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FTP/P7-08: Deterministically Safe Highly Sub-Critical Fission-Fusion Hybrid Reactors

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Fusion Fission Hybrids present a much less technically demanding, nearer term, application of fusion research. Pre-conceptual designs of Fission-Fusion Hybrids are based on conventional tokamaks and spherical tokamaks are presented and compared. The designs have multiple unique features, relative to other hybrid approaches. The worst of nuclear accidents- the criticality accidents –are deterministically excluded, even for a worst case core rearrangement in an extreme accident. This feature is unique to a Hybrid driven by a relatively strong neutron source, with a judiciously chosen fission blanket and fuel cycle. Nuclear fuel reprocessing is minimized or avoided entirely if possible. For waste incineration or fuel production, high support ration fuel cycles are examined where a single hybrid can support many more fission reactors of the same power. Incremental waste incineration rates are several times faster than for fission-only or accelerator approaches. The fission and fusion blankets are physically separate- to insure safety, and to allow a maximum utilization of existing technology. The fusion driver is a replaceable module that allows the use of two fusion modules to achieve high system availability, when a single module has availability of only ˜ 40%. Detailed neutronic calculations demonstrate the waste incineration, fuel production and direct energy production capabilities of these hybrids. Fuel breeding for Light Water Reactors (LWRs) is possible with no fuel reprocessing, in which, a single hybrid can support about 4 LWRs of comparable power.

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