*CESE

The keyword *CESE provides input data for the Conservation Element/Solution Element (CESE) compressible fluid solver:

CESE_BOUNDARY_AXISYMMETRIC_*{OPTION}

CESE_BOUNDARY_BLAST_LOAD}*

CESE_BOUNDARY_CONJ_HEAT_*{OPTION}

CESE_BOUNDARY_CYCLIC_*{OPTION}

CESE_BOUNDARY_FSI_*{OPTION}

CESE_BOUNDARY_NON_REFLECTIVE_*{OPTION}

CESE_BOUNDARY_PRESCRIBED_*{OPTION}

CESE_BOUNDARY_REFLECTIVE_*{OPTION}

CESE_BOUNDARY_SLIDING_*{OPTION}

CESE_BOUNDARY_SOLID_WALL_*{OPTION1}_{OPTION2}

*CESE_CHEMISTRY_D3PLOT

*CESE_CONTROL_LIMITER

*CESE_CONTROL_MESH_MOV

*CESE_CONTROL_SOLVER

*CESE_CONTROL_TIMESTEP

*CESE_DATABASE_ELOUT

*CESE_DATABASE_FLUXAVG

*CESE_DATABASE_FSIDRAG

*CESE_DATABASE_POINTOUT

*CESE_DATABASE_SSETDRAG

*CESE_DEFINE_NONINERTIAL

*CESE_DEFINE_POINT

*CESE_DRAG

*CESE_EOS_CAV_HOMOG_EQUILIB_

*CESE_EOS_IDEAL_GAS

*CESE_EOS_INFLATOR1

*CESE_EOS_INFLATOR2

*CESE_FSI_EXCLUDE

*CESE_INITIAL

CESE_INITIAL_*{OPTION}

*CESE_INITIAL_CHEMISTRY

*CESE_INITIAL_CHEMISTRY_ELEMENT

*CESE_INITIAL_CHEMISTRY_PART

*CESE_INITIAL_CHEMISTRY_SET

*CESE_MAT_000

*CESE_MAT_001 (*CESE_MAT_GAS)

*CESE_MAT_002

*CESE_PART

*CESE_SURFACE_MECHSSID_D3PLOT

*CESE_SURFACE_MECHVARS_D3PLOT

Note that when performing a chemistry calculation with the CESE solver, initialization should only be done with the *CESE_INITIAL_CHEMISTRY_… cards, not the *CESE_-INITIAL… cards.

CESE_BOUNDARY_AXISYMMETRIC_*OPTION

Available options are:

MSURF

MSURF_SET

SET

SEGMENT

Purpose: Define an axisymmetric boundary condition on the axisymmetric axis for the 2D axisymmetric CESE compressible flow solver.

The MSURF and MSURF_SET options are used when the CESE mesh has been created using *MESH cards. The SET and SEGMENT cards are used when *ELEMENT_SOLID cards are used to define the CESE mesh.

Card Summary:

Card 1a. This card is included if the keyword option is MSURF. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

MSURFID							

Card 1b. This card is included if the keyword option is MSURF_SET. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

MSURF_S							

Card 1c. This card is included if the keyword option is SET. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

SSID							

Card 1d. This card is included if the keyword option is SEGMENT. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

N1	N2	N3	N4				

Data Card Definitions:

Surface Part Card. Card 1 format used when the MSURF keyword option is active. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1a	1	2	3	4	5	6	7	8
Variable	MSURFID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
MSURFID	Mesh surface part ID referenced in *MESH_SURFACE_ELEMENT cards.

Surface Part Set Card. Card 1 format used when the MSURF_SET keyword option is active. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1b	1	2	3	4	5	6	7	8
Variable	MSURF_S							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
MSURF_S	Identifier of a set of mesh surface part IDs created with a *LSO_-ID_SET card, where each mesh surface part ID in the set is referenced in *MESH_SURFACE_ELEMENT cards.

Set Card. Card 1 format used when the SET keyword option is active. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1c	1	2	3	4	5	6	7	8
Variable	SSID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
SSID	Segment set ID

Segment Cards. Card 1 format used when SEGMENT keyword option is active. Include an additional card for each corresponding pair of segments. This input ends at the next keyword ("*") card.

Card 1d	1	2	3	4	5	6	7	8
Variable	N1	N2	N3	N4				
Type	I	I	I	I				
Default	none	none	none	none				

VARIABLE	DESCRIPTION
N1, N2, …	Node IDs defining a segment

Remarks:

1. **Restrictions.** This boundary condition can only be used on the axisymmetric axis for the 2D axisymmetric CESE fluid solver.

CESE_BOUNDARY_BLAST_LOAD_*OPTION

Available options include:

MSURF

MSURF_SET

SET

SEGMENT

Purpose: For the CESE compressible flow solver, set boundary values for velocity, density, and pressure from a blast wave defined by a *LOAD_BLAST_ENHANCED card. Boundary values are applied at the centroid of elements connected with this boundary. *OPTION* = SET and *OPTION* = SEGMENT are for user defined meshes whereas *OPTION* = MSURF and *OPTION* = MSURF_SET are associated with the automatic volume mesher (See *MESH keywords). In other words, the MSURF and MSURF_SET options are used when the CESE mesh has been created using *MESH cards. The SET and SEGMENT cards are used when *ELEMENT_SOLID cards are used to define the CESE mesh.

Card Summary:

Card 1a. This card is included if the keyword option is MSURF.

BID	MSURFID						

Card 1b. This card is included if the keyword option is MSURF_SET.

BID	MSURF_S						

Card 1c. This card is included if the keyword option is SET.

BID	SSID						

Card 1d. This card is included if the keyword option is SEGMENT.

BID	N1	N2	N3	N4			

Data Card Definitions:

Surface Part Card. Card 1 format used when the MSURF keyword option is active.

Card 1a	1	2	3	4	5	6	7	8
Variable	BID	MSURFID						
Type	I	I						
Default	none	none						

VARIABLE	DESCRIPTION
BID	Blast source ID (see *LOAD_BLAST_ENHANCED)
MSURFID	A mesh surface part ID referenced in *MESH_SURFACE_ELEMENT cards

Surface Part Set Card. Card 1 format used when the MSURF_SET keyword option is active.

Card 1b	1	2	3	4	5	6	7	8
Variable	BID	MSURF_S						
Type	I	I						
Default	none	none						

VARIABLE	DESCRIPTION
BID	Blast source ID (see *LOAD_BLAST_ENHANCED)
MSURF_S	Identifier of a set of mesh surface part IDs created with a *LSO_ID_SET card, where each mesh surface part ID in the set is referenced in *MESH_SURFACE_ELEMENT cards.

Set Card. Card 1 format used when the SET keyword option is active.

Card 1c	1	2	3	4	5	6	7	8
Variable	BID	SSID						
Type	I	I						
Default	none	none						

VARIABLE	DESCRIPTION
BID	Blast source ID (see *LOAD_BLAST_ENHANCED)
SSID	Segment set ID

Segment Card. Card 1 for SEGMENT keyword option is active.

Card 1d	1	2	3	4	5	6	7	8
Variable	BID	N1	N2	N3	N4			
Type	I	I	I	I	I			
Default	none	none	none	none	none			

VARIABLE	DESCRIPTION
BID	Blast source ID (see *LOAD_BLAST_ENHANCED)
N1, N2, …	Node ID's defining a segment

CESE_BOUNDARY_CONJ_HEAT_*OPTION

Available options are:

MSURF

MSURF_SET

SET

SEGMENT

Purpose: Define a conjugate heat transfer interface condition for CESE compressible flows. This condition identifies those boundary faces of the CESE mesh that are in contact with non-moving structural parts and through which heat flows. This is only possible when the structural thermal solver is also being used in the structural parts.

The MSURF and MSURF_SET options are used when the CESE mesh has been created using *MESH cards. The SET and SEGMENT cards are used when *ELEMENT_SOLID cards are used to define the CESE mesh.

Card Summary:

Card 1a. This card is included when the keyword option is MSURF. Include as many cards as necessary. This input ends at the next keyword ("*") card.

MSURFID							

Card 1b. This card is included when the keyword option is MSURF_SET. Include as many cards as necessary. This input ends at the next keyword ("*") card.

MSURF_S							

Card 1c. This card is included when the keyword option is SET. Include as many cards as necessary. This input ends at the next keyword ("*") card.

SSID							

Card 1d. This card is included when the keyword option is SEGMENT. Include as many cards as necessary. This input ends at the next keyword ("*") card.

N1	N2	N3	N4				

Data Card Definitions:

Surface Part Card. Card 1 used when the MSURF keyword option is active. Include as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1a	1	2	3	4	5	6	7	8
Variable	MSURFID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
MSURFID	Mesh surface part ID referenced in *MESH_SURFACE_ELEMENT cards.

Surface Part Set Card. Card 1 used when the MSURF_SET keyword option is active. Include as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1b	1	2	3	4	5	6	7	8
Variable	MSURF_S							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
MSURF_S	Identifier of a set of mesh surface part IDs created with an *LSO_-ID_SET card, where each mesh surface part ID in the set is referenced in *MESH_SURFACE_ELEMENT cards.

Set Card. Card 1 used when the SET keyword option is active. Include as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1c	1	2	3	4	5	6	7	8
Variable	SSID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
SSID	Segment set ID

Segment Cards. Card 1 used when SEGMENT keyword option is active. Include an additional card for each corresponding pair of segments. This input ends at the next keyword ("*") card.

Card 1d	1	2	3	4	5	6	7	8
Variable	N1	N2	N3	N4				
Type	I	I	I	I				
Default	none	none	none	none				

VARIABLE	DESCRIPTION
N1, N2, …	Node IDs defining a segment

Remarks:

1. **Restrictions.** This boundary condition should only be imposed on a CESE mesh boundary that is in contact with non-moving structural parts. An Eulerian CESE solver is required as is use of the structural thermal solver.

CESE_BOUNDARY_CYCLIC_*OPTION

Available options are:

MSURF

MSURF_SET

SET

SEGMENT

Purpose: Define a cyclic (periodic) boundary condition for CESE compressible flows. This cyclic boundary condition can be used on periodic boundary surfaces.

The MSURF and MSURF_SET options are used when the CESE mesh has been created using *MESH cards. The SET and SEGMENT cards are used when *ELEMENT_SOLID cards are used to define the CESE mesh.

Card Summary:

Include as many sets of the following cards as needed. This input ends at the next keyword ("*") card.

Card 1a. This card is included when the keyword option is set to MSURF.

MSURFID1	MSURFID2	CYCTYP					

Card 1b. This card is included when the keyword option is set to MSURF_SET.

MSRF_S1	MSRF_S2	CYCTYP					

Card 1c. This card is included when the keyword option is set to SET.

SSID1	SSID2	CYCTYP					

Card 1d. This card is included when the keyword option is set to SEGMENT.

ND1	ND2	ND3	ND4	NP1	NP2	NP3	NP4

Card 2a. This card is included for the MSURF, MSURF_SET, and SET options when CYCTYP = 1.

AXISX1	AXISY1	AXISZ1	DIRX	DIRY	DIRZ	ROTANG	

Card 2b. This card is included for the MSURF, MSURF_SET, and SET options when CYCTYP = 2.

TRANSX	TRANSY	TRANSZ					

Data Card Definitions:

Surface Part Card. Card 1 format when the MSURF keyword option is active

Card 1a	1	2	3	4	5	6	7	8
Variable	MSURFID1	MSURFID2	CYCTYP					
Type	I	I	I					
Default	none	none	0					
Remarks	2	2	1					

VARIABLE	DESCRIPTION
MSURFID1, MSURFID2	Mesh surface part IDs referenced in *MESH_SURFACE_ELEMENT cards.
CYCTYP	Relationship between the two cyclic boundary condition surfaces: EQ.0: None assumed (default) EQ.1: The first surface is rotated about an axis to match the second surface. EQ.2: The faces of the first surface are translated in a given direction to obtain the corresponding faces on the second surface.

Surface Part Set Card. Card 1 format when the MSURF_SET keyword option is active

Card 1b	1	2	3	4	5	6	7	8
Variable	MSRF_S1	MSRF_S2	CYCTYP					
Type	I	I	I					
Default	none	none	0					
Remarks	3	3	1					

VARIABLE	DESCRIPTION
MSRF_S1, MSRF_S2	Identifiers of two sets of mesh surface part IDs, each created with a *LSO_ID_SET card, where each mesh surface part ID in each set is referenced in *MESH_SURFACE_ELEMENT cards.
CYCTYP	Relationship between the two cyclic boundary condition surfaces: EQ.0: None assumed (default) EQ.1: The first surface is rotated about an axis to match the second surface. EQ.2: The faces of the first surface are translated in a given direction to obtain the corresponding faces on the second surface.

Set Card. Card 1 format when the SET keyword option is active

Card 1c	1	2	3	4	5	6	7	8
Variable	SSID1	SSID2	CYCTYP					
Type	I	I	I					
Default	none	none	0					
Remarks	4	4	1					

VARIABLE	DESCRIPTION
SSID1, SSID2	A pair of segment set IDs.
CYCTYP	Relationship between the two cyclic boundary condition surfaces: EQ.0: None assumed (default) EQ.1: The first surface is rotated about an axis to match the second surface. EQ.2: The faces of the first surface are translated in a given direction to obtain the corresponding faces on the second surface.

Segment Card. Card 1 format when SEGMENT keyword option is active. Include an additional card for each corresponding pair of segments. This input ends at the next keyword ("*") card.

Card 1d	1	2	3	4	5	6	7	8
Variable	ND1	ND2	ND3	ND4	NP1	NP2	NP3	NP4
Type	I	I	I	I	I	I	I	I
Default	none	none	none	none	none	none	none	none

VARIABLE	DESCRIPTION
ND*i*, NP*i*	Node IDs defining a pair of segments: ND1, ND2, ND3, ND4 define the first segment, while NP1, NP2, NP3, NP4 define the second segment. This pair of segments must match either through a geometric translation or rotation.

Rotation Case Card. Additional card for the MSURF, MSURF_SET, and SET options when CYCTYP = 1.

Card 2a	1	2	3	4	5	6	7	8
Variable	AXISX1	AXISY1	AXISZ1	DIRX	DIRY	DIRZ	ROTANG	
Type	F	F	F	F	F	F	F	
Default	0.0	0.0	0.0	none	none	none	none	

VARIABLE	DESCRIPTION
AXIS[Z,Y,Z]1	A point on the axis of rotation
DIR[X,Y,Z]	The direction which together with AXIS[X,Y,Z]1 defines the axis of rotation
ROTANG	The angle of rotation (in degrees) that transforms the centroid of each face on the first surface to the centroid of the corresponding face on the second surface

Translation Case Card. Additional card for the MSURF, MSURF_SET, and SET options when CYCTYP = 2.

Card 2b	1	2	3	4	5	6	7	8
Variable	TRANSX	TRANSY	TRANSZ					
Type	F	F	F					
Default	none	none	none					

VARIABLE	DESCRIPTION
TRANS[X,Y,Z]	The translation direction that enables the identification of the segment in the second surface that matches a segment in the first surface

Remarks:

1. **CYCTYP.** For the MSURF, MSURF_SET, or SET options with CYCTYP = 0, the code examines the geometry of two faces of the two surfaces in order to determine if the surfaces are approximately parallel (CYCTYP = 2) or related through a rotation (CYCTYP = 1). The geometric parameters required are then computed.

2. **MSURF.** For the MSURF option, the number of mesh surface elements must be the same in each mesh surface part. The mesh surface elements in each mesh surface part are then internally ordered to match pairwise between the two mesh surface parts.

3. **MSURF_SET.** For the MSURF_SET option, the number of mesh surface elements must be the same in each mesh surface part set. The mesh surface elements in each mesh surface part set are then internally ordered to match pairwise between the two mesh surface part sets.

4. **SET.** For the SET option, the same number of segments must be in each set. The segments in each set are then internally ordered to match pairwise between the two sets.

CESE_BOUNDARY_FSI_*OPTION

Available options are:

MSURF

MSURF_SET

SET

SEGMENT

Purpose: Define an FSI boundary condition for the moving mesh CESE compressible flow solver. This card must not be combined with the immersed-boundary method CESE solver; doing so will result in an error termination condition.

This boundary condition must be applied on a surface of the CESE computational domain that is co-located with surfaces of the outside boundary of the structural mechanics' mesh. The nodes of the two meshes will generally not be shared.

The MSURF and MSURF_SET options are used when the CESE mesh has been created using *MESH cards. The SET and SEGMENT cards are used when *ELEMENT_SOLID cards are used to define the CESE mesh.

Card Summary:

Card 1a. This card is included if the keyword option is MSURF. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

MSURFID							

Card 1b. This card is included if the keyword option is MSURF_SET. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

MSURF_S							

Card 1c. This card is included if the keyword option is SET. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

SSID							

Card 1d. This card is included if the keyword option is SEGMENT. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

N1	N2	N3	N4				

Data Card Definitions:

Surface Part Card. Card 1 format used when the MSURF keyword option is active. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1a	1	2	3	4	5	6	7	8
Variable	MSURFID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
MSURFID	Mesh surface part ID referenced in *MESH_SURFACE_ELEMENT cards

Surface Part Set Card. Card 1 format used when the MSURF_SET keyword option is active. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1b	1	2	3	4	5	6	7	8
Variable	MSURF_S							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
MSURF_S	Identifier of a set of mesh surface part IDs created with a *LSO_-ID_SET card, where each mesh surface part ID in the set is referenced in *MESH_SURFACE_ELEMENT cards.

Set Card. Card 1 format used when the SET keyword option is active. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1c	1	2	3	4	5	6	7	8
Variable	SSID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
SSID	Segment set ID

Segment Cards. Card 1 format used when SEGMENT keyword option is active. Include an additional card for each corresponding pair of segments. This input ends at the next keyword ("*") card.

Card 1d	1	2	3	4	5	6	7	8
Variable	N1	N2	N3	N4				
Type	I	I	I	I				
Default	none	none	none	none				

VARIABLE	DESCRIPTION
N1, …	Node IDs defining a segment

Remarks:

1. **Conjugate Heat Transfer Problems.** This boundary condition card is also needed for conjugate heat transfer problems with the moving mesh CESE solver.

CESE_BOUNDARY_NON_REFLECTIVE_*OPTION

Available options are:

MSURF

MSURF_SET

SET

SEGMENT

Purpose: Define a passive boundary condition for CESE compressible flows. This non-reflective boundary condition (NBC) provides an artificial computational boundary for an open boundary that is passive.

Use the MSURF and MSURF_SET options when you use the *MESH cards to generate the CESE mesh. Use the SET and SEGMENT cards when *ELEMENT_SOLID cards define the CESE mesh.

Card Summary:

Card 1a. Include this card for the MSURF keyword option. Include as many cards as necessary. This input ends at the next keyword ("*") card.

MSURFID							

Card 1b. Include this card for the MSURF_SET keyword option. Include as many cards as necessary. This input ends at the next keyword ("*") card.

MSURF_S							

Card 1c. Include this card for the SET keyword option. Include as many cards as necessary. This input ends at the next keyword ("*") card.

SSID							

Card 1d. Include this card for the SEGMENT keyword option. Include an additional card for each corresponding pair of segments. This input ends at the next keyword ("*") card.

N1	N2	N3	N4				

Data Card Definitions:

Surface Part Card. Card 1 used when the MSURF keyword option is active. Include as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1a	1	2	3	4	5	6	7	8
Variable	MSURFID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
MSURFID	Mesh surface part ID referenced by *MESH_SURFACE_ELEMENT cards

Surface Part Set Card. Card 1 used when the MSURF_SET keyword option is active. Include as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1b	1	2	3	4	5	6	7	8
Variable	MSURF_S							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
MSURF_S	ID of a set of mesh surface parts created with an *LSO_ID_SET card, where each mesh surface part ID in the set is referenced by *MESH_SURFACE_ELEMENT cards.

Set Card. Card 1 used when the SET keyword option is active. Include as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1c	1	2	3	4	5	6	7	8
Variable	SSID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
SSID	Segment set ID

Segment Cards. Card 1 used when the SEGMENT keyword option is active. Include an additional card for each corresponding pair of segments. This input ends at the next keyword ("*") card.

Card 1d	1	2	3	4	5	6	7	8
Variable	N1	N2	N3	N4				
Type	I	I	I	I				
Default	none	none	none	none				

VARIABLE	DESCRIPTION
N1, N2, …	Node IDs defining a segment

Remarks:

1. **Normal application of this boundary condition.** We recommend imposing this boundary condition on an open surface far from the main disturbed flow (the further away, the better), meaning an almost uniform flow on the boundary surface.

2. **Default boundary condition for CESE.** LS-DYNA automatically assigns the non-reflective boundary condition to any boundary segment not already assigned a boundary condition by any of the *CESE_BOUNDARY_… cards.

CESE_BOUNDARY_PRESCRIBED_*OPTION

Available options include:

MSURF

MSURF_SET

SET

SEGMENT

Purpose: For the CESE compressible flow solver, set boundary values for velocity, density, pressure, and temperature. Boundary values are applied at the centroid of elements connected with this boundary. Use keyword options SET or SEGMENT for user-defined meshes, meaning mesh specified with *ELEMENT_SOLID card. Use MSURF or MSURF_SET for meshes created with the automatic volume mesher, meaning meshes generated with the *MESH cards.

Card Summary:

A set of data cards for this keyword consists of 3 of the following cards:

1. Card 1 specifies the object to which the boundary condition is applied. Its format depends on the keyword option.
2. Card 2 reads in load curve IDs.
3. Card 3 reads in scale factors.

For each boundary condition to be specified include one set of cards. This input ends at the next keyword ("*") card.

Card 1a. Include this card for the MSURF keyword option.

MSURFID	IDCOMP						

Card 1b. Include this card for the MSURF_SET keyword option.

MSURF_S	IDCOMP						

Card 1c. Include this card for the SET keyword option.

SSID	IDCOMP						

Card 1d. Include this card for the SEGMENT keyword option.

N1	N1	N3	N4	IDCOMP			

Card 2. This card is required.

LC_U	LC_V	LC_W	LC_RHO	LC_P	LC_T		

Card 3. This card is required.

SF_U	SF_V	SF_W	SF_RHO	SF_P	SF_T		

Data Card Definitions:

Surface Part Card. Card 1 format for the MSURF keyword option

Card 1a	1	2	3	4	5	6	7	8
Variable	MSURFID	IDCOMP						
Type	I	I						
Default	none	none						

VARIABLE	DESCRIPTION
MSURFID	Mesh surface part ID referenced in *MESH_SURFACE_ELEMENT cards
IDCOMP	For inflow boundaries in problems involving chemical reacting flows, this ID references a *CHEMISTRY_COMPOSITION card that gives the chemical mixture of the fluid entering the domain

Surface Part Set Card. Card 1 format for the MSURF_SET keyword option

Card 1b	1	2	3	4	5	6	7	8
Variable	MSURF_S	IDCOMP						
Type	I	I						
Default	none	none						

VARIABLE	DESCRIPTION
MSURF_S	ID of a set of mesh surface parts created with a *LSO_ID_SET card, where each mesh surface part ID in the set is referenced in *MESH_SURFACE_ELEMENT cards.
IDCOMP	For inflow boundaries in problems involving chemical reacting flows, this ID references a *CHEMISTRY_COMPOSITION card that gives the chemical mixture of the fluid entering the domain

Set Card. Card 1 format for the SET keyword option

Card 1c	1	2	3	4	5	6	7	8
Variable	SSID	IDCOMP						
Type	I	I						
Default	none	none						

VARIABLE	DESCRIPTION
SSID	Segment set ID
IDCOMP	For inflow boundaries in problems involving chemical reacting flows, this ID references a *CHEMISTRY_COMPOSITION card that gives the chemical mixture of the fluid entering the domain

Segment Card. Card 1 for the SEGMENT keyword option

Card 1d	1	2	3	4	5	6	7	8
Variable	N1	N1	N3	N4	IDCOMP			
Type	I	I	I	I	I			
Default	none	none	none	none	none			

VARIABLE	DESCRIPTION
N1, N2, …	Node IDs defining a segment

VARIABLE	DESCRIPTION
IDCOMP	For inflow boundaries in problems involving chemical reacting flows, this ID references a *CHEMISTRY_COMPOSITION card that gives the chemical mixture of the fluid entering the domain

Load Curve Card.

Card 2	1	2	3	4	5	6	7	8
Variable	LC_U	LC_V	LC_W	LC_RHO	LC_P	LC_T		
Type	I	I	I	I	I	I		
Remarks	1	1	1	1	1	1		

VARIABLE	DESCRIPTION
LC_U	Load curve ID to describe the x-component of the velocity as a function of time; see *DEFINE_CURVE. GT.0: Load curve ID EQ.0: Constant value of SF_U EQ.-1: Solver computes the boundary value for x-component of velocity
LC_V	Load curve ID to describe the y-component of the velocity as a function of time GT.0: Load curve ID EQ.0: Constant value of SF_V EQ.-1: Solver computes the boundary value for y-component of velocity
LC_W	Load curve ID to describe the z-component of the velocity as a function of time GT.0: Load curve ID EQ.0: Constant value of SF_W EQ.-1: Solver computes the boundary value for x-component of velocity

VARIABLE	DESCRIPTION
LC_RHO	Load curve ID to describe the density as a function of time GT.0: Load curve ID EQ.0: Constant value of SF_RHO EQ.-1: Solver computes the boundary value for density
LC_P	Load curve ID to describe the pressure as a function of time GT.0: Load curve ID EQ.0: Constant value of SF_P EQ.-1: Solver computes the boundary value for pressure
LC_T	Load curve ID to describe the temperature as a function of time GT.0: Load curve ID EQ.0: Constant value of SF_T EQ.-1: Solver computes the boundary value for temperature

Scale Factor Card.

Card 3	1	2	3	4	5	6	7	8
Variable	SF_U	SF_V	SF_W	SF_RHO	SF_P	SF_T		
Type	F	F	F	F	F	F		
Default	1.0	1.0	1.0	1.0	1.0	1.0		

VARIABLE	DESCRIPTION
SF_U	Scale factor for LC_U
SF_V	Scale factor for LC_V
SF_W	Scale factor for LC_W
SF_RHO	Scale factor for LC_RHO
SF_P	Scale factor for LC_P
SF_T	Scale factor for LC_T

Remarks:

1. **Well-posed boundaries.** On each centroid or set of centroids, the variables (v_x, v_y, v_z, ρ, P, T) with provided values must be consistent and make the model well-posed (that is, be such that the solution of the model exists, is unique, and is physical).

CESE_BOUNDARY_PRESCRIBED_VN_*OPTION

Available options include:

MSURF

MSURF_SET

SET

SEGMENT

Purpose: For the CESE compressible flow solver, set boundary values for velocity, density, pressure, and temperature. Boundary values are applied at the centroid of elements connected with this boundary. Use keyword options SET or SEGMENT for user-defined meshes, that is, meshes specified with *ELEMENT_SOLID cards. Use MSURF or MSURF_SET for meshes generated with the automatic volume mesher, meaning created with *MESH cards.

Card Summary:

A set of data cards for this keyword consists of 3 of the following cards:

1. Card 1 specifies the object to which the boundary condition is applied. Its format depends on the keyword option.
2. Card 2 reads in load curve IDs.
3. Card 3 reads in scale factors.

For each boundary condition, include one set of cards. This input ends at the next keyword ("*") card.

Card 1a. Include this card for the MSURF keyword option.

MSURFID	IDCOMP						

Card 1b. Include this card for the MSURF_SET keyword option.

MSURF_S	IDCOMP						

Card 1c. Include this card for the SET keyword option.

SSID	IDCOMP						

Card 1d. Include this card for the SEGMENT keyword option.

N1	N1	N3	N4	IDCOMP			

Card 2. This card is required.

LC_VN			LC_RHO	LC_P	LC_T		

Card 3. This card is required.

SF_VN			SF_RHO	SF_P	SF_T		

Data Card Definitions:

Surface Part Card. Card 1 format for the MSURF keyword option

Card 1a	1	2	3	4	5	6	7	8
Variable	MSURFID	IDCOMP						
Type	I	I						
Default	none	none						

VARIABLE	DESCRIPTION
MSURFID	A mesh surface part ID referenced in *MESH_SURFACE_ELEMENT cards
IDCOMP	For inflow boundaries in problems involving chemical reacting flows, this ID references a *CHEMISTRY_COMPOSITION card that gives the chemical mixture of the fluid entering the domain.

.

Surface Part Set Card. Card 1 format for the MSURF_SET keyword option

Card 1b	1	2	3	4	5	6	7	8
Variable	MSURF_S	IDCOMP						
Type	I	I						
Default	none	none						

VARIABLE	DESCRIPTION
MSURF_S	ID of a set of mesh surface parts created with a *LSO_ID_SET card, where each mesh surface part ID in the set is referenced in *MESH_SURFACE_ELEMENT cards.
IDCOMP	For inflow boundaries in problems involving chemical reacting flows, this ID references a *CHEMISTRY_COMPOSITION card that gives the chemical mixture of the fluid entering the domain.

Set Card. Card 1 format for the SET keyword option

Card 1c	1	2	3	4	5	6	7	8
Variable	SSID	IDCOMP						
Type	I	I						
Default	none	none						

VARIABLE	DESCRIPTION
SSID	Segment set ID
IDCOMP	For inflow boundaries in problems involving chemical reacting flows, this ID references a *CHEMISTRY_COMPOSITION card that gives the chemical mixture of the fluid entering the domain.

Segment Card. Card 1 for the SEGMENT keyword option

Card 1d	1	2	3	4	5	6	7	8
Variable	N1	N1	N3	N4	IDCOMP			
Type	I	I	I	I	I			
Default	none	none	none	none	none			

VARIABLE	DESCRIPTION
N1, N2, …	Node IDs defining a segment

VARIABLE	DESCRIPTION
IDCOMP	For inflow boundaries in problems involving chemical reacting flows, this ID references a *CHEMISTRY_COMPOSITION card that gives the chemical mixture of the fluid entering the domain.

Load Curve Card.

Card 2	1	2	3	4	5	6	7	8
Variable	LC_VN			LC_RHO	LC_P	LC_T		
Type	I			I	I	I		
Remarks	1			1	1	1		

VARIABLE	DESCRIPTION
LC_VN	Load curve ID to describe the normal velocity as a function of time; see *DEFINE_CURVE. GT.0: Load curve ID EQ.0: Constant value of SF_VN EQ.-1: Solver determines the boundary value for the normal velocity
LC_RHO	Load curve ID to describe the density as a function of time GT.0: Load curve ID EQ.0: Constant value of SF_RHO EQ.-1: Solver determines the boundary value for the density
LC_P	Load curve ID to describe the pressure as a function of time GT.0: Load curve ID EQ.0: Constant value of SF_P EQ.-1: Solver determines the boundary value for the pressure
LC_T	Load curve ID to describe the temperature as a function of time GT.0: Load curve ID EQ.0: Constant value of SF_T

VARIABLE	DESCRIPTION
	EQ.-1: Solver determines the boundary value for the temperature

Scale Factor Card.

Card 3	1	2	3	4	5	6	7	8
Variable	SF_VN			SF_RHO	SF_P	SF_T		
Type	F			F	F	F		
Default	1.0			1.0	1.0	1.0		

VARIABLE	DESCRIPTION
SF_VN	Scale factor for LC_VN
SF_RHO	Scale factor for LC_RHO
SF_P	Scale factor for LC_P
SF_T	Scale factor for LC_T

Remarks:

1. **Well-posed boundary conditions.** On each centroid or set of centroids, the variables (V_N, ρ, P, T) with provided values must be consistent and make the model well-posed (that is, be such that the solution of the model exists, is unique and physical).

CESE_BOUNDARY_REFLECTIVE_*OPTION

Available options are:

MSURF

MSURF_SET

SET

SEGMENT

Purpose: Define a reflective boundary condition for the CESE compressible flow solver. You can apply this boundary condition on a symmetrical surface or a solid wall of the computational domain. Use the MSURF or MSURF_SET keyword options when generating the CESE mesh with the *MESH cards. Use the SET or SEGMENT keyword options cards when *ELEMENT_SOLID cards specify CESE mesh.

Card Summary:

Card 1a. Include this card for the MSURF keyword option. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

MSURFID							

Card 1b. Include this card for the MSURF_SET keyword option. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

MSURF_S							

Card 1c. Include this card for the SET keyword option. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

SSID							

Card 1d. Include this card for the SEGMENT keyword option. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

N1	N2	N3	N4				

Data Card Definitions:

Surface Part Card. Card 1 format for the MSURF keyword option. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1a	1	2	3	4	5	6	7	8
Variable	MSURFID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
MSURFID	Mesh surface part ID referenced in *MESH_SURFACE_ELEMENT cards.

Surface Part Set Card. Card 1 format for the MSURF_SET keyword option. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1b	1	2	3	4	5	6	7	8
Variable	MSURF_S							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
MSURF_S	ID of a set of mesh surface parts created with a *LSO_ID_SET card, where each mesh surface part ID in the set is referenced in *MESH_SURFACE_ELEMENT cards.

Set Card. Card 1 format for the SET keyword option. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1c	1	2	3	4	5	6	7	8
Variable	SSID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
SSID	Segment set ID

Segment Cards. Card 1 format for the SEGMENT keyword option. Include an additional card for each corresponding pair of segments. This input ends at the next keyword ("*") card.

Card 1d	1	2	3	4	5	6	7	8
Variable	N1	N2	N3	N4				
Type	I	I	I	I				
Default	none	none	none	none				

VARIABLE	DESCRIPTION
N1, N2, …	Node IDs defining a segment

Remarks:

1. **Effect of the boundary condition.** This boundary condition has the same effect as a solid-wall boundary condition for inviscid flows.

CESE_BOUNDARY_SLIDING_*OPTION

Available options are:

MSURF

MSURF_SET

SET

SEGMENT

Purpose: Allows the nodes of a fluid surface to translate in the main direction of the mesh movement. This feature is useful in piston-type applications.

Use the MSURF or MSURF_SET keyword options when generating the CESE mesh with *MESH cards. Use the SET and SEGMENT keywords when *ELEMENT_SOLID cards specify the CESE mesh.

Card Summary:

Card 1a. Include this card for the MSURF keyword option. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

MSURFID							

Card 1b. Include this card for the MSURF_SET keyword option. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

MSURF_S							

Card 1c. Include this card for the SET keyword option. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

SSID							

Card 1d. Include this card for the SEGMENT keyword option. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

N1	N2	N3	N4				

Data Card Definitions:

Surface Part Card. Card 1 format for the MSURF keyword option. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1a	1	2	3	4	5	6	7	8
Variable	MSURFID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
MSURFID	Mesh surface part ID referenced in *MESH_SURFACE_ELEMENT cards.

Surface Part Set Card. Card 1 format used when the MSURF_SET keyword option is active. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1b	1	2	3	4	5	6	7	8
Variable	MSURF_S							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
MSURF_S	ID of a set of mesh surface parts created with a *LSO_ID_SET card, where each mesh surface part ID in the set is referenced in *MESH_SURFACE_ELEMENT cards.

Set Card. Card 1 format used when the SET keyword option is active. Provide as many cards as necessary. This input ends at the next keyword ("*") card.

Card 1c	1	2	3	4	5	6	7	8
Variable	SSID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
SSID	Segment set ID

Segment Cards. Card 1 format used when SEGMENT keyword option is active. Include an additional card for each corresponding pair of segments. This input ends at the next keyword ("*") card.

Card 1d	1	2	3	4	5	6	7	8
Variable	N1	N2	N3	N4				
Type	I	I	I	I				
Default	none	none	none	none				

VARIABLE	DESCRIPTION
N1, N2, …	Node IDs defining a segment

CESE_BOUNDARY_SOLID_WALL_*OPTION1_{OPTION2}

For *OPTION1*, the choices are:

MSURF

MSURF_SET

SET

SEGMENT

For *OPTION2*, the choices are:

<BLANK>

ROTAT

Purpose: Define a solid wall boundary condition for this CESE compressible flow solver. This boundary condition models a solid boundary, that is, the physical boundary for the flow field. This boundary condition is a slip boundary condition for inviscid flows and a no-slip boundary condition for viscous flows.

Use the MSURF or MSURF_SET options when generating the CESE mesh through the *MESH cards. Use the SET or SEGMENT keyword options cards when *ELEMENT_-SOLID cards define the CESE mesh. Use the ROTAT keyword option for a rotating solid boundary condition.

Card Summary:

Card Sets. The following sequence of cards comprises a *single set*. LS-DYNA continues reading *CESE_BOUNDARY_SOLID_WALL card sets until the next keyword ("*") card.

Card 1a. Include this card when *OPTION1* is MSURF and *OPTION2* is not set (<BLANK>).

MSURFID	LCID	VX	VY	VZ			

Card 1b. Include this card when *OPTION1* is MSURF and *OPTION2* is ROTAT.

MSURFID	LCID	VX	VY	VZ	NX	NY	NZ

Card 1c. Include this card when *OPTION1* is MSURF_SET and *OPTION2* is not set (<BLANK>).

MSURF_S	LCID	VX	VY	VZ			

Card 1d. Include this card when *OPTION1* is MSURF_SET and *OPTION2* is ROTAT.

MSURF_S	LCID	VX	VY	VZ	NX	NY	NZ

Card 1e. Include this card when *OPTION1* is SET and *OPTION2* is not set (<BLANK>).

SSID	LCID	VX	VY	VZ			

Card 1f. Include this card when *OPTION1* is SET and *OPTION2* is ROTAT.

SSID	LCID	VX	VY	VZ	NX	NY	NZ

Card 1g. Include this card when *OPTION1* is SEGMENT and *OPTION2* is not set (<BLANK>).

N1	N2	N3	N4	LCID	VX	VY	VZ

Card 1h.1. Include this card when *OPTION1* is SEGMENT and *OPTION2* is ROTAT.

N1	N2	N3	N4	LCID	VX	VY	VZ

Card 1h.2. Include this card when *OPTION1* is SEGMENT and *OPTION2* is ROTAT.

N1	N2	N3					

Data Card Definitions:

Surface Part Card (Non-Rotating Boundary). Card 1 format used when the MSURF keyword option is active and the ROTAT keyword option is inactive.

Card 1a	1	2	3	4	5	6	7	8
Variable	MSURFID	LCID	VX	VY	VZ			
Type	I	I	F	F	F			
Default	none	0	0.0	0.0	0.0			
Remarks		2	2	2	2			

VARIABLE	DESCRIPTION
MSURFID	Mesh surface part ID referenced in *MESH_SURFACE_ELEMENT cards.
LCID	Load curve ID to define this solid wall boundary movement
VX, VY, VZ	Velocity vector of the solid wall: LCID.EQ.0: Vector defined by (VX, VY, VZ). LCID.NE.0: Vector defined by both the load curve and (VX, VY, VZ).

Surface Part Card (Rotating Boundary). Card 1 format used when the MSURF keyword option is active and the ROTAT keyword option is active.

Card 1b	1	2	3	4	5	6	7	8
Variable	MSURFID	LCID	VX	VY	VZ	NX	NY	NZ
Type	I	I	F	F	F	F	F	F
Default	none	none	0.0	0.0	0.0	0.0	0.0	0.0

VARIABLE	DESCRIPTION
MSURFID	Mesh surface part ID referenced in *MESH_SURFACE_ELEMENT cards.
LCID	Load curve ID giving the rotating speed frequency (HZ). LCID must be specified.
VX, VY, VZ	x, y, and z-coordinates of a point on the rotating axis
NX, NY, NZ	Unit vector of the rotating axis (not used for the 2D case)

Surface Part Set Card (Non-Rotating Boundary). Card 1 format used when the MSURF_SET keyword option is active and the ROTAT keyword option is not active.

Card 1c	1	2	3	4	5	6	7	8
Variable	MSURF_S	LCID	VX	VY	VZ			
Type	I	I	F	F	F			
Default	none	0	0.0	0.0	0.0			
Remarks		2	2	2	2			

VARIABLE	DESCRIPTION
MSURF_S	ID of a set of mesh surface part IDs created with a *LSO_ID_SET card, where each mesh surface part ID in the set is referenced in *MESH_SURFACE_ELEMENT cards.
LCID	Load curve ID to define this solid wall boundary movement
VX, VY, VZ	Velocity vector of the solid wall: LCID.EQ.0: Vector defined by (VX, VY, VZ). LCID.NE.0: Vector defined by both the load curve and (VX, VY, VZ).

Surface Part Set Card (Rotating Boundary). Card 1 format used when the MSURF_SET keyword option is active and the ROTAT keyword option is active.

Card 1d	1	2	3	4	5	6	7	8
Variable	MSURF_S	LCID	VX	VY	VZ	NX	NY	NZ
Type	I	I	F	F	F	F	F	F
Default	none	0	0.0	0.0	0.0	0.0	0.0	0.0

VARIABLE	DESCRIPTION
MSURF_S	ID of a set of mesh surface part IDs created with a *LSO_ID_SET card, where each mesh surface part ID in the set is referenced in *MESH_SURFACE_ELEMENT cards.
LCID	Load curve ID giving the rotating speed frequency (HZ). LCID must be specified.
VX, VY, VZ	x, y, and z-coordinates of a point on the rotating axis
NX, NY, NZ	Unit vector of the rotating axis (not used for the 2D case)

Segment Set Card (Non-Rotating Boundary). Card 1 format used when the SET keyword option is active and the ROTAT keyword option is not active.

Card 1e	1	2	3	4	5	6	7	8
Variable	SSID	LCID	VX	VY	VZ			
Type	I	I	F	F	F			
Default	none	none	0.0	0.0	0.0			
Remarks		2	2	2	2			

VARIABLE	DESCRIPTION
SSID	Segment set ID
LCID	Load curve ID to define this solid wall boundary movement
VX, VY, VZ	Velocity vector of the solid wall: LCID.EQ.0: Vector defined by (VX, VY, VZ). LCID.NE.0: Vector defined by both the load curve and (VX, VY, VZ).

Segment Set Card (Rotating Boundary). Card 1 format used when the SET keyword option is active and the ROTAT keyword option is active.

Card 1f	1	2	3	4	5	6	7	8
Variable	SSID	LCID	VX	VY	VZ	NX	NY	NZ
Type	I	I	F	F	F	F	F	F
Default	none	none	0.0	0.0	0.0	0.0	0.0	0.0

VARIABLE	DESCRIPTION
SSID	Segment set ID
LCID	Load curve ID giving the rotating speed frequency (HZ). LCID must be specified.
VX, VY, VZ	x, y, and z-coordinates of a point on the rotating axis
NX, NY, NZ	Unit vector of the rotating axis (not used for the 2D case)

Segment Card (Non-Rotating Boundary). Card 1 format used when the SEGMENT keyword option is active and the ROTAT keyword option is not active.

Card 1g	1	2	3	4	5	6	7	8
Variable	N1	N2	N3	N4	LCID	VX	VY	VZ
Type	I	I	I	I	I	F	F	F
Default	none	none	none	none	0	0.0	0.0	0.0
Remarks					2	2	2	2

VARIABLE	DESCRIPTION
N1, N2, N3, N4	Node IDs defining a segment
LCID	Load curve ID to define this solid wall boundary movement

VARIABLE	DESCRIPTION
VX, VY, VZ	Velocity vector of the solid wall: LCID.EQ.0: Vector defined by (VX, VY, VZ). LCID.NE.0: Vector defined by both the load curve and (VX, VY, VZ).

Segment Card (Rotating Boundary). Card 1 format used when the SEGMENT keyword option is active and the ROTAT keyword option is active.

Card 1h.1	1	2	3	4	5	6	7	8
Variable	N1	N2	N3	N4	LCID	VX	VY	VZ
Type	I	I	I	I	I	F	F	F
Default	none	none	none	none	0	0.0	0.0	0.0

Rotating Axis Card for Segment. Additional card for the "Segment Card (Rotating Boundary)" case that is read when the ROTAT keyword option is used.

Card 1h.2	1	2	3	4	5	6	7	8
Variable	NX	NY	NZ					
Type	F	F	F					
Default	0.0	0.0	0.0					

VARIABLE	DESCRIPTION
N1, N2, N3, N4	Node IDs defining a segment
LCID	Load curve ID giving the rotating speed frequency (HZ). LCID must be specified.
VX, VY, VZ	x, y, and z-coordinates of a point on the rotating axis
NX, NY, NZ	Unit vector of the rotating axis (not used for the 2D case)

Remarks:

1. **Boundary movement.** In this solid-wall condition, the boundary movement can only be in the tangential direction of the wall and should not affect the fluid domain size and mesh during the calculation. Otherwise, you should use an FSI or moving mesh solver. Also, this moving solid boundary condition only affects viscous flows (no-slip BC).

2. **Regular solid wall boundary condition.** If LCID = 0 and VX = VY = VZ = 0.0 (default), this boundary condition is a regular solid wall boundary condition.

*CESE_CHEMISTRY_D3PLOT

Purpose: Cause mass fractions of the listed chemical species to be added to the CESE d3plot output. This is only used when chemistry is being solved with the CESE solver.

Card 1	1	2	3	4	5	6	7	8
Variable	MODELID							
Type	I							
Default	none							

Species Cards. Include one card for each species to be included in the d3plot database. This input ends at the next keyword ("*") card.

Card 2	1	2	3	4	5	6	7	8
Variable	SPECIES							
Type	A							

VARIABLE	DESCRIPTION
MODELID	Identifier of a Chemkin-compatible chemistry model.
SPECIES	Name of a chemical species that is defined in the chemistry model identified by MODELID (see *CHEMISTRY_MODEL).

*CESE_CONTROL_LIMITER

Purpose: Sets some stability parameters used in the CESE scheme for this CESE compressible flow solver.

Card 1	1	2	3	4	5	6	7	8
Variable	IDLMT	ALFA	BETA	EPSR				
Type	I	F	F	F				
Default	0	0.0	0.0	0.0				
Remarks		1	2	3				

VARIABLE	DESCRIPTION
IDLMT	Set the stability limiter option (See CESE theory manual): EQ.0: limiter format 1 (Re-weighting). EQ.1: limiter format 2 (Relaxing).
ALFA	Re-weighting coefficient (See CESE theory manual)
BETA	Numerical viscosity control coefficient (See CESE theory manual)
EPSR	Stability control coefficient (See CESE theory manual)

Remarks:

1. $\alpha \geq 0$; larger values give more stability, but less accuracy. Usually $\alpha = 2.0$ or 4.0 will be enough for normal shock problems.

2. $0 \leq \beta \leq 1$; larger values give more stability. For problems with shock waves, $\beta = 1.0$ is recommended.

3. $\varepsilon \geq 0$; larger values give more stability, but less accuracy.

*CESE_CONTROL_MESH_MOV

Purpose: For moving mesh CESE, this keyword is used to choose the type of algorithm to be used for calculating mesh movement.

Card 1	1	2	3	4	5	6	7	8
Variable	MMSH	LIM_ITER	RELTOL					
Type	I	I	F					
Default	1	100	1.0e-3					

VARIABLE	DESCRIPTION
MMSH	Mesh motion selector: EQ.1: mesh moves using an implicit ball-vertex spring method. EQ.9: the IDW scheme is used to move the mesh.
LIM_ITER	Maximum number of linear solver iterations for the ball-vertex linear system.
RELTOL	Relative tolerance to use as a stopping criterion for the iterative linear solver (conjugate gradient solver with diagonal scaling preconditioner).

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*CESE_CONTROL_SOLVER

Purpose: Set general purpose control variables for the CESE compressible flow solver.

Card 1	1	2	3	4	5	6	7	8
Variable	ICESE	IFLOW	IGEOM	IFRAME	MIXID	IDC	ISNAN	
Type	I	I	I	I	I	F	I	
Default	0	0	none	0	none	0.25	0	
Remarks			1			2		

VARIABLE	DESCRIPTION
ICESE	Sets the framework of the CESE solver. EQ.0: Fixed Eulerian EQ.100: Moving Mesh FSI EQ.200: Immersed boundary FSI
IFLOW	Sets the compressible flow types: EQ.0: Viscous flows (laminar) EQ.1: Inviscid flows
IGEOM	Sets the geometric dimension: EQ.2: Two-dimensional (2D) problem EQ.3: Three-dimensional (3D) problem EQ.101: 2D axisymmetric
IFRAME	Choose the frame of reference: EQ.0: Usual non-moving reference frame (default) EQ.1000: Non-inertial rotating reference frame
MIXID	Chemistry model ID that defines the chemical species to include in the mixing model (see *CHEMISTRY_MODEL). The species information is given through the model's card specifying the Chemkin-compatible input.

VARIABLE	DESCRIPTION
IDC	Contact interaction detection coefficient (for FSI and conjugate heat transfer problems).
ISNAN	Flag to check for a NaN in the CESE solver solution arrays at the completion of each time step. This option can be useful for debugging purposes. There is a cost overhead when this option is active. EQ.0: No checking EQ.1: Checking is active.

Remarks:

1. **2D Solvers and Mesh Geometry.** For the 2D (IGEOM = 2) or 2D axisymmetric (IGEOM = 101) solver, the mesh should only be distributed in the *x*-*y* plane with the boundary conditions given only at the *x*-*y* domain boundaries. Otherwise, a warning message will be given, and the 3D solver will be triggered instead.

   The 2D axisymmetric case will work only if the 2D mesh and corresponding boundary conditions are properly defined, with the *x* and *y* coordinates corresponding to the radial and axial directions, respectively.

2. **Contact Interaction Detection Coefficient.** IDC is the same type of variable that is input on the *ICFD_CONTROL_FSI card. For an explanation, see Remark 1 for the *ICFD_CONTROL_FSI card.

3. **CESE Solver and Restarts.** Restarts are supported for the CESE solver. However, restarts do not currently work for simulations with conjugate heat transfer.

*CESE_CONTROL_TIMESTEP

Purpose: Sets the time-step control parameters for the CESE compressible flow solver.

Card 1	1	2	3	4	5	6	7	8
Variable	IDDT	CFL	DTINT					
Type	I	F	F					
Default	0	0.9	10^{-3}					

VARIABLE	DESCRIPTION
IDDT	Sets the time step option: EQ.0: fixed time step size (DTINT, meaning the given initial time step size) NE.0: the time step size will be calculated based on the given CFL-number and the flow solution at the previous time step.
CFL	CFL number (Courant–Friedrichs–Lewy condition) ($0.0 < CFL \leq 1.0$)
DTINT	Initial time step size

*CESE_DATABASE_ELOUT

Purpose: Enable the output of CESE data on elements. If more than one element set is defined, then several output files will be generated.

Output Options Card.

Card 1	1	2	3	4	5	6	7	8
Variable	OUTLV	DTOUT						
Type	I	F						
Default	0	0.						

Element Sets Card. Include as many cards as needed. This input ends at the next keyword ("*") card.

Card 2	1	2	3	4	5	6	7	8
Variable	ELSID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
OUTLV	Determines if the output file should be created: EQ.0: No output file is generated. EQ.1: The output file is generated.
DTOUT	Time interval to print the output. If DTOUT is equal to 0.0, then the CESE timestep will be used.
ELSID	Solid elements set ID

Remarks:

1. **Database File Name.** The file name for this database is cese_elout.dat.

2. **Restrictions.** The *CESE_DATABASE… cards (pointout/elout) are restricted to CFD-only problems. They do not give correct results for chemically reacting flow where *CESE couples with *CHEMISTRY.

*CESE_DATABASE_FLUXAVG

Purpose: Enable the output of CESE data on segment sets. If more than one segment set is defined, then several output files will be generated.

Output Options Card.

Card 1	1	2	3	4	5	6	7	8
Variable	OUTLV	DTOUT						
Type	I	F						
Default	0	0.						

Segment Sets Card. Include as many cards as needed. This input ends at the next keyword ("*") card.

Card 2	1	2	3	4	5	6	7	8
Variable	SSID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
OUTLV	Determines if the output file should be created: EQ.0: No output file is generated. EQ.1: The output file giving the average fluxes is generated.
DTOUT	Time interval to print the output. If DTOUT is equal to 0.0, then the CESE time step will be used.
SSID	Segment set ID

Remarks:

1. **Database File Name.** The file name for this database is cese_fluxavg.dat.

2. **Restrictions.** The *CESE_DATABASE… cards (pointout/elout/…) are restricted to CFD-only problems. They do not give correct results for chemically reacting flow where *CESE couples with *CHEMISTRY.

*CESE_DATABASE_FSIDRAG

Purpose: Enable the output of the total fluid pressure force applied to solid parts in FSI problems at every time step.

Output Options Card.

Card 1	1	2	3	4	5	6	7	8
Variable	OUTLV							
Type	I							
Default	0							

VARIABLE	DESCRIPTION
OUTLV	Determines if the output file should be created: EQ.0: No output file is generated. EQ.1: The output file giving the pressure forces is generated.

Remarks:

1. **Database File Names.** The file names for this database are cese_dragsol.dat, cese_dragshell.dat, cese_dragsol2D.dat and cese_dragbeam.dat, depending on what kind of solid is used.

*CESE_DATABASE_POINTOUT

Purpose: Enable the output of CESE data at points.

Output Options Card.

Card 1	1	2	3	4	5	6	7	8
Variable	PSID	DTOUT	PSTYPE	VX	VY	VZ		
Type	I	F	I	F	F	F		
Default	0	0.	0	0.	0.	0.		

Point Specification Card. Include as many cards as needed. This input ends at the next keyword ("*") card.

Card 2	1	2	3	4	5	6	7	8
Variable	PID	X	Y	Z				
Type	I	F	F	F				
Default	none	none	none	none				

VARIABLE	DESCRIPTION
PSID	Point set ID
DTOUT	Time interval to print the output. If DTOUT is equal to 0.0, then the CESE timestep will be used.
PSTYPE	Point set type: EQ.0: Fixed points EQ.1: Tracer points using prescribed velocity EQ.2: Tracer points using fluid velocity
VX, VY, VZ	Constant velocities to be used when PSTYPE = 1
PID	Point ID

VARIABLE	DESCRIPTION
X, Y, Z	Initial coordinates of the point

Remarks:

1. **Database File Name.** The file name for this database is cese_pointout.dat.

2. **Restrictions.** The *CESE_DATABASE… cards (pointout/elout) are restricted to CFD-only problems. They do not give correct results for chemically reacting flow where *CESE couples with *CHEMISTRY.

*CESE_DATABASE_SSETDRAG

Purpose: Enable the output of CESE drag forces on segment sets. If more than one segment set is specified, then several output files will be generated.

Output Options Card.

Card 1	1	2	3	4	5	6	7	8
Variable	OUTLV	DTOUT						
Type	I	F						
Default	0	0.						

Segment Sets Card. Include as many cards as needed. This input ends at the next keyword ("*") card.

Card 2	1	2	3	4	5	6	7	8
Variable	SSID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
OUTLV	Determines if the output file should be created: EQ.0: No output file is generated. EQ.1: The output file giving the average fluxes is generated.
DTOUT	Time interval to print the output. If DTOUT is equal to 0.0, then the CESE timestep will be used.
SSID	Segment set ID

Remarks:

1. **Database File Name.** The file name for this database is cese_ssetdrag.dat.

2. **Friction Drag Results and Mesh Size.** For the friction drag to give consistent results, special care must be given to the mesh close to the solid wall boundary (good capturing of the boundary layer behavior). We recommend a very fine structured mesh.

*CESE_DEFINE_NONINERTIAL

Purpose: Define the CESE problem domain as a non-inertial rotating frame that rotates at a constant rate. This is used in rotating problems such as spinning cylinders, wind turbines and turbo machinery.

Card 1	1	2	3	4	5	6	7	8
Variable	FREQ	LCID	PID	Nx	Ny	Nz		
Type	F	I	I	F	F	F		
Default	none	0	none	none	none	none		

Card 2	1	2	3	4	5	6	7	8
Variable	L	R	RELV					
Type	F	F	I					
Default	none	none	0					

VARIABLE	DESCRIPTION
FREQ	Frequency of rotation.
LCID	Load curve ID for scaling factor of FREQ.
PID	Starting point ID for the reference frame (See *CESE_DEFINE_-POINT).
Nx, Ny, Nz	Rotating axis direction.
L	Length of rotating frame.
R	Radius of rotating frame.

VARIABLE	DESCRIPTION
RELV	Velocity display mode: EQ.0: Relative velocity, only the non-rotating components of the velocity are output. EQ.1: Absolute velocity is output.

*CESE_DEFINE_POINT

Purpose: Define points to be used by the CESE solver.

Point Cards. Include one card for each point. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	NID	X	Y	Z				
Type	I	F	F	F				
Default	none	none	none	none				

VARIABLE	DESCRIPTION
NID	Identifier for this point.
X, Y, Z	Coordinates of the point.

*CESE_DRAG

Purpose: Provide the far-field (or free-stream) fluid pressure.

Card 1	1	2	3	4	5	6	7	8
Variable	PRESS							
Type	F							

VARIABLE	DESCRIPTION
PRESS	Value of the free-stream fluid pressure (in units used by the current problem).

*CESE_EOS_CAV_HOMOG_EQUILIB

Purpose: Define the coefficients in the equation of state (EOS) for the homogeneous equilibrium cavitation model.

Include as many cards as needed. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	EOSID	ρ_{vap}	ρ_{liq}	a_{vap}	a_{liq}	μ_{vap}	μ_{liq}	P_{SatVap}
Type	I	F	F	F	F	F	F	F
Default	none	0.8	880.0	334.0	1386.0	1.435e-5	1.586e-4	1.2e+4

VARIABLE	DESCRIPTION
EOSID	Equation of state identifier
ρ_{vap}	density of the saturated vapor
ρ_{liq}	density of the saturated liquid
a_{vap}	sound speed of the saturated vapor
a_{liq}	sound speed of the saturated liquid
μ_{vap}	dynamic viscosity of the vapor
μ_{liq}	dynamic viscosity of the liquid
P_{SatVap}	pressure of the saturated vapor

Remarks:

1. Once a cavitation EOS is used, the cavitation flow solver will be triggered.

2. In this homogeneous equilibrium cavitation model, a barotropic equation of state is used. This model can be used in small scale & high speed cavitation flows, and it is not good for large-scale, low-speed cavitation calculations.

*CESE_EOS_IDEAL_GAS

Purpose: Define the coefficients Cv and Cp in the equation of state for an ideal gas in the CESE fluid solver.

Card 1	1	2	3	4	5	6	7	8
Variable	EOSID	Cv	Cp					
Type	I	F	F					
Default	none	717.5	1004.5					

VARIABLE	DESCRIPTION
EOSID	Equation of state identifier
Cv	Specific heat at constant volume
Cp	Specific heat at constant pressure

Remarks:

1. **Units.** As with other solvers in LS-DYNA, the user is responsible for unit consistency. For example, if a user wants to use dimensionless variables, Cv and Cp should also be replaced by the corresponding dimensionless ones.

*CESE_EOS_INFLATOR1

Purpose: To define an EOS using Cp and Cv thermodynamic expansions for an inflator gas mixture with a single temperature range.

Card 1	1	2	3	4	5	6	7	8
Variable	EOSID							
Type	I							
Default	none							

Card 2	1	2	3	4	5	6	7	8
Variable	Cp0	Cp1	Cp2	Cp3	Cp4			
Type	F	F	F	F	F			
Default	0.	0.	0.	0.	0.			

Card 3	1	2	3	4	5	6	7	8
Variable	Cv0	Cv1	Cv2	Cv3	Cv4			
Type	F	F	F	F	F			
Default	0.	0.	0.	0.	0.			

VARIABLE	DESCRIPTION
EOSID	Equation of state identifier for the CESE solver.
Cp0, …, Cp4	Coefficients of temperature-dependent specific heat at constant pressure $C_p(T) = C_{p0} + C_{p1}\,T + C_{p2}\,T^2 + C_{p3}\,T^3 + C_{p4}\,T^4$

VARIABLE	DESCRIPTION
Cv0, …, Cv4	Coefficients of temperature-dependent specific heat at constant volume $C_v(T) = C_{v0} + C_{v1}\,T + C_{v2}\,T^2 + C_{v3}\,T^3 + C_{v4}\,T^4$

Remark:

1. These coefficient expansions for the specific heats over the entire temperature range are generated by the 0-D inflator model solver. See *CHEMISTRY_CONTROL_-INFLATOR and *CHEMISTRY_INFLATOR_PROPERTIES for details related to running that solver.

*CESE_EOS_INFLATOR2

Purpose: To define an EOS using Cp and Cv thermodynamic expansions for an inflator gas mixture with two temperature ranges, one below 1000 degrees Kelvin, and the other above 1000 degrees Kelvin.

Card 1	1	2	3	4	5	6	7	8
Variable	EOSID							
Type	I							
Default	none							

Card for the expansion of Specific Heat at Constant Pressure. Valid for T < 1000 ^{0}K

Card 2	1	2	3	4	5	6	7	8
Variable	Cp1_0	Cp1_1	Cp1_2	Cp1_3	Cp1_4			
Type	F	F	F	F	F			
Default	0.	0.	0.	0.	0.			

Card for the expansion of Specific Heat at Constant Pressure. Valid for T > 1000 ^{0}K.

Card 3	1	2	3	4	5	6	7	8
Variable	Cp2_0	Cp2_1	Cp2_2	Cp2_3	Cp2_4			
Type	F	F	F	F	F			
Default	0.	0.	0.	0.	0.			

Card for the expansion of Specific Heat at Constant Volume. Valid for T < 1000 ^{0}K

Card 4	1	2	3	4	5	6	7	8
Variable	Cv1_0	Cv1_1	Cv1_2	Cv1_3	Cv1_4			
Type	F	F	F	F	F			
Default	0.	0.	0.	0.	0.			

Card for the expansion of Specific Heat at Constant Volume. Valid for T > 1000 ^{0}K.

Card 5	1	2	3	4	5	6	7	8
Variable	Cv2_0	Cv2_1	Cv2_2	Cv2_3	Cv2_4			
Type	F	F	F	F	F			
Default	0.	0.	0.	0.	0.			

VARIABLE	DESCRIPTION
EOSID	Equation of state identifier for the CESE solver.
Cp1_0, …, Cp1_4	Coefficients of temperature-dependent specific heat at constant pressure valid for T < 1000 ^{0}K. $C_{p1}(T) = C_{p1\_0} + C_{p1\_1}\,T + C_{p1\_2}\,T^2 + C_{p1\_3}\,T^3 + C_{p1\_4}\,T^4$
Cp2_0, …, Cp2_4	Coefficients of temperature-dependent specific heat at constant pressure valid for T > 1000 ^{0}K. $C_{p2}(T) = C_{p2\_0} + C_{p2\_1}\,T + C_{p2\_2}\,T^2 + C_{p2\_3}\,T^3 + C_{p2\_4}\,T^4$
Cv1_0, …, Cv1_4	Coefficients of temperature-dependent specific heat at constant volume valid for T < 1000 ^{0}K. $C_{v1}(T) = C_{v1\_0} + C_{v1\_1}\,T + C_{v1\_2}\,T^2 + C_{v1\_3}\,T^3 + C_{v1\_4}\,T^4$
Cv2_0, …, Cv2_4	Coefficients of temperature-dependent specific heat at constant volume valid for T > 1000 ^{0}K. $C_{v2}(T) = C_{v2\_0} + C_{v2\_1}\,T + C_{v2\_2}\,T^2 + C_{v2\_3}\,T^3 + C_{v2\_4}\,T^4$

Remark:

2. These coefficient expansions for the specific heats over two temperature ranges are generated by the 0-D inflator model solver. See *CHEMISTRY_CONTROL_INFLATOR and *CHEMISTRY_INFLATOR_PROPERTIES for details related to running that solver.

*CESE_FSI_EXCLUDE

Purpose: Provide a list of mechanics solver parts that are not involve in the CESE FSI calculation. This is intended to be used as an efficiency measure for parts that will not involve significant FSI interactions with the CESE compressible fluid solver..

Include as many cards as needed. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	PID1	PID2	PID3	PID4	PID5	PID6	PID7	PID8
Type	I	I	I	I	I	I	I	I
Default	none	none	none	none	none	none	none	none

VARIABLE	DESCRIPTION
PIDn	IDs of mechanics parts that will be excluded from the FSI interaction calculation with the CESE solver.

*CESE_INITIAL

Purpose: Specify constant initial conditions (ICs) for flow variables at the centroid of each fluid element.

Card 1	1	2	3	4	5	6	7	8
Variable	U	V	W	RH	P	T		
Type	F	F	F	F	F	F		
Default	0	0.0	0.0	1.225	0.0	0.0		

VARIABLE	DESCRIPTION
U, V, W	x-, y-, z-velocity components, respectively
RHO	Density, ρ
P	Pressure, P
T	Temperature, T

Remarks:

1. **Required Input.** Usually, only two of ρ, P, and T need to be specified (besides the velocity). If all three are given, only ρ and P will be used.

2. **Applicable Elements.** These initial conditions will be applied only in those elements that have not been assigned a value by *CESE_INITIAL_*OPTION* cards for individual elements or sets of elements.

CESE_INITIAL_*OPTION

Available options include:

SET

ELEMENT

Purpose: Specify initial conditions for the flow variables at the centroid of each element in a set of elements or at the centroid of a single element.

Include as many cards as needed. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	EID/ESID	U	V	W	RHO	P	T	
Type	I	F	F	F	F	F	F	
Default	none	0.0	0.0	0.0	1.225	0.0	0.0	
Remarks					1	1	1	

VARIABLE	DESCRIPTION
EID/ESID	Solid element ID (EID) or solid element set ID (ESID)
U, V, W	x-, y-, z-velocity components, respectively
RHO	Density, ρ
P	Pressure, P
T	Temperature, T

Remarks:

1. **Required Input.** Usually, only two of ρ, P, and T need to be specified (along with the velocity). If all three are given, only ρ and P will be used.

2. **Initial Condition Specification Priority.** The priority of this card is higher than *CESE_INITIAL, meaning that if an element is assigned an initial value by this card, *CESE_INITIAL will no longer apply to that element.

*CESE_INITIAL_CHEMISTRY

Purpose: Initializes the chemistry and fluid state in every element of the CESE mesh that has not already been initialized by one of the other *CESE_INITIAL_CHEMISTRY cards. This is only used when chemistry is being solved with the CESE solver.

Card 1	1	2	3	4	5	6	7	8
Variable	CHEMID	COMPID						
Type	I	I						
Default	none	none						

Card 2	1	2	3	4	5	6	7	8
Variable	UIC	VIC	WIC	RHOIC	PIC	TIC	HIC	
Type	F	F	F	F	F	F	F	
Default	none	none	none	none	none	none	none	

VARIABLE	DESCRIPTION
CHEMID	Identifier of chemistry control card to use
COMPID	Identifier of chemical composition to use
UIC	*X*-component of the fluid velocity
VIC	*Y*-component of the fluid velocity
WIC	*Z*-component of the fluid velocity
RHOIC	Initial fluid density
PIC	Initial fluid pressure
TIC	Initial fluid temperature

VARIABLE	DESCRIPTION
HIC	Initial fluid enthalpy. However, when CHEMID refers to a ZND 1-step reaction card, this is the progressive variable (degree of combustion).

*CESE_INITIAL_CHEMISTRY_ELEMENT

Purpose: Initialize the chemistry and fluid state in every element of the list of CESE elements. This keyword is only used when chemistry is being solved with the CESE solver.

Card 1	1	2	3	4	5	6	7	8
Variable	CHEMID	COMPID						
Type	I	I						
Default	none	none						

Card 2	1	2	3	4	5	6	7	8
Variable	UIC	VIC	WIC	RHOIC	PIC	TIC	HIC	
Type	F	F	F	F	F	F	F	
Default	none	none	none	none	none	none	none	

Element List Card. Include as many cards as necessary. This input ends at the next keyword ("*") card.

Card 3	1	2	3	4	5	6	7	8
Variable	ELE1	ELE2	ELE3	ELE4	ELE5	ELE6	ELE7	ELE8
Type	I	I	I	I	I	I	I	I

VARIABLE	DESCRIPTION
CHEMID	Identifier of chemistry control card to use (see *CHEMISTRY_CONTROL._...)
COMPID	Identifier of chemical composition to use (see *CHEMISTRY_COMPOSITION)
UIC	*X*-component of the fluid velocity

VARIABLE	DESCRIPTION
VIC	*Y*-component of the fluid velocity
WIC	*Z*-component of the fluid velocity
RHOIC	Initial fluid density
PIC	Initial fluid pressure
TIC	Initial fluid temperature
HIC	Initial fluid enthalpy. However, when CHEMID refers to a ZND 1-step reaction card (see *CHEMISTRY_CONTROL_ZND), this is the progressive variable (degree of combustion).
ELE*i*	User element numbers to initialize

*CESE_INITIAL_CHEMISTRY_PART

Purpose: Initialize the chemistry and fluid state in every element of the specified CESE part that has not already been initialized by *CESE_INITIAL_CHEMISTRY_ELEMENT or *CESE_INITIAL_CHEMISTRY_SET cards. This keyword is only used when chemistry is being solved with the CESE solver.

Card 1	1	2	3	4	5	6	7	8
Variable	PARTID	CHEMID	COMPID					
Type	I	I	I					
Default	none	none	none					

Card 2	1	2	3	4	5	6	7	8
Variable	UIC	VIC	WIC	RHOIC	PIC	TIC	HIC	
Type	F	F	F	F	F	F	F	
Default	none	none	none	none	none	none	none	

VARIABLE	DESCRIPTION
PARTID	Identifier of the CESE part on which to initialize (see *CESE_PART)
CHEMID	Identifier of the chemistry control card to use (see *CHEMISTRY_-CONTROL._...)
COMPID	Identifier of the chemical composition to use (see *CHEMISTRY_-COMPOSITION)
UIC	*X*-component of the fluid velocity
VIC	*Y*-component of the fluid velocity
WIC	*Z*-component of the fluid velocity
RHOIC	Initial fluid density

VARIABLE	DESCRIPTION
PIC	Initial fluid pressure
TIC	Initial fluid temperature
HIC	Initial fluid enthalpy. However, when CHEMID refers to a ZND 1-step reaction card (see *CHEMISTRY_CONTROL_ZND), this is the progressive variable (degree of combustion).

*CESE_INITIAL_CHEMISTRY_SET

Purpose: Initializes the chemistry and fluid state in every element of the specified element set in the CESE mesh that has not already been initialized by *CESE_INITIAL_CHEMISTRY_ELEMENT cards. This is only used when chemistry is being solved with the CESE solver.

Card 1	1	2	3	4	5	6	7	8
Variable	SETID	CHEMID	COMPID					
Type	I	I	I					
Default	none	none	none					

Card 2	1	2	3	4	5	6	7	8
Variable	UIC	VIC	WIC	RHOIC	PIC	TIC	HIC	
Type	F	F	F	F	F	F	F	
Default	none	none	none	none	none	none	none	

VARIABLE	DESCRIPTION
SETID	Identifier of the CESE element set to initialize
CHEMID	Identifier of chemistry control card to use (see *CHEMISTRY_CONTROL._...)
COMPID	Identifier of chemical composition to use (see *CHEMISTRY_COMPOSITION)
UIC	*X*-component of the fluid velocity
VIC	*Y*-component of the fluid velocity
WIC	*Z*-component of the fluid velocity
RHOIC	Initial fluid density

VARIABLE	DESCRIPTION
PIC	Initial fluid pressure
TIC	Initial fluid temperature
HIC	Initial fluid enthalpy. However, when CHEMID refers to a ZND 1-step reaction card (see *CHEMISTRY_CONTROL_ZND), this is the progressive variable (degree of combustion).

*CESE_MAT_000

Purpose: Define the fluid (gas) properties in a viscous flow for the CESE solver.

Material Definition Cards. Include one card for each instance of this material type. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	MID	MU	K					
Type	I	F	F					
Default	none	none	none					

VARIABLE	DESCRIPTION
MID	Material identifier
MU	Fluid dynamic viscosity. For Air at 15 °C, MU = 1.81×10^{-5} $^{kg}/_{ms}$
K	Thermal conductivity of the fluid

Remarks:

1. The viscosity is only used viscous flows, so for inviscid flows, it is not necessary to define it. The thermal conductivity is only used to calculate the heat transfer between the structure and the thermal solver when coupling is activated.

2. As with other solvers in LS-DYNA, the user is responsible for unit consistency. For example, if dimensionless variables are used, MU should be replaced by the corresponding dimensionless one.

*CESE_MAT_001(_GAS)

Purpose: Define the fluid (gas) properties in a viscous flow for the CESE solver.

Include as many cards as needed. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	MID	C1	C2	PRND				
Type	I	F	F	F				
Default	none	1.458E-6	110.4	0.72				

VARIABLE	DESCRIPTION
MID	Material identifier
C1, C2	Two coefficients in the Sutherland's formula for viscosity, i.e., $$\mu = \frac{C_1 T^{\frac{3}{2}}}{T + C_2}$$ where C_1 and C_2 are constants for a given gas. For example, for air at moderate temperatures, $$C_1 = 1.458 \times 10^{-6}\,\mathrm{kg/msK^{1/2}}, \quad C_2 = 110.4\,\mathrm{K}$$
PRND	The Prandtl Number (used to determine the coefficient of thermal conductivity). It is approximately constant for most gases. For air at standard conditions PRND = 0.72.

Remarks:

1. C1 and C2 are only used to calculate the viscosity in viscous flows, so for inviscid flows, this material card is not needed. The Prandtl number is used to extract the thermal conductivity, which is used when thermal coupling with the structure is activated.

2. As with other solvers in LS-DYNA, the user is responsible for unit consistency. For example, if dimensionless variables are used, C_1 and C_2 should be replaced by the corresponding dimensionless ones.

*CESE_MAT_002

Purpose: Define the fluid (gas) properties in a viscous flow for the CESE solver.

Material Definition Cards. Include one card for each instance of this material type. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	MID	MU0	SMU	K0	SK	T0		
Type	I	F	F	F	F	F		
Default	none	1.716E-5	111.	0.0241	194.0	273.0		

VARIABLE	DESCRIPTION
MID	Material identifier
MU0 / SMU	Two coefficients appearing in the equation derived by combining Sutherland's formula with the power law for dilute gases: $$\frac{\mu}{\mu_0} = \left(\frac{T}{T_0}\right)^{3/2} \frac{T_0 + S_\mu}{T + S_\mu} \ .$$ μ_0 is a reference value, and S_μ is an effective temperature called the Sutherland constant, which is characteristic of the gas. For air at moderate temperatures, $$\mu_0 = 1.716 \times 10^{-5}\,\mathrm{Ns/m^2}\,, \qquad S_\mu = 111\ \mathrm{K}$$
K0/SK	Two coefficients appearing in the equation derived by combining Sutherland's formula with the power law for dilute gases: $$\frac{k}{k_0} = \left(\frac{T}{T_0}\right)^{3/2} \frac{T_0 + S_k}{T + S_k} \ .$$ Here k is the thermal conductivity, k_0 is a reference value, and S_k is the Sutherland constant, which is characteristic of the gas. For air at moderate temperatures, $$k_0 = 0.0241\ \mathrm{W/m}\,, \qquad S_k = 194\ \mathrm{K}$$
T0	Reference temperature, T_0. The default value (273.0) is for air, in degrees K.

Remarks:

1. **Fields that Depend on Problem Physics.** The viscosity is only used for viscous flow. Therefore, for inviscid flows, it is not necessary to define it. The thermal conductivity is only used to calculate the heat transfer between the structure and the thermal solver when coupling is activated.

2. **Unit Consistency.** As with other solvers in LS-DYNA, the user is responsible for unit consistency. For example, if dimensionless variables are used, MU should be replaced by the corresponding dimensionless one.

*CESE_PART

Purpose: Define CESE solver parts, meaning connect CESE material and EOS information.

Part Cards. Include one card for each CESE part. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	PID	MID	EOSID					
Type	I	I	I					
Default	none	none	none					

VARIABLE	DESCRIPTION
PID	Part identifier (must be different from any PID on a *PART card)
MID	Material identifier defined by a *CESE_MAT_… card
EOSID	Equation of state identifier defined by a *CESE_EOS_… card

Remarks:

1. **Material for inviscid flows.** Since material coefficients are only used in viscous flows, the MID can be left blank for inviscid flows.

*CESE_SURFACE_MECHSSID_D3PLOT

Purpose: Identify the surfaces to be used in generating surface D3PLOT output for the CESE solver. These surfaces must be on the outside of volume element parts that are in contact with the CESE fluid mesh. The variables in question are part of the CESE FSI solution process or of the CESE conjugate heat transfer solver.

Include as many cards as needed. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	SSID	SurfaceLabel						
Type	I	A						
Default	none	none						

VARIABLE	DESCRIPTION
SSID	Mechanics solver segment set ID that is in contact with the fluid CESE mesh.
SurfaceLabel	Name to use in d3plot output to identify the SSID for the LSPP user.

*CESE_SURFACE_MECHVARS_D3PLOT

Purpose: List of variables to output on the surfaces designated by the segment set IDs given in the *CESE_SURFACE_MECHSSID_D3PLOT cards. Most of the allowed variables are defined only on the fluid-structure interface, and so the segment set IDs defining a portion of the fluid-structure interface must involve only segments (element faces) that are on the outside of volume element parts that are in contact with the CESE fluid mesh.

Include as many cards as needed. This input ends at the next keyword ("*") card.

Card 1	1	2	3	4	5	6	7	8
Variable	Output Quantity							
Type	A							
Default	none							

VARIABLE	DESCRIPTION
Output Quantity	Descriptive phrase for the mechanics surface variable to output for the LSPP user. Output will be done on all SSIDs selected by the *CESE_SURFACE_MECHSSID_D3PLOT cards in the problem. Supported variables include: FLUID FSI FORCE FLUID FSI PRESSURE INTERFACE TEMPERATURE SOLID INTERFACE HEAT FLUX FLUID INTERFACE HEAT FLUX INTERFACE HEAT FLUX RATE SOLID INTERFACE DISPLACEMENT SOLID INTERFACE VELOCITY SOLID INTERFACE ACCELERATION Force, displacement, velocity, and acceleration are output as vector quantities. The rest of the variables are scalar quantities. The fluxes are in the normal direction to the fluid/structure interface, with the heat fluxes relative to the normal pointing into the structure.