Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

Fraunhofer Institut Zuverlässigkeit und Mikrointegration

Adaption to scientific and technical progress under Directive 2002/95/EC

Stakeholder contribution for exemption 8

"Cadmium and its compounds in electrical contacts and cadmium plating except for applications banned under Directive 91/338/EEC amending Directive 76/769/EEC relating to restrictions on the marketing and use of certain dangerous substances and preparations"

submitted 1 February 2008

by Robert L. Ekowicki

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29-Jan-08

Subject: Rohs Exemptions. Cadmium

To: Stephanie Zangl

From: Robert Ekowicki

I understand from your email of January 28, 2008, that the stakeholder consultation on the review has been launched.

As a start in this review, I again refer to my email of January 21, 2008 to you.

Final Report Freiburg, 28 July 2006

Good afternoon,
“In this final report, under section 6.7.1 "Cd in electrical contacts", "The usual alternatives being silver nickel (AgNi) for low current and silver tin oxide (AgSnO) for higher current applications"

In my response to request the continued use of AgCdo contacts, it is based on actual testing of these AgCdo contacts in every application. Alternate contacts were tried with little success.

When I started work in this field, I researched and contacted many experts.
From what I found, most work performed on contacts was done in a lab. The setup was two opposing contacts on a cam that moved the contacts to a close and open position in a straight line.

I see no data in the final report that support the claim that AgNi and AgSno is an acceptable replacement for AgCdo contacts.
Therefore my question is: Do you have any data that supports this claim and a drawing or picture of the actual test setup?”
Thank you,
Bob Ekowicki

As you see in my above request, it is very important to see what tests were performed in determining that the two above suggested replacements can actually function as replacements for AgCdo electrical contacts.

The research that I performed in the 60's and 70's showed that most research was performed in a lab and not in the actual applications. That might have been satisfactory for many applications but in my area of expertise, applying thermal protector to electrical applications proved contrary to that decision.

The devices that I was involved with are what you called thermal protectors. Another word for these devices is "Self resetting thermal protectors" (SHTP).

If you can obtain the IEC standards, the requirements for these devices are in the standards IEC 60730-1 and the requirements in the Part's 2's. These standards are applicable only to the thermal protector of many different types.
When they are applied to the end product, they are then tested to the IEC 60335-1 and their part 2's. The IEC 60335 is for the end products. Examples are washing machines, dryers, dishwashers, electric blankets, etc.

The major difference between what was tested in the lab on just the contacts and these contacts in a thermal protector is that the two opposing contacts are attached to 2 different items. One is that the movable contact is attached to a bimetal material and the other to a stationary terminal. That stationary terminal may or may not have some movement when the two contacts meet or separate or close.
If I am correct on how contacts are tested in an experimental lab, the cam action moves the contacts together and separates them; the making and breaking of the contacts have the same gram pressure. Also, the contact point will always be on the same plane.
Contact used in thermal protectors, do not have operate like that.
Thermal protectors have the following:
1 – When the bimetal starts to heat up, due to current and or external heat source, the contacts start to slide on each other. The make and break point is always in a different area.
2 – At the time when the contacts start to open, the contact pressure will be at zero.

3 – Zero opening pressure will allow an electrical arc to form. If there is not enough separation, the contacts will weld together.
4 – On closing, if the gap between the contacts is too small, again we will strike an electrical arc and the contacts will weld together.
5 - The cadmium oxide in these contacts act as an arc quencher to extinguish the arc. I do not know of any substitute material that has this capability.

Regarding the bimetal and its attached contact:
The bimetal comes in many sizes in both thickness and square area
Depending who is forming this bimetal for their particular thermal protector, each manufacturer has its own method. What type of contact that might work for one manufacturer might not work for the other manufacturer in a same end product.

In trying not to leave anything out, I will address the use of protectors that are used in automotive DC applications.
The major of these thermo devices over the years did not have contacts that contained cadmium. As I remember, they were made of the following material: fine silver, copper silver and a few other silver based material.
As the electrical motors used in automobiles changed over the years and new motors were introduced to the market, it was proved that the above contacts would not protect these motors. In trying to find a combination of contacts to offer similar protection, AgCdo contacts were tried. These contacts proved to be very successful in these applications.

When I was first hired in the mid 60's, we were mostly involved in automotive products.

We were just introducing a new product to the residential AC market.
We made a thermal protector for this market but did not identify any particular application. Our sales force went to visit potential customers.
A few customers were interested and gave us their product to test.
In the early stages, we found that fine silver or coin silver contacts worked satisfactorily in these limited applications.
As our business grew into other applications and with products that drew higher currents, we found that our two contacts were not able to satisfactorily protect the product.
At that point, we tried contacts that contained AgCdo material.
To our surprise, it performed superior to anything we tried before.

All the 3 above or more types of contacts on the products we introduced are used on a product mostly with currents from 0 to 15 amps and 120/240 volts AC. The round contact is approx..093 inches diameter and .080 inches thick. The silver thickness is approx .025 inches.

With the use of these contacts over many years, we were able to reduce the silver thickness and percent of cadmium in the silver.
We were also, because the AgCdo contact on the bimetal worked so well, able to replace the opposite AgCdo contact with a fine silver contact.
Applications, like compressor motors for refrigeration, where the motors had fault currents of 80 amperes or higher, our product was not able to replace either of the AgCdo contacts.

What was found in contacts that didn't contain any AgCdo was that under continuous operation (cycling), the AC arc that was created when the device opened, couldn't contain the arc within the surface of the contacts.
Either molten silver was plated on the bimetal or the AC arc was distinguished on the bimetal. These conditions changed the operating features of the bimetal.
Either of these conditions created early failure that led to the apparatus either causing a fire or a potential electrical shock.
Changing to contacts containing cadmium eliminated the majority of these failures.

Please remember that what I have been discussing are Self resetting thermal protectors (SHTP). Contacts used in other devices may not need to have cadmium. You need to discuss their need and what contacts they do use for their products.

Regarding applications that draw currents in excess of 10 amperes and exceeding 100 amperes, thermal protectors had to be made larger in order to handle the higher currents. In this case, in order to pass similar tests, both contacts had to be made with AgCdo contacts and with larger contacts. In some cases the silver thickness had to be increased because of the silver depletion during cycling of the thermal protector.

Because of our success in selling a quality thermal protector, our business was very successful. We became a leader in the protector business.

At this point, many manufacturers of contacts began calling on us to sell their products.
We needed alternate sources of components.
In order to approve an alternate supplier, we devised a two step test for the approval process.

The 1st step was a bench test:
In this test, we would make 100 devices with the new proposed supplier and 100 with the present approved supplier on the identical equipment.
Results of the test had to show that the new supplier be either equal or better than the present supplier.
The test involved testing a variety of currents and AC voltages from 120 volts to 600 volts.
The loads were .5 and .75 PF, or resistive or tungsten.
If results were satisfactory, then we would go to step 2.
The most severe application test is applying the thermal protector to an electrical AC motor.
Usually the thermal protector is placed in contact with the windings of the motor. In North America, the test requirement is that the thermal protector, when the motor rotor is blocked, must be able to cycle for 18 days. At the end of the test, the motor cannot fail a dielectric breakdown test.
To be assured that we are not substituting a good component with a bad component, the tests could take up to a year.
I have performed these types of test over a 30 year period.
I have approved many suppliers and rejected a few. Those I rejected, I retested. The contacts failed again.
Therefore as I have stated in the past, I believe it will take 5 to 10 years in order to find an acceptable replacement of AgCdo contacts in thermal protectors. This is contingent upon a manufacturer of contacts having the capability to come up with a material that is not presently in the market place.
Did I say 5 to 10 years? Maybe, but after we have an AgCdo replacement we still have a lot of work to do.
Contacts are not just some type of silver but most of the contacts are of three layers. The bottom layer is usually steel for welding the contact to another material. The material between the silver and steel is copper and then the top layer of Agcdo. Because the silver contains cadmium oxide, it is difficult to impossible to bond it directly to copper.
The contact manufacturers found that if they used a bonding material of either silver nickel or fine silver, it make a good bonding agent.

When I approved suppliers of contacts with Agcdo contacts, our specification excluded silver nickel.
Some years later we noticed that after some additional testing we were getting early failure with contacts that were once satisfactory. We metallurgically cross sectioned the contact and found that the supplier switched the bonding material from fine silver to silver nickel.
When they supplied replacement contacts with the correct bonding material, the protectors were now satisfactory.
The silver nickel layer reduced the heat transfer flow from the AgCdo contact to the copper, thus increasing the depletion of the contact surface until the contacts welded together.
Therefore from my experiences, I can testify that silver nickel contacts are not a replacement for AgCdo contacts.

If there is ever a replacement for AgCdo contacts, I hope that there is no problem in bonding the material to copper.
If the process to bond the new material to copper is patented to exclude other contacts manufacturers from using it, it would take many years to resolve the patent issue. Supply problem.

So now we have a replacement for AgCdo contacts and many contact manufacturers that can supply the contacts.
The next step is to manufacture samples for our customers to test. I can say that in most cases they would be able to accommodate our request. But I know the 1st question they will ask "Do you have a test agency approval to use these contacts" Agency approval is with test houses like VDE (Germany), BEAB (England), Demko (Demark), UL (USA) and others. That approval process could take up to 2 years if there is not a problem. After approval by the required test agency, the customer will start his own testing. My experiences with the products we submitted in the past, are that this could take up to 4 years.
So now, worst case, we can see 16 years before final approval for production of these new devices.

Depending on the motor, what current it will draw and how much heat from the motor that the thermal protector will see will control how many cycles the thermal protector will obtain. Why am I stating this?
In your 2006 final report, it mentions 10,000 cycles.

Testing of thermal protectors to the 18 day test on motors, the thermal protector may cycle only 1,000 times or as much as 25,000 cycles.
In some limited applications, the thermal protector has to cycle 100,000 times.
If 10,000 cycles is the requirement to replace AgCdo contacts, this will allow devices to be installed that do not meet the industry standards.

Today, with the new generation of universal motors in European washing machines, because of the location of the thermal protector, the thermal protector cycles every few seconds. The present EN 60335 standard states that the protector only has to cycle 300 times but this requirement was issued when the induction motors were used in the washing machines.
Today, 300 cycles can be obtained in a few minutes. That is not enough endurance capability to protect these motors from causing a fire.
The washing machine could be on for an hour and if the timer failed, hours or days.

I was involved with all this for 30 years. I was also directed to test thermal devices from competitors. We had to do similar tests on those units that we were competing with. All competitors used similar AgCdo contacts on their products.

What I have stated so far only addresses a few items regarding what it takes to make a reliable thermal protector.
I believe if anyone rushes to find a substitute material will do a great harm to the industry that requires the use of thermal protectors in their products.

After you read this, if you have any questions or need explanation, please let me know.

Sincerely yours,

Bob Ekowicki