ON THE GREATER SECURITY OF NONSTICK PANS

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1. PREAMBLE

In 2006, we were asked to give our opinion on several press releases published by different subjects aiming to raise doubts and arouse alarms on the use of all-clad nonstick cookware. In particular, a press release from the Condacons on January 27th of the same year had caused great sensation: it invited to "seize 150 million Teflon pans". In that occasion, we clarified that these alarms were caused by a double misunderstanding by the Codacons in the interpretation of the initiative of the American *Environmental Protection Agency* (EPA)[1]. This clarification eased the alarms to stop quickly, as demonstrated by the fact that the Codacons took note, acknowledged the misunderstandings, relaxed and interrupted all further action.

Here is a brief summary of the argumentations that we released at the time. Teflon® is the registered brand of DuPont for some polymers containing fluorine and used, among other purposes, to produce nonstick cookware with a thin layered polymer coating. These polymers are the polytetrafluoroethylene (PTFE) and its similar, like the perfluoroalkoxy polymers (PFA). In common use, the word *teflon* (without the indication of the registered brand) is, as clarified for example in the Italian dictionary Zingarelli: "the commercial name of plastic material […], very resistant to acids, to solvents, to mechanical usury, used as an electrical insulator, in the chemical industry for gaskets, coatings, and as textile fiber"; in particular, it is used as a synonym of nonstick coating.[2]

«The alarm set off by the American authorities», to which the Codacons referred to, did not relate to the cookware Teflon® but to another substance, the perfluorooctanoic acid ($C_7F_{15}COOH$) and its salts, mainly ammonium, indicated below as PFOA. The considerations that follow referring to Teflon® concern all the fluorinated polymers which, having used PFOA as an additive, have underwent processes similar to the Teflon® in the cookware coating. Below, although we specify the registered brand, we relate to the general meaning because it applies to all the cookware coating materials which have used PFOA as an additive during the production process.

So, the first big misunderstanding of the Codacons was the following: the PFOA was, within the limits of the analytical detection, absent in the Teflon® of the cookware under accusation.[3] In short, the accused fact hadn't been committed as far as we knew: it was like accusing A to have killed B and discovered B was still alive.

Moreover, «the alarm set off by the American authorities» was more willingly represented by the letter sent by Stephen L. Johnson, CEO of the EPA, to the eight principal worldwide suppliers of PFOA on January 25th, 2006.[4] EPA's letter wasn't an alarm but an invitation to participate to research programs aimed to determine whether the PFOA presented risks for the human health. And this was the second big misunderstanding: to talk about alarms was completely inappropriate, even maybe tendentious.

This letter underlined that the research program "will enable to take conscious decisions on the actions to undertake in order to manage every potential risk". In short, far from being an alarm, the EPA invited to explore the existence of potential risks - if there were any - of one substance (the PFOA) that had been broadly used for nearly 50 years (and which, we repeat, was absent of the coating material of the cookware that was asked to be seized).

So, the debate was concluded that year 2006: Codacons acknowledged its misunderstandings, relaxed and stopped all further action. Actually, on January 30th 2006, Codacons wrote in a "restorative" letter that it "never asserted that Teflon was a harmful substance for health" (even though a few days before it had asked offhandedly to the Ministry of Health to "seize 150 million Teflon pans").[5]

The debate set off by the Codacon's press release finished in 2006. Meanwhile, there were recently new alarms set off occasionally by minor organizations, or even by citizens, in newspapers or on the Internet (websites, blogs, forums…). Most of these alarms relate to the Codacon's one but nobody seems to have noticed that Codacons backed off, that the alarms were ungrounded and that their relationship to the cookware was inexistent. As an example, we quote below a few alarms in chronological order among the most significant for their widespread source or for their authoritativeness:[6]

1. *News* of the *Foundation for Cancer Research* (September 2009): In a Decalogue for the prevention (of tumors), after listing 7 rather efficient measures, the *News* list 3 of them (the 3 last ones) which compromise the credibility of the others: «8) Do not use food with aspartame; 9) Use peanut oil or olive oil to fry; 10) do not use cookware with teflon».

2. Article in the magazine *Salvagente* (November 5-12th, 2009) headlined: «Suspects on Teflon are back. Red alarm on nonstick cookware."

3. Article in the specialized newspaper *Salute* of daily national newspaper *la Repubblica* (March 9th, 2010), headlined: «Bye bye Teflon, cookware more secure». (On March 23rd the national newspaper, upon specific request, accepted to rectify).

4. March 1st, 2010, article published on the website of *Medicina Democratica* of Alessandria: http://alessandriamd.blogspot.com/2010/03/lettera-mina.html, in which it is written that although "Codacons asked to seize 150 million Teflon pans. The Ministry of Environment had to commission another research to the CNR, what is more without financing it". They do not mention that the Codacon's request had been withdrawn.

It seems thus necessary - although it wouldn't be, if only those who express even legitimate concern could stay free from doubtful preconceptions - to repeat a few circumstances. In this occasion, we will highlight the new elements from 2006 to nowadays.

2. MEANING OF RISK ASSESSMENT

When a certification body, officially recognized and scientifically accredited, considers it is necessary to investigate on the possible dangerousness of an agent (as EPA has done for the PFOA, as explained above), it does not mean that this agent is dangerous and no alarm should be set off following this decision. In general, these investigations are made on agents or on those for which, for a reason or the other, some suspects of potential risk have come to light or which have such a widespread diffusion to suggest an investigation on the potential risks. For example, the International Agency for Cancer Research (IARC), on this basis has assessed hundreds of agents for their carcinogenic potential. Among the investigated substances there was also tea, a drink so widespread to justify the investigation. The latter lasts, typically, a few years: at the end, the IARC classifies the carcinogenic potential of the investigated substance in one of these 5 groups (1, 2A, 2B, 3, 4).[7]

Tea, for example, was classified in group 3. For comparison: in class 1 there are 107 agents, among which tobacco smoke, sun radiation and the birth-control pill; in class 2B there are 249 agents, among which coffee. In class 3 (in which was classified tea) was inserted also the PTFE, the substance used for the cookware coating. **So it is the least to say that what has been suggested by the *Foundation on Cancer Research* in the 10th point of the Decalogue to prevent cancer is unjustified.**[8]

It is worth noticing that in the IARC classification there are no group labeled "certainly non carcinogenic" and that the most, let's say, secure - group 4 - is labeled as a group of substances "likely non carcinogenic" and has *only one substance*, compared to almost 1000 agents studied until now. We shouldn't be surprised: as a best practice, the certifying bodies are driven by a prudential spirit for obvious reasons which are not only opportunities but also scientifically proven: it is methodologically impossible to establish the safe harmlessness of anything, but it is much easier to establish the dangerousness.

So, in tribute to the spirit described above which sets off the evaluation of the risks of an agent, the EPA decided to start one on the PFOA. The PFOA has been used in fact for over 60 years in different industrial sectors, a wide use that sole justified the increase of attention. The substance is moreover very stable and thus persistent in the environment, a fact that - a research has spotlighted – brought the presence of traces (less than 5ppb, parts per billion) in the blood of almost all the inhabitants of the United States[9], although no negative effect was put in evidence.[10] So EPA was right to set off the investigation. At the same time, as a pure precaution, EPA spurred the companies that were interested to reduce by 95% the use of PFOA within 2010, and to make every effort to completely eliminate it within 2015. We underline these words to repeat that the EPA was giving no obligations nor any bans. As quoted: «*the Agency invited industry to commit to reducing PFOA by 95% by 2010 and work toward elimination of emission by 2015; therefore the Agency has decided not to wait until it has all the answers on PFOA*».[11] With the same precautionary spirit, EPA's Scientific committee chose to classify the PFOA as «*likely to be carcinogenic*», even though a study[12] did not justify this choice, some members of the Committee did not agree[13] and the EPA's *Office of Pollution Prevention and Toxics* (OPPT) suggested to classify it as «*suggestive carcinogenic, but not sufficient to assess human carcinogenic potential*». A choice, however, that has been done well before EPA demanded to launch the research programs.

In 2008, the IARC inserted the PFOA in the list of the 20 "high priority" agents which should be examined in the period 2010-14 in order to classify them in one of the groups described above.[14]

3. STATE OF RISK

Without prejudice of the fact that the PFOA is absent from the cookware coating material as we have extensively explained in our document in 2006 quoted in note 1, is there anything new we can say since then?

10 years have passed since EPA set off its own evaluation of the risks of PFOA, which they managed to do quickly thanks to the cooperation of the companies involved after 2006. It is a feature of the scientific methodology that the more the elements of truth of a conjecture emerge the more it will be investigated; and the more the conjecture is investigated the less plausible it will be, thus it would then be quite rightly set aside as implausible.

In all these years, research did not sit back and nevertheless very few has emerged. Naturally, maybe because what is to be discovered hasn't emerged yet. Or maybe because there is very little more to say. Besides:

(i) The German federal Institute for the evaluation of risks asserted that "the proper use of coated cookware does not represent a danger for health";[15]

(ii) The Danish Technological Institute controlled and approved the coatings in Teflon®;[16]

(iii) The scientific group EFSA on alimentary additives, flavorings, technological coadjuvants and material in contact with food (AFC) expressed a favorable opinion on the use of PFOA in products made by sintering at high temperatures (the spokesman of this scientific commission, Carola Sonderman, in an interview to the Bureau of National Affairs declared that «making cookware is an example of a use of PFOA that would be authorized under the panel's recommendation».[17])

A sole study, almost isolated, asserts there is a statistical *association* between the presence of PFOA in the blood and thyroid disorders.[18] This study is important because it gives, for the first time, a direction on which to insist to determine the dangerousness of PFOA. We must clarify though that:

a) *Statistical association* does not mean there is a cause-effect relationship (we know there is a statistical association between the decrease of birth rate and the decrease of the population of storks, but the first are not caused by the last);

b) The authors feel they have not understood the mechanisms of this association and they don't exclude confounding factors;

c) The *European Food Safety Authority* (EFSA)[19] evaluated at 1500 ng/kg-p.c. (Nanograms per corporal weight) the TDI (*Tolerable Daily Intake*) of the PFOA and assessed inferior to 6 ng/kg-p.c-die the food exposition of the population to the PFOA, the latter being evaluated at 50% of the total exposition. It is clear that, as underlined in the EFSA report, "the risk of negative effects of the PFOA on all the population is improbable". In any case, coming back to cookware - object of our study - PFOA is, as already said, absent. Though, since with "absent" we must intend "inferior to the limit of the detection of analysis", scientifically it would be more correct to say that in the PTFE that coats the cookware of PFOA there is less than 100 ng per m^2 of nonstick surface.

d) A more recent Italian work[20] detected the presence of PFOA for a quantity not superior to 25 ng/m^2 of nonstick surface. This means that a child of 10kg should ingest every day the PFOA present in 600 pans, each of them with a surface of 1m2, to exceed the quantity of TDI evaluated by the EFSA. In brief, the widespread presence of PFOA in the blood of the population where it has been detected is due to quite different reasons than the ingestion connected to the use of Teflon® in nonstick cookware. EFSA reminds in the quoted report that among the significant factors is the dispersion of PFOA during industrial processes, half coming from the food chain and the other half from other means (exposition in closed environments). In any case, the total exposition is well inferior to the quantity of TDI evaluated by EFSA.

e) To the question: «Are there some measures consumers can adopt to reduce their exposition to PFOA?", EPA answered: "The available information indicates that the daily use of consumable products does not raise any concerns. At the moment, there are no measures the EPA suggests to consumers to reduce the exposition to PFOA".[21] In a recent interview[22] concerning the levels of PFOA in potable water (in which they refer to industrial pollution, not to the hypothetical ingestion from the cookware), a CNR expert has confirmed that the concentration doesn't seem dangerous. We quote him because, even more so, he does not raise any concerns on the doses of PFOA you could ingest from the nonstick coatings in the kitchen: not only for those used nowadays that do never enter in contact with PFOA, but also for those used some time ago for which the potential residues of this additive has been referred to above and where we have demonstrated the absolute practical inconsistency.

<u>In conclusion</u>:

(a) The PFOA is a substance that has been investigated for at least 10 years for potential risks that are still nowadays to be demonstrated;
(b) Where there are some, they are for far higher concentrations compared to those which we are exposed to;
(c) The entity of our exposure is half due to the food chain through the ingestion of contaminated food and half due to the environmental exposure;
(d) The contamination through the use of non-stick cookware is actually absent and, however, absolutely negligible compared to the environmental contaminations and those coming from the food chain, both of which have an irrelevant sanitary significance (points (a) and (b)).

4. ON THE GREATER SECURITY OF NONSTICK PANS

At this point, since we are dealing with an issue – the consumer's legitimate preoccupation concerning the risks arising from the use of nonstick pans – and hoping we have cleared any doubt on the feared risks of the PFOA, which not only has no sanitary nor any environmental relevance in its concentration in the environment but is also absent from the cookware object of this report – it seems more essential than appropriate to comment on the risks coming from the use of the nonstick cookware, which are different from the risks where there is PFOA which are inexistent. In particular, since we cannot be exempted of using cookware, nonstick or not, we have to ask ourselves: beyond the immediate practical convenience and focusing on the sanitary and/or environmental security, is the use of cookware in which the food doesn't stick better, worse or indifferent compared to the cookware where the food sticks?

We must be aware that when the food sticks in the cookware there are chemical transformations in the food that remains stuck at the bottom of the pan due to the overheating and the attendant dehydration. In this cooking process, the energy coming from the heat source (electric stove, flame, radiation or other) is distributed in the mass inside the cookware at least until the mixing of the liquids take place, voluntarily or involuntarily. In case this mixing does not happen, the incoming energy definitely remains located and concentrated in the places in which the food sticks in the pan where the prevented mixing involves an uncontrollable overheating.

You can't generalize with all the food, because these are complex phenomena and subject to many variables intertwined between them; but the creation of harmful or even toxic substances not only is to exclude, but in a lot of cases is even asserted. They are substances under a special observation by different bodies because carcinogenic, as some heterocyclic amines, the acetaldehyde, of which we will immediately say something, and the polycyclic aromatic hydrocarbons, among which the benzopyrene; or suspected carcinogenic, or at least irritating, as the acrylamide, the acetaldehyde or the acrolein; or moreover the progenitor of free radicals well-known for the damages to the cells.[23]

In his treaty of chemistry applied to the phenomena that occur while cooking food in the kitchen,[24] Nicoletti reminds that, for example, meat and protein food in general are very reactive on a chemical point of view and chemical reactions have the tendency to accelerate when the temperature rises: in other words, potential dangerous reactions become even more dangerous if the environment is overheated because they occur faster producing at the same time greater doses of harmful products.

The Author explains the muscle tissues have free amino acids and others are created by proteins during cooking. In the overheated microenvironment in which the food sticks to the pan there are amino acids with their amine groups ready to react, as we will soon explain, with the risk of generating unhealthy composites that can contaminate the food that didn't stick and that will be consumed.

Moreover, among those blocked in the protein chains there are some called basics because they have a second amine group which, in contrast to the other, stays free because it is not used in the creation of the chain. In the presence of carbohydrates, for example glucose, present in most food or always ready to be formed by its own natural polymers as the starch of flower and of potatoes or from the glycogen of the liver, those ammine groups can react with the glucose aldehydic groups or of other carbohydrates, setting off a group of reactions studied among the firsts by the Italian Amadori and the French Maillard. They are very common phenomena in the production of food, and likely considered harmless if contained under certain limits: for example, they produce the nice color of the bread crust (cooked but not burned) without raising concerns. In the food that sticks in the cookware the situation is usually very different and in principle harder on our health.

In order to give an idea of this type of problem, the Author reports the results of an experiment. In presence of air, the products of the reactions of Amadori-Maillard can react to creatinine, heterocyclic composite present in meat to give heterocyclic ammines among which the one known under the name MeIQx (2-ammine-3,8- dimetilimidazo[4,5-*f*]chinossalina), classified by IARC in group 2B as explained above.[25] Well, at 37 °C we need 84 days to obtain the quantity that is formed in only 2 hours at 128°C. For comparison, a frying oil reaches easily 180°C.[26] So, the places in which the food sticks in the cookware the temperature is much higher even if it stays around the 100°C of the boiling water in the rest of the cookware. So, a few minutes in those conditions generates an important risk.

Let's quickly study another fundamental class of food components, those of the triglyceride (to which belongs most of the edible fat). These composites, when they are warm, undergo the chemical attack of the water in the food or added to cook. This reaction is called hydrolysis and produces 1,2,3-propanetriol (better known as glycerin or glycerol) and free fatty acids. In high temperature, the glycerin undergoes a chemical transformation: water is eliminated from its molecule and the product is the acrolein mentioned above, or

acrylic aldehyde, which is toxic for the liver and irritating for the stomach lining.

Another advantage of the non-stick cookware is the fact it enables to use very few quantity of fat, in contrast to the cookware which is not nonstick in which high quantity of fat is used to lessen the risk of food sticking in the cookware. It is well known though that the use of fat contributes to the occurrence of cardiovascular diseases and nutritionists highly suggest to reduce the consumption of fat. In this regard, the American Heart Association suggests explicitly to use, where it is possible, nonstick cookware: «*A pan made with nonstick metal or coated with a nonstick surface is a terrific investment, because it lets you use little or no oil without having food stick*».[27] A similar suggestion comes from the American National Stroke Association, in its «*Tips for eating healthy*» in which they list in first place: «*If sautéing something, use nonstick cookware*».[28]

To complete, a few considerations are to be done on the involuntary ingestion of portions of the nonstick cookware coating. Even though they have a low coefficient of friction, which makes them highly slippery, the teflon coatings can get scratched although less than other materials. It is thus natural to ask oneself it they are possible consequences and, in particular, what happens concerning the ingestion of small bits of coating.

Well, one of the main features of this material is its chemical inertia: if it wasn't it would rapidly degrade for its chemical reaction to the composites of the food prepared in the cookware. If part of the thin coating finishes accidentally in our body, it wouldn't undergo any chemical transformation, not even in the stomach, and it would be expelled as it is with the feces and the body would be completely indifferent to its passage.

A few problems can soar when the scratch exposes the metal underneath. The following possible inconveniences are practically the same as the cookware that is not nonstick. Adding to this that once the process of detachment in one point is done, the risk is that it will grow more rapidly around that point until the specific function of the cookware becomes obsolete: precisely to be nonstick. The companies that use it to produce coated pots and pans should invite the consumer, if they do not do it already, to not use the nonstick cookware as a cutting board and, in order to mix the food and clean the nonstick portion of the cookware not use metallic tools but proper ones in order to make the cookware last which, if properly used, can last several years. The latter usually expires for the end-of-life of other elements (for example the handles) and not for the coating precisely thanks to its chemical inertia. In the end: a scratched nonstick cookware should be replaced simply because it is not fulfilling it specific function of being nonstick.

Another confirmation to what we have asserted until now, is what the American Food & Drug Administration has to say about it: «*Perfluorocarbon resin is a tough, nonporous and stable plastic material that gives cookware and bakeware a surface to which foods will not stick and that cleans easily and quickly. FDA has approved the use of this material as safe for food-contact surfaces. The Agency has determined that neither the particles that may chip off nor the fumes given off at high temperatures pose a health hazard. However, because this nonstick finish may be scratched by sharp or rough-edged kitchen tools, the manufacturer's recommendations should be consulted and the use of utensils that may scratch, abrasive scouring pads, or cleaners avoided*».[29]

The use of cookware that is not nonstick has also some environmental pitfalls compared to the use of nonstick cookware. Among being unpleasant, the necessary preliminary manual work to clean a pan which is not nonstick asks much more water and detergent than nonstick pans. In the case of aluminum pans, the energetic and long scrub pours in the sewers a little bit of abraded aluminum. In brief: more input of detergent and aluminum in the environment.

So, once asserted, as it has been, that the nonstick coating of the cookware has no sanitary nor environmental relevance, a comparative evaluation damages/benefits between the nonstick cookware and the one that is not can only be in favor of the first one.

5. CONCLUSIONS

In view of the above, we have no hesitations in asserting that:

The use of nonstick cookware is safer and more environmental friendly than the use of cookware which is not nonstick.

PLEASE NOTE: that 31 attached documents are part of this report, composed of the documents quoted in Notes 1, 3-7, 10-22, 25-29.

NOTES

[1] F. Battaglia and G. Fochi, *Sulla presunta nocività del pentolame antiaderente* (2006).

[2] Other commercial names: fluon, algoflon, alflon, fluobond, fluoroloy, fluorosint, gaflon, klingerflon, polyflon, polyfluron, hostaflon, etc.

[3] (a) P. Honigfort, Consumer Safety Officer, Center for Food Safety and Applied Nutrition, U.S.A. Department of Health and Human Services: Letter on November 16th, 2005 to S. Korzenowski, Innovation Leader, DuPont Chemical Solutions Enterprise ("The potential for PFOA migration from perfluorocarbon resins used on cookware is negligible"); (b) C.R. Powley et al., *Analyst* **130**, 1299-1302 (2005); (c) *Efsa J.* **248**, 1, (2005); (d) *BfR*, Selected questions and answers about cookware and roastware with a non-stick coating, 1.11.2005, (e) S.T. Washburn et al., Environ. Sci. Technol. **39**, 3904 (2005).

[4] EPA letter to Dupont on January 25th, 2006.

[5] Codacons Letter to the law firm Bernini, and made public by Codacons on its own website: http://www.codacons.it/articolo.asp?idInfo=55717&id.

[6] (a) Foundation for cancer research "Fernanda e Gaudienzo Renzi", *Notiziario* September 2009; (b) G. Nardelli, *Il Salvagente*, November 5-12th, 2009; (c) E. Naselli, *Repubblica* (Sezione Salute), March 9th 2010; (d) L. Balza, *Medicina Democratica*, http://alessandriamd.blogspot.com/2010/03/lettera-mina.html.

[7] http://monographs.iarc.fr/ENG/Classification/index.php.

[8] Points 8 and 9 of this Decalogue are also groundless but not being object of this report we do not comment on them. Please see, however, note 14.

[9] Please see references in Note 6 of the document in Note 1.

[10] The American Council on Science and Health, *Teflon® and Human Health: Do the Charges Stick? Assessing the Safety of the Chemical PFOA* (2005).

[11] Letter in Note 4 and attached letter.

[12] J. L. Kennedy *et al.*, *Crit. Rev. Toxicol.* **34**, 351-384 (2004).

[13] EPA-SAB, PFOA Review Panel, Draft Risk Assessment of Potential Human Health Effects Associated with PFOa and Its Salts (2006).

[14] Iarc, *Internal Report 08/001: Recommended priorities for Iarc monographs during 2010-2014* (June 2008). On this subject, we would like to underline that aspartame is not part of these, but is listed among the 17 agents of "medium priority" worthy of attention for the period 2010-2014. This raise doubts on the credibility of this Decalogue published in 2009 by the *Foundation for Cancer Research* mentioned above which considered that not consuming aspartame was a determinant measure (even to be part of the Decalogue) to prevent cancer.

[15] Rif. (d) in Note 3.

[16] DTI certificates, 20.2.2004 e 30.4.2004.

[17] P. Phibbs, Regulation&Law n. 160, *Restricted uses of PFOA*, August 19th, 2005.

[18] D. Melzer, N. Rice, M. H. Depledge, W. E. Henley, T. S. Galloway, *Env. Health Persp.* **118**, 686-692 (2010).

[19] *Efsa J.* **653**, 1 (2008);

[20] M. Bononi and F. Tateo, Am. J. Agricolture and Biological Sci. **2**, 191 (2007).
[21] http://www.epa.gov/oppt/pfoa/pubs/faq.html.
[22] P. Altea, Interview at S. Polesello, *Laboratorio 2000*, **5**, 20-21 (2010).
[23] Please see references in Note 21 in the document in Note 1.
[24] R. Nicoletti, "*Cucina, chimica e salute*", Aracne Editrice (2009), pag. 95-99.
[25] M. A. E. Johansson, M. Jaegerstad, *Carcinogenesis* **15**, 1511-1518 (1994).
[26] E. Perrson, G. Graziani, R. Ferracane, V. Fogliano, K. Skog, *Food and Chem. Tox.* **41**, 1587-1597 (2003).
[27] American Heart Association, *Healthy Cooking Tips for People with Heart Failure* (2010): http://www.learn.gwtg.americanheart.org/presenter.jhtml?identifier=355.
[28] National Stroke Association, *Hope: The Stroke Recovery Guide* (2007), cap. 3, pag. 49: http://www.stroke.org/site/PageServer?pagename=HOPE.
[29] FDA, *Food Code 2009, Annex 3 - Public Health Reasons / Administrative Guidelines - Chapter 4, Equipment, Utensils, and Linens* (2009), pag. 447: http://www.fda.gov/Food/FoodSafety/RetailFoodProtection/FoodCode/FoodCode2009/ucm189212.htm.