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U.S. Nuclear Regulatory Commission,
Document Control Desk,
Washington, D.C. 20555

Attention: Ms. B. Sosa
Project Manager, ACR

Reference:

1. Letter J. Kim to G. Archinoff, "Requests for Additional Information – Thermalhydraulic Data for ACR-700 Application", September 23, 2004.

Re: Response to RAIs on Thermal Hydraulic Data: ACR-700 Data – Non-proprietary Version

In response to NRC's request for additional information on thermal hydraulic data (Reference 1) and in support of the NRC's pre-application review of the ACR-700, attachment 1 provides the requested thermal hydraulic data on ACR-700.

The proprietary version of our response to these RAIs is submitted under a separate cover.

If you have any questions on this letter and/or the enclosed material please contact me at (301) 332-9152.

Yours sincerely,



for: Glenn Archinoff
Manager ACR Licensing

/Attachments:

1. Response to NRC's RAIs on Thermal Hydraulic Data – ACR-700 Data (Non-Proprietary)

D070

Attachment 1

(Letter G. Archinoff to B. Sosa, "Response to RAIs on Thermal Hydraulic Data: ACR-700 Data – Non-proprietary Version", October 04, 2004)

Response to NRC's RAIs on Thermal Hydraulic Data – ACR-700 Data (Non-Proprietary)

For the ACR-700 design, AECL's response to NRC's RAIs on Thermal Hydraulic data are provided in the table below. Please also note the following regarding the data provided:

- All pressures provided in the table above are in MPa(g);
- The steady state pressure, temperature and flow rate are nominal values;
- The lowest elevation channel data provided are for channel S11;
- The average channel data provided are for channel J7;
- The hottest channel data provided are for channel K8.

INLET HEADERS

Parameter	ACR-700
length (m)	
diameter (m)	
metal thickness (m)	
material	Carbon Steel
metal mass (kg)	
metal density (kg/m ³)	7833
metal specific heat (kJ/kg K)	0.465
surface roughness (mm)	
# feeders	146
feeder diameter at header (m)	
off take angles (1, 2, 3, 4, 5) (degrees)	
# ECI injection ports	1
injection port diameter (m)	
axial location of first injection port (m)	
axial location of second injection port (m)	N/A

axial location of interconnect line (m)	N/A
ECI flow range (kg/s)	0 - 1800
Interconnect flow range (kg/s)	N/A
break orifice size (m)	
break location	No restriction
mass flow rate (steady state) (kg/s)	
average pressure (steady state) (MPa)	
average temperature (steady state) (°C)	

OUTLET HEADERS

Parameter	ACR-700
length (m)	
diameter (m)	
metal thickness (m)	
material	Carbon Steel
metal mass (kg)	
metal density (kg/m ³)	7833
metal specific heat (kJ/kg·K)	0.465
surface roughness (mm)	
# feeders	146
feeder diameter at header (m)	
off take angles (1, 2, 3, 4, 5) (degrees)	
# ECI injection ports	0
injection port diameter (m)	N/A
axial location of first injection port (m)	N/A
axial location of second injection port (m)	N/A
axial location of interconnect line (m)	
ECI flow range (kg/s)	N/A
interconnect ECI flow range (kg/s)	0 - 1000
break orifice size (m)	
break location	No restriction
mass flow rate (steady state) (kg/s)	
average pressure (steady state) (MPa)	
average temperature (steady state) (°C)	

INLET FEEDER (Leading to the lowest elevation fuel channel.) Channel S11 is considered here as the lowest elevation channel.

Parameter	ACR-700
length of pipe-header to reducer (m)	
length of pipe-reducer to channel (m)	
diameter of pipe-header to reducer (m), D1	
diameter of pipe-reducer to channel (m), D2	
metal thickness-header to reducer (m)	
metal thickness-reducer to channel (m)	
material	Stainless steel
metal mass (kg)	
metal density (kg/m ³)	7833
metal specific heat (kJ/kg K)	0.46
surface roughness (mm)	
elevation drop-header to channel (m)	
K value for total form loss K1 refers to D1 K2 refers to D2	
reference parameter for K value	D1 D2
temperature at header (steady state) (°C)	
temperature at end-fitting (steady state) (°C)	
pressure at header (steady state) (MPa)	
pressure at end-fitting (steady state) (MPa)	
mass flow rate (steady state) (kg/s)	

OUTLET FEEDER (Leading to the lowest elevation fuel channel S11.)

Parameter	ACR-700
length of pipe-header to reducer (m)	
length of pipe-reducer to channel (m)	
diameter of pipe-header to reducer (m), D1	
diameter of pipe-reducer to channel (m), D2	
metal thickness-header to reducer (m)	
metal thickness-reducer to channel (m)	
material	Stainless steel
metal mass (kg)	
metal density (kg/m ³)	7833
metal specific heat (kJ/kg K)	0.46
surface roughness (mm)	
elevation drop-header to channel (m)	
K value for total form loss K1 refers to D1 K2 refers to D2	
reference parameter for K value	D1 D2
temperature at header (steady state) (°C)	
temperature at end-fitting (steady state) (°C)	
pressure at header (steady state) (MPa)	
pressure at end-fitting (steady state) (MPa)	
mass flow rate (steady state) (kg/s)	

INLET FEEDER (For the average fuel channel.) The average fuel channel is considered here to be channel J7.

Parameter	ACR-700
length of pipe-header to reducer (m)	
length of pipe-reducer to channel (m)	
diameter (ID) of pipe-header to reducer (m), D1	
diameter (ID) of pipe-reducer to channel (m), D2	
metal thickness-header to reducer (m)	
metal thickness-reducer to channel (m)	
material	stainless steel
metal mass (kg)	
metal density (kg/m ³)	7833
metal specific heat (kJ/kg K)	0.46
surface roughness (mm)	
elevation drop-header to channel (m)	
K value for total form loss K1 refers to D1 K2 refers to D2	
reference parameter for K value	D1 D2
temperature at header (steady state) (°C)	
temperature at end-fitting (steady state) (°C)	
pressure at header (steady state) (MPa)	
pressure at end-fitting (steady state) (MPa)	
mass flow rate (steady state) (kg/s)	

OUTLET FEEDER (For the average fuel channel) The average fuel channel is considered here to be channel J7.

Parameter	ACR-700
length of pipe-header to reducer (m)	
length of pipe-reducer to channel (m)	
diameter (ID) of pipe-header to reducer (m), D1	
diameter (ID) of pipe-reducer to channel (m), D2	
metal thickness-header to reducer (m)	
metal thickness-reducer to channel (m)	
material	Stainless steel
metal mass (kg)	
metal density (kg/m ³)	7833
metal specific heat (kJ/kg K)	0.46
surface roughness (mm)	
elevation drop-header to channel (m)	
K value for total form loss K1 refers to D1 K2 refers to D2	
reference parameter for K value	D1 D2
temperature at header (steady state) (°C)	
temperature at end-fitting (steady state) (°C)	
pressure at header (steady state) (MPa)	
pressure at end-fitting (steady state) (MPa)	
mass flow rate (steady state) (kg/s)	

INLET FEEDER (For the hottest fuel channel.) The hottest channel is K8.

Parameter	ACR-700
length of pipe-header to reducer (m)	
length of pipe-reducer to channel (m)	
diameter (ID) of pipe-header to reducer (m), D1	
diameter (ID) of pipe-reducer to channel (m), D2	
metal thickness-header to reducer (m)	
metal thickness-reducer to channel (m)	
material	Stainless steel
metal mass (kg)	
metal density (kg/m ³)	7833
metal specific heat (kJ/kg K)	0.46
surface roughness (mm)	
elevation drop-header to channel (m)	
K value for total form loss K1 refers to D1 K2 refers to D2	
reference parameter for K value	D1 D2
temperature at header (steady state) (°C)	
temperature at end-fitting (steady state) (°C)	
pressure at header (steady state) (MPa)	
pressure at end-fitting (steady state) (MPa)	
mass flow rate (steady state) (kg/s)	

OUTLET FEEDER (For the hottest fuel channel). The hottest channel is K8.

Parameter	ACR-700
length of pipe-header to reducer (m)	
length of pipe-reducer to channel (m)	
Diameter (ID) of pipe-header to reducer (m), D1	
diameter (ID) of pipe-reducer to channel (m), D2	
metal thickness-header to reducer (m)	
metal thickness-reducer to channel (m)	
material	Stainless steel
metal mass (kg)	
metal density (kg/m ³)	7833
metal specific heat (kJ/kg K)	0.46
surface roughness (mm)	
elevation drop-header to channel (m)	
K value for total form loss K1 refers to D1 K2 refers to D2	
reference parameter for K value	D1 D2
temperature at header (steady state) (°C)	
temperature at end-fitting (steady state) (°C)	
pressure at header (steady state) (MPa)	
pressure at end-fitting (steady state) (MPa)	
mass flow rate (steady state) (kg/s)	

INLET ENDFITTING

Parameter	ACR-700
material	Modified Type 403 stainless steel
metal mass (kg); excluding: closure plug, liner tube, fuel support plug	
mass, closure plug (kg)	
mass, fuel support plug (kg)	
mass, liner tube (kg)	
metal density (kg/m ³)	7750
metal specific heat (kJ/kg K)	0.46
fluid volume (m ³); excluding: closure plug, liner tube and fuel support plug	
flow area at feeder connect (m ²)	
hydraulic diameter at feeder connect (m)	
flow area at channel connect (m ²)	
hydraulic diameter at channel connect (m)	
flow area in annulus (m ²)	
hydraulic diameter in annulus (m)	
flow area of all the little holes (m ²)	
hydraulic diameter of the holes (m)	
K value for total form loss	
reference parameter for K value	
temperature drop-hottest channel K8 (°C)	
temperature drop-average channel J7 (°C)	
temperature drop-lowest elevation channel S11 (°C)	

pressure drop-hottest channel K8 (MPa)	
pressure drop-average channel J7 (MPa)	
pressure drop-lowest elevation channel S11 (MPa)	
mass flow rate-hottest channel K8 (kg/s)	
mass flow rate-average channel J7 (kg/s)	
mass flow rate-lowest elevation channel S11 (kg/s)	

OUTLET ENDFITTING

Parameter	ACR-700
material	Modified Type 403 stainless steel
metal mass (kg)	
mass, closure plug (kg)	
mass, fuel support plug (kg)	
mass, liner tube	
metal density (kg/m ³)	7750
metal specific heat (kJ/kg·K)	0.46
fluid volume (m ³)	
flow area at feeder connect (m ²)	
hydraulic diameter at feeder connect (m)	
flow area at channel connect (m ²)	
hydraulic diameter at channel connect (m)	
flow area in annulus (m ²)	
hydraulic diameter in annulus (m)	
flow area of all the little holes (m ²)	
hydraulic diameter of the holes (m)	
K value for total form loss	
reference parameter for K value	
temperature drop-hottest channel K8 (°C)	
temperature drop-average channel J7 (°C)	
temperature drop-lowest elevation channel S11 (°C)	
pressure drop-hottest channel K8 (MPa)	
pressure drop-average channel J7 (MPa)	

pressure drop-lowest elevation channel S11 (MPa)	
mass flow rate-hottest channel K8 (kg/s)	
mass flow rate-average channel J7 (kg/s)	
mass flow rate-lowest elevation channel S11 (kg/s)	

FUEL RODS

Parameter	ACR-700	
# rods	35	8
cladding outer diameter (m) (nominal)		
cladding thickness (m) (nominal)		
cladding material	Zr-4	
cladding mass/bundle (kg)		
cladding density (kg/m ³) (at room temperature)	6550	
material specific heat (kJ/kg K) (at room temperature; 300K)	0.281	
fuel outer diameter (m)		
fuel material	Sintered pellets of slightly enriched UO ₂ and natural UO ₂ and Dysprosium	
fuel mass/bundle (kg)	(U mass) (UO ₂ mass)	
fuel density (kg/m ³)	10650	
fuel specific heat (kJ/kg K) Unirradiated UO ₂ at room temperature (300K)	0.237	
hottest channel power (kW) (channel K8)		
hotttest channel decay power (kW)		
average channel power (kW) (channel J7)		
average channel decay power (kW)		
bottom channel (S11) power (kW)		
bottom channel decay power (kW)		
fuel length (m)	5.943	

length of pressure tube	
inner diameter of pressure tube (m)	
thickness of pressure tube (m)	
material type	Zr-2.5Nb
metal mass (kg)	
material density (kg/m ³)	6570
material specific heat (kJ/kg K)	0.330

CHANNEL HYDRAULICS

Parameter	ACR-700
fluid volume (m ³)	
fluid length (m)	
flow area (m ²)	
hydraulic diameter (m)	
wetted perimeter (m)	
K value for total form loss	
reference parameter for K value	
average surface roughness of channel (mm)	
inlet pressure-hot channel (MPa) (channel K8)	
outlet pressure-hot channel (MPa) (channel K8)	
inlet temperature-hot channel (°C) (channel K8)	
outlet temperature-hot channel (°C) (channel K8)	
mass flow rate-hot channel (kg/s) (channel K8)	
inlet pressure-average channel (MPa) (channel J7)	
outlet pressure-average channel (MPa) (channel J7)	
inlet temperature-average channel (°C) (channel J7)	
outlet temperature-average channel (°C) (channel J7)	
mass flow rate-average channel (kg/s) (channel J7)	
inlet pressure-lowest elevation channel (MPa) (channel S11)	
outlet pressure-lowest elevation channel (MPa) (channel S11)	
inlet temperature-lowest elevation channel (°C) (channel S11)	
outlet temperature-lowest elevation channel (°C) (channel S11)	
mass flow rate-lowest elevation channel (kg/s) (channel S11)	