates the tank from the vaporizer. Tubing then proceeds overhead on a utilities pipe rack through the north yard, under the north elevated concrete walkway, up the north wall of the building, and along the roof of B-1, running along the north and east parapets. It then drops down to roof level, running over blocks of wood all the way to the west side of the wafer fab where the tubing drops into the building at the two points of use: the burn-boxes. The hydrogen fires these two boxes to burn off unused gas from fab equipment.

Protection: The bulk tank is well detached, placed parallel to major buildings, and separated by a concrete block wall. An excess flow valve is provided downstream of the regulator at the tank; this valve will shut off supply if the tubing breaks. Gas detection is provided at all points of use with alarm to the proprietary center. High level alarm will shut down the supply at the main tank. There are remote manual shutoffs in each chase and at the security post.

Deficiencies: None

Pyrophoric Gas Use

Location: B-1 wafer fab.

Description:

- Cylinders of silane are received just-in-time and installed in the fab gas cabinet immediately. These cylinders are wheeled on a dolly into the wafer fab chase to special supply cabinets. There are five silane cabinets, each with a single 55 ft³ cylinder of silane at 200-400 psig. Cabinets are of heavy sheet metal construction. All cabinets are in the utility chase area surrounding the clean rooms. Two cabinets are at column N-16, and three at N/10-11. One-quarter inch welded stainless tubing inside of ½ inch welded stainless containment tubing conveys the gas from its cylinder overhead through the chase to the point of use, the tool inside the clean room. Typical conveying pressures are around 10 psig, regulated by single regulators inside the source cabinet. Gas is metered to the tool (diffusion furnaces) through mass measuring devices that also have regulators to further reduce pressure supplied to the tool to a few psig.
- Exhausts from the tools that use silane are manifolded through stainless tubing to heavy metal hydrogen-fired burn boxes. Two burn boxes are in the chase west of the "backend" module. These burn boxes exhaust to outside atmosphere directly through the roof. Gas cabinet tubing purge lines are piped to burn boxes also.

[Fire Protection Solutions 668 N. Coast Highway Ste 518, Laguna Beach, CA 92651](#)

Special Hazards

Pyrophoric Gas Use

Protection: Fab sprinklers (ordinary hazard pipe schedule, wet-pipe: at roof, in clean rooms at ceiling and mid-height wall level). Each silane cabinet has an MDA (gas detection) monitor (see "Protection" under "Wafer Fab"). Each cabinet has a sprinkler with a separate control valve for the silane cabinets system. Each cabinet has valving arranged identically to the others to minimize operator error in changing cylinders. Each cabinet has a dedicated nitrogen cylinder for the pressurization phase of line purging to permit changing cylinders. Each cabinet is ventilated individually to atmosphere directly through the roof through stainless steel ducting. Tubing from each cabinet to the point of use is double wall seamless (welded) stainless steel for containment. Nitrogen flows back from the tool into the gas cabinet in the annular space of the delivery tubing; hence, the MDA system can identify potential inner tubing leakage. The silane cylinder is provided with a calibrated orifice before connection to the tool supply tubing. An excess flow valve at the cabinet will cutoff flow in the event of major leak. Valve positions, purge vent vacuum pressure, excess flow, low silane cylinder pressure, and high silane discharge pressure are all supervised with individual audible and visual annunciation at each cabinet and at the proprietary alarm panel. Regulator failure in the supply cabinet should still not over pressurize the tool due to the use of mass flow metering prior to the tool.

Deficiencies: Generally well arranged system due to the gas monitoring system and existing safeguards. However, it is desirable to put all supply cabinets in a separate building and the south hazardous materials buildings just completed are available for this.

Plastic Wet Benches

Location: B-1 wafer fab.

Description: There are two electric-strip-heated polypropylene wet benches: one in the "wet etch" module south of column J-12.5 using "caros", an acid, and a second in the diffusion furnaces module near column L-16 using a phosphorous/water solution. The electric-strip is a 2240 watt blanket on the outside of the ceramic basin being heated.

Protection: Sprinklers in fab at roof level, ceiling level and mid-height wall level, the latter with a separate flow switch and control valve. The caros bench has UV/IR flame detection which is interlocked to shut off the heater and is supervised at the proprietary alarm panel. Heaters are interlocked to shutdown on low liquid level and high bath temperature. The use of hot plates in the fab is banned.

Deficiencies: Need to establish PMs for the interlocks; otherwise, acceptable arrangement.

Protection Survey



Fire Protection Solution
668 N. Coast Highway, Suite 51
Laguna Beach, CA 9265
(866) 777-FIRE

Location Surveyed

Global Integrated Chip Solutions

**Mill Street
Billville, WY 81274**

Survey By **John Doe**
12503 Honor Park Drive
Houston, TX 77065
Phone: 832-237-9646
Fax: 832-237-9647

Conferred With

Benny Goodman, Plant Manager
Lionel Hampton, Production Manager
Teddy Wilson, Security and Fire Systems Manager

Survey: **May 15, 2002**

New Recommendations Resulting From This Survey

There are no new items to submit as a result of this survey.

Recommendations Observed Completed This Survey

Items 99.07, 09, 10, 13, 14, 16, 18b, 19-21, and 23-31 have been completed. Item 99.04 was partially completed by extension of VESDA to the implanters and was removed as completed due to reevaluation of the system's coverage of the trackers, aligners, and steppers. Items 94.06, 11, 18a, and 22 were removed to a maintenance type corrections list.

Human Element Recommendations

99.09 Alarm Response

Management Programs

Change the present policy of investigating sprinkler water flow or smoke detection alarm signals prior to initiating the call for the fire department. Loss potential is increased more by a delay in calling for assistance than it is by an unnecessary call for assistance. (Mr. Wilson will implement.)

Physical Recommendations

99.01 Ventilation

Construction

Arrange the Wafer Fab ventilation systems to be 100% fresh air (with no recirculation), or to switch to this mode upon detection of smoke by the VESDA system or upon sprinkler waterflow. In order to accomplish this, motorized pressure relief air dampers are needed on the roof. These dampers would be arranged to keep chase pressure slightly above atmospheric when all return air dampers have shut while the supply air handlers continue to run. Presently, 27% of the Fab air recirculates, with air from all modules mingling in the equipment chase prior to returning to the various air handlers. The potential for spreading contamination (from a fire or a dopant release) is therefore high. The full time exhaust mode is preferable to the smoke/sprinkler actuated mode. Since the clean-up costs and production interruption costs always exceed the actual damage costs in this type of operation, this is the way to address that exposure. (Management agrees with the desirability of this arrangement; however, this would only be done as a long term improvement based upon improvement in the financial prospects for this site.)

Fire Protection Solutions 668 N. Coast Highway Ste 518, Laguna Beach, CA 92651

This report is intended to assist you in reducing the potential for property damage resulting from fire and related perils. The recommendations are not intended to replace any responsibility you may have to maintain a safe workplace, operation, or product. The report does not imply that all other hazards or conditions not mentioned in the report are acceptably arranged or meet the requirements of any local, state, or national standard or code. This report is only advisory and the final decisions must be made by you.

Physical Recommendations

99.01 Ventilation

Construction

99.02 Pyrophoric Gas Supply

Special Hazards

Remove the pyrophoric gases from the actual fab building and locate them (still inside individual cabinets) within the cut-off hazardous materials building south of RB-1. No changes to the supply system and supervision systems need to be made in conjunction with this. This is important for lowering the potential for dopant release and for fire within the combustible Fab building. This has become the industry norm as a result of the numerous losses that have occurred from accidental gas releases. (This is being considered for completion in the next two years provided financial prospects improve; the physical locations for this relocation already exist.)

99.03 Fab Sprinkler Improvement

Private Protection

Change the sidewall sprinkler system throughout the Wafer Fab to a preaction system. Actuate the preaction system by a VESDA level 3 alarm and by the smoke detection in the air handlers. Provide manual release stations at accessible locations. The potential for contamination from water damage from a broken sprinkler head far exceeds the costs of implementing this since the sprinklers are already arranged with their own control valve. (Costs were obtained and it was decided to consider this item if a new fab is added in RB-2.)

99.08 Valve Supervision

Alarm Service

Extend the proprietary alarm system to cover all fire protection valves larger than 2 inches. This is to alert security of possible tampering as well as to reduce potential for a valve to accidentally be left shut. This is also in accordance with facilities document FAC-018, section 3.2.2. (In agreement though the time frame will be left open at present; a quote will be obtained as part of the RB-2 Fab feasibility study.)

[Fire Protection Solutions 668 N. Coast Highway Ste 518, Laguna Beach, CA 92651](http://www.fireprotection.com)

This report is intended to assist you in reducing the potential for property damage resulting from fire and related perils. The recommendations are not intended to replace any responsibility you may have to maintain a safe workplace, operation, or product. The report does not imply that all other hazards or conditions not mentioned in the report are acceptably arranged or meet the requirements of any local, state, or national standard or code. This report is only advisory and the final decisions must be made by you.

Recommendation Loss Expectancies

	Loss Expectancy Before Completion	Estimated Cost to Complete	Loss Expectancy After Completed
99.01	\$3,500,000	\$800,000	\$200,000
99.02	\$3,250,000	\$125,000	\$200,000
99.03	\$1,250,000	\$100,000	\$200,000
99.08		\$3,500	
99.09		\$0	

Items are blank where no predictable loss expectancy event can be formulated, such as with human element recommendation. Blank loss expectancy does not imply low loss potential--it could be just the opposite.

Fire Protection Solutions 668 N. Coast Highway Ste 518, Laguna Beach, CA 92651

This report is intended to assist you in reducing the potential for property damage resulting from fire and related perils. The recommendations are not intended to replace any responsibility you may have to maintain a safe workplace, operation, or product. The report does not imply that all other hazards or conditions not mentioned in the report are acceptably arranged or meet the requirements of any local, state, or national standard or code. This report is only advisory and the final decisions must be made by you.