Reactivity and power distribution anomalies

Tranzijenti koji uzrokuju znatniju promjenu reaktivnosti

- Dio su zahtjevanih sigurnosnih analiza NE
- Znatnija promjena reaktivnosti podrazumjeva se u vezanom proračunu
- Relevantni PWR tranzijenti
  - Povećanje odvođenja topline na sekundarnoj strani,
  - Nekontrolirano izvlačenje banke kontrolnih šipki
  - Start neaktivne pumpe u jednoj od rashladnih petlji,
  - Neplanirano deboriranje jezgre,
  - Izvlačenje jednog kontrolnog sklopa na snazi,
  - Lom parovoda,
  - Izbacivanje kontrolnog sklopa

Primjena modela točkaste kinetike

- Potrebni podaci:
  - udjeli i vremenske konstante zakašnjelih neutrona,
  - vrijeme života promptnih neutrona,
  - koeficijenti reaktivnosti u ovisnosti o TH varijablama,
  - težinski koeficijenti da se približno uzme u obzir prostorna raspodjela neutronskog fluksa,
  - scram reaktivnost u ovisnosti o vremenu nakon obustave i
  - udjeli i vremensko ponašanje ostatne topline.
- Primjena ograničena na:
  - uniformne promjene reaktivnosti
  - male promjene reaktivnosti
  - situacije u kojima brzo dolazi do obustave reaktora.
- U suprotnom uvesti dodatne konzervativnosti

Tranzijenti za koje je korištenje 3D kinetike važno

- **Lom parovoda**
  - velike nesimetrične promjene reaktivnosti, lokalizirani poremećaj zbog pretpostavke o zaglavljenom kontrolnom sklopu
- **Start neaktivne petlje**
  - nesimetrično unošenje reaktivnosti
- **Izbacivanje/izvlačenje kontrolnog sklopa**
  - prostorno lokalizirana promjena, ograničenje na lokalnu promjenu entalpije goriva
- **Smanjenje koncentracije bora**
  - velike promjene reaktivnosti, neuniformna raspodjela bora
- **ATWS tranzijenti**
  - potreba za točnim proračunom efekata povratne veze
- **Odziv instrumentacije**
  - određivanje kritičnih postavnih vrijednosti

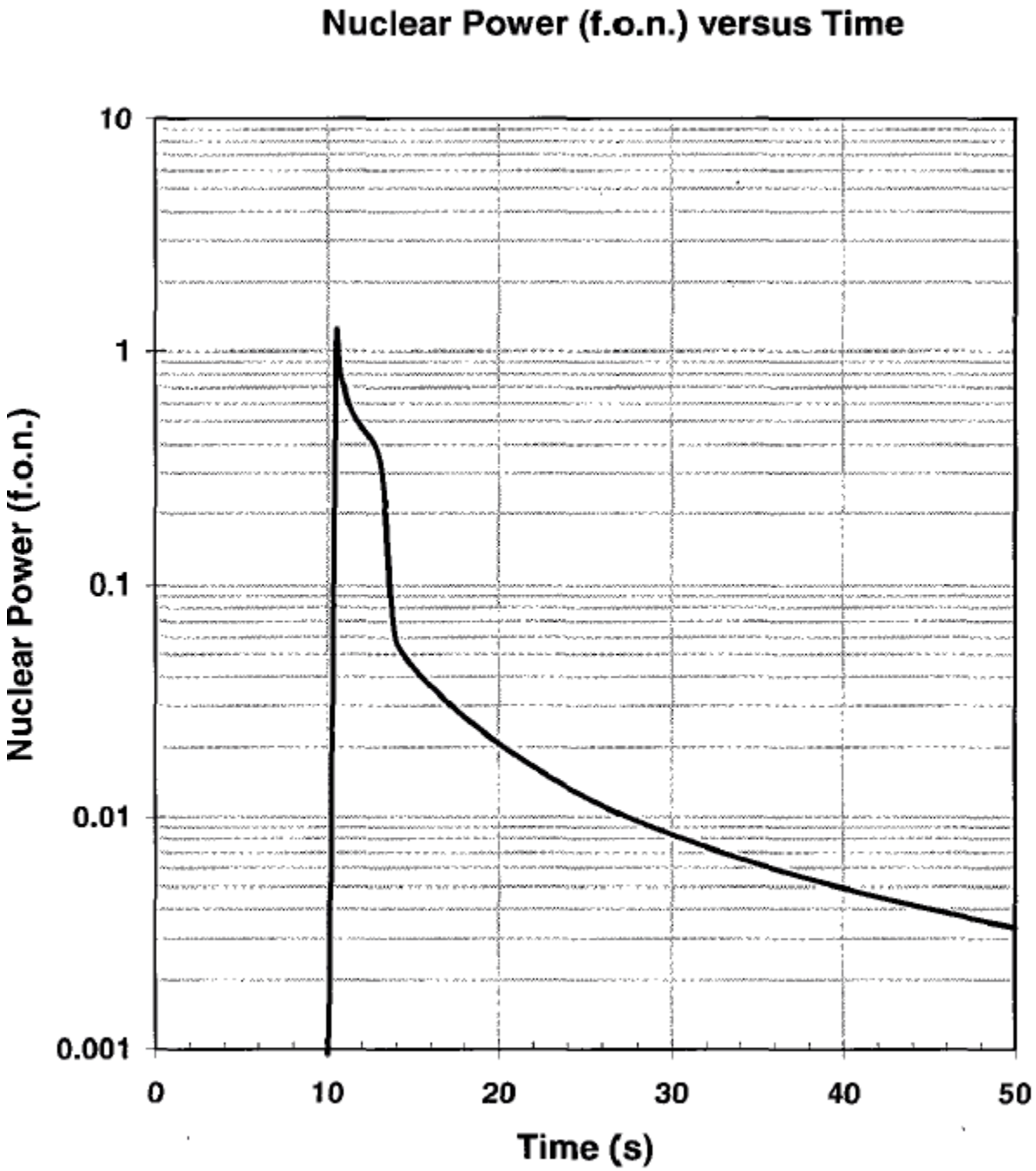
Reactivity and power distribution anomalies

- Uncontrolled Control Rod Assembly Withdrawal From a Subcritical or Low Power Startup Condition
- Uncontrolled Control Rod Assembly Withdrawal At Power
- Control Rod Misoperation (System Malfunction or Operator Error)
- Startup Of An Inactive Loop at an Incorrect Temperature
- Chemical And Volume Control System Malfunction That Results In a Decrease In Boron Concentration In The Reactor Coolant (PWR)
- Inadvertent Loading And Operation Of a Fuel Assembly In An Improper Position
- Spectrum Of Rod Ejection Accidents (PWR)

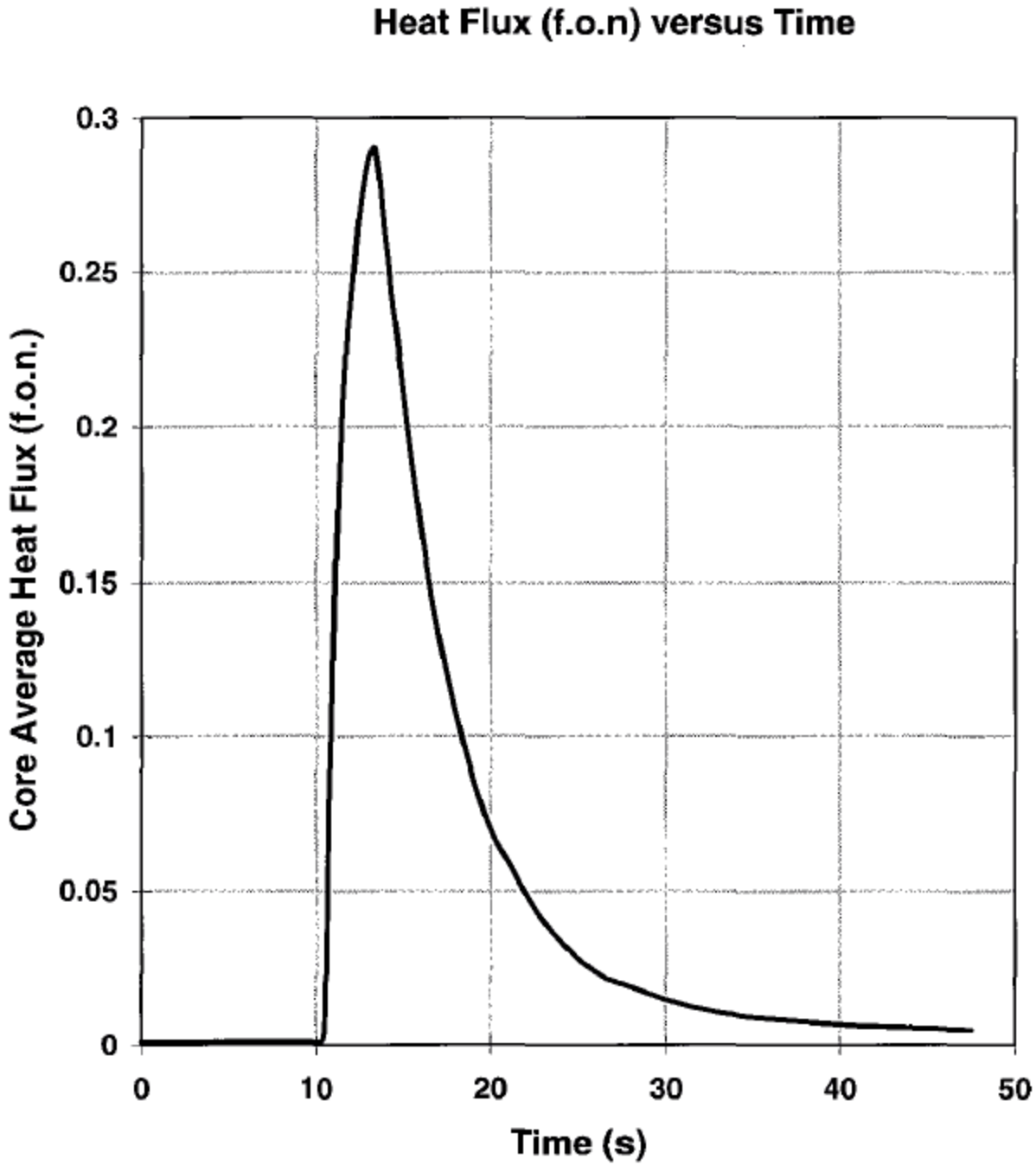
Incident	Reactor Trip Functions	ESF Actuation Functions	Other Equipment	ESF Equipment
15.4 REACTIVITY AND POWER DISTRIBUTION ANOMALIES				
15.4.1 - Uncontrolled RCCA bank withdrawal from a subcritical or low power startup condition	-Source Range Neutron Flux -Intermediate Range Neutron Flux -Power Range Neutron Flux -Power Range Neutron Flux Positive Rate--High	-----	-----	-----
15.4.2 - Uncontrolled RCCA bank withdrawal at power	-Power Range Neutron Flux -Overtemperature Delta T -Overpower Delta T -Pressurizer Pressure-High -Pressurizer Water Level--High -Power Range Neutron Flux Positive Rate-High	-----	-Steam Generator Safety Valves -Pressurizer Relief and Safety Valves	-----
15.4.3 - RCCA misoperation	-Power Range Neutron Flux Negative Rate--High -Overtemperature Delta T	-----	-----	-----
15.4.4 - Startup of an inactive reactor coolant loop at an incorrect temperature	-Power Range Neutron Flux	-----	-----	-----
15.4.5 - Malfunction or failure of the flow controller in a BWR	(Not Applicable to Krško)			
15.4.6 - CVCS malfunction causing a decrease in boron concentration in the reactor coolant	-Source Range Neutron Flux -Intermediate Range Neutron Flux -Power Range Neutron Flux -Overtemperature Delta T	-----	-----	-----
15.4.7 - Inadvertent loading of and operation with a fuel assembly in an improper position	-----	-----	-----	-----
15.4.8 - Spectrum of RCCA ejection accidents	-Power Range Neutron Flux -Power Range Neutron Flux Positive Rate--High	-----	-----	-----
15.4.9 - Spectrum of rod drop accidents in a BWR	(Not applicable to Krško)			

Incident	Reactor Trip Functions	ESF Actuation Functions	Other Equipment	ESF Equipment
15.5 INCREASE IN REACTOR COOLANT INVENTORY				
15.5.1 - Inadvertent operation of the ECCS during power operation	-----	Not Applicable to Krško		
15.5.2 - CVCS malfunction causing an increase in reactor coolant inventory	No trip credited	N/A	-SG Safety Valves -Pressurizer Safety Valves	-----
15.5.3 - BWR transients	(Not Applicable to Krško)			

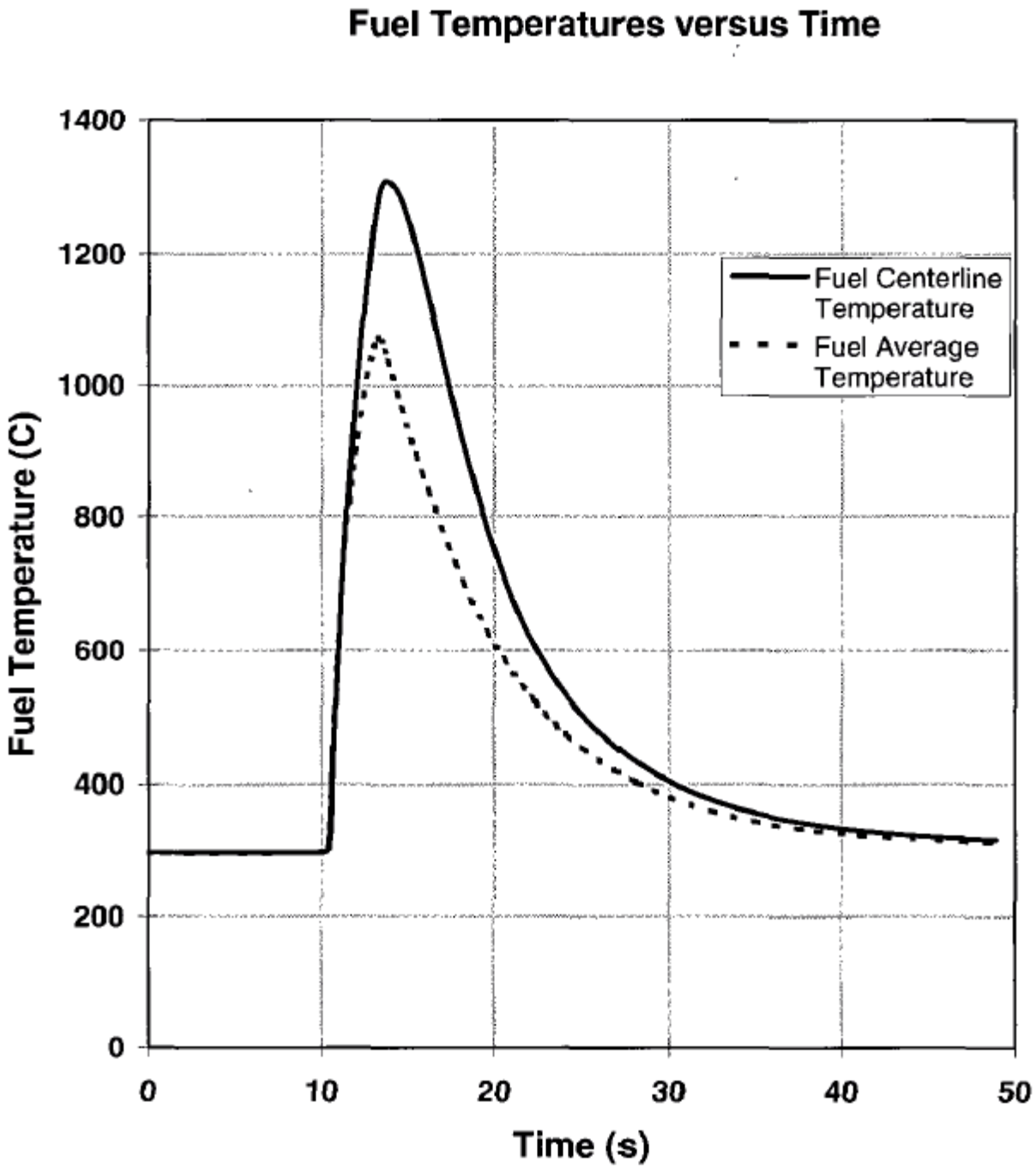
RWFS


Nuclear Power (f.o.n.) versus Time
Nuclear Power (f.o.n.)
10
1
0.1
0.01
0.001
0
10
20
30
40
50
Time (s)

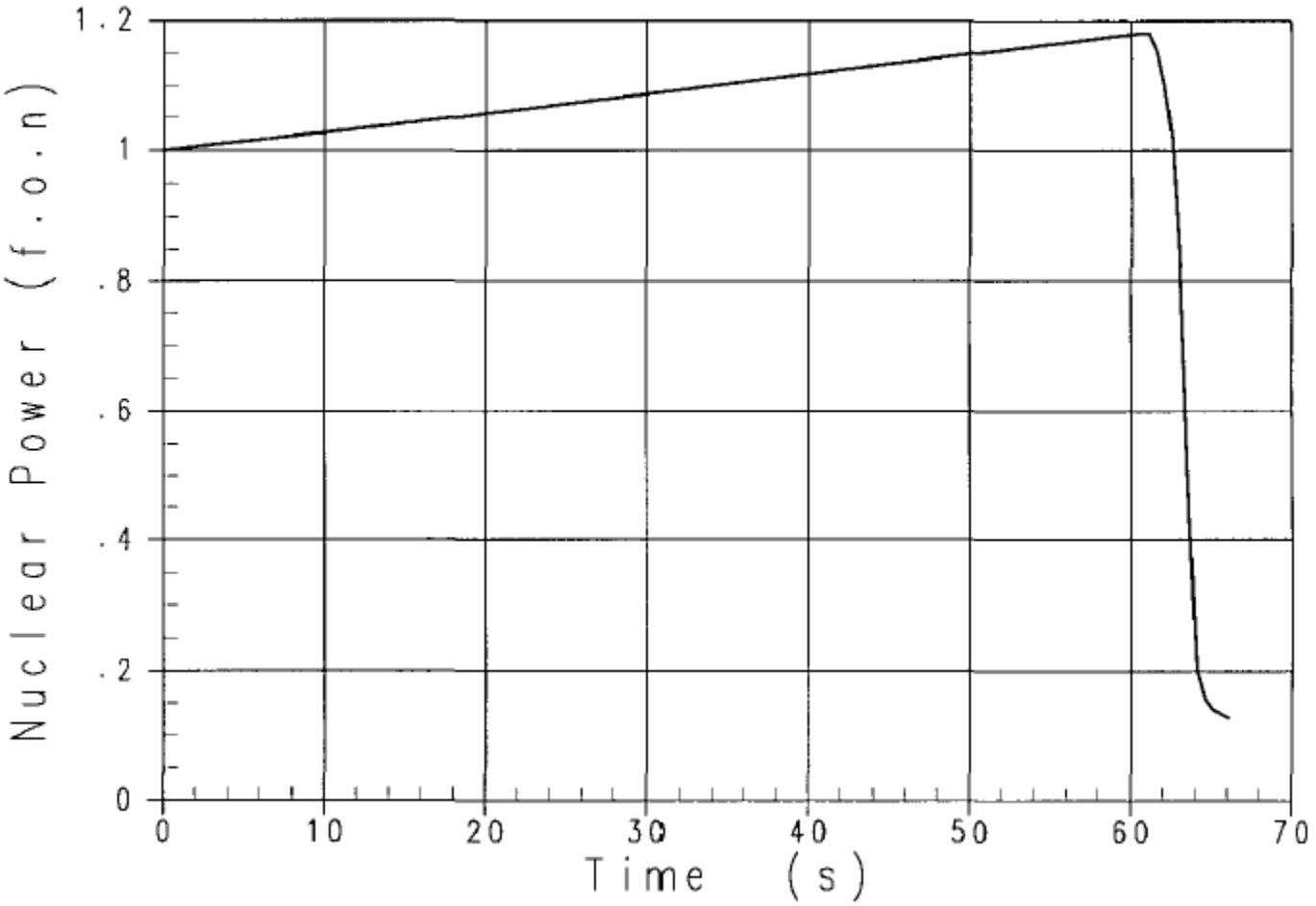
RWFS


Heat Flux (f.o.n) versus Time
Core Average Heat Flux (f.o.n.)
0.3
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
Time (s)

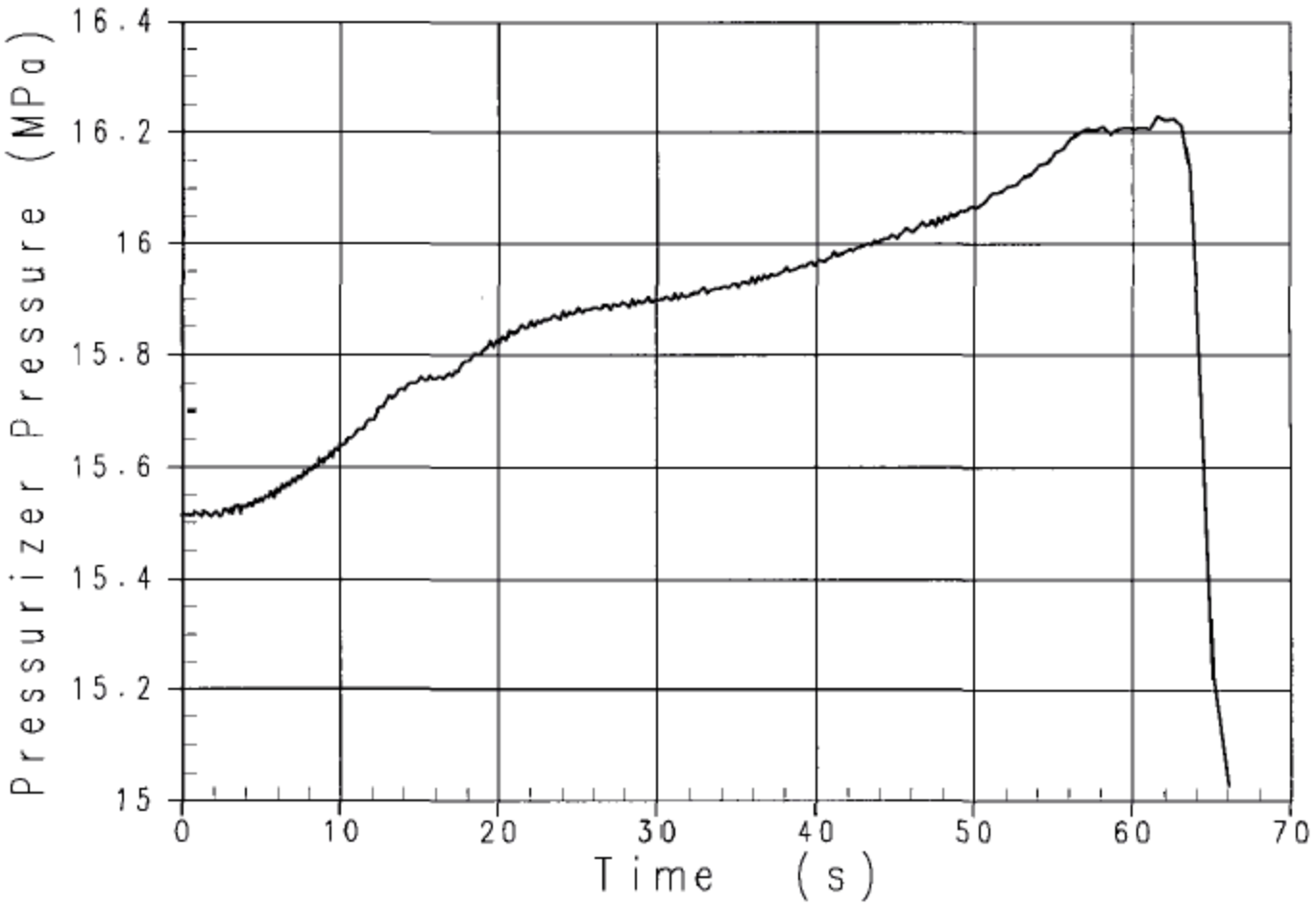
RWFS


Fuel Temperatures versus Time
Fuel Temperature (C)
1400
1200
1000
800
600
400
200
0
0
10
20
30
40
50
Time (s)
Fuel Centerline Temperature
Fuel Average Temperature

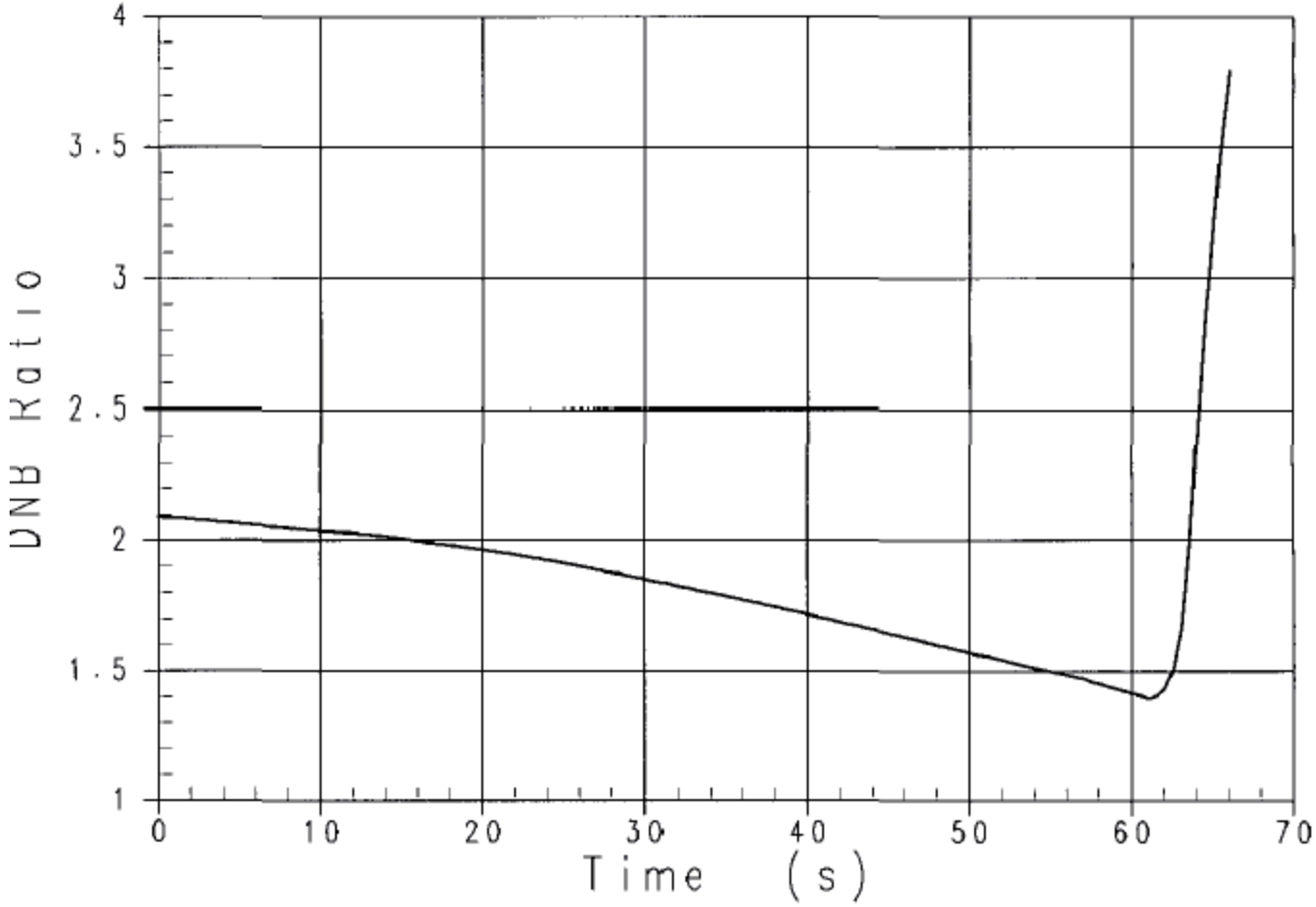
RWAP, 2.4 pcm/s



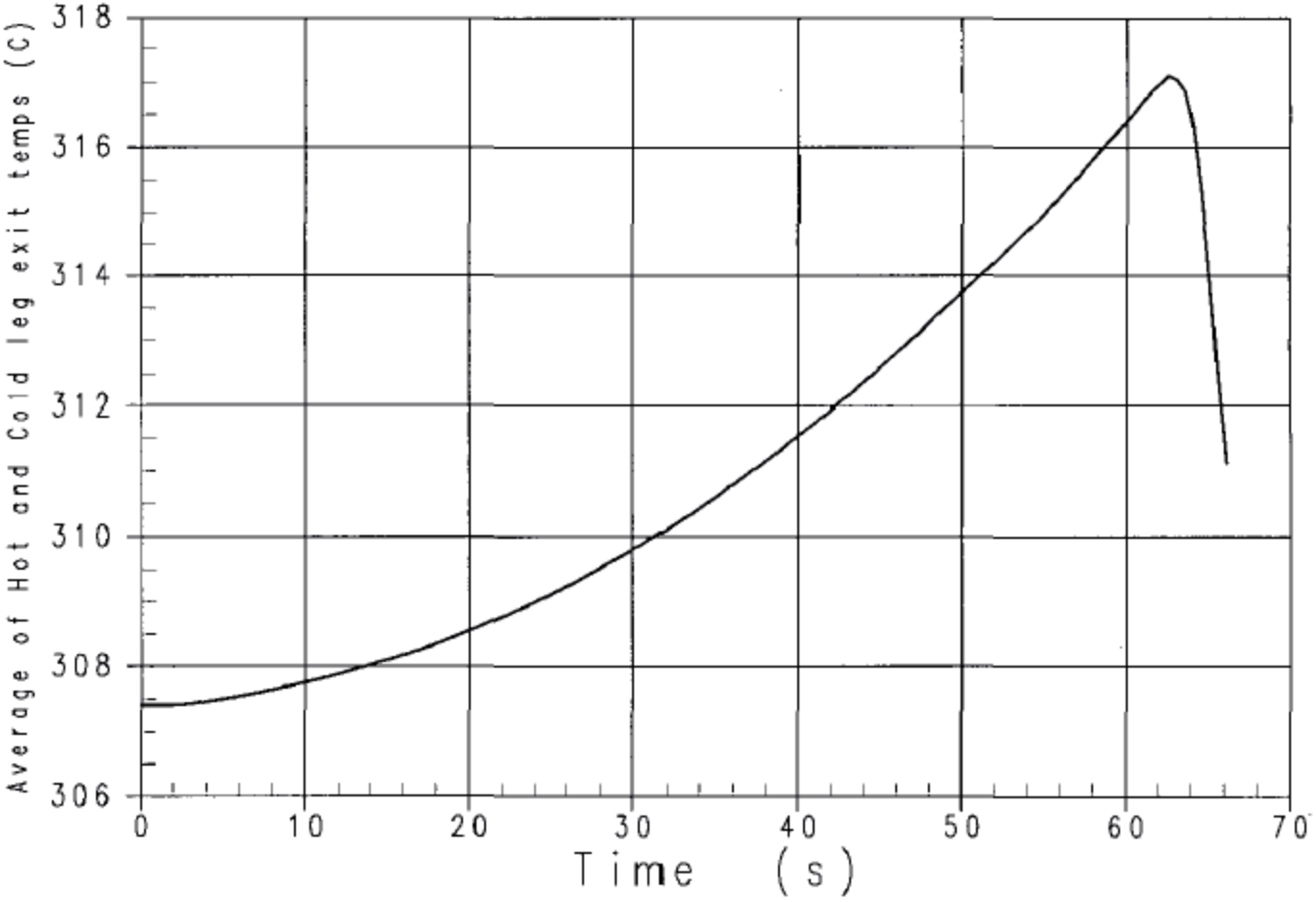
RWAP, 2.4 pcm/s


Pressurizer Pressure (MPa)
16.4
16.2
16
15.8
15.6
15.4
15.2
15
0
10
20
30
40
50
60
70
Time (s)

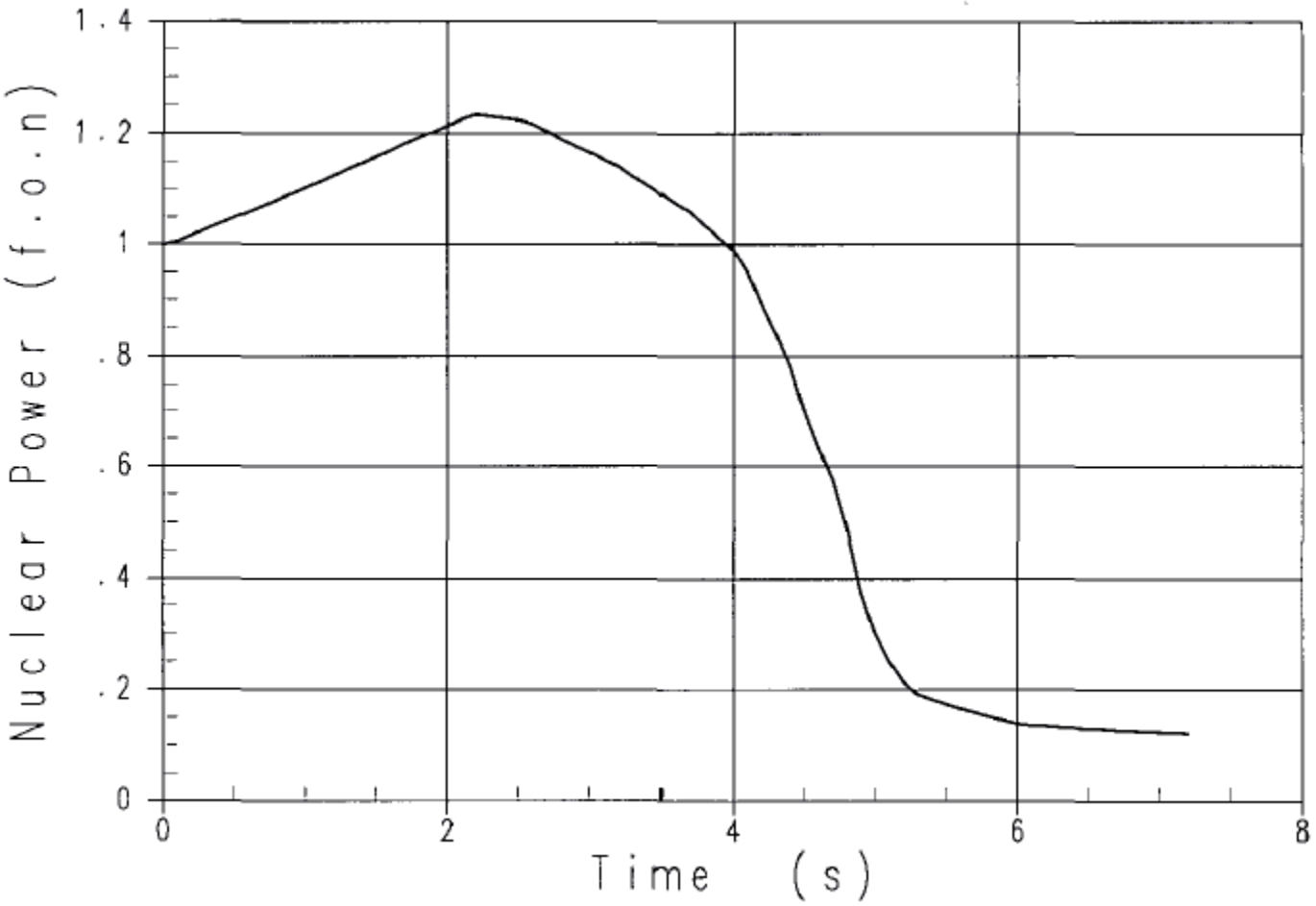
RWAP, 2.4 pcm/s



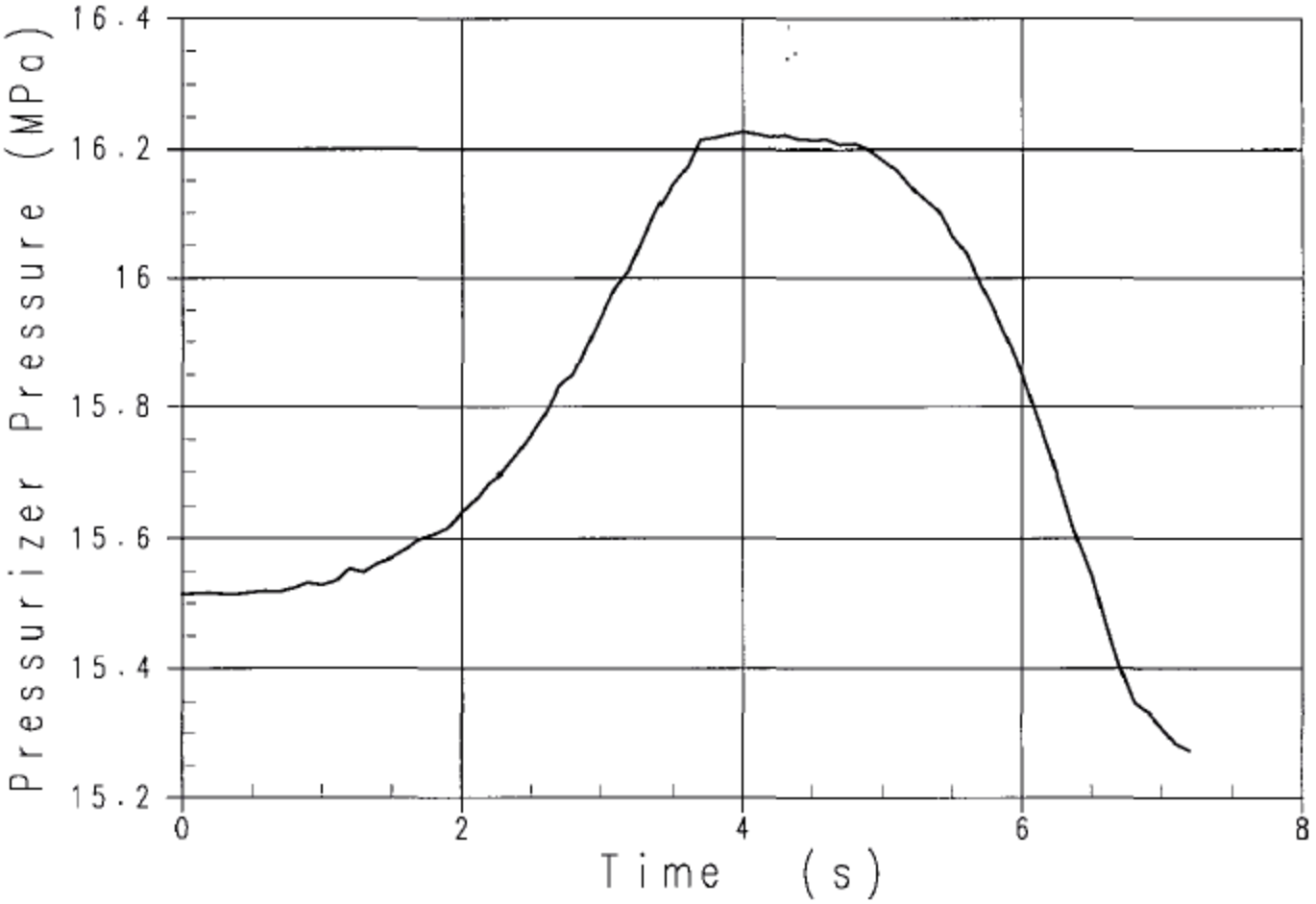
RWAP, 2.4 pcm/s


Average of Hot and Cold leg exit temps (C)
318
316
314
312
310
308
306
0
10
20
30
40
50
60
70
Time (s)

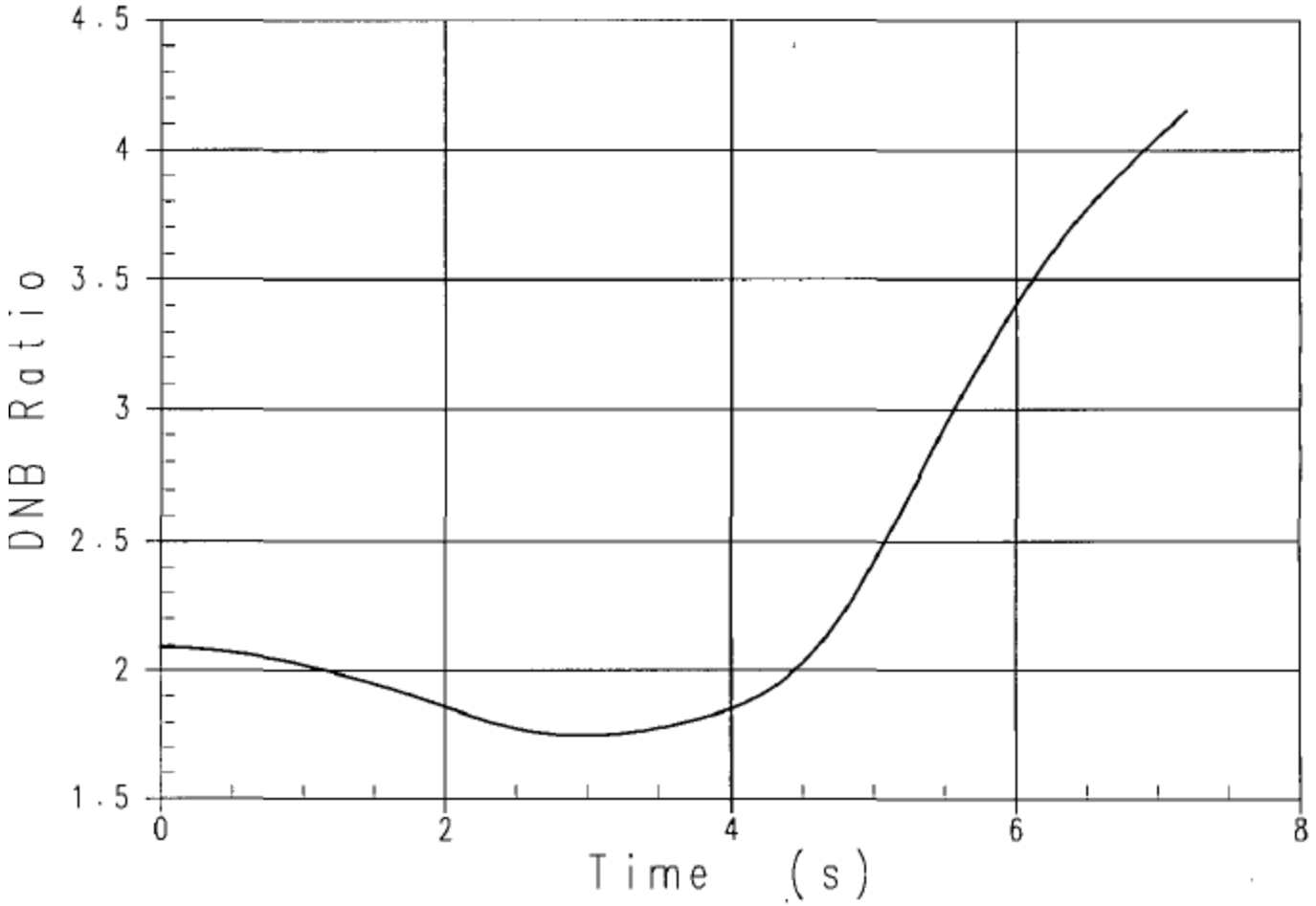
RWAP, 80 pcm/s



RWAP, 80 pcm/s


Pressurizer Pressure (MPa)
16.4
16.2
16
15.8
15.6
15.4
15.2
0
2
4
6
8
Time (s)

RWAP, 80 pcm/s



RWAP vs insertion rate pcm/s