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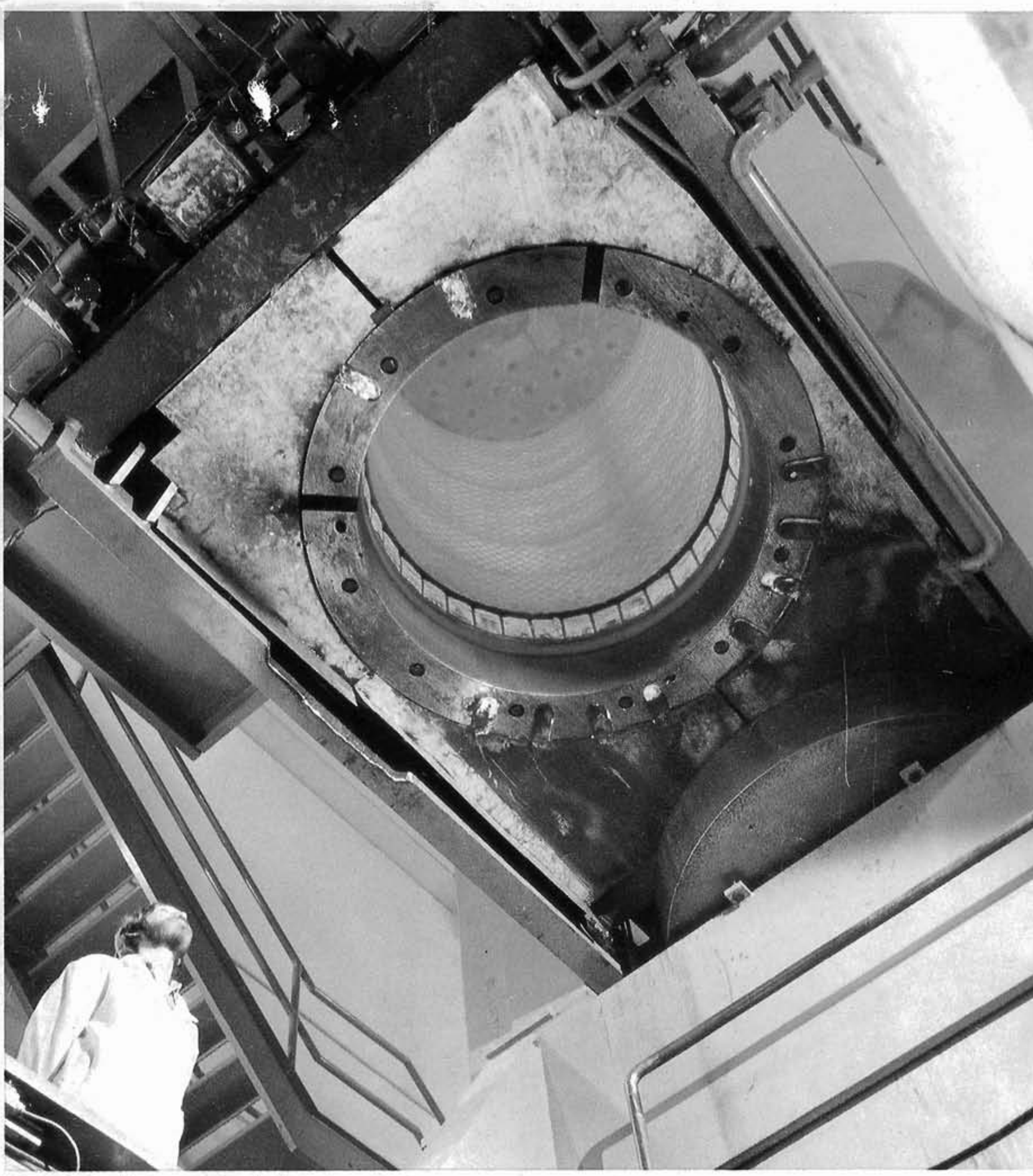


Technology update

ISOSTATIC PRESSING: stating the art

Minimizing NC downtime—

by environmental control

Minimizing NC downtime by environmental control

Controlling the environment within a computer or CNC cabinet is the most cost-effective way to achieve maximum uptime and reduced maintenance. Here's how.

CNC and similar computer devices can be considered as having at least "semi-intelligence" because they use sophisticated algorithms. In fact, by virtue of their flexibility and productivity, we pay as much as $50 to $100 per hour to have these "semi-intelligent employees" in our plants, versus the $5 to $15 per hour we pay human employees.

As with humans, CNC productivity depends on how well environmental needs are met. When these automated employees repeatedly and randomly stop work and demand to see the company maintenance man, we often don't recognize what they're trying to tell us: They can no more work under extremely adverse conditions than can humans.

The environmental problems primarily responsible for downtime are temperature buildup and fluctuation, dirt, vibration, oxidation, and nonconditioned power supplies. *All* are relatively inexpensive to correct.

Temperature problems

In any electronic controller there is a mix of transistors, diodes and integrated circuits (ICs), all of which have upper and lower temperature limits for good operation. Accordingly, cabinet temperatures must be maintained within the narrowest allowable temperature range (the lowest of the upper-limiting temperatures and the highest of the lower-limiting temperatures). Upper limits are usually determined by transistors, which may fail at temperatures as low as 150 F; 50 F is normally a good lower limit.

Close monitoring of over 300 field installations has shown that a marked increase in operating stability and a decrease in maintenance downtime can be had if control cabinet interiors are held between 75 F and 100 F. Also, any cabinet interior exceeding 120 F during the warmest season of the year should be given additional cooling capacity. If the ambient temperature exceeds 120 F, there will be 150 F to 170 F hot-spots between circuit boards. Semiconductor devices within these hot-spot areas will be even hotter—definitely causing problems.

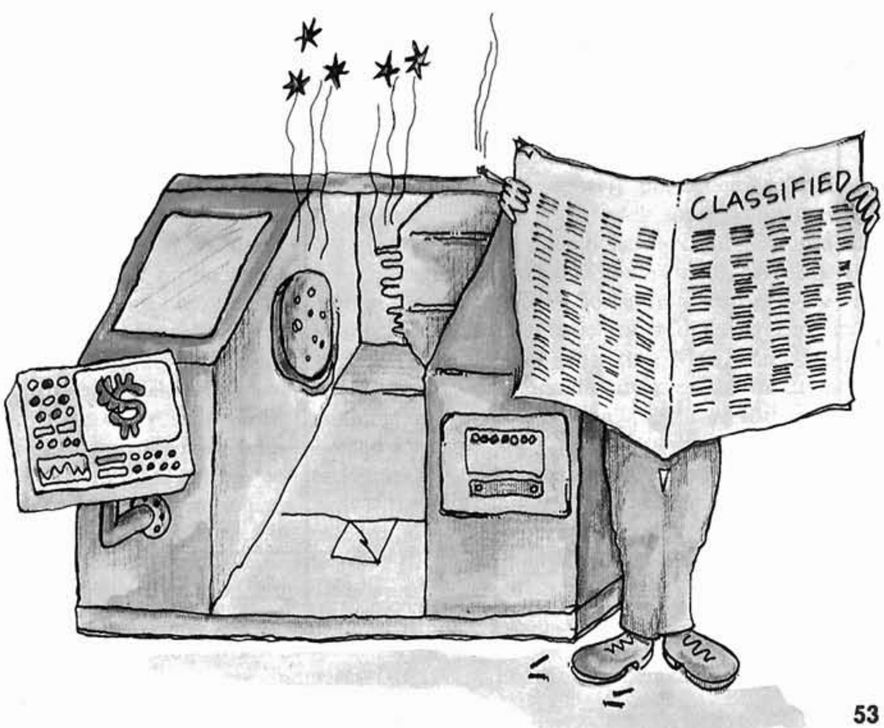
Unfortunately, proper air conditioning is often declined as an option at purchase time strictly because of cost. As with humans working in overly hot environments, inadequate cabinet cooling will lead to frequent work interruptions or total failure.

Another problem is temperature fluctuation. As transistors and ICs work at alternating high and low temperatures (e.g., hot afternoons and cold early mornings in spring and fall), the microscopic hairwires that connect IC chips to IC package pins expand and contract repeatedly until connections break, **Figure 1.** Properly engineered electronic cabinet air conditioners will keep temperatures at 80 F to 95 F. If shop temperatures drop substantially, the conditioners pump warm gases through the coils and plates—thus preventing cooling below a danger point and excessive temperature fluctuations.

Temperature gages with a magnetic base for easy mounting, and a peak-holding needle for easy detection of maximum temperatures are useful for determining which control cabinets, if any, have experienced temperatures of 120 F or more. They are available for about $25. If problems are indicated, professional counsel can recommend which kind of air conditioner would be most reliable and how to position it on the cabinet. Positioning is crucial because it is important to ensure that cold air entering the cabinet neither directly hits circuit boards nor counteracts convection currents induced by muffin fans. Baffles and muffin fans are engineered into cabinets to assist hot air rising up and away from circuitry, **Figure 2.**

Dirt

Many electronic control cabinets, even recent models, are inadequately sealed against contaminated shop air—



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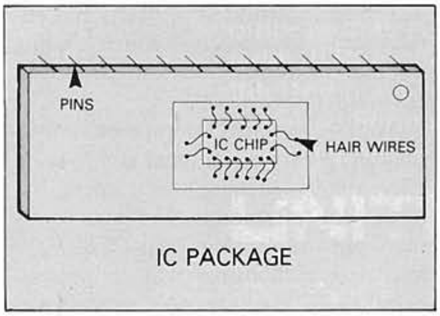
detectable by a rapid buildup of oily dirt or metallic dust on circuit boards. Contamination can enter through wire ducts, vent panels, around switches and door edges if improperly sealed. Contamination buildup will establish conductive paths, leading to shorting between wires and board traces, intermittent disruptions, and finally permanent hardware failures.

Often (even among name-brand manufacturers) shop air is circulated through the cabinet for cooling. This traditional practice started back when DC motor drives were always motor-generator (MG) sets. A lot of air was needed to keep the MG sets cool, and associated relay controls were unaffected. However, after the evolution from MG sets and relays to SCR drives and electronic technology, updating designs for cabinet cooling seems to have been forgotten.

Yet, DC motor drives are more sensitive to minor changes of heat and contamination than digital integrated circuitry because they are built with analog electronic components, i.e., operational amplifiers etc. Even though interior cabinet temperatures may remain below 120 F, it is recommended that any existing shop air ventilation system be sealed off to prevent dirt from entering the cabinet and that recirculating air conditioners be installed. Use adhesive-backed foam-rubber strips for sealing around doors and panel edges, and duct-sealing putty or any nonflammable flexible material for sealing around cable and knockout holes.

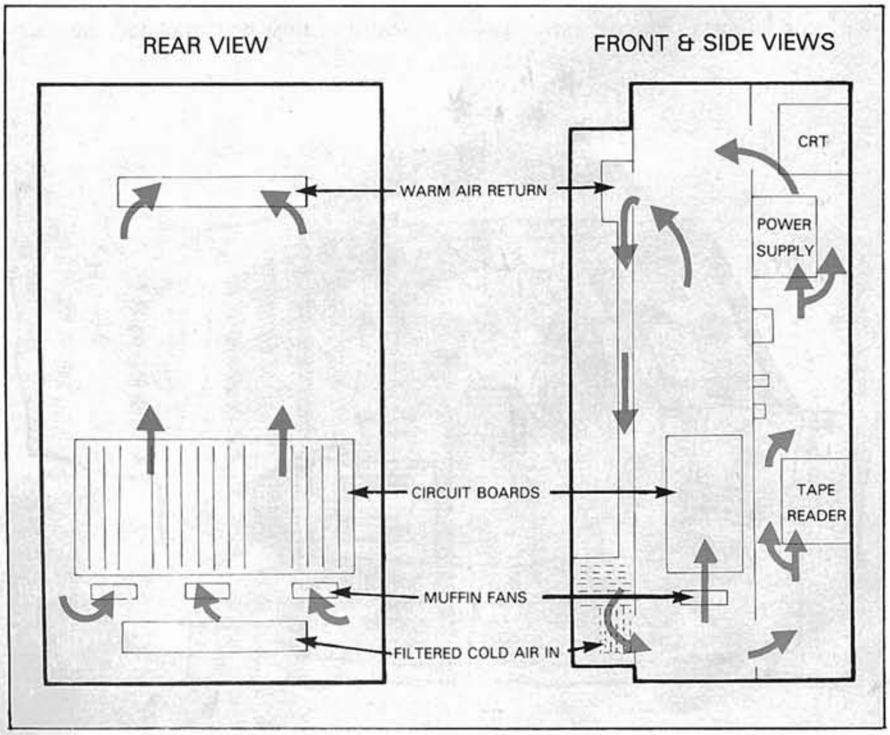
Contamination buildup should be considered practically. Unless there is corrosion or shorting, a little dirt may be innocuous, especially in very dry climates. Humidity plus contamination will accelerate corrosion and oxidation. If a shop air-cooled cabinet has only a mild contamination buildup over two years without any problems, it may be sufficient to improve air filtration by placing a 1" disposable filter pad over the incoming air vent.

Intake vents are usually protected by washable metal filters or screens, but these do little to stop welding smoke, metallic dust or coolant mists, whereas treated disposable filters will catch these contaminants. Electrostatic filters will also take out both dusts and oil mists, but they can be as expensive as closed-loop air conditioners to install and operate, and they provide no cooling.



1. Microscopic size of hair wires and circuit components on integrated circuit (IC) chips (100 to 10,000 digital logic gates on a ⅛" × ⅛" IC chip) make reliable operation sensitive to excessive or fluctuating temperatures, vibration, and to voltage spikes and transients as well.

2. Cooling air circulation within a control cabinet. Filters cleanse entering cold air. Baffles and muffin fans assist hot air to rise up and away from circuitry. Supplemental air conditioning may be required to keep interior temperatures within limits.



Vibration and oxidation

Electronic controllers and computers suffer when subjected to excessive vibration. Depending on the vibration severity and duration:

- Friction connections (circuit-board socket or plug socket) can move from areas of low resistance (good connections) to oxidized high resistance (bad connections).
- Circuit boards can gradually vibrate out of their sockets.
- Lead connections can be sheared.

Intermittent or lost connections can cause machine jumping, runaways or even wrecks. The remedy is to place vibration-absorbing mounting pads under the control cabinet, or to use rubber-center vibration-isolating bolt mounts. The writer has seen several instances of dramatic reductions in maintenance after vibration mounts were installed.

Oxidized friction contacts may result from simple aging as well as vibration-induced movement. There have been instances where oxidative buildup on older controls became so troublesome that a control retrofit was being considered. With the application of a contact cleaner and deoxidation treatment, complete reliability was restored.

Normally, any application of a solution to circuit-board connectors or plug pins is prohibited or discouraged because:

- Some solutions may clean the surface, but cause corrosion later.
- Other solutions may prevent further oxidation, but will not remove existing oxidation and will leave a thin dirt-attracting film.

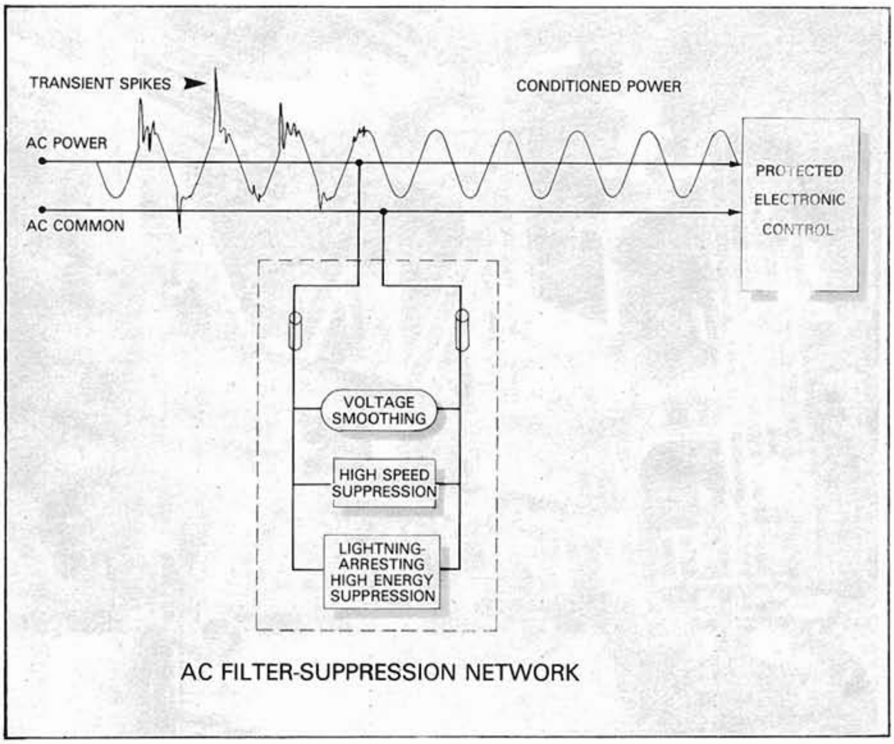
Erasers should never be used to clean connector pins because they are likely to abrade away the thin silver or gold plating, thus ruining the conductive surface.

There is one solution, however, which, when applied as recommended, has been proven to clean contacts without subsequent oxidation or dirt buildup. The product is Cramolin Red, from Caig Laboratories Inc, Escondido, CA. **Circle E7** for further information.

Power supply conditioning

Definitely the most effective action to ensure controller reliability is to protect them with new generation solid-state transient suppressors. Without such suppressors, transient noise or voltage spikes can enter a system via power supply or signal lines and cause both disruption and destruction. Good suppression networks, responding 10 to 1000 times faster to transients than older-type devices, are now available. Many controls are installed in industrial environments with no transient protection at all, as it is up to the end user to provide "clean AC power." Unfortunately, there is no such thing as "clean" AC power in an industrial environment.

Even if the power supplied to your plant is relatively clean—which it usually is not—power surges, voltage spikes and other transients are generated within the plant itself as a result of operating motors, fluorescent lights, solenoids, SCRs, switching circuits, welding equipment etc. As these devices are switched on and off, surges or spikes are transmitted onto power or signal lines. If these transients get into computerized equipment, they may be misinterpreted as digital commands or other information, thereby causing machine runaways, jumping axes, loss of memory or other disruptions. While these are costly, if the transients are sufficiently strong, they will destroy sensitive components, causing additional hardware failures and downtime. The combination of weak transients and heat will also cause eventual destructive hardware failures, **Figure 3.**



3. Process controllers, CAM computers and data loggers can suffer excessive downtime if not properly protected against harsh industrial AC power transients. Modern suppression networks can respond 10 to 1000 times faster to transients than older devices.

Older devices for transient suppression have been:

- *Inductive-capacitive filters* that give good reduction of radio frequency noise of a known band width but do not clamp (stop) fast-rising transients at any given level or threshold. (A filter smooths; a suppressor clamps at a certain threshold or limit.)
- *Resistance-capacitance filters* have medium speed and capability, but like inductive-capacitive filters do not clamp fast transients.
- *Metal-oxide varistor (MOV) suppressors* have semi-fast response capability and good clamping capabilities for up to one millisecond.
- *Isolation transformers* are often thought of as transient suppression devices, but are very inefficient for their relatively high price. They will reduce common-mode transients to a lesser transverse-mode transient by some given dB value. However, they will pass transverse-mode transients, a major problem.
- *Gas-tube suppressors* are very slow to respond and have other problems in AC power applications.
- *Selenium-stack suppressors* have been replaced by MOVs because of the former's much slower response time and comparatively bulky size.
- *Zener-diode suppressors* have very fast response time but very low current or suppression capacity. They are useful in DC applications for protecting digital ICs or signal-line electronic components.

These older suppressor technologies were adequate for vacuum tube and relay-control systems, but not for ICs and microcomputer components because the latter are easily damaged by smaller and faster power fluctuations. The result is that CNCs, CAM computers, process controllers, data loggers etc can suffer excessive downtime if not properly protected from the harsh industrial AC power environment.

Trade literature states that solid-state components have "life-time reliability"; yet these systems fail regularly when installed with nonconditioned AC power supplies.

Suppression networks vary both in response time and energy capacity. Care should be taken in selecting the proper unit capabilities and location for a system. Consultation may be beneficial as recent developments have changed past practices in system grounding and suppression techniques.

To properly protect your CNC machine tools, seek suppression networks with 1 to 6 nanosecond response time and 15,000 joule or 20,000 peak amp capacity. Some units also provide electromagnetic and radio frequency interference protection. Many *black-box* suppressors are advertised in an attempt to capitalize on this universal problem. Beware of units containing nothing more than a MOV and a capacitor, and bearing a very high price tag.

Proper protection for "semi-intelligent employees" will allow them to operate on any power line in the "jungle" without damage or interruption from transient spikes.

For more information, **circle E8.** ■