EGG-WM--9043

DE91 001829

IN SITU VITRIFICATION
SOFTWARE REQUIREMENTS SPECIFICATION

Revision 1.1

William H. Grush
Earl S. Marwil

September 1990

Scientific Computing Unit
Computer Applications and Technology Transfer Group
Information Resources Department
EG&G Idaho, Inc.
Idaho Falls, Idaho 83415

Prepared for the
U. S. Department of Energy
Idaho Operations Office
Under DOE Contract No. DE-AC07-76ID01570

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

IN SITU VITRIFICATION SOFTWARE
REQUIREMENTS SPECIFICATION
EGG-WM-9043

Approved By:

S. K. Merrill, Manager
In Situ Vitrification

Date:

9/17/90

Prepared By:

W. H. Grush

Date:

9/14/90

Reviewed By:

S. D. Matthews
Technical Reviewer

Date:

17 Sep 90

ABSTRACT

This report describes the Software Requirements Specification for the Electrical Resistance Heating and Thermal Energy Transport models of the In-Situ Vitrification (ISV) process. It contains the Data Flow Diagrams, Process Specifications, Data Structure Diagrams, and the Data Dictionary.

CONTENTS

ABSTRACT	ii
INTRODUCTION	1
DATA FLOW DIAGRAMS	1
PROCESS SPECIFICATIONS	2
DATA STRUCTURE DIAGRAMS	2
DATA DICTIONARY	2
SOFTWARE DESIGN SPECIFICATION	2
REFERENCES	2
APPENDIX A - DATA FLOW DIAGRAMS	A-1
APPENDIX B - PROCESS SPECIFICATIONS	B-1
APPENDIX C - DATA STRUCTURE DIAGRAMS	C-1
APPENDIX D - DATA DICTIONARY	D-1

IN SITU VITRIFICATION SOFTWARE REQUIREMENTS SPECIFICATION

INTRODUCTION

This software requirements specification describes the In Situ Vitrification (ISV) simulation of the coupled Electrical Resistance Heating (ERH) and Thermal Energy Transport (TET) problems. Other aspects of the ISV modeling effort are to be simulated with stand alone models. These other models include the process chemistry, gas release, melt flow, vapor transport, and combustion in the hood. Experimental results and analysis with stand alone simulation models may indicate that coupling of these other simulations to the ERH and TET problems is required. This software requirements specification allows as much flexibility as possible for that contingency. For a full discussion of all of the physical models considered for the ISV, the reader should refer to the ISV Modeling Requirements [1] and the ISV Implementation Plan [2].

A software requirements specification is a model on paper of the intended software system. Details of the data structures and functional processes are given and analyzed for consistency and completeness. This is a critical part of any software development to ensure that all of the requirements are incorporated in the software. The following sections briefly describe the data flow diagrams, the data structure diagrams, and the data dictionary. All of these diagrams are maintained by a software tool kit called Software through Pictures (StP) licensed to EG&G by Interactive Development Environments (IDE) [3]. This allows a great deal of flexibility in developing the software requirements to try various scenarios and keep the ideas best suited to the project. Additionally, the software requirements are easily maintainable. In particular, for the ISV project, the requirements for software modeling are likely to change frequently, based on the ongoing experimental program and other analysis associated with this project.

DATA FLOW DIAGRAMS

The data flow diagrams for the ISV simulation of the ERH and TET problems are included as Appendix A. The diagrams are organized starting at the "top" level or context level diagram. Level "0" is decomposed to show the controlling executive process through which the user can choose input data preparation, simulation, or viewing the simulation output.

The input processor manages all of the user interface in building the problem data file and the geometry file used by the simulation processor. A binary format for the files was chosen to facilitate the Quality Assurance (QA) of the problem definition associated with each simulation run. The user is allowed to change or create problem definitions only through interaction with the input processor.

The simulation processor is given only the name of the problem, which identifies the input data file and is used to construct all file names used or created by the simulation processor. The simulation models may be run independently for software verification and validation. As coupled models the ERH problem is solved at the beginning of each TET time step. The ERH problem is a static or steady state problem in this context, given the electrode potentials, the depth of the electrodes, and the prescribed boundary conditions. To account for the cycle of positive and negative voltage applied to each of four electrodes, two static problems are solved and the results averaged to produce the element heat generation rates. The TET problem is then solved for a given time step, using the heat generation rate within each element computed by the ERH model. The results of both models are stored at specified intervals for subsequent post-processing.

The output processor allows the user to view the simulation results in either a tabular printed format for selected problem variables or in a more convenient graphic format.

PROCESS SPECIFICATIONS

At the lowest level in a data flow description is the process specifications. These are written in pseudo-code and generally correspond to a module which can be implemented as code. Each process specification (pspec) performs a single function or task. The pspecs are included as Appendix B.

DATA STRUCTURE DIAGRAMS

The data structure diagrams for the ISV simulation of the ERH and TET problems are included as Appendix C. The data structure diagrams show the hierarchy of data structure defined for the software.

DATA DICTIONARY

The data dictionary for the ISV simulation of the ERH and TET problems is included as Appendix D. The data dictionary describes each data element as having a data type, constraints, a value, and other attributes as necessary. At a minimum, to be a data element, a type must be specified. Types may be integer, real, logical, or any other standard data type or a data type specified in the software requirements. For example, we have defined a 3D_vector as a data type consisting of X, Y, and Z real components, rather than specifying components for every vector as a unique data structure.

SOFTWARE DESIGN SPECIFICATION

The next stage of the software development is to derive a software architecture from the software requirements. This document represents a snapshot of the requirements at this time. The software requirements may change as a result of changing modeling requirements or questions raised during design specification. Therefore, the final authority on the software requirements specification is the on-line diagrams, process specifications, and data dictionary as maintained in StP.

REFERENCES

- [1] R.J. MacKinnon, D.C. Mecham, et al., Modeling Requirements for In Situ Vitrification, EG&G Idaho, Inc. Draft Report, December 1989.
- [2] R.J. MacKinnon, et al., In Situ Vitrification Model Development and Implementation Plan, EG&G Idaho, Inc. Draft Report, March 1990.
- [3] Software Through Pictures, Release 4.2, Interactive Development Environments (IDE), San Francisco, CA, March 1990.
- [4] R.S. Pressman, Software Engineering, A Practitioner's Approach, McGraw-Hill, San Francisco, CA, 1987.
- [5] E. Yourdon, Modern Structured Analysis, Yourdon Press, Englewood Cliffs, NJ, 1989.

APPENDIX A - DATA FLOW DIAGRAMS

Diagram: top
Diagram: 0
Diagram: 2
Diagram: 2.1
Diagram: 3
Diagram: 3.3
Diagram: 3.3.2
Diagram: 3.3.3
Diagram: 3.3.4
Diagram: 3.3.5
Diagram: 3.3.7
Diagram: 3.4
Diagram: 3.4.2
Diagram: 3.4.2.5
Diagram: 3.4.3
Diagram: 3.4.4
Diagram: 3.4.5
Diagram: 3.4.7
Diagram: 4

Project: In Situ Vitrification
Diagram: top
Name: context

Project: In Situ Vitrification
 Diagram: 0
 Name: ISV

Project: In Situ Vitrification
 Diagram: 2
 Name: input_processor

Project: In Situ Vitrification
Diagram: 2.1
Name: ISV_input_executive

Project: In Situ Vitrification
Diagram: 3
Name: simulate_ERH_and_TET_process

Project: In Situ Vitrification
Diagram: 3.3
Name: solve_ERH_problem

Project: In Situ Vitrification
Diagram: 3.3.2
Name: assemble_ERH_element_equations

Name: apply_ERH_flux_boundary_condition

Name: `apply_ERH_electrode_position_boundary_condition`

Name: compute_ERH_element_current_density

Project: In Situ Vitrification
Diagram: 3.4
Name: solve_TET_problem

Project: In Situ Vitrification
Diagram: 3.4.2
Name: assemble_TET_element_equations

Project: In Situ Vitrification

Diagram: 3.4.2.5

Name: compute_TET_element_GP_thermal_quantities

Name: `apply_TET_convection_boundary_condition`

Name: `apply_TET_radiation_boundary_condition`

Project: In Situ Vitrification

Diagram: 3.4.5

Name: apply_TET_temperature_boundary_condition

Project: In Situ Vitrification
 Diagram: 3.4.7
 Name: compute_TET_element_heat_flux

Project: In Situ Vitrification
 Diagram: 4
 Name: output_processor

APPENDIX B - PROCESS SPECIFICATIONS

Process 1: Executive
Process 2.2: load_base_case
Process 2.3: view_component
Process 2.4: modify_component
Process 2.5: store_new_case
Process 2.1.1: input_dialog_manager
Process 2.1.2: check_problem_consistency
Process 2.1.3: estimate_problem_resources
Process 3.1: simulation_executive
Process 3.2: get_problem_definition
Process 3.5: write_results
Process 3.3.1: ERH_executive
Process 3.3.6: solve_ERH_global_equations
Process 3.3.2.1: ERH_element_equations_executive
Process 3.3.2.2: compute_ERH_element_shape_function_GP_values
Process 3.3.2.3: compute_ERH_element_GP_potential
Process 3.3.2.4: compute_ERH_element_GP_electrical_conductivity
Process 3.3.2.5: accumulate_ERH_element_equation_GP_component
Process 3.3.3.1: flux_boundary_executive
Process 3.3.3.2: compute_flux_element_shape_function_GP_values
Process 3.3.3.3: compute_ERH_surface_element_GP_current_density
Process 3.3.3.4: accumulate_flux_boundary_integral_GP_component
Process 3.3.4.1: electrode_position_boundary_executive
Process 3.3.4.2: get_nodal_electrode_potential_boundary_value
Process 3.3.5.1: potential_boundary_executive
Process 3.3.5.2: get_nodal_potential_boundary_value
Process 3.3.7.1: ERH_element_current_density_executive
Process 3.3.7.2: recompute_ERH_element_shape_function_GP_values
Process 3.3.7.3: recompute_ERH_element_GP_potential
Process 3.3.7.4: compute_ERH_element_GP_potential_gradient
Process 3.3.7.5: recompute_ERH_element_GP_electrical_conductivity
Process 3.3.7.6: compute_ERH_element_GP_current_density
Process 3.3.7.7: compute_ERH_element_GP_heat_generation_rate
Process 3.4.1: TET_executive
Process 3.4.6: solve_TET_global_equations
Process 3.4.2.1: TET_element_equations_executive
Process 3.4.2.2: compute_TET_element_shape_function_GP_values
Process 3.4.2.3: compute_TET_element_GP_temperature
Process 3.4.2.4: compute_TET_element_GP_ERH_heat_generation_rate
Process 3.4.2.6: compute_TET_element_GP_heat_generation_rate
Process 3.4.2.7: accumulate_TET_element_equation_GP_component
Process 3.4.2.5.1: compute_TET_element_GP_thermal_conductivity
Process 3.4.2.5.2: compute_TET_element_GP_density_heat_capacity
Process 3.4.2.5.3: compute_TET_element_GP_phase_change_energy
Process 3.4.2.5.4: compute_TET_element_GP_electrical_conductivity
Process 3.4.3.1: convection_boundary_executive
Process 3.4.3.2: compute_nodal_chtc
Process 3.4.3.3: compute_convection_element_shape_function_GP_values

Process 3.4.3.4: compute_convection_element_GP_temperature
Process 3.4.3.5: compute_GP_chtc
Process 3.4.3.6: accumulate_convection_boundary_integral_GP_component
Process 3.4.4.1: radiation_boundary_executive
Process 3.4.4.2: compute_nodal_rhtc
Process 3.4.4.3: compute_radiation_element_shape_function_GP_values
Process 3.4.4.4: compute_radiation_element_GP_temperature
Process 3.4.4.5: compute_GP_rhtc
Process 3.4.4.6: accumulate_radiation_boundary_integral_GP_component
Process 3.4.5.1: temperature_boundary_executive
Process 3.4.5.2: get_nodal_temperature_boundary_value
Process 3.4.7.1: TET_element_heat_flux_executive
Process 3.4.7.2: recompute_TET_element_shape_function_GP_values
Process 3.4.7.3: recompute_TET_element_GP_temperature
Process 3.4.7.4: compute_TET_element_GP_temperature_gradient
Process 3.4.7.5: recompute_TET_element_GP_thermal_conductivity
Process 3.4.7.6: compute_TET_element_GP_heat_flux
Process 4.1: ISV_output_executive
Process 4.2: load_general_problem_data
Process 4.3: display_data_channels

Process 1

Executive

Process 1: Executive

Pspec generated 4 September 1990 at 14:57:19

This process has 5 data flows:

input data flows

ISV_menu_selection

output data flows

ISV_menu

input_selection

simulate_selection

output_selection

description

Get command line options

Repeat (

 Display ISV_menu

 Receive ISV_menu_selection

 Switch (ISV_menu_selection) {

 case input:

 Initiate input_process

 break;

 case simulation:

 Initiate simulation

 break;

 case output:

 Initiate output_process

 break;

 case quit:

 Exit;

) end switch

) Until ()

end pspec

Process 2.2
load_base_case

Process 2.2: load_base_case

Pspec generated 4 September 1990 at 14:58:03

This process has 3 data flows:

input data flows

base_case_name
problem_data_file

output data flows

problem_data

description

Foreach component of problem_data
Set default values

End

Foreach componet of base_case_data
Read problem component_data

End

end pspec

Process 2.3
view_component

Process 2.3: view_component

Pspec generated 4 September 1990 at 14:58:06

This process has 3 data flows:

input data flows

 component_name
 problem_data

output data flows

 component_displays

description

Define display_description using component_name

Create display using component_data and display_description

end pspec

Process 2.4
modify_component

Process 2.4: modify_component

Pspec generated 4 September 1990 at 14:58:09

This process has 3 data flows:

input data flows

- component_name
- component_new_data
- problem_data

output data flows

- problem_data

description

Load component_data into save buffer

While (new_component_data) {

- Replace component_data with new_component_data

} end while

If (undo) then

- Replace component_data with save buffer

else

- Store modified_component_data

endif

end pspec

Process 2.5
store_new_case

Process 2.5: store_new_case

Pspec generated 4 September 1990 at 14:58:12

This process has 6 data flows:

input data flows

new_case_name
ascii_only
problem_data

output data flows

xdr_binary_problem_file
xdr_binary_geometry_file
problem_data_file

description

Store problem_data to new_case_data_file

If (not ascii_only) then

Store geometry description to xdr_binary_geometry_file
Store problem description to xdr_binary_problem_file

endif

end pspec

Process 2.1.1

input_dialog_manager

Process 2.1.1: input_dialog_manager

Pspec generated 4 September 1990 at 14:58:51

This process has 13 data flows:

input data flows

- input_menu_selection
- input_responses
- input_selection
- resources_estimate
- consistency

output data flows

- input_menu
- input_prompts
- base_case_name
- component_name
- component_name
- component_new_data
- new_case_name
- ascii_only
- consistency

description

Display input_menu

Display resources estimate

Get input_menu_selection

Switch (input_menu_selection) {

 case load:

- Get list of problem names
- Display list of problem names
- Prompt for selection
- Get base_case_name
- Set all consistency flags
- Invoke load process
- break;

 case view:

- Display list of component names
- Prompt for selection
- Get component_name
- Invoke view process
- break;

 case modify:

- Prompt for new component data
- Get new_component data
- Set component consistency flag
- Invoke modify process
- break;

 case store:

- Check consistency flags
- if (consistent) then

```

        Prompt for new problem name
        Get new_case_name
        Invoke store process
    else
        Confirm store of inconsistent data
        Get confirmation
        If ( confirmed ) then
            Set ascii_only flag
            Prompt for new problem name
            Get new_case_name
            Invoke store process
        else
            Set component_name
            Invoke view process
        endif
    endif
    break;
case quit:
    Clean-up
    Return
    break;
case default:
    Display error message
} end case
end pspec

```

Process 2.1.2

check_problem_consistency

Process 2.1.2: check_problem_consistency

Pspec generated 4 September 1990 at 14:58:57

This process has 2 data flows:

input data flows

 problem_data
 consistency

output data flows

 consistency

description

Foreach component of problem_data

{

 If modified then

 Check component consistency

 Endif

}

Perform component dependent checks

end pspec

Process 2.1.3

estimate_problem_resources

Process 2.1.3: estimate_problem_resources

Pspec generated 4 September 1990 at 14:59:01

This process has 2 data flows:

input data flows

 problem_data

output data flows

 resources_estimate

description

Estimate cpu

Estimate memory

Estimate disk

Display resources estimate

end pspec

Process 3.1
simulation_executive

Process 3.1: simulation_executive

Pspec generated 4 September 1990 at 14:59:51

This process has 11 data flows:

input data flows

- simulate_selection
- simulation_menu_selection
- problem_controls
- ERH_messages
- TET_messages

output data flows

- simulation_summary
- ERH_controls
- TET_controls
- output_level
- case_name
- simulation_menu

description

- Get list of case names
- Display case names
- Get case_name
- Invoke get_problem_definition

- Set ERH initial values
- Set TET initial values to zero
- Write initial values

- Repeat {
 - Solve ERH problem (solve number_of_electrodes/2 problems and average)
 - Solve TET problem
 - Write results using output_frequency
- } Until (completed or terminated)

- Produce simulation summary

end pspec

Process 3.2
get_problem_definition

Process 3.2: get_problem_definition

Pspec generated 4 September 1990 at 14:59:41

This process has 10 data flows:

input data flows

- case_name
- xdr_binary_geometry_file
- xdr_binary_problem_file

output data flows

- problem_controls
- problem_variables
- ERH_boundary_conditions
- TET_boundary_conditions
- FE_mesh
- FE_method
- material_properties

description

Get case geometry from xdr_binary_geometry_file
Load FE_mesh, FE_method, material_composition, and boundary_conditions

Get case data from xdr_binary_problem_file
Load problem_variables
Return problem_controls

end pspec

Process 3.5
write_results

Process 3.5: write_results

Pspec generated 4 September 1990 at 14:59:47

This process has 3 data flows:

input data flows

output_level
problem_variables

output data flows

xdr_binary_problem_file

description

Receive output_level

Receive problem variables

Switch output_level (defined_levels) {

case 0:

write level 0 values
break;

case 1:

write level 1 values (plus level 0)
break;

case 2:

write level 2 values (plus level 1)
break;

}

end pspec

Process 3.3.1
ERH_executive

Process 3.3.1: ERH_executive

Pspec generated 4 September 1990 at 15:00:53

This process has 10 data flows:

input data flows

- ERH_controls
- delta_potential

output data flows

- current_density_request
- ERH_messages
- ERH_algorithm_controls
- electrical_potential
- ERH_algorithm_controls
- ERH_algorithm_controls
- ERH_algorithm_controls
- ERH_algorithm_controls

description

```
Repeat (
  form_ERH_global_equations (
    assemble ERH element equations
    apply flux boundary conditon
    apply electrode boundary conditon
    apply potential boundary conditon
  )
  solve_ERH_global_equations

  If (ERH_iteration_limit reached ) then
    terminate ERH problem
  endif

) Until ( ERH_relative_tolerance )

update electrical_potential values

compute_current_density

end pspec
```

Process 3.3.6

solve_ERH_global_equations

Process 3.3.6: solve_ERH_global_equations

Pspec generated 4 September 1990 at 15:00:50

This process has 3 data flows:

input data flows

ERH_algorithm_controls

ERH_global_equations

output data flows

delta_potential

description

Factor ERH_global_equations

Solve factored linear system

Return delta_potential

end pspec

Process 3.3.2.1

ERH_element_equations_executive

Process 3.3.2.1: ERH_element_equations_executive

Pspec generated 4 September 1990 at 15:02:07

This process has 6 data flows:

input data flows

- ERH_element_equation_GP_component
- ERH_algorithm_controls
- nodes
- elements

output data flows

- ERH_alpha
- ERH_global_equations

description

Foreach element {

 Foreach element node {

 Foreach Gauss_point {

- compute shape function and derivative values
- compute Gauss point potential
- compute Gauss point electrical conductivity
- accumulate local element equation GP component

 }

 apply integration rule to compute local element equation

 }

 accumulate local element nodal equation into global equations

}

end pspec

Process 3.3.2.2

compute_ERH_element_shape_function_GP_values

Process 3.3.2.2: compute_ERH_element_shape_function_GP_values

Pspec generated 4 September 1990 at 15:02:01

This process has 3 data flows:

input data flows

3D_canonical_functions

nodal_coordinates

output data flows

3D_ERH_element

description

compute determinant of transformation

evaluate shape functions at specified point

evaluate derivative functions at specified point

end pspec

Process 3.3.2.3

compute_ERH_element_GP_potential

Process 3.3.2.3: compute_ERH_element_GP_potential

Pspec generated 4 September 1990 at 15:02:11

This process has 3 data flows:

input data flows

electrical_potential

fcn

output data flows

GP_potential

description

```
Foreach node {  
    accumulate nodal potential times shape function value  
}
```

end pspec

Process 3.3.2.4

compute_ERH_element_GP_electrical_conductivity

Process 3.3.2.4: compute_ERH_element_GP_electrical_conductivity

Pspec generated 4 September 1990 at 15:02:04

This process has 5 data flows:

input data flows

- element_composition
- electrical_conductivity
- GP_potential
- temperature

output data flows

- GP_electrical_conductivity

description

evaluate electrical conductivity correlation

end pspec

Process 3.3.2.5

accumulate_ERH_element_equation_GP_component

Process 3.3.2.5: accumulate_ERH_element_equation_GP_component

Pspec generated 4 September 1990 at 15:02:14

This process has 5 data flows:

input data flows

GP_electrical_conductivity

ERH_alpha

electrical_potential

3D_ERH_element

output data flows

ERH_element_equation_GP_component

description

Scale GP_electrical_conductivity by one-eighth element volume (det)

Compute local stiffness matrix from derv and GP_electrical_conductivity

end pspec

Process 3.3.3.1

flux_boundary_executive

Process 3.3.3.1: flux_boundary_executive

Pspec generated 4 September 1990 at 15:02:52

This process has 8 data flows:

input data flows

- nodes
- elements
- Neumann_boundaries
- boundary_integral_GP_component
- ERH_Neumann_boundary_index
- ERH_algorithm_controls
- ERH_global_equations

output data flows

- ERH_alpha
- ERH_global_equations

description

Foreach surface element in the boundary {

 Foreach surface element node {

 Foreach 2D_Gauss_point {

 compute all shape function values
 compute Gauss current density
 accumulate boundary integral GP component

 }

 apply integration rule to compute contribution to local equation

 }

 accumulate local element nodal equation into global equations

}

end pspec

Process 3.3.3.2

.compute_flux_element_shape_function_GP_values

Process 3.3.3.2: compute_flux_element_shape_function_GP_values

Pspec generated 4 September 1990 at 15:02:59

This process has 3 data flows:

input data flows

2D_canonical_functions

nodal_coordinates

output data flows

2D_ERH_flux_element

description

transform canonical element to physical element

calculate function values at specified point

calculate dis

end pspec

Process 3.3.3.3

compute_ERH_surface_element_GP_current_density

Process 3.3.3.3: compute_ERH_surface_element_GP_current_density

Pspec generated 4 September 1990 at 15:03:03

This process has 3 data flows:

input data flows

current_density_boundary_condition
func

output data flows

GP_current_density

description

Foreach component of current density {

Foreach node of element {
accumulate current density component times function value
}

}

end pspec

Process 3.3.3.4

accumulate_flux_boundary_integral_GP_component

Process 3.3.3.4: accumulate_flux_boundary_integral_GP_component

Pspec generated 4 September 1990 at 15:03:08

This process has 4 data flows:

input data flows

ERH_alpha

GP_current_density

2D_ERH_flux_element

output data flows

boundary_integral_GP_component

description

scale GP_current density by dis

compute GP contribution to each nodal equation

end pspec

Process 3.3.4.1

electrode_position_boundary_executive

Process 3.3.4.1: electrode_position_boundary_executive

Pspec generated 4 September 1990 at 15:03:51

This process has 7 data flows:

input data flows

- nodal_electrode_potential_boundary_value
- ERH_Dirichlet_boundary_index
- nodes
- Dirichlet_boundaries
- ERH_algorithm_controls
- electrode_position
- ERH_global_equations

output data flows

- ERH_global_equations

description

Foreach node from top node to bottom node of electrode position (

- Get nodal electrode potential boundary value
- Define nodal equation
- Add penalty term to global equation to fix electrode potential value

)

end pspec

Process 3.3.4.2

get_nodal_electrode_potential_boundary_value

Process 3.3.4.2: get_nodal_electrode_potential_boundary_value

Pspec generated 4 September 1990 at 15:03:47

This process has 2 data flows:

input data flows

electrode_boundary_condition

output data flows

nodal_electrode_potential_boundary_value

description

Evaluate electrode potential boundary value correlation

end pspec

Process 3.3.5.1

potential_boundary_executive

Process 3.3.5.1: potential_boundary_executive

Pspec generated 4 September 1990 at 15:04:30

This process has 6 data flows:

input data flows

- nodal_potential_boundary_value
- ERH_Dirichlet_boundary_index
- nodes
- Dirichlet_boundaries
- ERH_algorithm_controls
- ERH_global_equations

output data flows

- ERH_global_equations

description

Foreach node in Dirichlet boundary {

- Get nodal potential boundary value
- Define nodal equation
- Add penalty term to global equation to fix potential value

}

end pspec

Process 3.3.5.2

get_nodal_potential_boundary_value

Process 3.3.5.2: get_nodal_potential_boundary_value

Pspec generated 4 September 1990 at 15:04:27

This process has 2 data flows:

input data flows

 potential_boundary_condition

output data flows

 nodal_potential_boundary_value

description

Evaluate potential boundary value correlation

end pspec

Process 3.3.7.1

ERH_element_current_density_executive

Process 3.3.7.1: ERH_element_current_density_executive

Pspec generated 5 September 1990 at 14:27:02

This process has 7 data flows:

input data flows

- current_density_request
- nodes
- elements
- GP_current_density
- GP_heat_generation_rate

output data flows

- current_density
- heat_generation_rate

description

Foreach element {

 Foreach element node {

 Foreach Gauss_point {

- compute shape function and derivative values
- compute Gauss point potential
- compute Gauss point electrical conductivity
- compute Gauss point current density

 }

 extrapolate Gauss point current density to nodes

}

average nodal current density from surrounding elements

end pspec

Process 3.3.7.2

recompute_ERH_element_shape_function_GP_values

Process 3.3.7.2: recompute_ERH_element_shape_function_GP_values

Pspec generated 5 September 1990 at 14:26:53

This process has 3 data flows:

input data flows

- 3D_canonical_functions
- nodal_coordinates

output data flows

- 3D_ERH_flux_element

description

- compute determinant of transformation
- evaluate shape functions at specified point
- evaluate derivative functions at specified point

end pspec

Process 3.3.7.3

recompute_ERH_element_GP_potential

Process 3.3.7.3: recompute_ERH_element_GP_potential

Pspec generated 5 September 1990 at 14:27:07

This process has 3 data flows:

input data flows

 electrical_potential

 fcn

output data flows

 GP_potential

description

Foreach node (

 accumulate nodal potential times shape function value

)

end pspec

Process 3.3.7.4

compute_ERH_element_GP_potential_gradient

Process 3.3.7.4: compute_ERH_element_GP_potential_gradient

Pspec generated 5 September 1990 at 14:27:15

This process has 3 data flows:

input data flows

 derv

 electrical_potential

output data flows

 GP_potential_gradient

description

Foreach component direction {

 Foreach node of element {

 accumulate potential times component derivative value

 }

}

end pspec

Process 3.3.7.5

recompute_ERH_element_GP_electrical_conductivity

Process 3.3.7.5: recompute_ERH_element_GP_electrical_conductivity

Pspec generated 5 September 1990 at 14:26:58

This process has 5 data flows:

input data flows

electrical_conductivity

element_composition

GP_potential

temperature

output data flows

GP_electrical_conductivity

description

evalute electrical conductivity correlation

end pspec

Process 3.3.7.6

compute_ERH_element_GP_current_density

Process 3.3.7.6: compute_ERH_element_GP_current_density

Pspec generated 5 September 1990 at 14:27:11

This process has 3 data flows:

input data flows

GP_electrical_conductivity

GP_potential_gradient

output data flows

GP_current_density

description

compute GP_electrical_conductivity times GP_temp_grad

end pspec

Process 3.3.7.7

compute_ERH_element_GP_heat_generation_rate

Process 3.3.7.7: compute_ERH_element_GP_heat_generation_rate

Pspec generated 5 September 1990 at 14:27:18

This process has 3 data flows:

input data flows

GP_current_density

GP_potential_gradient

output data flows

GP_heat_generation_rate

description

compute GP_current_density times GP_potential_gradient

end pspec

Process 3.4.1
TET_executive

Process 3.4.1: TET_executive

Pspec generated 4 September 1990 at 15:06:06

This process has 12 data flows:

input data flows

- TET_controls
- delta_temperature

output data flows

- heat_flux_request
- TET_messages
- TET_algorithm_controls
- temperature
- electrode_position
- time
- TET_algorithm_controls
- TET_algorithm_controls
- TET_algorithm_controls
- TET_algorithm_controls

description

```
Repeat {
  Repeat {
    set trial_time to time plus delta_time

    Repeat {
      form_TET_global_equations {
        assemble TET element equations
        apply convection boundary condition
        apply radiation boundary condition
        apply temperature boundary condition
      }
      solve_TET_global_equations
    } Until ( TET_iteration_limit or TET_relative_tolerance )

    If ( not converged or temperature change exceeds limit ) then
      If ( delta_time <= min_dt ) then
        terminate TET problem
      endif
      reduce delta_time
    endif
  } Until ( converged and temperature change within limit )

  set time to trial_time
  adjust delta_time
  update temperature values
  update electrode position
} Until ( time equals TET_final_time )
```

```
compute_heat_flux
```

```
end pspec
```


Process 3.4.6

solve_TET_global_equations

Process 3.4.6: solve_TET_global_equations

Pspec generated 4 September 1990 at 15:06:01

This process has 3 data flows:

input data flows

TET_algorithm_controls

TET_global_equations

output data flows

delta_temperature

description

Factor TET_global_equations

Solve factored linear system

Return delta_temperature

end pspec

Process 3.4.2.1

TET_element_equations_executive

Process 3.4.2.1: TET_element_equations_executive

Pspec generated 5 September 1990 at 14:33:40

This process has 7 data flows:

input data flows

TET_element_equation_GP_component

TET_algorithm_controls

nodes

elements

output data flows

delta_time

TET_alpha

TET_global_equations

description

Foreach element {

Foreach element node {

Foreach Gauss_point {

compute shape function and derivative values

compute Gauss point temperature

compute Gauss point thermal quantities

compute Gauss point ERH heat generation rate

compute Gauss point heat generation rate

accumulate local element equation GP component

}

apply integration rule to compute local element equation

}

accumulate local element nodal equation into global equations

}

end pspec

Process 3.4.2.2

compute_TET_element_shape_function_GP_values

Process 3.4.2.2: compute_TET_element_shape_function_GP_values

Pspec generated 5 September 1990 at 14:33:36

This process has 3 data flows:

input data flows

3D_canonical_functions

nodal_coordinates

output data flows

3D_TET_element

description

compute determinant of transformation

evaluate shape functions at specified point

evaluate derivative functions at specified point

end pspec

Process 3.4.2.3

compute_TET_element_GP_temperature

Process 3.4.2.3: compute_TET_element_GP_temperature

Pspec generated 5 September 1990 at 14:33:44

This process has 3 data flows:

input data flows

temperature

fcn

output data flows

GP_temperature

description

Foreach node {

accumulate nodal temperature times shape function value

}

end pspec

Process 3.4.2.4

compute_TET_element_GP_ERH_heat_generation_rate

Process 3.4.2.4: compute_TET_element_G ERH_heat_generation_rate

Pspec generated 5 September 1990 at 14:33:54

This process has 3 data flows:

input data flows

fcu

heat_generation_rate

output data flows

GP_ERH_heat_generation_rate

description

Foreach node of element {

accumulate nodal heat_generation_rate component times fcu value

}

end pspec

Process 3.4.2.6

compute_TET_element_GP_heat_generation_rate

Process 3.4.2.6: compute_TET_element_GP_heat_generation_rate

Pspec generated 5 September 1990 at 14:33:51

This process has 5 data flows:

input data flows

- delta_time
- GP_phase_change_energy
- GP_electrical_conductivity
- GP_ERH_heat_generation_rate

output data flows

- GP_heat_generation_rate

description

compute phase change energy rate
sum ERH heat generation rate and phase change energy rate

end pspec

Process 3.4.2.7

accumulate_TET_element_equation_GP_component

Process 3.4.2.7: accumulate_TET_element_equation_GP_component

Pspec generated 5 September 1990 at 14:33:47

This process has 8 data flows:

input data flows

- GP_density_heat_capacity
- GP_heat_generation_rate
- TET_alpha
- delta_time
- GP_thermal_conductivity
- temperature
- 3D_TET_element

output data flows

- TET_element_equation_GP_component

description

Scale GP_thermal_conductivity by one-eighth element volume (det)

Scale GP_density_heat_capacity by one-eighth element volume

Scale GP_heat_generation_rate by one-eighth element volume

Compute local stiffness matrix as function of derv and GP_thermal_conductivity

Compute local rhs as function of fcn and GP_heat_generation_rate

Compute local mass matrix as function of fcn and GP_density_heat_capacity

Perform diagonal lumping of mass matrix by row sum

Add stiffness matrix contribution to rhs

Add stiffness and mass matrix contributions

end pspec

Process 3.4.2.5.1

compute_TET_element_GP_thermal_conductivity

Process 3.4.2.5.1: compute_TET_element_GP_thermal_conductivity

Pspec generated 4 September 1990 at 15:08:09

This process has 4 data flows:

input data flows

GP_temperature
element_composition
thermal_conductivity

output data flows

GP_thermal_conductivity

description

evaluate thermal conductivity correlation

end pspec

Process 3.4.2.5.2

compute_TET_element_GP_density_heat_capacity

Process 3.4.2.5.2: compute_TET_element_GP_density_heat_capacity

Pspec generated 4 September 1990 at 15:08:13

This process has 6 data flows:

input data flows

- heat_capacity
- GP_temperature
- density
- element_composition

output data flows

- GP_density_heat_capacity
- GP_heat_capacity

description

- evaluate density correlation
- evaluate heat capacity correlation
- compute density and heat_capacity product

end pspec

Process 3.4.2.5.3

compute_TET_element_GP_phase_change_energy

Process 3.4.2.5.3: compute_TET_element_GP_phase_change_energy

Pspec generated 4 September 1990 at 15:08:15

This process has 10 data flows:

input data flows

- heat_of_fusion
- melting_point
- GP_temperature
- solid_fraction
- GP_heat_capacity
- density
- element_composition
- boiling_point
- heat_of_vaporization

output data flows

- GP_phase_change_energy

description

```
if ( GP_temp passes through melting_point ) then
    compute fraction melted
    compute fusion energy
endif
```

```
if ( GP_temp passes through boiling_point ) then
    compute fraction vaporized
    compute vaporization energy
endif
```

add fusion energy to vaporization energy for phase change energy

end pspec

Process 3.4.2.5.4

compute_TET_element_GP_electrical_conductivity

Process 3.4.2.5.4: compute_TET_element_GP_electrical_conductivity

Pspec generated 4 September 1990 at 15:08:19

This process has 4 data flows:

input data flows

electrical_conductivity

GP_temperature

element_composition

output data flows

GP_electrical_conductivity

description

evaluate electrical conductivity correlation

end pspec

Process 3.4.3.1

convection_boundary_executive

Process 3.4.3.1: convection_boundary_executive

Pspec generated 4 September 1990 at 15:09:01

This process has 8 data flows:

input data flows

- nodes
- elements
- Neumann_boundaries
- boundary_integral_GP_component
- TET_Neumann_boundary_index
- TET_algorithm_controls
- TET_global_equations

output data flows

- TET_alpha
- TET_global_equations

description

Foreach surface element in the boundary {

- Get nodal convection heat transfer coefficients

- Foreach surface element node {

- Foreach 2D_Gauss_point {

- compute all shape function values
 - compute Gauss point temperature
 - compute Gauss point convection heat transfer coef
 - accumulate boundary integral GP component

- }

- apply integration rule to compute contribution to local equation

- }

- accumulate local element nodal equation into global equations

}

end pspec

Process 3.4.3.2

compute_nodal_chtc

Process 3.4.3.2: compute_nodal_chtc

Pspec generated 4 September 1990 at 15:08:58

This process has 3 data flows:

input data flows

convection_boundary_condition

temperature

output data flows

nodal_chtc

description

evaluate chtc coefficient correlation

end pspec

Process 3.4.3.3

compute_convection_element_shape_function_GP_values

Process 3.4.3.3: compute_convection_element_shape_function_GP_values

Pspec generated 4 September 1990 at 15:09:06

This process has 3 data flows:

input data flows

2D_canonical_functions

nodal_coordinates

output data flows

2D_TET_convection_element

description

calculate function values at specified point

calculate dis

end pspec

Process 3.4.3.4

compute_convection_element_GP_temperature

Process 3.4.3.4: compute_convection_element_GP_temperature

Pspec generated 4 September 1990 at 15:09:10

This process has 3 data flows:

input data flows

temperature

func

output data flows

GP_temperature

description

```
Foreach node of element {  
    accumulate temperature times function value  
}
```

end pspec

Process 3.4.3.5
compute_GP_chtc

Process 3.4.3.5: compute_GP_chtc

Pspec generated 4 September 1990 at 15:09:14

This process has 3 data flows:

input data flows

nodal_chtc

func

output data flows

GP_chtc

description

```
Foreach node of element {  
    accumulate chtc times function value  
}
```

end pspec

Process 3.4.3.6

accumulate_convection_boundary_integral_GP_component

Process 3.4.3.6: accumulate_convection_boundary_integral_GP_component

Pspec generated 4 September 1990 at 15:09:17

This process has 7 data flows:

input data flows

- TET_alpha
- GP_chtc
- GP_temperature
- convection_air_temperature
- 2D_TET_convection_element

output data flows

- boundary_integral_GP_component
- convection_energy

description

scale GP_chtc by dis

compute GP contribution to each nodal equation

end pspec

Process 3.4.4.1

radiation_boundary_executive

Process 3.4.4.1: radiation_boundary_executive

Pspec generated 4 September 1990 at 15:10:00

This process has 8 data flows:

input data flows

- nodes
- elements
- Neumann_boundaries
- boundary_integral_GP_component
- TET_Neumann_boundary_index
- TET_algorithm_controls
- TET_global_equations

output data flows

- TET_alpha
- TET_global_equations

description

Foreach surface element in the boundary {

 Get nodal radiation heat transfer coefficients

 Foreach surface element node {

 Foreach 2D_Gauss_point {

 compute all shape function values

 compute Gauss point temperature

 compute Gauss point radiation heat transfer coef

 accumulate boundary integral GP component

 }

 apply integration rule to compute contribution to local equation

 }

 accumulate local element nodal equation into global equations

}

end pspec

Process 3.4.4.2

compute_nodal_rhtc

Process 3.4.4.2: compute_nodal_rhtc

Pspec generated 4 September 1990 at 15:09:57

This process has 3 data flows:

input data flows

radiation_boundary_condition
temperature

output data flows

nodal_rhtc

description

evaluate rhtc coefficient correlation

end pspec

Process 3.4.4.3

compute_radiation_element_shape_function_GP_values

Process 3.4.4.3: compute_radiation_element_shape_function_GP_values

Pspec generated 4 September 1990 at 15:10:05

This process has 3 data flows:

input data flows

2D_canonical_functions

nodal_coordinates

output data flows

2D_TET_radiation_element

description

calculate function values at specified point

calculate dis

end pspec

Process 3.4.4.4

compute_radiation_element_GP_temperature

Process 3.4.4.4: compute_radiation_element_GP_temperature

Pspec generated: 4 September 1990 at 15:10:08

This process has 3 data flows:

input data flows

temperature

func

output data flows

GP_temperature

description

```
Foreach node of element {  
    accumulate temperature times function value  
}
```

end pspec

Process 3.4.4.5
compute_GP_rhtc

Process 3.4.4.5: compute_GP_rhtc

Pspec generated 4 September 1990 at 15:10:12

This process has 3 data flows:

input data flows

nodal_rhtc

func

output data flows

GP_rhtc

description

```
Foreach node of element {  
    accumulate rhtc times function value  
}
```

end pspec

Process 3.4.4.6

accumulate_radiation_boundary_integral_GP_component

Process 3.4.4.6: accumulate_radiation_boundary_integral_GP_component

Pspec generated 4 September 1990 at 15:10:15

This process has 7 data flows:

input data flows

- TET_alpha
- GP_rhfc
- GP_temperature
- radiation_air_temperature
- 2D_TET_radiation_element

output data flows

- boundary_integral_GP_component
- radiation_energy

description

scale GP_rhfc by dis

compute GP contribution to each nodal equation

end pspec

Process 3.4.5.1

temperature_boundary_executive

Process 3.4.5.1: temperature_boundary_executive

Pspec generated 4 September 1990 at 15:10:57

This process has 6 data flows:

input data flows

- nodal_temperature_boundary_value
- TET_Dirichlet_boundary_index
- nodes
- Dirichlet_boundaries
- TET_algorithm_controls
- TET_global_equations

output data flows

- TET_global_equations

description

Foreach node in Dirichlet boundary {

- Get nodal temperature boundary value
- Define nodal equation
- Add penalty term to global equation to fix temperature value

}

end pspec

Process 3.4.5.2

get_nodal_temperature_boundary_value

Process 3.4.5.2: get_nodal_temperature_boundary_value

Pspec generated 4 September 1990 at 15:10:54

This process has 2 data flows:

input data flows

temperature_boundary_condition

output data flows

nodal_temperature_boundary_value

description

Evaluate temperature boundary value correlation

end pspec

Process 3.4.7.1

TET_element_heat_flux_executive

Process 3.4.7.1: TET_element_heat_flux_executive

Pspec generated 4 September 1990 at 15:11:37

This process has 5 data flows:

input data flows

heat_flux_request

nodes

elements

GP_heat_flux

output data flows

heat_flux

description

Foreach Gauss_point {

 Foreach element {

 Foreach element node {

 compute shape function and derivative values

 compute Gauss point temperature

 compute Gauss point thermal conductivity

 compute Gauss point heat flux

 }

 }

 extrapolate Gauss point heat flux to nodes

 }

average nodal heat flux from surrounding elements

end pspec

Process 3.4.7.2

recompute_TET_element_shape_function_GP_values

Process 3.4.7.2: recompute_TET_element_shape_function_GP_values

Pspec generated 4 September 1990 at 15:11:31

This process has 3 data flows:

input data flows

- 3D_canonical_functions
- nodal_coordinates

output data flows

- 3D_TET_flux_element

description

- compute determinant of transformation
- evaluate shape functions at specified point
- evaluate derivative functions at specified point

end pspec

Process 3.4.7.3

recompute_TET_element_GP_temperature

Process 3.4.7.3: recompute_TET_element_GP_temperature

Pspec generated 4 September 1990 at 15:11:42

This process has 3 data flows:

input data flows

temperature

fcn

output data flows

GP_temperature

description

Foreach node {

accumulate nodal temperature times shape function value

}

end pspec

Process 3.4.7.4

compute_TET_element_GP_temperature_gradient

Process 3.4.7.4: compute_TET_element_GP_temperature_gradient

Pspec generated 4 September 1990 at 15:11:48

This process has 3 data flows:

input data flows

derv

temperature

output data flows

GP_temperature_gradient

description

Foreach component direction {

Foreach node of element {

accumulate temperature times component derivative value

}

}

end pspec

Process 3.4.7.5

recompute_TET_element_GP_thermal_conductivity

Process 3.4.7.5: recompute_TET_element_GP_thermal_conductivity

Pspec generated 4 September 1990 at 15:11:34

This process has 4 data flows:

input data flows

thermal_conductivity

element_composition

GP_temperature

output data flows

GP_thermal_conductivity

description

evalute thermal conductivity correlation

end pspec

Process 3.4.7.6

compute_TET_element_GP_heat_flux

Process 3.4.7.6: compute_TET_element_GP_heat_flux

Pspec generated 4 September 1990 at 15:11:45

This process has 3 data flows:

input data flows

GP_thermal_conductivity

GP_temperature_gradient

output data flows

GP_heat_flux

description

compute thermal conductivity times GP_temperature_gradient

end pspec

Process 4.1

ISV_output_executive

Process 4.1: ISV_output_executive

Pspec generated 4 September 1990 at 15:12:30

This process has 10 data flows:

input data flows

- output_menu_selection
- output_responses
- output_selection
- solution_summary
- display_attributes_file

output data flows

- selected_problem_name
- output_prompts
- output_menu
- channel_name
- display_attributes_file
- attribute_buffer

description

Set load_problem into output_menu_selection

Do (forever) {

 Switch (output_menu_selection) {

 case load_problem:

- Get list of problem names
- Display list of problem names
- Prompt for selection
- Get selected_problem_name
- Invoke load process
- Set load_channels into output_menu_selection
- break;

 case load_channels:

- Display channel names menu
- Get chan_name_selection
- Switch (chan_name_selection) {

 case channel_name;

- Put channel_name in buffer
- Display channel names menu
- Get chan_name_selection
- break;

 case load_problem_request:

- Set load_problem into output_menu_selection
- continue
- break;

 case display_request:

- Set display_data into output_menu_selection
- continue
- break ;

Process 4.2

load_general_problem_data

Process 4.2: load_general_problem_data

Pspec generated 4 September 1990 at 15:12:39

This process has 3 data flows:

input data flows

selected_problem_name

xdr_binary_problem_file

output data flows

solution_summary

description

Open the problem file using selected_problem_name

Read time history information from problem file

Load time history information into solution summary

Read available data channel names for problem file

Load available data channel names into solution summary

end pspec

Process 4.3

display_data_channels

Process 4.3: display_data_channels

Pspec generated 4 September 1990 at 15:12:43

This process has 7 data flows:

input data flows

- xdr_binary_geometry_file**
- xdr_binary_problem_file**
- channel_buffer**
- attribute_buffer**

output data flows

- tabular_output**
- graphic_output**
- channel_data**

description

Read data channel name(s) and display attributes
Load required problem data from problem file and geometry file
Produce the specified graphic or tabular output

end pspec

APPENDIX C - DATA STRUCTURE DIAGRAMS

Diagram: 2D_physical_element
Diagram: 3D_correlation
Diagram: 3D_physical_element
Diagram: 3D_vector
Diagram: ERH_boundary_conditions
Diagram: FE_mesh
Diagram: FE_method
Diagram: GP_values
Diagram: ISV_executive_io
Diagram: TET_boundary_conditions
Diagram: boundary_variables
Diagram: correlation
Diagram: element_variables
Diagram: input_executive_io
Diagram: material_properties
Diagram: matrix_equation
Diagram: misc
Diagram: node_variables
Diagram: output_executive_io
Diagram: problem_controls
Diagram: problem_data
Diagram: simulation_executive_io

Project: In Situ Vitrification
Diagram: 2D_physical_element

Project: In Situ Vitrification
Diagram: 3D_correlation

Project: In Situ Vitrification
Diagram: 3D_physical_element

Project: In Situ Vitrification
Diagram: 3D_vector

Project: In Situ Vitrification
Diagram: FE_mesh

Project: In Situ Vitrification
Diagram: FE_method

Project: In Situ Vitrification
Diagram: GP_values

Project: In Situ Vitrification
Diagram: TET_boundary_conditions

Project: In Situ Vitrification
Diagram: correlation

Project: In Situ Vitrification
Diagram: element_variables

Project: In Situ Vitrification
Diagram: input_executive_io

Project: In Situ Vitrification
Diagram: material_properties

Project: In Situ Vitrification
Diagram: misc

nodal electrode
potential
boundary value

nodal
potential
boundary value

nodal
temperature
boundary value

nodal
chtc

nodal
rhtc

Project: In Situ Vitrification
Diagram: node_variables

Project: In Situ Vitrification
Diagram: output_executive_io

Project: In Situ Vitrification
Diagram: problem_controls

Project: In Situ Vitrification
Diagram: problem_data

Project: In Situ Vitrification
Diagram: simulation_executive_io

APPENDIX D - DATA DICTIONARY

Data Dictionary

2D_Gauss_point

Defined as Data Element in FE_method

Used in 1 Data Structure

2D_Gauss_points (Iteration)

Note DataDefinition

Type: 2D_vector

2D_derivative_values

Defined as Data Element in FE_method

Used in 1 Data Structure

2D_Gauss_point_index (Sequence)

Note DataDefinition

Type: 2D_vector

2D_function_value

Defined as Data Element in FE_method

Used in 1 Data Structure

2D_Gauss_point_index (Sequence)

Note DataDefinition

Type: real

3D_Gauss_point

Defined as Data Element in FE_method

Used in 1 Data Structure

3D_Gauss_points (Iteration)

Note DataDefinition

Type: 3D_vector

3D_derivative_values

Defined as Data Element in FE_method

Used in 1 Data Structure

3D_Gauss_point_index (Sequence)

Note DataDefinition

Type: 3D_vector

3D_function_value

Defined as Data Element in FE_method

Used in 1 Data Structure

3D_Gauss_point_index (Sequence)

Note DataDefinition

Type: real

ERH_Dirichlet_boundary_index

Defined as Data Element in ERH_boundary_conditions

Used in 1 Data Structure

ERH_Dirichlet_boundary_conditions (Sequence)

Used in 2 Data Flows

DFD diagram level 3.3.4

From: ERH_boundary_conditions (Data Store)

To: electrode_position_boundary_executive (Process)

DFD diagram level 3.3.5

From: ERH_boundary_conditions (Data Store)

To: potential_boundary_executive (Process)

Note DataDefinition

Type: integer

ERH_Neumann_boundary_index

Defined as Data Element in ERH_boundary_conditions

Used in 1 Data Structure
 ERH_Neumann_boundary_condition (Sequence)

Used in 1 Data Flow
 DFD diagram level 3.3.3
 From: ERH_boundary_conditions (Data Store)
 To: flux_boundary_executive (Process)

Note DataDefinition
 Type: integer

ERH_alpha
 Defined as Data Element in problem_controls

Used in 1 Data Structure
 ERH_algorithm_controls (Sequence)

Used in 2 Data Flows
 DFD diagram level 3.3.2
 From: ERH_element_equations_executive (Process)
 To: accumulate_ERH_element_equation_GP_component (Process)
 DFD diagram level 3.3.3
 From: flux_boundary_executive (Process)
 To: accumulate_flux_boundary_integral_GP_component (Process)

Note DataDefinition
 Type: real

ERH_messages
 Defined as Data Element in simulation_executive_io

Used in 1 Data Structure
 simulation_messages (Sequence)

Used in 2 Data Flows
 DFD diagram level 3
 From: solve_ERH_problem (Process)
 To: simulation_executive (Process)
 DFD diagram level 3.3
 From: ERH_executive (Process)
 To: Offpage.3.3 (Offpage Connector)

Note DataDefinition
 Type: text

ERH_tolerance
 Defined as Data Element in problem_controls

Used in 1 Data Structure
 ERH_algorithm_controls (Sequence)

Note DataDefinition
 Type: real

GP_ERH_heat_generation_rate
 Defined as Data Element in GP_values

Used in 1 Data Flow
 DFD diagram level 3.4.2
 From: compute_TET_element_GP_ERH_heat_generation_rate (Process)
 To: compute_TET_element_GP_heat_generation_rate (Process)

Note DataDefinition
 Type: real

GP_chtc
 Defined as Data Element in GP_values

Used in 1 Data Flow
 DFD diagram level 3.4.3
 From: compute_GP_chtc (Process)
 To: accumulate_convection_boundary_integral_GP_component (Process)

Note DataDefinition

Type: real

GP_current_density
 Defined as Data Element in GP_values
 Used in 3 Data Flows
 DFD diagram level 3.3.3
 From: compute_ERH_surface_element_GP_current_density (Process)
 To: accumulate_flux_boundary_integral_GP_component (Process)
 DFD diagram level 3.3.7
 From: compute_ERH_element_GP_current_density (Process)
 To: ERH_element_current_density_executive (Process)
 DFD diagram level 3.3.7
 From: compute_ERH_element_GP_current_density (Process)
 To: compute_ERH_element_GP_heat_generation_rate (Process)
 Note DataDefinition
 Type: 3D vector

GP_density_heat_capacity
 Defined as Data Element in GP_values
 Used in 2 Data Flows
 DFD diagram level 3.4.2.5
 From: compute_TET_element_GP_density_heat_capacity (Process)
 To: Offpage.3.4.2.5 (Offpage Connector)
 DFD diagram level 3.4.2
 From: compute_TET_element_GP_thermal_quantities (Process)
 To: accumulate_TET_element_equation_GP_component (Process)
 Note DataDefinition
 Type: real

GP_electrical_conductivity
 Defined as Data Element in GP_values
 Used in 4 Data Flows
 DFD diagram level 3.4.2.5
 From: compute_TET_element_GP_electrical_conductivity (Process)
 To: Offpage.3.4.2.5 (Offpage Connector)
 DFD diagram level 3.4.2
 From: compute_TET_element_GP_thermal_quantities (Process)
 To: compute_TET_element_GP_heat_generation_rate (Process)
 DFD diagram level 3.3.2
 From: compute_ERH_element_GP_electrical_conductivity (Process)
 To: accumulate_ERH_element_equation_GP_component (Process)
 DFD diagram level 3.3.7
 From: recompute_ERH_element_GP_electrical_conductivity (Process)
 To: compute_ERH_element_GP_current_density (Process)
 Note DataDefinition
 Type: 3D vector

GP_heat_capacity
 Defined as Data Element in GP_values
 Used in 1 Data Flow
 DFD diagram level 3.4.2.5
 From: compute_TET_element_GP_density_heat_capacity (Process)
 To: compute_TET_element_GP_phase_change_energy (Process)
 Note DataDefinition
 Type: real

GP_heat_flux
 Defined as Data Element in GP_values
 Used in 1 Data Flow
 DFD diagram level 3.4.7

From: compute_TET_element_GP_heat_flux (Process)

To: TET_element_heat_flux_executive (Process)

Note DataDefinition

Type: 3D vector

GP_heat_generation_rate

Defined as Data Element in GP_values

Used in 2 Data Flows

DFD diagram level 3.4.2

From: compute_TET_element_GP_heat_generation_rate (Process)

To: accumulate_TET_element_equation_GP_component (Process)

DFD diagram level 3.3.7

From: compute_ERH_element_GP_heat_generation_rate (Process)

To: ERH_element_current_density_executive (Process)

Note DataDefinition

Type: real

GP_phase_change_energy

Defined as Data Element in GP_values

Used in 2 Data Flows

DFD diagram level 3.4.2.5

From: compute_TET_element_GP_phase_change_energy (Process)

To: Offpage.3.4.2.5 (Offpage Connector)

DFD diagram level 3.4.2

From: compute_TET_element_GP_thermal_quantities (Process)

To: compute_TET_element_GP_heat_generation_rate (Process)

Note DataDefinition

Type: real

GP_potential

Defined as Data Element in GP_values

Used in 2 Data Flows

DFD diagram level 3.3.2

From: compute_ERH_element_GP_potential (Process)

To: compute_ERH_element_GP_electrical_conductivity (Process)

DFD diagram level 3.3.7

From: recompute_ERH_element_GP_potential (Process)

To: recompute_ERH_element_GP_electrical_conductivity (Process)

Note DataDefinition

Type: real

GP_potential_gradient

Defined as Data Element in GP_values

Used in 2 Data Flows

DFD diagram level 3.3.7

From: compute_ERH_element_GP_potential_gradient (Process)

To: compute_ERH_element_GP_current_density (Process)

DFD diagram level 3.3.7

From: compute_ERH_element_GP_potential_gradient (Process)

To: compute_ERH_element_GP_heat_generation_rate (Process)

Note DataDefinition

Type: real

GP_rhtc

Defined as Data Element in GP_values

Used in 1 Data Flow

DFD diagram level 3.4.4

From: compute_GP_rhtc (Process)

To: accumulate_radiation_boundary_integral_GP_component (Process)

Note DataDefinition

Type: real

GP_temperature

Defined as Data Element in GP_values

Used in 8 Data Flows

DFD diagram level 3.4.2.5

From: Offpage.3.4.2.5 (Offpage Connector)

To: compute_TET_element_GP_thermal_conductivity (Process)

DFD diagram level 3.4.2.5

From: Offpage.3.4.2.5 (Offpage Connector)

To: compute_TET_element_GP_density_heat_capacity (Process)

DFD diagram level 3.4.7

From: recompute_TET_element_GP_temperature (Process)

To: recompute_TET_element_GP_thermal_conductivity (Process)

DFD diagram level 3.4.2.5

From: Offpage.3.4.2.5 (Offpage Connector)

To: compute_TET_element_GP_electrical_conductivity (Process)

DFD diagram level 3.4.2

From: compute_TET_element_GP_temperature (Process)

To: compute_TET_element_GP_thermal_quantities (Process)

DFD diagram level 3.4.3

From: compute_convection_element_GP_temperature (Process)

To: accumulate_convection_boundary_integral_GP_component (Process)

DFD diagram level 3.4.4

From: compute_radiation_element_GP_temperature (Process)

To: accumulate_radiation_boundary_integral_GP_component (Process)

DFD diagram level 3.4.2.5

From: Offpage.3.4.2.5 (Offpage Connector)

To: compute_TET_element_GP_phase_change_energy (Process)

Note DataDefinition

Type: real

GP_temperature_gradient

Defined as Data Element in GP_values

Used in 1 Data Flow

DFD diagram level 3.4.7

From: compute_TET_element_GP_temperature_gradient (Process)

To: compute_TET_element_GP_heat_flux (Process)

Note DataDefinition

Type: real

GP_thermal_conductivity

Defined as Data Element in GP_values

Used in 3 Data Flows

DFD diagram level 3.4.2.5

From: compute_TET_element_GP_thermal_conductivity (Process)

To: Offpage.3.4.2.5 (Offpage Connector)

DFD diagram level 3.4.7

From: recompute_TET_element_GP_thermal_conductivity (Process)

To: compute_TET_element_GP_heat_flux (Process)

DFD diagram level 3.4.2

From: compute_TET_element_GP_thermal_quantities (Process)

To: accumulate_TET_element_equation_GP_component (Process)

Note DataDefinition

Type: 3D vector

ISV_menu

Defined as Data Element in ISV_executive_io

Used in 1 Data Structure

ISV_executive_io (Sequence)
 Used in 2 Data Flows
 DFD diagram level 0
 From: Executive (Process)
 To: Offpage.0 (Offpage Connector)
 DFD diagram level top
 From: ISV (Process)
 To: ISV_analyst (External)
 Note DataDefinition
 Type: menu

TET_Dirichlet_boundary_index
 Defined as Data Element in TET_boundary_conditions
 Used in 1 Data Structure
 TET_Dirichlet_boundary_condition (Sequence)
 Used in 1 Data Flow
 DFD diagram level 3.4.5
 From: TET_boundary_conditions (Data Store)
 To: temperature_boundary_executive (Process)
 Note DataDefinition
 Type: integer

TET_Neumann_boundary_index
 Defined as Data Element in TET_boundary_conditions
 Used in 1 Data Structure
 TET_Neumann_boundary_conditions (Sequence)
 Used in 2 Data Flows
 DFD diagram level 3.4.3
 From: TET_boundary_conditions (Data Store)
 To: convection_boundary_executive (Process)
 DFD diagram level 3.4.4
 From: TET_boundary_conditions (Data Store)
 To: radiation_boundary_executive (Process)
 Note DataDefinition
 Type: integer

TET_alpha
 Defined as Data Element in problem_controls
 Used in 1 Data Structure
 TET_algorithm_controls (Sequence)
 Used in 3 Data Flows
 DFD diagram level 3.4.2
 From: TET_element_equations_executive (Process)
 To: accumulate_TET_element_equation_GP_component (Process)
 DFD diagram level 3.4.3
 From: convection_boundary_executive (Process)
 To: accumulate_convection_boundary_integral_GP_component (Process)
 DFD diagram level 3.4.4
 From: radiation_boundary_executive (Process)
 To: accumulate_radiation_boundary_integral_GP_component (Process)
 Note DataDefinition
 Type: real

TET_messages
 Defined as Data Element in simulation_executive_io
 Used in 1 Data Structure
 simulation_messages (Sequence)
 Used in 2 Data Flows
 DFD diagram level 3

From: solve_TET_problem (Process)
 To: simulation_executive (Process)
 DFD diagram level 3.4
 From: TET_executive (Process)
 To: Offpage.3.4 (Offpage Connector)
 Note DataDefinition
 Type: text

TET_tolerance
 Defined as Data Element in problem_controls
 Used in 1 Data Structure
 TET_algorithm_controls (Sequence)
 Note DataDefinition
 Type: real

abscissa
 Defined as Data Element in correlation
 Used in 1 Data Structure
 linear_piece (Sequence)
 Note DataDefinition
 Type: real

ascii_only
 Defined as Data Element in input_executive_io
 Used in 2 Data Flows
 DFD diagram level 2
 From: ISV_input_executive (Process)
 To: store_new_case (Process)
 DFD diagram level 2.1
 From: input_dialog_manager (Process)
 To: Offpage.2.1 (Offpage Connector)
 Note DataDefinition
 Type: logical

attribute_name
 Defined as Data Element in output_executive_io
 Used in 1 Data Structure
 attribute (Sequence)
 Note DataDefinition
 Type: string

attribute_value
 Defined as Data Element in output_executive_io
 Used in 1 Data Structure
 attribute (Sequence)
 Note DataDefinition
 Type: alphanumeric

base_case_name
 Defined as Data Element in input_executive_io
 Used in 1 Data Structure
 input_responses (Selection)
 Used in 2 Data Flows
 DFD diagram level 2
 From: ISV_input_executive (Process)
 To: load_base_case (Process)
 DFD diagram level 2.1
 From: input_dialog_manager (Process)
 To: Offpage.2.1 (Offpage Connector)
 Note DataDefinition
 Type: menu pick

boiling_point

Defined as Data Element in material_properties

Used in 1 Data Structure

physical_properties (Sequence)

Used in 1 Data Flow

DFD diagram level 3.4.2.5

From: material_properties (Data Store)

To: compute_TET_element_GP_phase_change_energy (Process)

Note DataDefinition

Type: real

bottom_node

Defined as Data Element in boundary_variables

Used in 1 Data Structure

electrode_position (Sequence)

Note DataDefinition

Type: integer

boundary_node_index

Defined as Data Element in FE_mesh

Used in 1 Data Structure

Dirichlet_boundary (Iteration)

Note DataDefinition

Type: integer

case_name

Defined as Data Element in simulation_executive_io

Used in 1 Data Structure

simulation_menu_selection (Sequence)

Used in 1 Data Flow

DFD diagram level 3

From: simulation_executive (Process)

To: get_problem_definition (Process)

Note DataDefinition

Type: menu pick

channel_data

Defined as Data Element in output_executive_io

Used in 1 Data Structure

channels (Sequence)

Used in 1 Data Flow

DFD diagram level 4

From: display_data_channels (Process)

To: channel_buffer (Data Store)

Note DataDefinition

Type: vector

channel_list

Defined as Data Element in output_executive_io

Used in 1 Data Structure

solution_summary (Sequence)

Note DataDefinition

Type: list

channel_name

Defined as Data Element in output_executive_io

Used in 1 Data Structure

channels (Sequence)

Used in 1 Data Flow

DFD diagram level 4

From: ISV_output_executive (Process)

To: channel_buffer (Data Store)

Note DataDefinition
 Type: string

component_displays
 Defined as Data Element in input_executive_io
 Used in 1 Data Structure
 input_executive_io (Sequence)
 Used in 3 Data Flows
 DFD diagram level top
 From: ISV (Process)
 To: ISV_analyst (External)
 DFD diagram level 0
 From: input_processor (Process)
 To: Offpage.0 (Offpage Connector)
 DFD diagram level 2
 From: view_component (Process)
 To: Offpage.2 (Offpage Connector)

Note DataDefinition
 Type: text

component_name
 Defined as Data Element in input_executive_io
 Used in 1 Data Structure
 input_responses (Selection)
 Used in 3 Data Flows
 DFD diagram level 2
 From: ISV_input_executive (Process)
 To: view_component (Process)
 DFD diagram level 2
 From: ISV_input_executive (Process)
 To: modify_component (Process)
 DFD diagram level 2.1
 From: input_dialog_manager (Process)
 To: Offpage.2.1 (Offpage Connector)

Note DataDefinition
 Type: menu pick

component_new_data
 Defined as Data Element in input_executive_io
 Used in 1 Data Structure
 input_responses (Selection)
 Used in 2 Data Flows
 DFD diagram level 2
 From: ISV_input_executive (Process)
 To: modify_component (Process)
 DFD diagram level 2.1
 From: input_dialog_manager (Process)
 To: Offpage.2.1 (Offpage Connector)

Note DataDefinition
 Type: numeric

consistency_flags
 Defined as Data Element in input_executive_io
 Used in 1 Data Structure
 consistency (Iteration)

Note DataDefinition
 Type: logical

constant_value

Defined as Data Element in correlation
 Used in 1 Data Structure
 correlation (Selection)
 Note DataDefinition
 Type: real

convection_air_temperature
 Defined as Data Element in TET_boundary_conditions
 Used in 1 Data Structure
 convection_boundary_element (Sequence)
 Used in 1 Data Flow
 DFD diagram level 3.4.3
 From: TET_boundary_conditions (Data Store)
 To: accumulate_convection_boundary_integral_GP_component (Process)
 Note DataDefinition
 Type: correlation

convection_energy
 Defined as Data Element in element_variables
 Used in 1 Data Structure
 element_energy_components (Sequence)
 Used in 3 Data Flows
 DFD diagram level 3.4
 From: apply_TET_convection_boundary_condition (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3
 From: solve_TET_problem (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3.4.3
 From: accumulate_convection_boundary_integral_GP_component (Process)
 To: problem_variables (Data Store)
 Note DataDefinition
 Type: real

convection_heat_transfer
 Defined as Data Element in TET_boundary_conditions
 Used in 1 Data Structure
 convection_boundary_element (Sequence)
 Note DataDefinition
 Type: correlation

cpu_estimate
 Defined as Data Element in input_executive_io
 Used in 1 Data Structure
 resources_estimate (Sequence)
 Note DataDefinition
 Type: real

cpu_used
 Defined as Data Element in simulation_executive_io
 Used in 1 Data Structure
 resources_used (Sequence)
 Note DataDefinition
 Type: real

current_density
 Defined as Data Element in node_variables
 Used in 1 Data Structure
 node_index (Sequence)
 Used in 3 Data Flows
 DFD diagram level 3

From: solve_ERH_problem (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3.3
 From: compute_ERH_element_current_density (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3.3.7
 From: ERH_element_current_density_executive (Process)
 To: problem_variables (Data Store)
 Note DataDefinition
 Type: 3D_vector
current_density_boundary_value
 Defined as Data Element in ERH_boundary_conditions
 Used in 1 Data Structure
 current_density_boundary_element (Sequence)
 Note DataDefinition
 Type: correlation
current_density_request
 Defined as Data Element in problem_controls
 Used in 1 Data Structure
 ERH_controls (Sequence)
 Used in 2 Data Flows
 DFD diagram level 3.3
 From: ERH_executive (Process)
 To: compute_ERH_element_current_density (Process)
 DFD diagram level 3.3.7
 From: Offpage.3.3.7 (Offpage Connector)
 To: ERH_element_current_density_executive (Process)
 Note DataDefinition
 Type: logical
delta_potential
 Defined as Data Element in matrix_equation
 Used in 1 Data Flow
 DFD diagram level 3.3
 From: solve_ERH_global_equations (Process)
 To: ERH_executive (Process)
 Note DataDefinition
 Type: vector
delta_temperature
 Defined as Data Element in matrix_equation
 Used in 1 Data Flow
 DFD diagram level 3.4
 From: solve_TET_global_equations (Process)
 To: TET_executive (Process)
 Note DataDefinition
 Type: vector
delta_time
 Defined as Data Element in problem_controls
 Used in 1 Data Structure
 time_step_control (Sequence)
 Used in 2 Data Flows
 DFD diagram level 3.4.2
 From: TET_element_equations_executive (Process)
 To: compute_TET_element_GP_heat_generation_rate (Process)
 DFD diagram level 3.4.2
 From: TET_element_equations_executive (Process)

To: accumulate_TET_element_equation_GP_component (Process)
 Note DataDefinition
 Type: real

density
 Defined as Data Element in material_properties
 Used in 1 Data Structure
 physical_properties (Sequence)
 Used in 2 Data Flows
 DFD diagram level 3.4.2.5
 From: material_properties (Data Store)
 To: compute_TET_element_GP_density_heat_capacity (Process)
 DFD diagram level 3.4.2.5
 From: material_properties (Data Store)
 To: compute_TET_element_GP_phase_change_energy (Process)
 Note DataDefinition
 Type: correlation

det
 Defined as Data Element in 3D_physical_element
 Used in 1 Data Structure
 3D_physical_element (Sequence)
 Note DataDefinition
 Type: real

dfdx
 Defined as Data Element in 3D_physical_element
 Used in 1 Data Structure
 derv (Sequence)
 Note DataDefinition
 Type: real

dfdy
 Defined as Data Element in 3D_physical_element
 Used in 1 Data Structure
 derv (Sequence)
 Note DataDefinition
 Type: real

dfdz
 Defined as Data Element in 3D_physical_element
 Used in 1 Data Structure
 derv (Sequence)
 Note DataDefinition
 Type: real

dis
 Defined as Data Element in 2D_physical_element
 Used in 1 Data Structure
 2D_physical_element (Sequence)
 Note DataDefinition
 Type: real

disk_estimate
 Defined as Data Element in input_executive_io
 Used in 1 Data Structure
 resources_estimate (Sequence)
 Note DataDefinition
 Type: integer

disk_used
 Defined as Data Element in simulation_executive_io
 Used in 1 Data Structure

resources_used (Sequence)
 Note DataDefinition
 Type: integer

electrode_boundary_index
 Defined as Data Element in boundary_variables
 Used in 1 Data Structure
 ERH_boundary_variables (Sequence)
 Note DataDefinition
 Type: integer

electrical_conductivity
 Defined as Data Element in material_properties
 Used in 1 Data Structure
 physical_properties (Sequence)
 Used in 5 Data Flows
 DFD diagram level 3.3
 From: material_properties (Data Store)
 To: assemble_ERH_element_equations (Process)
 DFD diagram level 3.3.2
 From: material_properties (Data Store)
 To: compute_ERH_element_GP_electrical_conductivity (Process)
 DFD diagram level 3.3
 From: material_properties (Data Store)
 To: compute_ERH_element_current_density (Process)
 DFD diagram level 3.3.7
 From: material_properties (Data Store)
 To: recompute_ERH_element_GP_electrical_conductivity (Process)
 DFD diagram level 3.4.2.5
 From: material_properties (Data Store)
 To: compute_TET_element_GP_electrical_conductivity (Process)
 Note DataDefinition
 Type: 3D_correlation

electrical_potential
 Defined as Data Element in node_variables
 Used in 1 Data Structure
 node_index (Sequence)
 Used in 9 Data Flows
 DFD diagram level 3
 From: solve_ERH_problem (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3
 From: problem_variables (Data Store)
 To: solve_ERH_problem (Process)
 DFD diagram level 3.3
 From: ERH_executive (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3.3
 From: problem_variables (Data Store)
 To: compute_ERH_element_current_density (Process)
 DFD diagram level 3.3
 From: problem_variables (Data Store)
 To: assemble_ERH_element_equations (Process)
 DFD diagram level 3.3.2
 From: problem_variables (Data Store)
 To: compute_ERH_element_GP_potential (Process)
 DFD diagram level 3.3.2

From: problem_variables (Data Store)
 To: accumulate_ERH_element_equation_GP_component (Process)
 DFD diagram level 3.3.7
 From: problem_variables (Data Store)
 To: recompute_ERH_element_GP_potential (Process)
 DFD diagram level 3.3.7
 From: problem_variables (Data Store)
 To: compute_ERH_element_GP_potential_gradient (Process)
 Note DataDefinition
 Type: real
electrode_potential_value
 Defined as Data Element in ERH_boundary_conditions
 Used in 1 Data Structure
 electrode_boundary_node (Sequence)
 Note DataDefinition
 Type: correlation
element_node_index
 Defined as Data Element in FE_mesh
 Used in 1 Data Structure
 element (Iteration)
 Note DataDefinition
 Type: integer
fcn
 Defined as Data Element in 3D_physical_element
 Used in 1 Data Structure
 function_values (Iteration)
 Used in 5 Data Flows
 DFD diagram level 3.3.2
 From: 3D_ERH_element (Data Store)
 To: compute_ERH_element_GP_potential (Process)
 DFD diagram level 3.3.7
 From: 3D_ERH_flux_element (Data Store)
 To: recompute_ERH_element_GP_potential (Process)
 DFD diagram level 3.4.2
 From: 3D_TET_element (Data Store)
 To: compute_TET_element_GP_temperature (Process)
 DFD diagram level 3.4.7
 From: 3D_TET_flux_element (Data Store)
 To: recompute_TET_element_GP_temperature (Process)
 DFD diagram level 3.4.2
 From: 3D_TET_element (Data Store)
 To: compute_TET_element_GP_ERH_heat_generation_rate (Process)
 Note DataDefinition
 Type: real
final_time
 Defined as Data Element in problem_controls
 Used in 1 Data Structure
 simulation_time_control (Sequence)
 Note DataDefinition
 Type: real
func
 Defined as Data Element in 2D_physical_element
 Used in 1 Data Structure
 2D_function_values (Iteration)
 Used in 5 Data Flows

DFD diagram level 3.3.3

From: 2D_ERH_flux_element (Data Store)

To: compute_ERH_surface_element_GP_current_density (Process)

DFD diagram level 3.4.3

From: 2D_TET_convection_element (Data Store)

To: compute_GP_chtc (Process)

DFD diagram level 3.4.4

From: 2D_TET_radiation_element (Data Store)

To: compute_GP_rhlc (Process)

DFD diagram level 3.4.3

From: 2D_TET_convection_element (Data Store)

To: compute_convection_element_GP_temperature (Process)

DFD diagram level 3.4.4

From: 2D_TET_radiation_element (Data Store)

To: compute_radiation_element_GP_temperature (Process)

Note DataDefinition

Type: real

functional_correlation

Defined as Data Element in correlation

Used in 1 Data Structure

correlation (Selection)

Note DataDefinition

Type: string

graphic_output

Defined as Data Element in output_executive_io

Used in 1 Data Structure

output_executive_io (Sequence)

Used in 3 Data Flows

DFD diagram level 0

From: output_processor (Process)

To: Offpage.0 (Offpage Connector)

DFD diagram level top

From: ISV (Process)

To: ISV_analyst (External)

DFD diagram level 4

From: display_data_channels (Process)

To: Offpage.4 (Offpage Connector)

Note DataDefinition

Type: graphic

heat_capacity

Defined as Data Element in material_properties

Used in 1 Data Structure

physical_properties (Sequence)

Used in 1 Data Flow

DFD diagram level 3.4.2.5

From: material_properties (Data Store)

To: compute_TET_element_GP_density_heat_capacity (Process)

Note DataDefinition

Type: correlation

heat_flux

Defined as Data Element in node_variables

Used in 1 Data Structure

node_index (Sequence)

Used in 3 Data Flows

DFD diagram level 3

From: solve_TET_problem (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3.4.7
 From: TET_element_heat_flux_executive (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3.4
 From: compute_TET_element_heat_flux (Process)
 To: problem_variables (Data Store)
 Note DataDefinition
 Type: 3D_vector
heat_flux_request
 Defined as Data Element in problem_controls
 Used in 1 Data Structure
 TET_controls (Sequence)
 Used in 2 Data Flows
 DFD diagram level 3.4.7
 From: Offpage.3.4.7 (Offpage Connector)
 To: TET_element_heat_flux_executive (Process)
 DFD diagram level 3.4
 From: TET_executive (Process)
 To: compute_TET_element_heat_flux (Process)
 Note DataDefinition
 Type: logical
heat_generation_rate
 Defined as Data Element in node_variables
 Used in 1 Data Structure
 node_index (Sequence)
 Used in 6 Data Flows
 DFD diagram level 3
 From: solve_ERH_problem (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3.3.7
 From: ERH_element_current_density_executive (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3.3
 From: compute_ERH_element_current_density (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3
 From: problem_variables (Data Store)
 To: solve_TET_problem (Process)
 DFD diagram level 3.4
 From: problem_variables (Data Store)
 To: assemble_TET_element_equations (Process)
 DFD diagram level 3.4.2
 From: problem_variables (Data Store)
 To: compute_TET_element_GP_ERH_heat_generation_rate (Process)
 Note DataDefinition
 Type: real
heat_of_fusion
 Defined as Data Element in material_properties
 Used in 1 Data Structure
 physical_properties (Sequence)
 Used in 1 Data Flow
 DFD diagram level 3.4.2.5
 From: material_properties (Data Store)

To: compute_TET_element_GP_phase_change_energy (Process)
 Note DataDefinition
 Type: real
heat_of_vaporization
 Defined as Data Element in material_properties
 Used in 1 Data Structure
 physical_properties (Sequence)
 Used in 1 Data Flow
 DFD diagram level 3.4.2.5
 From: material_properties (Data Store)
 To: compute_TET_element_GP_phase_change_energy (Process)
 Note DataDefinition
 Type: real
independent_variable
 Defined as Data Element in correlation
 Used in 1 Data Structure
 piecewise_linear_correlation (Sequence)
 Note DataDefinition
 Type: string
input_menu
 Defined as Data Element in input_executive_io
 Used in 1 Data Structure
 input_executive_io (Sequence)
 Used in 4 Data Flows
 DFD diagram level 0
 From: input_processor (Process)
 To: Offpage.0 (Offpage Connector)
 DFD diagram level 2
 From: ISV_input_executive (Process)
 To: Offpage.2 (Offpage Connector)
 DFD diagram level top
 From: ISV (Process)
 To: ISV_analyst (External)
 DFD diagram level 2.1
 From: input_dialog_manager (Process)
 To: Offpage.2.1 (Offpage Connector)
 Note DataDefinition
 Type: menu
input_prompts
 Defined as Data Element in input_executive_io
 Used in 1 Data Structure
 input_executive_io (Sequence)
 Used in 4 Data Flows
 DFD diagram level 0
 From: input_processor (Process)
 To: Offpage.0 (Offpage Connector)
 DFD diagram level top
 From: ISV (Process)
 To: ISV_analyst (External)
 DFD diagram level 2
 From: ISV_input_executive (Process)
 To: Offpage.2 (Offpage Connector)
 DFD diagram level 2.1
 From: input_dialog_manager (Process)
 To: Offpage.2.1 (Offpage Connector)

Note DataDefinition

Type: text

input_selection

Defined as Data Element in ISV_executive_io

Used in 1 Data Structure

ISV_menu_selection (Selection)

Used in 3 Data Flows

DFD diagram level 0

From: Executive (Process)

To: input_processor (Process)

DFD diagram level 2

From: Offpage.2 (Offpage Connector)

To: ISV_input_executive (Process)

DFD diagram level 2.1

From: Offpage.2.1 (Offpage Connector)

To: input_dialog_manager (Process)

Note DataDefinition

Type: menu pick

load_selection

Defined as Data Element in input_executive_io

Used in 1 Data Structure

input_menu_selection (Selection)

Note DataDefinition

Type: menu pick

mass_density

Defined as Data Element in element_variables

Used in 1 Data Structure

material_index (Sequence)

Note DataDefinition

Type: real

material_name

Defined as Data Element in material_properties

Used in 1 Data Structure

material (Sequence)

Note DataDefinition

Type: string

matrix

Defined as Data Element in matrix_equation

Used in 1 Data Structure

matrix_equation (Sequence)

Note DataDefinition

Type: matrix

melting_point

Defined as Data Element in material_properties

Used in 1 Data Structure

physical_properties (Sequence)

Used in 1 Data Flow

DFD diagram level 3.4.2.5

From: material_properties (Data Store)

To: compute_TET_element_GP_phase_change_energy (Process)

Note DataDefinition

Type: real

memory_estimate

Defined as Data Element in input_executive_io

Used in 1 Data Structure

resources_estimate (Sequence)
 Note DataDefinition
 Type: integer

memory_used
 Defined as Data Element in simulation_executive_io
 Used in 1 Data Structure
 resources_used (Sequence)
 Note DataDefinition
 Type: integer

min_dt
 Defined as Data Element in problem_controls
 Used in 1 Data Structure
 time_step_control (Sequence)
 Note DataDefinition
 Type: real

model_ERH
 Defined as Data Element in problem_controls
 Used in 1 Data Structure
 ERH_controls (Sequence)
 Note DataDefinition
 Type: logical

model_TET
 Defined as Data Element in problem_controls
 Used in 1 Data Structure
 TET_controls (Sequence)
 Note DataDefinition
 Type: logical

modify_selection
 Defined as Data Element in input_executive_io
 Used in 1 Data Structure
 input_menu_selection (Selection)
 Note DataDefinition
 Type: menu pick

new_case_name
 Defined as Data Element in input_executive_io
 Used in 1 Data Structure
 input_responses (Selection)
 Used in 2 Data Flows
 DFD diagram level 2
 From: ISV_input_executive (Process)
 To: store_new_case (Process)
 DFD diagram level 2.1
 From: input_dialog_manager (Process)
 To: Offpage.2.1 (Offpage Connector)
 Note DataDefinition
 Type: string

nodal_chtc
 Defined as Data Element in misc
 Used in 1 Data Flow
 DFD diagram level 3.4.3
 From: compute_nodal_chtc (Process)
 To: compute_GP_chtc (Process)
 Note DataDefinition
 Type: real

nodal_coordinates

Defined as Data Element in FE_mesh

Used in 1 Data Structure

node (Iteration)

Used in 7 Data Flows

DFD diagram level 3.4.2

From: FE_mesh (Data Store)

To: compute_TET_element_shape_function_GP_values (Process)

DFD diagram level 3.4.7

From: FE_mesh (Data Store)

To: recompute_TET_element_shape_function_GP_values (Process)

DFD diagram level 3.4.3

From: FE_mesh (Data Store)

To: compute_convection_element_shape_function_GP_values (Process)

DFD diagram level 3.4.4

From: FE_mesh (Data Store)

To: compute_radiation_element_shape_function_GP_values (Process)

DFD diagram level 3.3.2

From: FE_mesh (Data Store)

To: compute_ERH_element_shape_function_GP_values (Process)

DFD diagram level 3.3.3

From: FE_mesh (Data Store)

To: compute_flux_element_shape_function_GP_values (Process)

DFD diagram level 3.3.7

From: FE_mesh (Data Store)

To: recompute_ERH_element_shape_function_GP_values (Process)

Note DataDefinition

Type: 3D_vector

nodal_electrode_potential_boundary_value

Defined as Data Element in misc

Used in 1 Data Flow

DFD diagram level 3.3.4

From: get_nodal_electrode_potential_boundary_value (Process)

To: electrode_position_boundary_executive (Process)

Note DataDefinition

Type: real

nodal_potential_boundary_value

Defined as Data Element in misc

Used in 1 Data Flow

DFD diagram level 3.3.5

From: get_nodal_potential_boundary_value (Process)

To: potential_boundary_executive (Process)

Note DataDefinition

Type: real

nodal_rhtc

Defined as Data Element in misc

Used in 1 Data Flow

DFD diagram level 3.4.4

From: compute_nodal_rhtc (Process)

To: compute_GP_rhtc (Process)

Note DataDefinition

Type: real

nodal_temperature_boundary_value

Defined as Data Element in misc

Used in 1 Data Flow

DFD diagram level 3.4.5

From: get_nodal_temperature_boundary_value (Process)
 To: temperature_boundary_executive (Process)
 Note DataDefinition
 Type: real
number_of_matrix_solutions
 Defined as Data Element in simulation_executive_io
 Used in 1 Data Structure
 algorithm_summary (Sequence)
 Note DataDefinition
 Type: integer
number_of_steps
 Defined as Data Element in simulation_executive_io
 Used in 1 Data Structure
 algorithm_summary (Sequence)
 Note DataDefinition
 Type: integer
ordinate
 Defined as Data Element in correlation
 Used in 1 Data Structure
 linear_piece (Sequence)
 Note DataDefinition
 Type: real
output_frequency
 Defined as Data Element in problem_controls
 Used in 1 Data Structure
 output_controls (Sequence)
 Note DataDefinition
 Type: integer
output_level
 Defined as Data Element in problem_controls
 Used in 1 Data Structure
 output_controls (Sequence)
 Used in 1 Data Flow
 DFD diagram level 3
 From: simulation_executive (Process)
 To: write_results (Process)
 Note DataDefinition
 Type: integer
output_menu
 Defined as Data Element in output_executive_io
 Used in 1 Data Structure
 output_executive_io (Sequence)
 Used in 3 Data Flows
 DFD diagram level 0
 From: output_processor (Process)
 To: Offpage.0 (Offpage Connector)
 DFD diagram level top
 From: ISV (Process)
 To: ISV_analyst (External)
 DFD diagram level 4
 From: ISV_output_executive (Process)
 To: Offpage.4 (Offpage Connector)
 Note DataDefinition
 Type: menu
output_menu_selection

Defined as Data Element in output_executive_io

Used in 1 Data Structure

output_executive_io (Sequence)

Used in 3 Data Flows

DFD diagram level top

From: ISV_analyst (External)

To: ISV (Process)

DFD diagram level 0

From: Offpage.0 (Offpage Connector)

To: output_processor (Process)

DFD diagram level 4

From: Offpage.4 (Offpage Connector)

To: ISV_output_executive (Process)

Note DataDefinition

Type: menu pick

output_prompts

Defined as Data Element in output_executive_io

Used in 1 Data Structure

output_executive_io (Sequence)

Used in 3 Data Flows

DFD diagram level 0

From: output_processor (Process)

To: Offpage.0 (Offpage Connector)

DFD diagram level top

From: ISV (Process)

To: ISV_analyst (External)

DFD diagram level 4

From: ISV_output_executive (Process)

To: Offpage.4 (Offpage Connector)

Note DataDefinition

Type: text

output_responses

Defined as Data Element in output_executive_io

Used in 1 Data Structure

output_executive_io (Sequence)

Used in 3 Data Flows

DFD diagram level 0

From: Offpage.0 (Offpage Connector)

To: output_processor (Process)

DFD diagram level top

From: ISV_analyst (External)

To: ISV (Process)

DFD diagram level 4

From: Offpage.4 (Offpage Connector)

To: ISV_output_executive (Process)

Note DataDefinition

Type: menu pick

output_selection

Defined as Data Element in ISV_executive_io

Used in 1 Data Structure

ISV_menu_selection (Selection)

Used in 2 Data Flows

DFD diagram level 0

From: Executive (Process)

To: output_processor (Process)

DFD diagram level 4
 From: Offpage.4 (Offpage Connector)
 To: ISV_output_executive (Process)

Note DataDefinition
 Type: menu pick

potential_boundary_value
 Defined as Data Element in ERH_boundary_conditions
 Used in 1 Data Structure
 potential_boundary_node (Sequence)

Note DataDefinition
 Type: correlation

radiation_air_temperature
 Defined as Data Element in TET_boundary_conditions
 Used in 1 Data Structure
 radiation_boundary_element (Sequence)

Used in 1 Data Flow
 DFD diagram level 3.4.4
 From: TET_boundary_conditions (Data Store)
 To: accumulate_radiation_boundary_integral_GP_component (Process)

Note DataDefinition
 Type: correlation

radiation_energy
 Defined as Data Element in element_variables
 Used in 1 Data Structure
 element_energy_components (Sequence)

Used in 3 Data Flows
 DFD diagram level 3.4
 From: apply_TET_radiation_boundary_condition (Process)
 To: problem_variables (Data Store)

DFD diagram level 3
 From: solve_TET_problem (Process)
 To: problem_variables (Data Store)

DFD diagram level 3.4.4
 From: accumulate_radiation_boundary_integral_GP_component (Process)
 To: problem_variables (Data Store)

Note DataDefinition
 Type: real

radiation_heat_transfer
 Defined as Data Element in TET_boundary_conditions
 Used in 1 Data Structure
 radiation_boundary_element (Sequence)

Note DataDefinition
 Type: correlation

right_hand_side
 Defined as Data Element in matrix_equation
 Used in 1 Data Structure
 matrix_equation (Sequence)

Note DataDefinition
 Type: vector

selected_problem_name
 Defined as Data Element in output_executive_io
 Used in 1 Data Flow
 DFD diagram level 4
 From: ISV_output_executive (Process)
 To: load_general_problem_data (Process)

Note DataDefinition

Type: string

simulate_selection

Defined as Data Element in ISV_executive_io

Used in 1 Data Structure

ISV_menu_selection (Selection)

Used in 2 Data Flows

DFD diagram level 0

From: Executive (Process)

To: simulate_ERH_and_TET_process (Process)

DFD diagram level 3

From: Offpage.3 (Offpage Connector)

To: simulation_executive (Process)

Note DataDefinition

Type: menu pick

simulation_menu

Defined as Data Element in simulation_executive_io

Used in 1 Data Structure

simulation_executive_io (Sequence)

Used in 3 Data Flows

DFD diagram level 0

From: simulate_ERH_and_TET_process (Process)

To: Offpage.0 (Offpage Connector)

DFD diagram level 3

From: simulation_executive (Process)

To: Offpage.3 (Offpage Connector)

DFD diagram level top

From: ISV (Process)

To: ISV_analyst (External)

Note DataDefinition

Type: menu

simulation_time

Defined as Data Element in simulation_executive_io

Used in 1 Data Structure

simulation_summary (Sequence)

Note DataDefinition

Type: real

solid_fraction

Defined as Data Element in element_variables

Used in 1 Data Structure

material_index (Sequence)

Used in 4 Data Flows

DFD diagram level 3

From: problem_variables (Data Store)

To: solve_TET_problem (Process)

DFD diagram level 3.4.2

From: problem_variables (Data Store)

To: compute_TET_element_GP_thermal_quantities (Process)

DFD diagram level 3.4

From: problem_variables (Data Store)

To: assemble_TET_element_equations (Process)

DFD diagram level 3.4.2.5

From: problem_variables (Data Store)

To: compute_TET_element_GP_phase_change_energy (Process)

Note DataDefinition

Type: real

store_selection
 Defined as Data Element in input_executive_io
 Used in 1 Data Structure
 input_menu_selection (Selection)
 Note DataDefinition
 Type: menu pick

surface_element_node_index
 Defined as Data Element in FE_mesh
 Used in 1 Data Structure
 surface_element (Iteration)
 Note DataDefinition
 Type: integer

tabular_output
 Defined as Data Element in output_executive_io
 Used in 1 Data Structure
 output_executive_io (Sequence)
 Used in 3 Data Flows
 DFD diagram level 0
 From: output_processor (Process)
 To: Offpage.0 (Offpage Connector)
 DFD diagram level top
 From: ISV (Process)
 To: ISV_analyst (External)
 DFD diagram level 4
 From: display_data_channels (Process)
 To: Offpage.4 (Offpage Connector)
 Note DataDefinition
 Type: text

temperature
 Defined as Data Element in node_variables
 Used in 1 Data Structure
 node_index (Sequence)
 Used in 20 Data Flows
 DFD diagram level 3
 From: solve_TET_problem (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3
 From: problem_variables (Data Store)
 To: solve_ERH_problem (Process)
 DFD diagram level 3
 From: problem_variables (Data Store)
 To: solve_TET_problem (Process)
 DFD diagram level 3.4
 From: TET_executive (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3.4
 From: problem_variables (Data Store)
 To: compute_TET_element_heat_flux (Process)
 DFD diagram level 3.4
 From: problem_variables (Data Store)
 To: assemble_TET_element_equations (Process)
 DFD diagram level 3.4
 From: problem_variables (Data Store)
 To: apply_TET_convection_boundary_condition (Process)

DFD diagram level 3.4

From: problem_variables (Data Store)
To: apply_TET_radiation_boundary_condition (Process)

DFD diagram level 3.3

From: problem_variables (Data Store)
To: assemble_ERH_element_equations (Process)

DFD diagram level 3.3.2

From: problem_variables (Data Store)
To: compute_ERH_element_GP_electrical_conductivity (Process)

DFD diagram level 3.4.2

From: problem_variables (Data Store)
To: accumulate_TET_element_equation_GP_component (Process)

DFD diagram level 3.4.3

From: problem_variables (Data Store)
To: compute_nodal_chtc (Process)

DFD diagram level 3.4.4

From: problem_variables (Data Store)
To: compute_nodal_rhtc (Process)

DFD diagram level 3.4.2

From: problem_variables (Data Store)
To: compute_TET_element_GP_temperature (Process)

DFD diagram level 3.4.3

From: problem_variables (Data Store)
To: compute_convection_element_GP_temperature (Process)

DFD diagram level 3.4.4

From: problem_variables (Data Store)
To: compute_radiation_element_GP_temperature (Process)

DFD diagram level 3.4.7

From: problem_variables (Data Store)
To: recompute_TET_element_GP_temperature (Process)

DFD diagram level 3.4.7

From: problem_variables (Data Store)
To: compute_TET_element_GP_temperature_gradient (Process)

DFD diagram level 3.3

From: problem_variables (Data Store)
To: compute_ERH_element_current_density (Process)

DFD diagram level 3.3.7

From: problem_variables (Data Store)
To: recompute_ERH_element_GP_electrical_conductivity (Process)

Note DataDefinition

Type: real

temperature_boundary_value

Defined as Data Element in TET_boundary_conditions

Used in 1 Data Structure

temperature_boundary_node (Sequence)

Note DataDefinition

Type: correlation

thermal_conductivity

Defined as Data Element in material_properties

Used in 1 Data Structure

physical_properties (Sequence)

Used in 3 Data Flows

DFD diagram level 3.4.7

From: material_properties (Data Store)
To: recompute_TET_element_GP_thermal_conductivity (Process)

DFD diagram level 3.4
 From: material_properties (Data Store)
 To: compute_TET_element_heat_flux (Process)
 DFD diagram level 3.4.2.5
 From: material_properties (Data Store)
 To: compute_TET_element_GP_thermal_conductivity (Process)
 Note DataDefinition
 Type: 3D_correlation
time
 Defined as Data Element in problem_data
 Used in 1 Data Structure
 problem_variables (Sequence)
 Used in 2 Data Flows
 DFD diagram level 3
 From: solve_TET_problem (Process)
 To: problem_variables (Data Store)
 DFD diagram level 3.4
 From: TET_executive (Process)
 To: problem_variables (Data Store)
 Note DataDefinition
 Type: real
time_history
 Defined as Data Element in output_executive_io
 Used in 1 Data Structure
 solution_summary (Sequence)
 Note DataDefinition
 Type: list
top_node
 Defined as Data Element in boundary_variables
 Used in 1 Data Structure
 electrode_position (Sequence)
 Note DataDefinition
 Type: integer
view_selection
 Defined as Data Element in input_executive_io
 Used in 1 Data Structure
 input_menu_selection (Selection)
 Note DataDefinition
 Type: menu pick
x_component
 Defined as Data Element in 3D_vector
 Used in 1 Data Structure
 3D_vector (Sequence)
 Note DataDefinition
 Type: real
x_component_correlation
 Defined as Data Element in 3D_correlation
 Used in 1 Data Structure
 3D_correlation (Sequence)
 Note DataDefinition
 Type: correlation
y_component
 Defined as Data Element in 3D_vector
 Used in 1 Data Structure
 3D_vector (Sequence)

Note DataDefinition

Type: real

y_component_correlation

Defined as Data Element in 3D_correlation

Used in 1 Data Structure

3D_correlation (Sequence)

Note DataDefinition

Type: correlation

z_component

Defined as Data Element in 3D_vector

Used in 1 Data Structure

3D_vector (Sequence)

Note DataDefinition

Type: real

z_component_correlation

Defined as Data Element in 3D_correlation

Used in 1 Data Structure

3D_correlation (Sequence)

Note DataDefinition

Type: correlation

END

DATE FILMED

12 / 05 / 90