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On Heat Loading, Novel Divertors, and Fusion Reactors

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A new magnetic divertor geometry has been proposed to solve reactor heat exhaust problems, which are far more severe for a reactor than for ITER. Using reactor-compatible coils to generate an extra X-point downstream from the main X-point, the new X-divertor (XD) is shown to greatly expand magnetic flux at the divertor plates. As a result, the heat is distributed over a larger area and the line length is greatly increased. The heat-flux limitations of a standard divertor (SD) force a high core radiation fraction (f_{Rad}) in most reactor designs that necessarily have a several times higher ratio of heating power to radius (P/R) than ITER. It is argued that such high values of f_{Rad} will probably have serious deleterious consequences on the core confinement and stability of a burning plasma. Operation with internal transport barriers (ITBs) does not appear to overcome this problem. By reducing the core f_{Rad} within an acceptable range, the X-divertor is shown to substantially lower the core confinement requirement for a fusion reactor. As a bonus, the XD also enables the use of liquid metals by reducing the MHD drag. A possible series of experiments for an efficient and attractive path to practical fusion power is suggested.