LETTERS TO THE EDITOR

COMMENTS ON "POST-ACCIDENT HYDROGEN GENERATION FROM PROTECTIVE COATINGS IN POWER REACTORS"

Dear Sir:

Three articles which have been published in *Nuclear Technology* on hydrogen evolution from coatings in power reactors [H. E. ZITTEL, **17**, 143 (1973); D. W. La BELLE, **10**, 454 (1971); C. D. WATSON, J. C. GRIESS, T. H. ROW, and G. A. WEST, **10**, 538 (1971)] have done a grave injustice to the nuclear coatings industry through their incomplete conclusions, or through improper use and interpretation of the data which they presented. All three articles have highlighted the fact that hydrogen will be evolved during a loss-of-coolant accident (LOCA) inside a nuclear containment vessel. However, none of these have dwelt upon the reason for specifying inorganic zinc-rich coatings inside nuclear containment—the requirement for long life in a nuclear containment environment of high temperature and humidity.

It is the hope of every architect/engineer, constructor, and owner of a nuclear reactor facility that there will never be a LOCA in any facility with which he is involved. One tests coatings and, in fact, all components inside primary containment for their ability to withstand the accident which we hope will never occur. The most severe exposures which the components in a nuclear reactor undergo are the environmental life conditions in that reactor during its 40-yr operative life. The operating conditions of high humidity (80 to 100%) and high temperature (80 to 150°F) are far more severe on a coating system or a functional system than is a LOCA.

Corrosion is commonplace in environments such as we have inside a nuclear containment vessel. To prevent corrosion, it is necessary that the optimum in corrosion protection be specified and utilized. The optimum technology currently available to the protective coatings industry today dictates that inorganic zinc primers plus suitable topcoats must be used in nuclear containment if we are in any way to approximate a 40-yr design life. The three referenced articles have created a fear among many licensing personnel, owners, and engineers who are not necessarily knowledgeable of protective coatings, causing them to specify that no inorganic zinc or galvanizing be used inside nuclear containment. This is a self-defeating specification in that it creates a high maintenance cost and premature failures of coating and protective systems during the actual operating life of the plant.

Note that hydrogen will be evolved from zinc-rich coatings and galvanizing inside nuclear reactors, but that the amount which will be evolved is a constant predictable amount and well within the capability for handling of the hydrogen recombining off-gas systems which are currently being installed in all nuclear reactors.

A recent series of calculations on a 1000-MW(e) (approximate) pressurized water reactor containment gave figures on hydrogen evolved during a LOCA (see Table I). It must be granted that inorganic zinc primers will contribute some hydrogen to the containment atmosphere during a LOCA; this small amount can easily be handled by the hydrogen recombining systems.

What the owner of the facility and his architect/engineer must consider is this: can they tolerate this small amount of hydrogen and account for it in their safety analysis report or should inorganic zinc be eliminated from containment? If inorganic zinc is removed from containment areas, the possibility of premature coating failure (10% rust in 10 mo at 130°F; 100% relative humidity for two coats of catalyzed epoxy-polyamide materials, as compared to Carbo Zinc 11 inorganic zinc primer which shows no rusting after four years of exposure to the same environment) must be considered by all parties involved.

TABLE I

Hydrogen Evolved During a Loss-of-Coolant Accident

	Hydrogen Generated in Containment Atmosphere (%)		
Source	1 day	10 days	30 days
Radiolysis of nuclear solution	0.50	1.20	1.70
Zirconium-water reaction	0.36	0.36	0.36
Electrolysis of water	trace	trace	trace
Corrosion of metals	0.003	0.03	0.09
Aluminum	0.06	0.60	1.80
Galvanized surfaces	0.69	0.69	0.69
Carbo-Zinc-11-coated surfaces (inorganic zinc at 3 to 5 mils)	0.34	0.34	0.34
Total	1.95	3.22	4.98

We feel that we must, therefore, add to Zittel's conclusion that inorganic zinc primers should be used in nuclear containment, but that, indeed, it will be necessary—if they are used—to account for them in the Safety Analysis Reports to the Atomic Energy Commission. It is our feeling, also, that if inorganic zinc primers are not used, accountability to the owner of the facility should be made for the frequent maintenance and high cost of same which will be required on the facility.

James R. Lopata

Carboline Company
St. Louis, Missouri

April 6, 1973

REPLY TO "COMMENTS ON 'POST-ACCIDENT HYDROGEN GENERATION FROM PROTECTIVE COATINGS IN POWER REACTORS' "

Dear Sir:

I wish to make the following response to the Letter-to-the-Editor submitted by J. R. Lopata of the Carboline Company. I regret that Lopata feels the nuclear coatings industry was slighted by my article, "Post Accident Hydrogen Generation and Control." However, it was not the intent of my article to demonstrate the acceptability, or endorse the use, of inorganic zinc-rich coatings inside nuclear containment.

My article was written in mid-1970 when post-LOCA hydrogen control via purging (venting) of pressurized water reactor containments was a much publicized subject. As I concluded in my article, purging affords an effective primary and backup means of hydrogen control following a loss-of-coolant accident (LOCA) at many reactor sites without significantly increasing the release of fission products and resulting site doses above those incurred from containment leakage alone. As for hydrogen generation, I stated that three major sources of hydrogen had to be considered: (a) the radiolysis of coolant water, (b) the zirconium-water reaction, and (c) the reaction of aluminum and zinc with the reactor building spray solution. The latter source would include inorganic zinc-rich coatings used in containment.

Provided the owner of a nuclear facility or his architect/engineer can account for all significant sources of hydrogen generation in containment, including inorganic zinc-rich coatings, in his safety analysis report and can demonstrate that purging results in acceptable site doses, the intent of my article is met. However, when a reduction in purging dose is required (i.e., a lengthening of the time before purging is required to allow for additional fission product decay), it is often sufficient just to minimize as low as practicable aluminum and zinc within containment. According to the figures presented by Lopata for a typical 1000-MW(e) plant, galvanized surfaces and inorganic zinc-rich-coated surfaces may generate ~1 vol% of the post-LOCA hydrogen, or one-fourth of the 4.1 vol% lower flammability limit for hydrogen. Galvanized and inorganic-zinc-coated surfaces will thus become primary items for reduction or elimination from containment.

Hydrogen recombiner systems provide for hydrogen removal within containment and eliminate the concern over increasing site doses by having to vent the reactor building, i.e., provided purging is not required as a backup means of hydrogen control. The recombiner obviously permits a greater allowance for hydrogen generation since the system can be properly sized to maintain the hydrogen concentration below its lower flammability limit. Thus, hydrogen from inorganic zinc-rich coatings can be more readily accommodated inside containment when recombiners are used.

Based on my experience with hydrogen generation and control, I cannot totally discount the use of inorganic zinc-rich coatings within reactor containment because of hydrogen evolution. However, even if these coatings pose no hydrogen problem, I would recommend that owners or architect/engineers further investigate the acceptability of these coatings under long-term service and LOCA environment conditions before specifying their use within containment.

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