SECTION_SPH_*{OPTION}

Available options include:

<BLANK>

ELLIPSE

INTERACTION (See Remark 3)

USER (See Remark 2)

Purpose: Define section properties for SPH particles.

NOTE: This feature is not supported for use in implicit calculations.

Card Sets. For each SPH section add one set of the following cards (depending on the keyword option). This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	SECID	CSLH	HMIN	HMAX	SPHINI	DEATH	START	SPHKERN
Type	I/A	F	F	F	F	F	F	I
Default	none	1.2	0.2	2.0	0.0	10^{20}	0.0	0

Ellipse Card. Additional card for ELLIPSE keyword option.

Card 2	1	2	3	4	5	6	7	8
Variable	HXCSLH	HYCSLH	HZCSLH	HXINI	HYINI	HZINI		
Type	F	F	F	F	F	F		

VARIABLE	DESCRIPTION
SECID	Section ID. SECID is referenced on the *PART card. A unique number or label must be specified.

VARIABLE	DESCRIPTION
CSLH	Constant used to calculate the initial smoothing length of the particles. The default value works for most problems. Values between 1.05 and 1.3 are acceptable. Taking a value less than 1 is inadmissible. Values larger than 1.3 will increase the computational time. The default value is recommended. See Remark 1.
HMIN	Scale factor for the minimum smoothing length. See Remark 1.
HMAX	Scale factor for the maximum smoothing length. See Remark 1.
SPHINI	Optional initial smoothing length (overrides true smoothing length). With this option LS-DYNA will not calculate the smoothing length during initialization, and the field CSLH is ignored.
DEATH	Time imposed SPH approximation is stopped.
START	Time imposed SPH approximation is activated.
SPHKERN	Option for SPH kernel functions (smoothing functions): EQ.0: Cubic spline kernel function (default). EQ.1: Quintic spline kernel function: a higher order smoothing function with a larger support size (recommend using with HMAX = 3.0 or larger). It is only available for the 3D case with FORM = 0, 1, 5, 6, 9 and 10 (see *CONTROL_SPH). EQ.2: Quadratic spline kernel function: it helps to relieve the problem of compressive instability and aims for HVI problems. It is only available for the 3D case with FORM = 0, 1, 5, and 6 (see *CONTROL_SPH). EQ.3: Quartic kernel function: this kernel function is very close to cubic spline kernel function but is more stable. It is only available for the 3D case with FORM = 0, 1, 5, and 6 (see *CONTROL_SPH).
HXCSLH	Constant applied for the smoothing length in the *x*-direction for the ellipse case.
HYCSLH	Constant applied for the smoothing length in the *y*-direction for the ellipse case.

VARIABLE	DESCRIPTION
HZCSLH	Constant applied for the smoothing length in the z-direction for the ellipse case.
HXINI	Optional initial smoothing length in the x-direction for the ellipse case (overrides true smoothing length)
HYINI	Optional initial smoothing length in the y-direction for the ellipse case (overrides true smoothing length)
HZINI	Optional initial smoothing length in the z-direction for the ellipse case (overrides true smoothing length)

Remarks:

1. **Smoothing Length.** The SPH processor in LS-DYNA employs a variable smoothing length. LS-DYNA computes the initial smoothing length, h_0, for each SPH part by taking the maximum of the minimum distance between every particle and then scaling this value by CSLH. The recommended values of CSLH should be used so that the radius of the support domain covers more than two layers of SPH particles along each direction. Every particle has its own smoothing length which varies in time according to the following equation:

$$\frac{d}{dt}h(t) = h(t)\nabla \cdot \mathbf{v} ,$$

where $h(t)$ is the smoothing length, and $\nabla \cdot \mathbf{v}$ is the divergence of the flow. The smoothing length increases as particles separate and reduces as the concentration increases. This scheme is designed to hold constant the number of particles in each neighborhood. In addition to being governed by the above evolution equation, the smoothing length is constrained to be between a user-defined upper and lower value,

$$\text{HMIN} \times h_0 < h(t) < \text{HMAX} \times h_0.$$

Defining a value of 1 for HMIN and 1 for HMAX will result in a constant smoothing length in time and space.

2. **USER Option.** The USER option allows the definition of customized subroutine for the variation of the smoothing length. A subroutine called *hdot* is defined in the file dyn21.F (Unix/linux) or lsdyna.f (Windows).

3. **Inter-Part Particle Interaction.** There are two fundamental ways that particles from different SPH parts can interact with each other. One way is

through "particle approximation" and the other way is through *DEFINE_-SPH_TO_SPH_COUPLING. When CONT = 0 in *CONTROL_SPH, "particle approximation" is used for all SPH parts in treating inter-part particle interaction. When CONT = 1 in *CONTROL_SPH, inter-part particle interaction by "particle approximation" occurs only for those SPH parts that use *SECTION_-SPH_INTERACTION, while any SPH part that does not make use of *SECTION_SPH_INTERACTION will not participate in inter-part particle interaction, *except* as defined using *DEFINE_SPH_TO_SPH_COUPLING.