CHINA SYNDROME

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INTRODUCTION

The China Syndrome is a hypothetical accident that would result from a core meltdown with the corium material penetrating through the pressure vessel then through the concrete mat below the pressure vessel of a Light Water Reactor, LWR.

The name: "China Syndrome" comes from the fictitious suggestion that the molten debris pool would sink down and re-emerge at the opposite side of the globe. The fact is, that even if a debris pool forms, it would cool down at a moderate depth of a few meters.

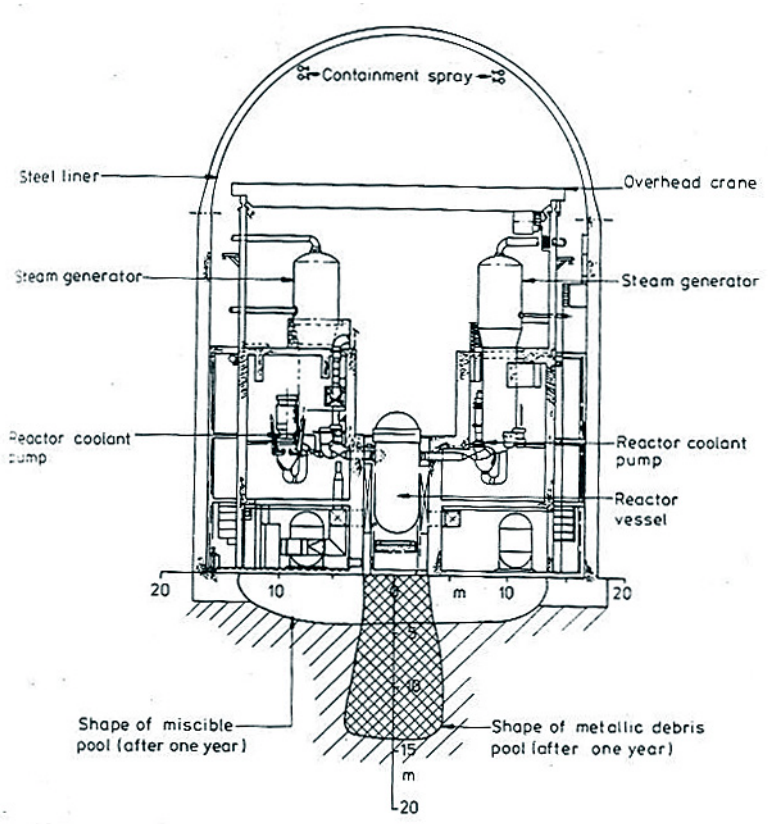

Figure 1. Debris pool for corium penetration of the base mat below a PWR pressure vessel. Miscible pool extent and metallic debris pool shape and depth after 1 year for a hypothetical core meltdown.

PHENOMENOLOGY

In the hypothetical postulated event of a LWR core meltdown, the molten core material or “corium” would penetrate the reactor vessel, down to the containment sump then to the containment’s concrete base mat.

If the molten pool is not cooled down by causing a steam explosion with any accumulated water in the containment sump, it is assumed that the heat generated from the decay of the molten fission products will keep the pool warm enough to sink down while increasing in radius according to:

$$r = Cz^{\frac{1}{4}} \tag{1}$$

where z is the depth of the sinking pool.

Two situations present themselves depending on the composition of the molten pool.

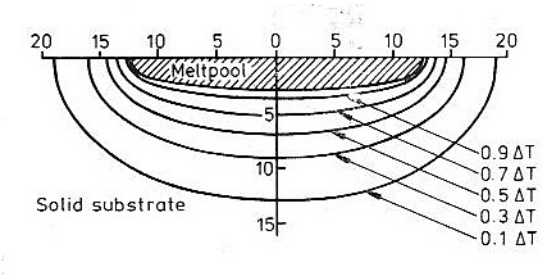

Figure 2. Temperature distribution above the ambient temperature around a miscible pool 13 m in radius and 3 m in depth after 1 year for a 3,000 MWth PWR.

1. OXIDE MELT

If the molten material is composed primarily of oxides, it is likely to be miscible with the base Mat concrete and the underlying rock.

A miscible molten of a limited depth at just 3 m would be formed and with a radius of 13 m. The pool would remain molten for a period of a few years.

The temperature around the pool will remain above the ambient temperature of the underlying rock, as the generated heat is dissipated in the rock around the pool.

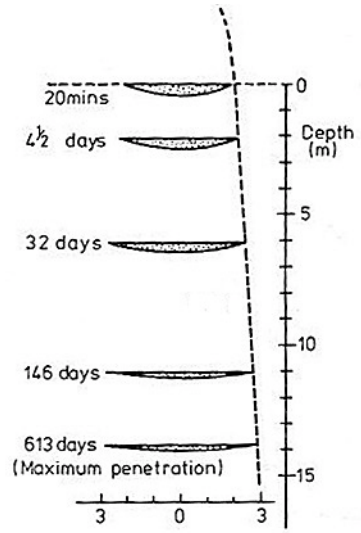

Figure 3. Hypothetical descent of a 3 m^3 lens-shaped immiscible debris pool to a maximum depth 14 m within 613 days.

2. MOLTEN STEEL MELT

If in the melting process steel from the pressure vessel also melts, it can dissolve the fission products from the molten fuel. If the molten steel oxidizes, the molten pool will be miscible with the concrete and the rock and a situation like the previous case arises.

If , on the other hand, the steel is not oxidized and remains in the metallic state, the mixed steel and fission products solution will not be miscible with the concrete and underlying rock.

In this case, the molten mixture will continue penetrating the base rock deeper. A molten immiscible pool can now penetrate further, but only to a depth of about 14 m.

This is certainly not the fictitious and physically impossible case to the center of the already molten Earth outer core or solid inner core, let alone to the other side.

DISCUSSION

The chemical interaction of the molten fuel and the concrete is more likely to generate significant amount of the water in the concrete as steam, and other gases such as hydrogen.

The steam and gases generation would more likely lead to the pressurization of the containment structure over an extended period of time, and eventually fail it, if no cooling is available.

This suggests that implementing a cooling process in the unlikely extreme situation of a core melt-through event is the scenario that is worthy of attention, and not the totally fictitious assumptions of the China Syndrome.