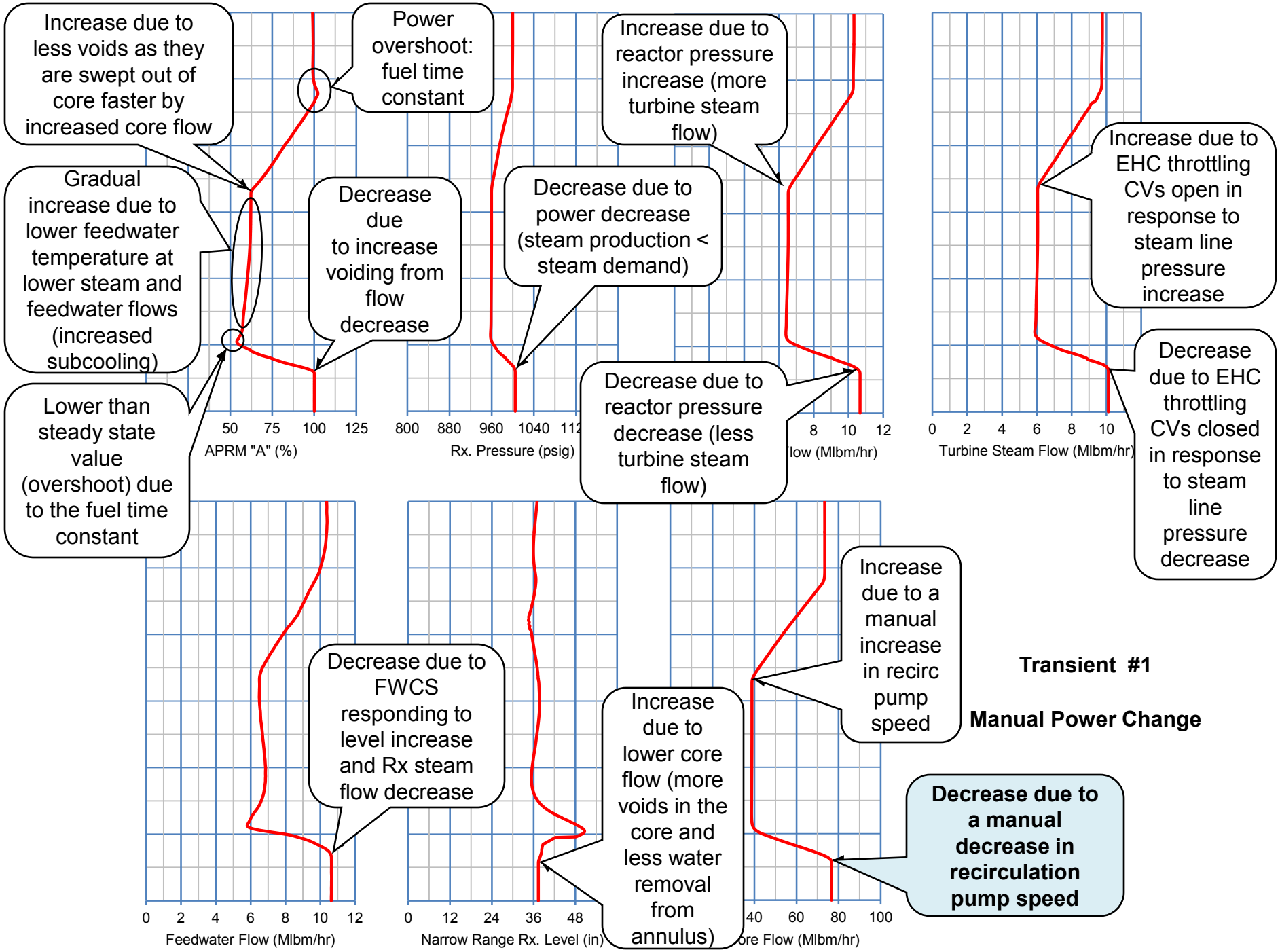
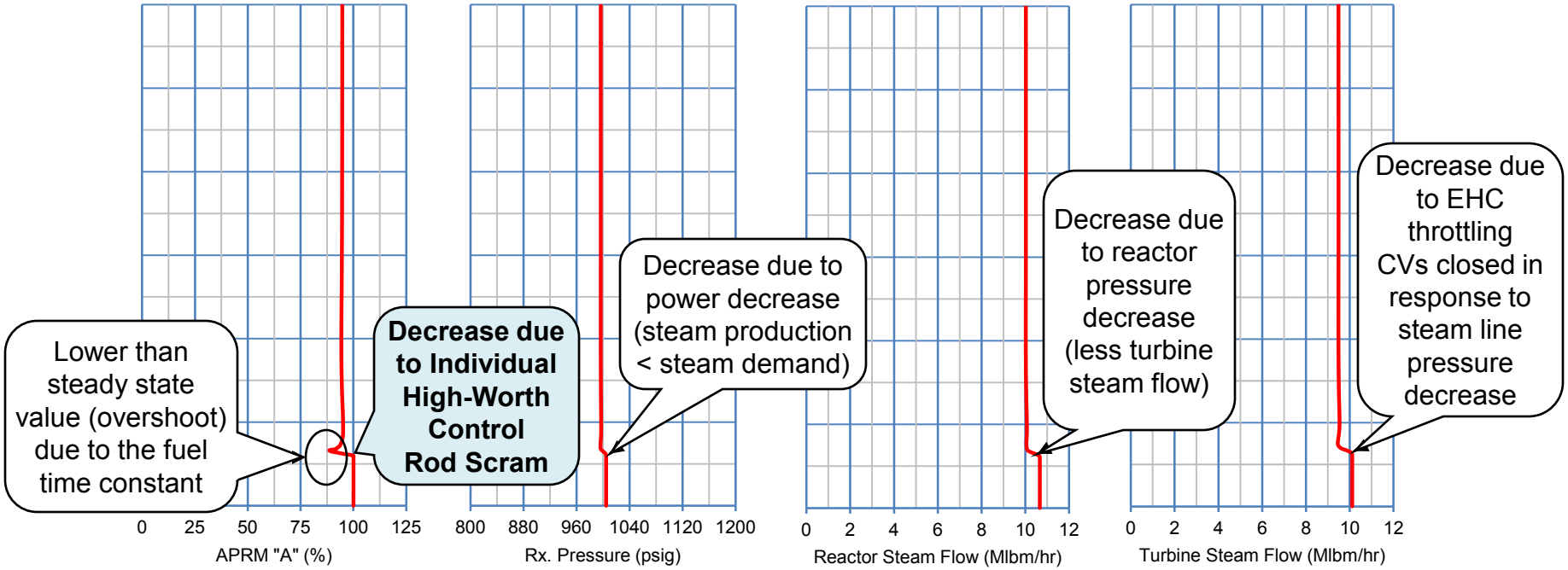
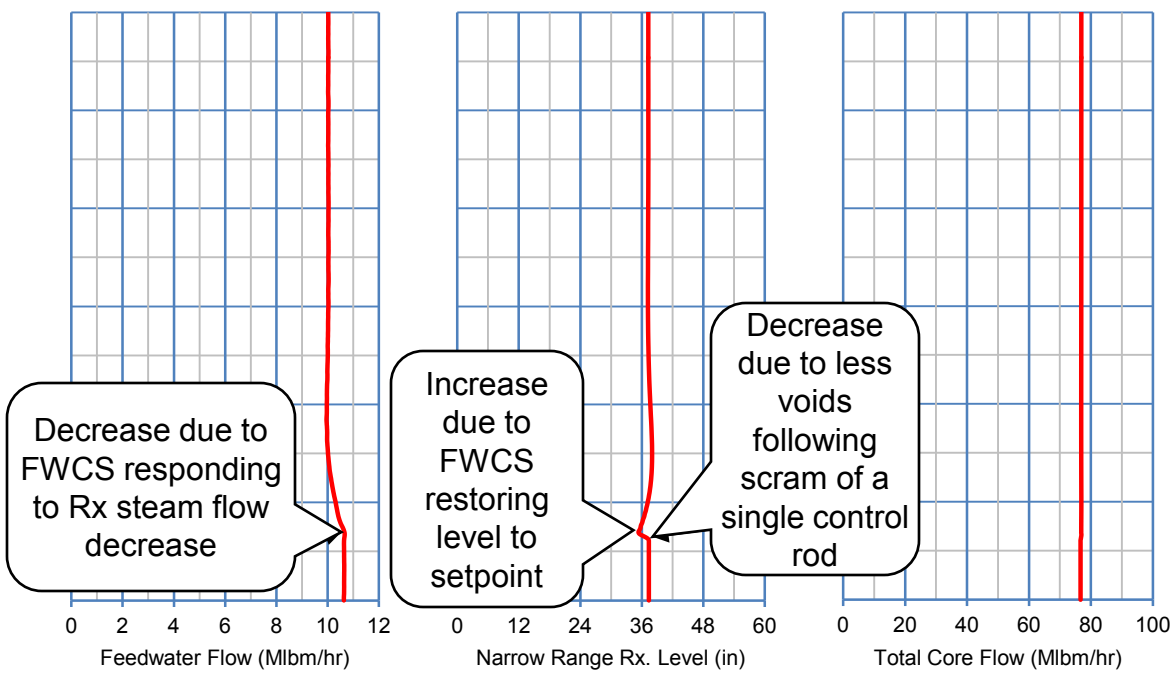


Transient #1

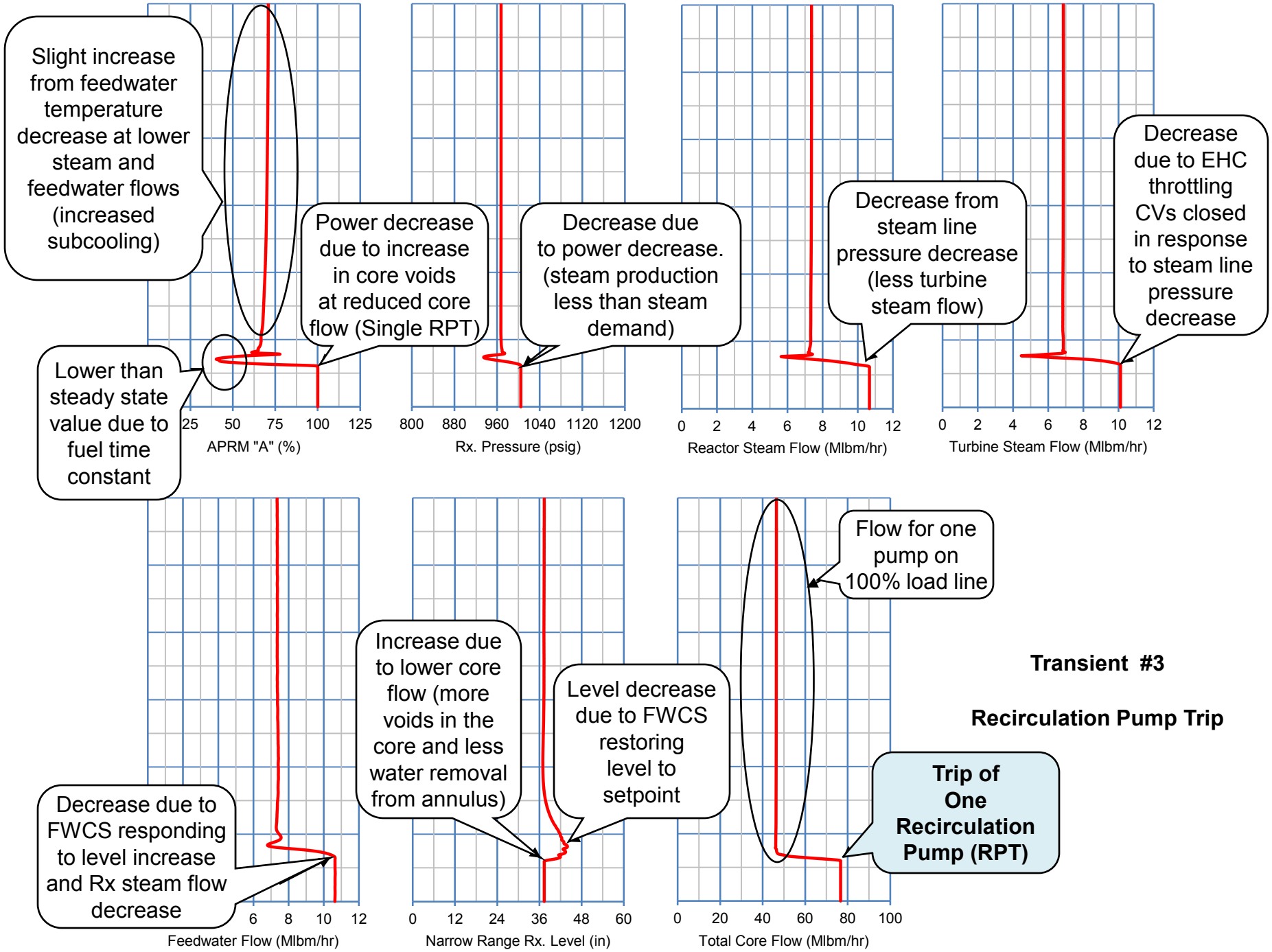
Manual Power Change





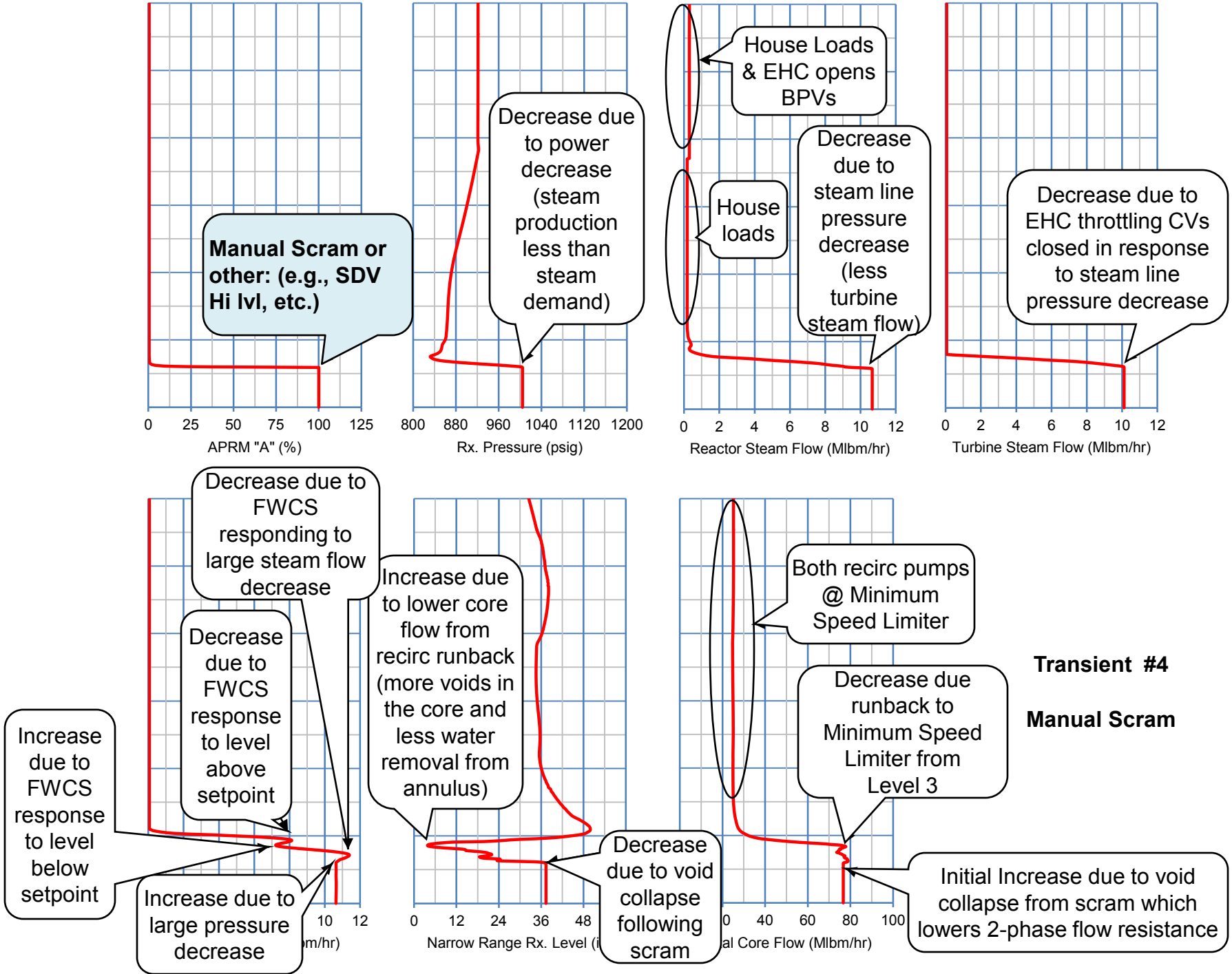
Transient #2

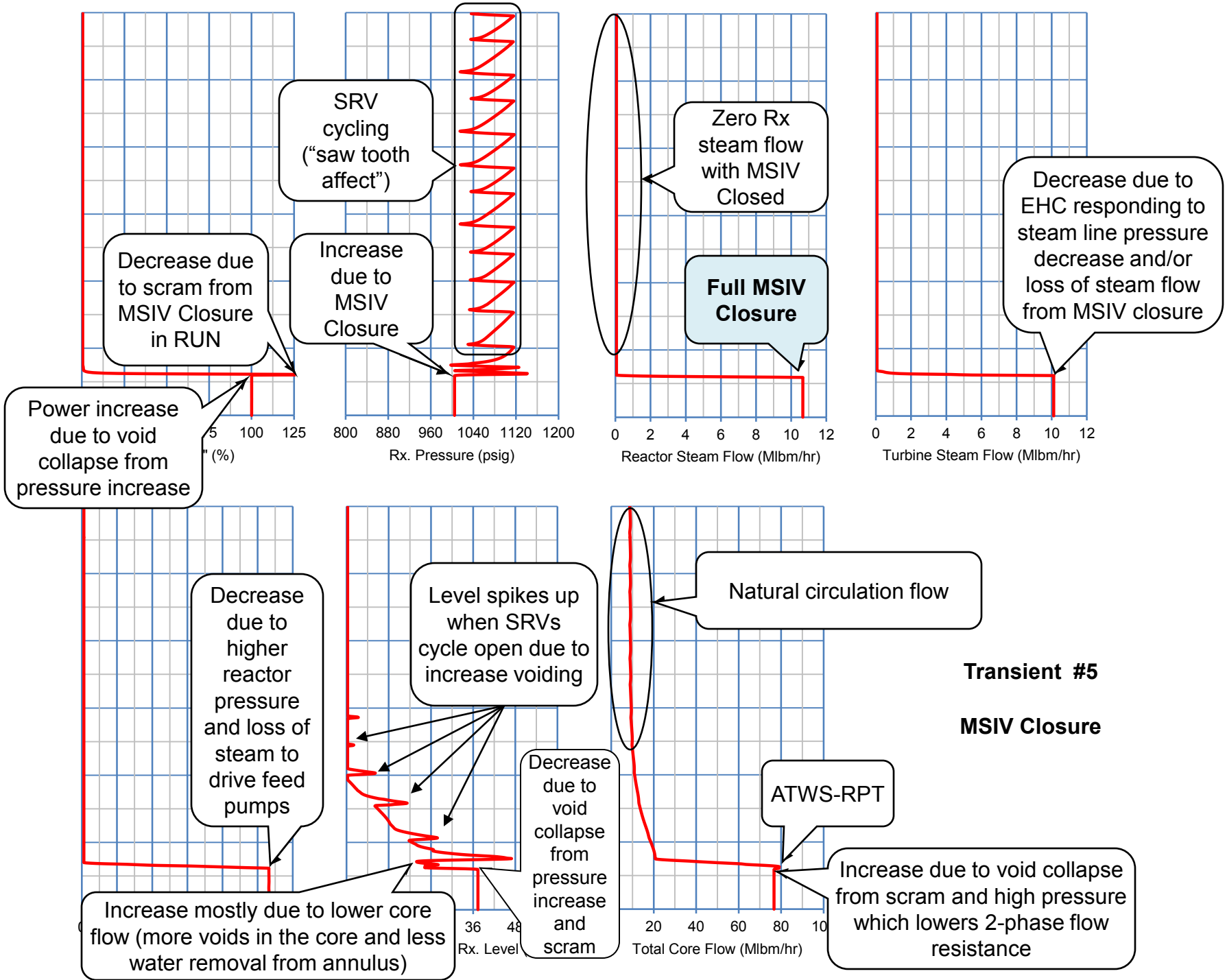
Individual High-Worth Control Rod Scram

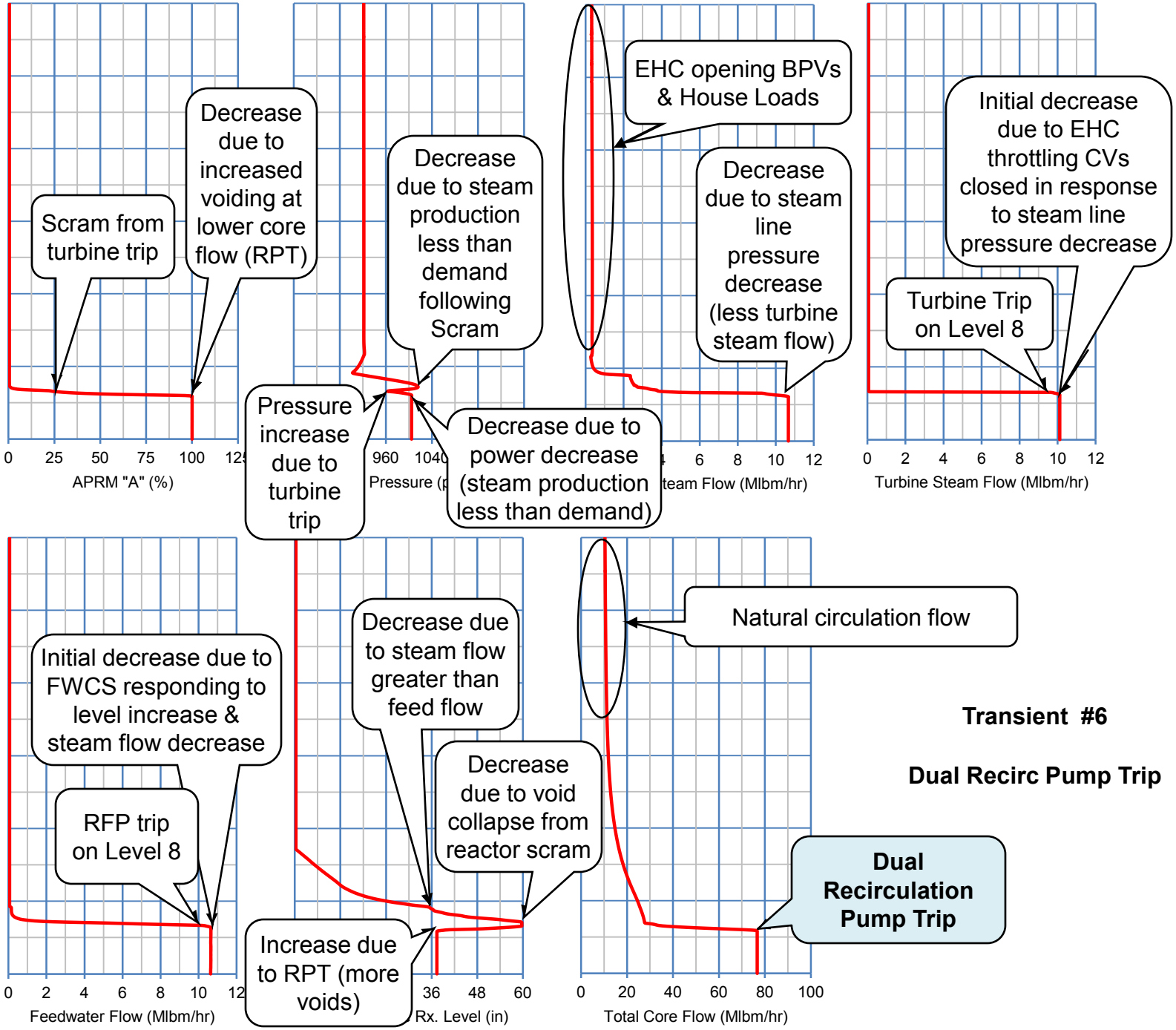


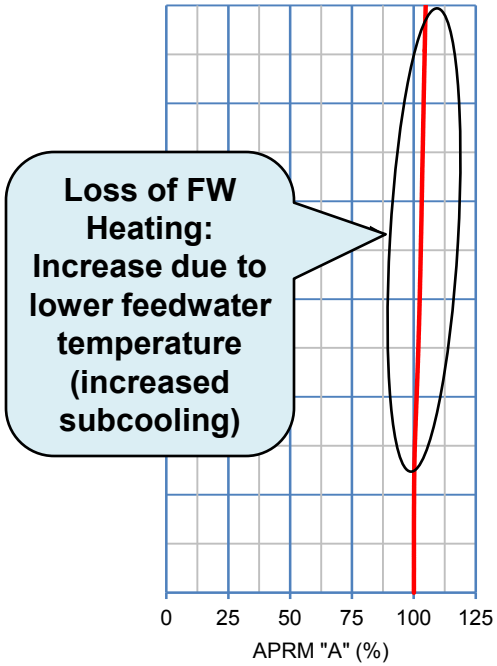
Transient #3

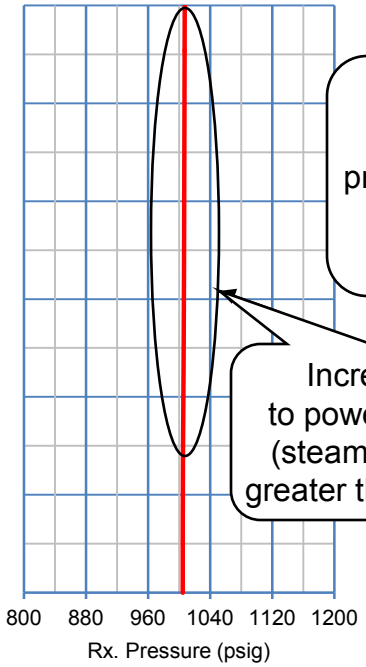
Recirculation Pump Trip

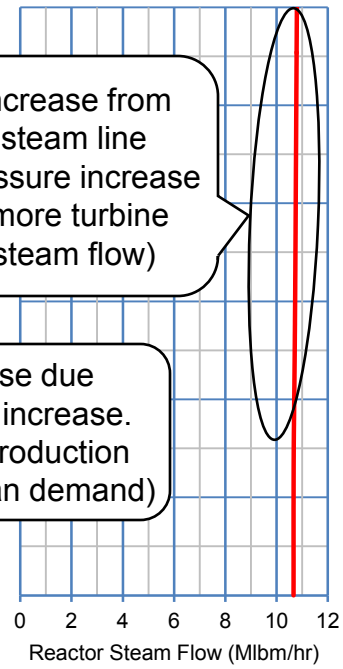

Manual Scram or other: (e.g., SDV Hi lvl, etc.)
0 25 50 75 100 125
APRM "A" (%)
Decrease due to power decrease (steam production less than steam demand)
800 880 960 1040 1120 1200
Rx. Pressure (psig)
House Loads & EHC opens BPVs
House loads
Decrease due to steam line pressure decrease (less turbine steam flow)
0 2 4 6 8 10 12
Reactor Steam Flow (Mlbm/hr)
Decrease due to EHC throttling CVs closed in response to steam line pressure decrease
0 2 4 6 8 10 12
Turbine Steam Flow (Mlbm/hr)
Decrease due to FWCS responding to large steam flow decrease
Decrease due to FWCS response to level above setpoint
Increase due to FWCS response to level below setpoint
Increase due to large pressure decrease
10 12
m/hr)
Increase due to lower core flow from recirc runback (more voids in the core and less water removal from annulus)
0 12 24 36 48
Narrow Range Rx. Level (i
Decrease due to void collapse following scram
Both recirc pumps @ Minimum Speed Limiter
Decrease due runback to Minimum Speed Limiter from Level 3
0 40 60 80 100
al Core Flow (Mlbm/hr)
Initial Increase due to void collapse from scram which lowers 2-phase flow resistance
Transient #4
Manual Scram

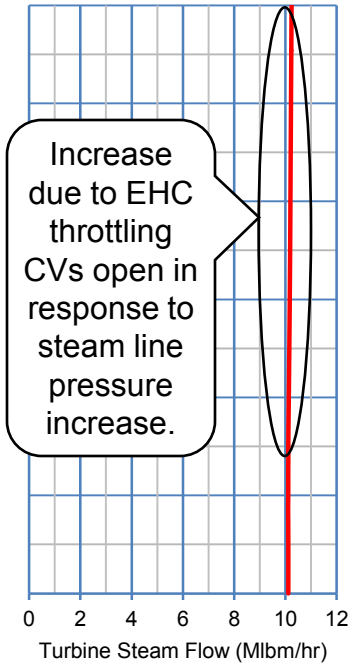

SRV cycling ("saw tooth affect")
Zero Rx steam flow with MSIV Closed
Decrease due to EHC responding to steam line pressure decrease and/or loss of steam flow from MSIV closure
Decrease due to scram from MSIV Closure in RUN
Increase due to MSIV Closure
Full MSIV Closure
Power increase due to void collapse from pressure increase
100 125
" (%)
800 880 960 1040 1120 1200
Rx. Pressure (psig)
0 2 4 6 8 10 12
Reactor Steam Flow (Mlbm/hr)
0 2 4 6 8 10 12
Turbine Steam Flow (Mlbm/hr)
Decrease due to higher reactor pressure and loss of steam to drive feed pumps
Level spikes up when SRVs cycle open due to increase voiding
Natural circulation flow
Transient #5
MSIV Closure
Decrease due to void collapse from pressure increase and scram
ATWS-RPT
Increase due to void collapse from scram and high pressure which lowers 2-phase flow resistance
Increase mostly due to lower core flow (more voids in the core and less water removal from annulus)
36 48
Rx. Level
20 40 60 80 10
Total Core Flow (Mlbm/hr)

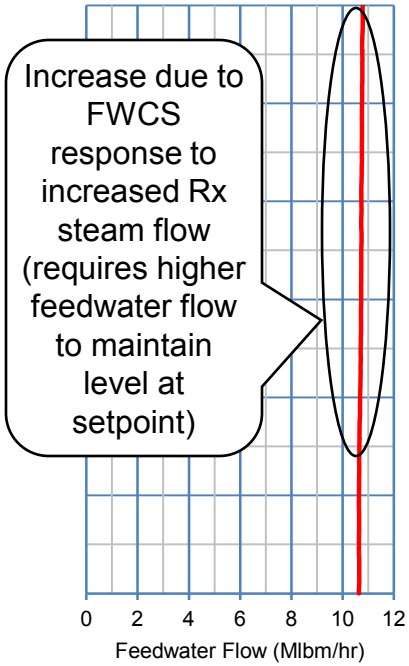

Scram from turbine trip
Decrease due to increased voiding at lower core flow (RPT)
0 25 50 75 100 125
APRM "A" (%)
Decrease due to steam production less than demand following Scram
Pressure increase due to turbine trip
Decrease due to power decrease (steam production less than demand)
960 1040
Pressure (p
EHC opening BPVs & House Loads
Decrease due to steam line pressure decrease (less turbine steam flow)
4 6 8 10 12
team Flow (Mlbm/hr)
Initial decrease due to EHC throttling CVs closed in response to steam line pressure decrease
Turbine Trip on Level 8
0 2 4 6 8 10 12
Turbine Steam Flow (Mlbm/hr)
Initial decrease due to FWCS responding to level increase & steam flow decrease
RFP trip on Level 8
0 2 4 6 8 10 12
Feedwater Flow (Mlbm/hr)
Decrease due to steam flow greater than feed flow
Decrease due to void collapse from reactor scram
Increase due to RPT (more voids)
36 48 60
Rx. Level (in)
Natural circulation flow
Dual Recirculation Pump Trip
0 20 40 60 80 100
Total Core Flow (Mlbm/hr)
Transient #6
Dual Recirc Pump Trip

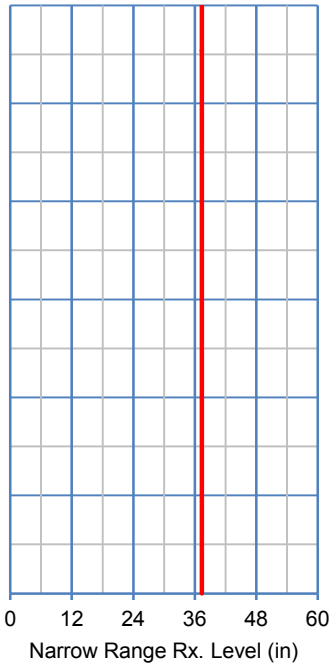


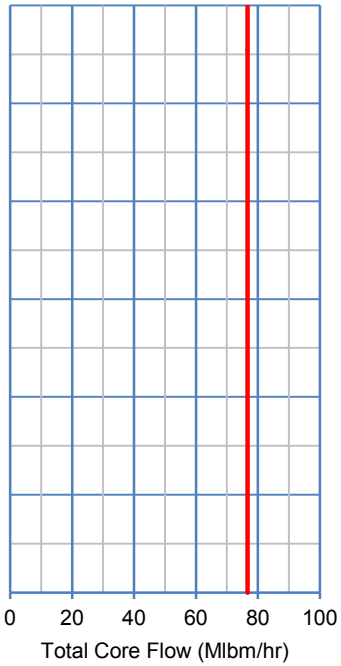






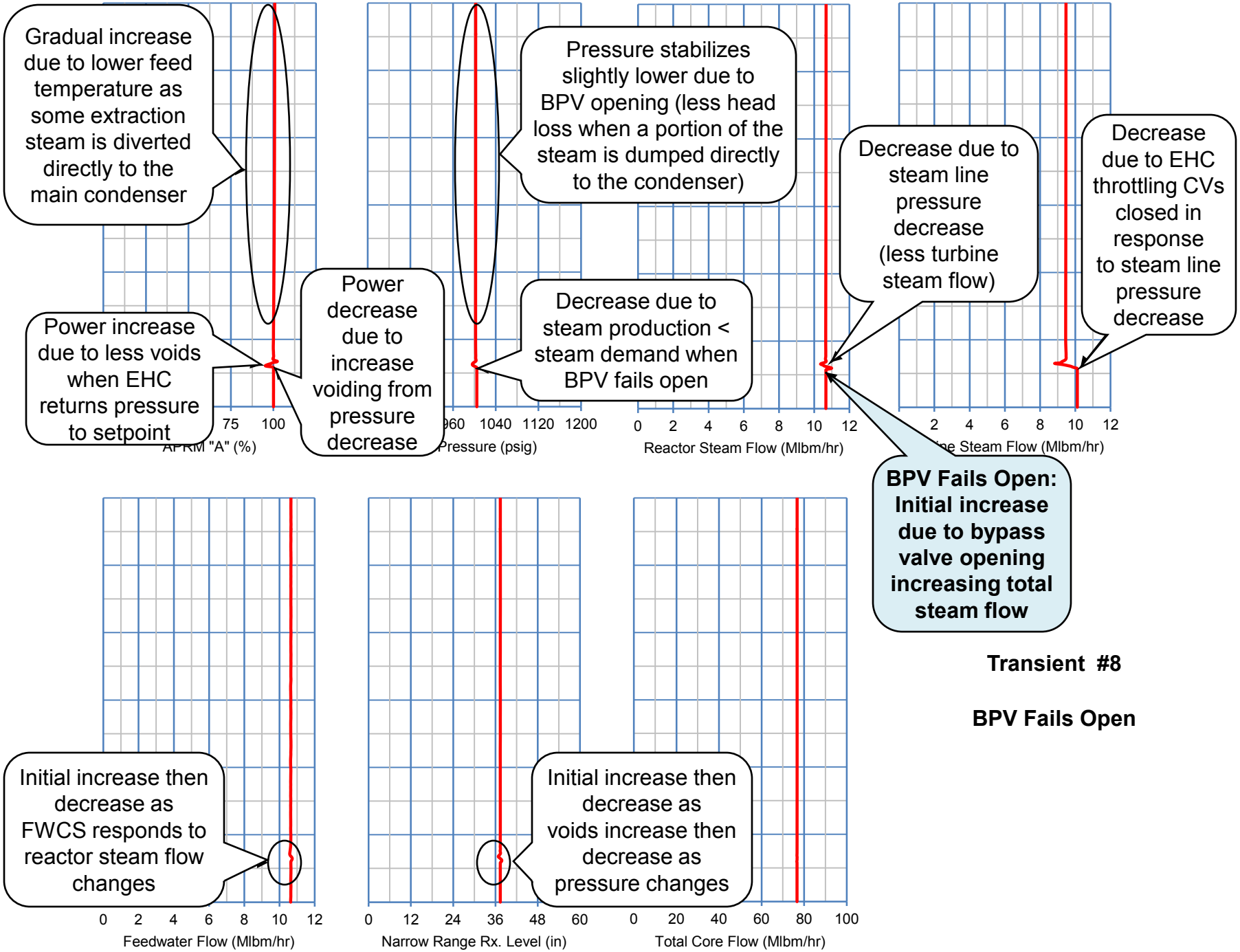


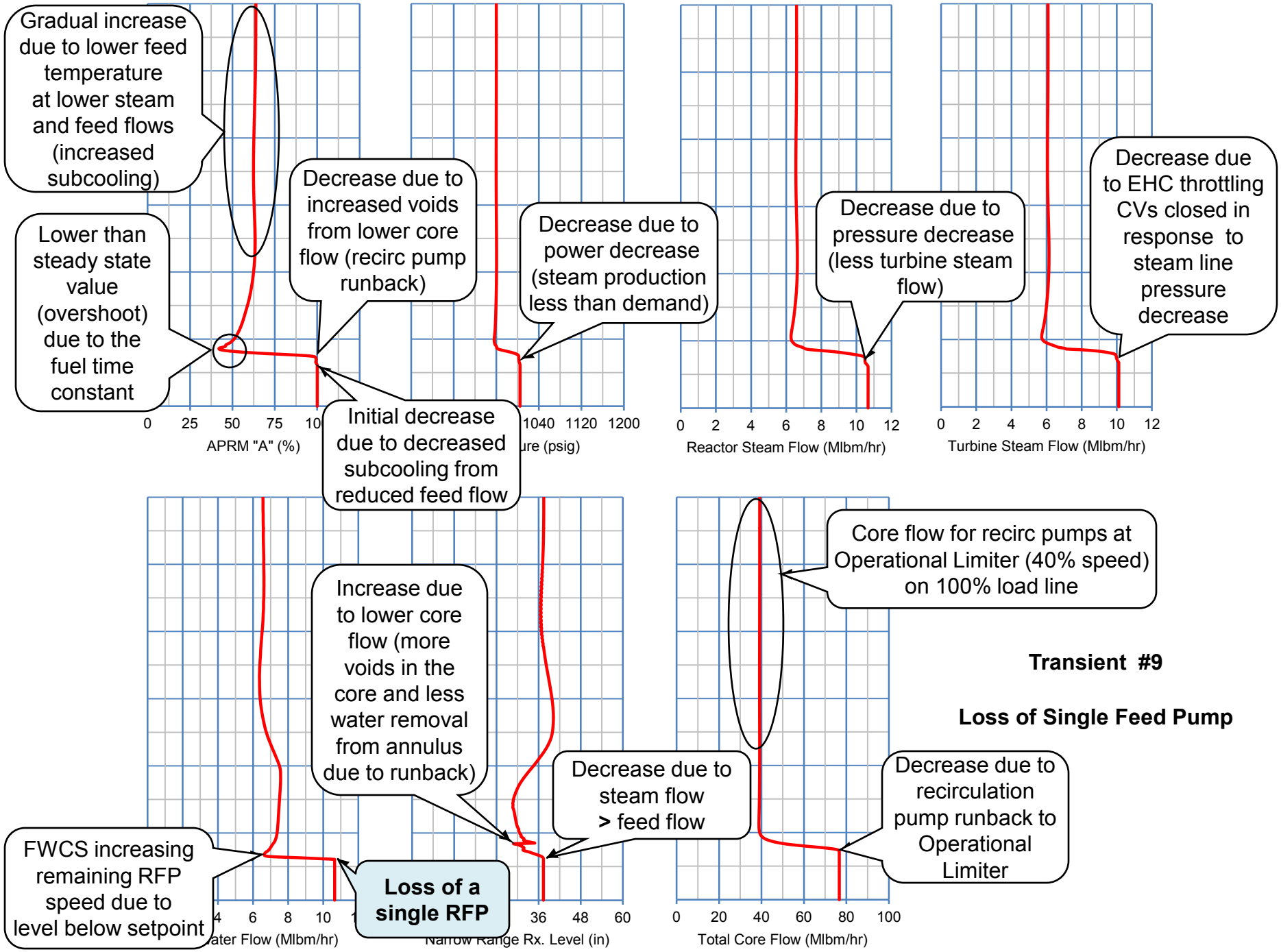


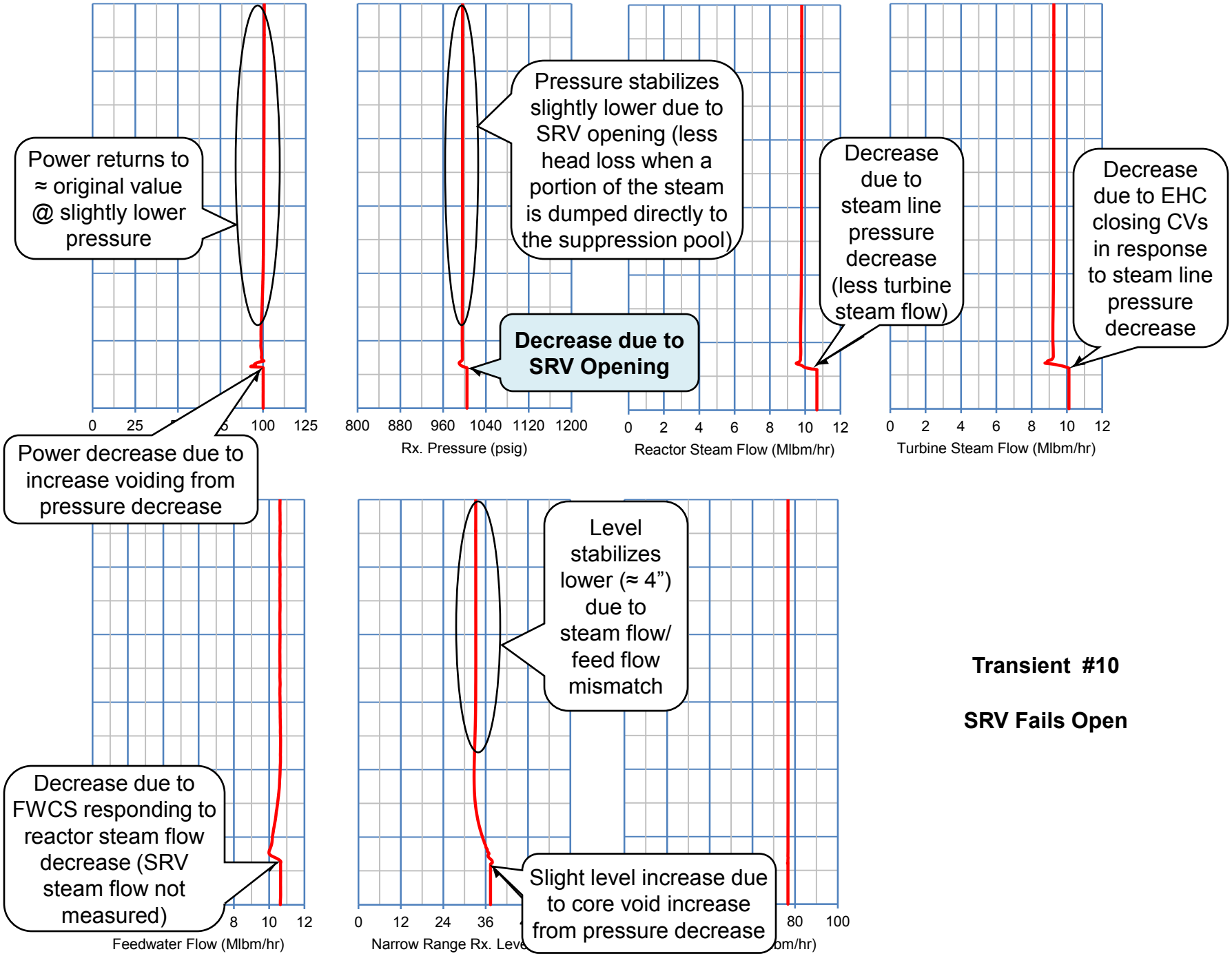


Transient #7

Loss of Feedwater Heating

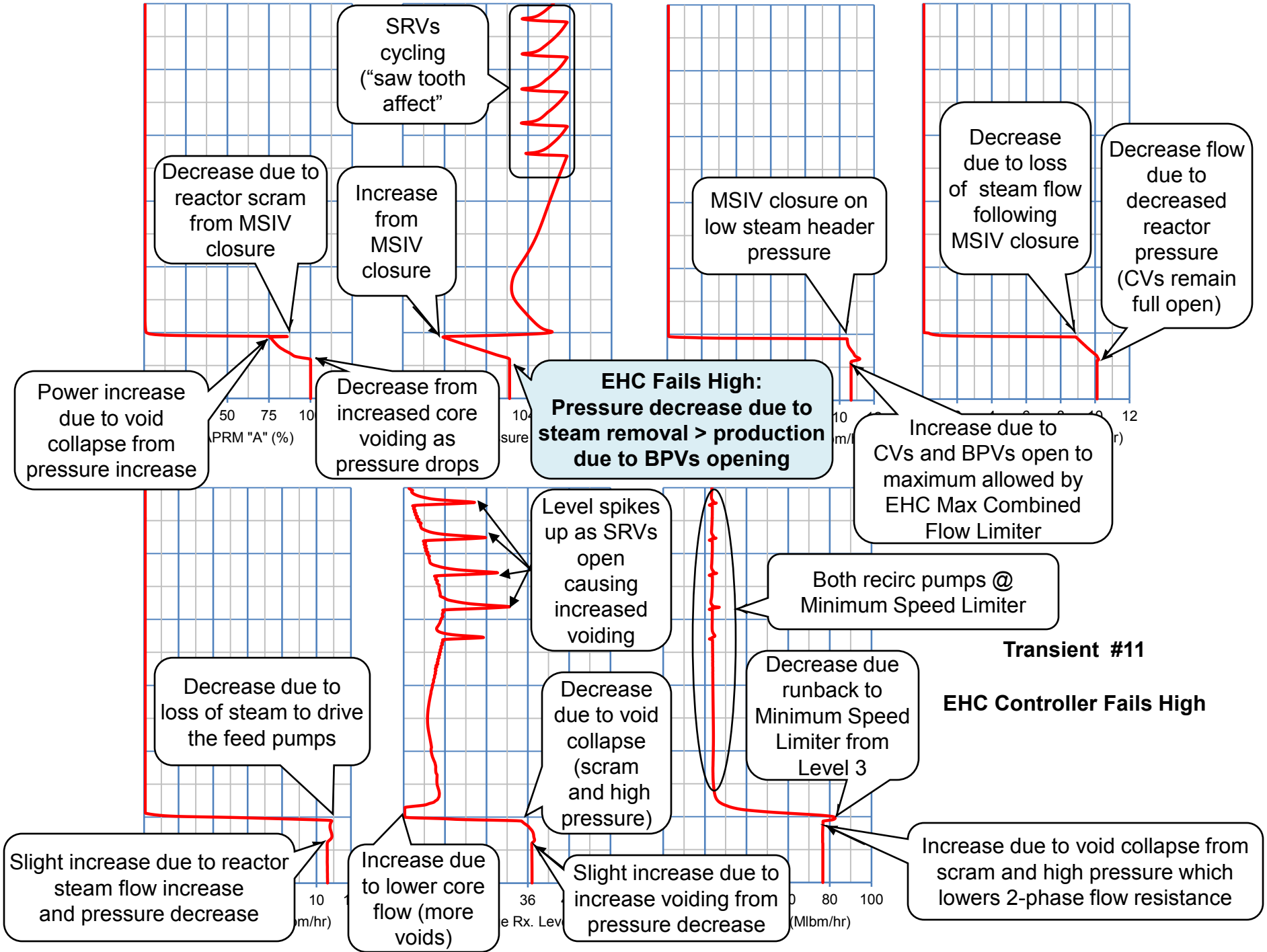

Gradual increase due to lower feed temperature as some extraction steam is diverted directly to the main condenser
Pressure stabilizes slightly lower due to BPV opening (less head loss when a portion of the steam is dumped directly to the condenser)
Decrease due to steam line pressure decrease (less turbine steam flow)
Decrease due to EHC throttling CVs closed in response to steam line pressure decrease
Power increase due to less voids when EHC returns pressure to setpoint
Power decrease due to increase voiding from pressure decrease
Decrease due to steam production < steam demand when BPV fails open
BPV Fails Open: Initial increase due to bypass valve opening increasing total steam flow
Transient #8
BPV Fails Open
Initial increase then decrease as FWCS responds to reactor steam flow changes
Initial increase then decrease as voids increase then decrease as pressure changes
75 100
APRM "A" (%)
960 1040 1120 1200
Pressure (psig)
0 2 4 6 8 10 12
Reactor Steam Flow (Mlbm/hr)
2 4 6 8 10 12
Steam Flow (Mlbm/hr)
0 2 4 6 8 10 12
Feedwater Flow (Mlbm/hr)
0 12 24 36 48 60
Narrow Range Rx. Level (in)
0 20 40 60 80 100
Total Core Flow (Mlbm/hr)

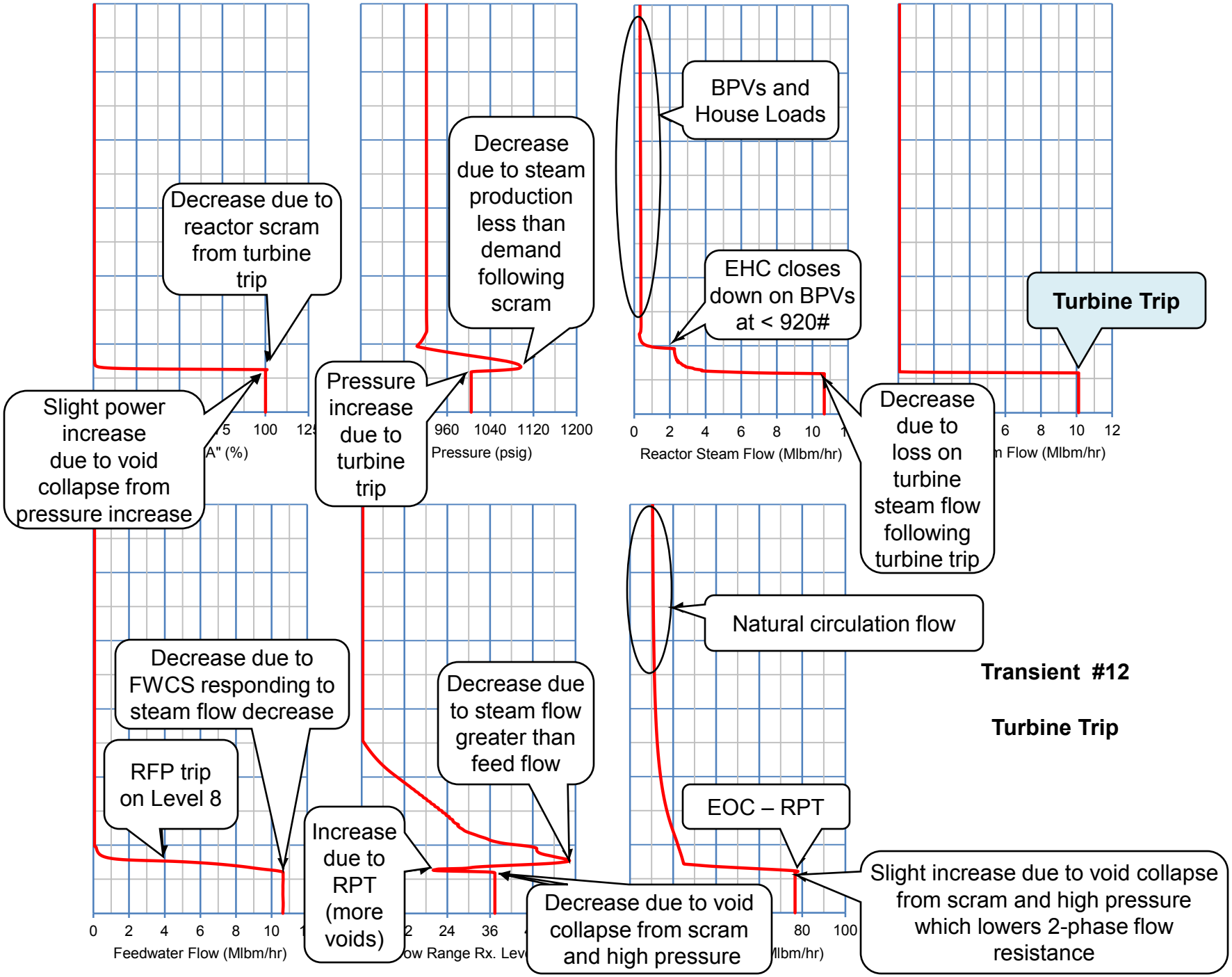

Gradual increase due to lower feed temperature at lower steam and feed flows (increased subcooling)
Lower than steady state value (overshoot) due to the fuel time constant
Decrease due to increased voids from lower core flow (recirc pump runback)
Initial decrease due to decreased subcooling from reduced feed flow
Decrease due to power decrease (steam production less than demand)
Decrease due to pressure decrease (less turbine steam flow)
Decrease due to EHC throttling CVs closed in response to steam line pressure decrease
0 25 50 75 10
APRM "A" (%)
1040 1120 1200
ure (psig)
0 2 4 6 8 10 12
Reactor Steam Flow (Mlbm/hr)
0 2 4 6 8 10 12
Turbine Steam Flow (Mlbm/hr)
Core flow for recirc pumps at Operational Limiter (40% speed) on 100% load line
Increase due to lower core flow (more voids in the core and less water removal from annulus due to runback)
Transient #9
Loss of Single Feed Pump
Decrease due to steam flow > feed flow
Decrease due to recirculation pump runback to Operational Limiter
FWCS increasing remaining RFP speed due to level below setpoint
Loss of a single RFP
4 6 8 10
ater Flow (Mlbm/hr)
36 48 60
Narrow Range Rx. Level (in)
0 20 40 60 80 100
Total Core Flow (Mlbm/hr)

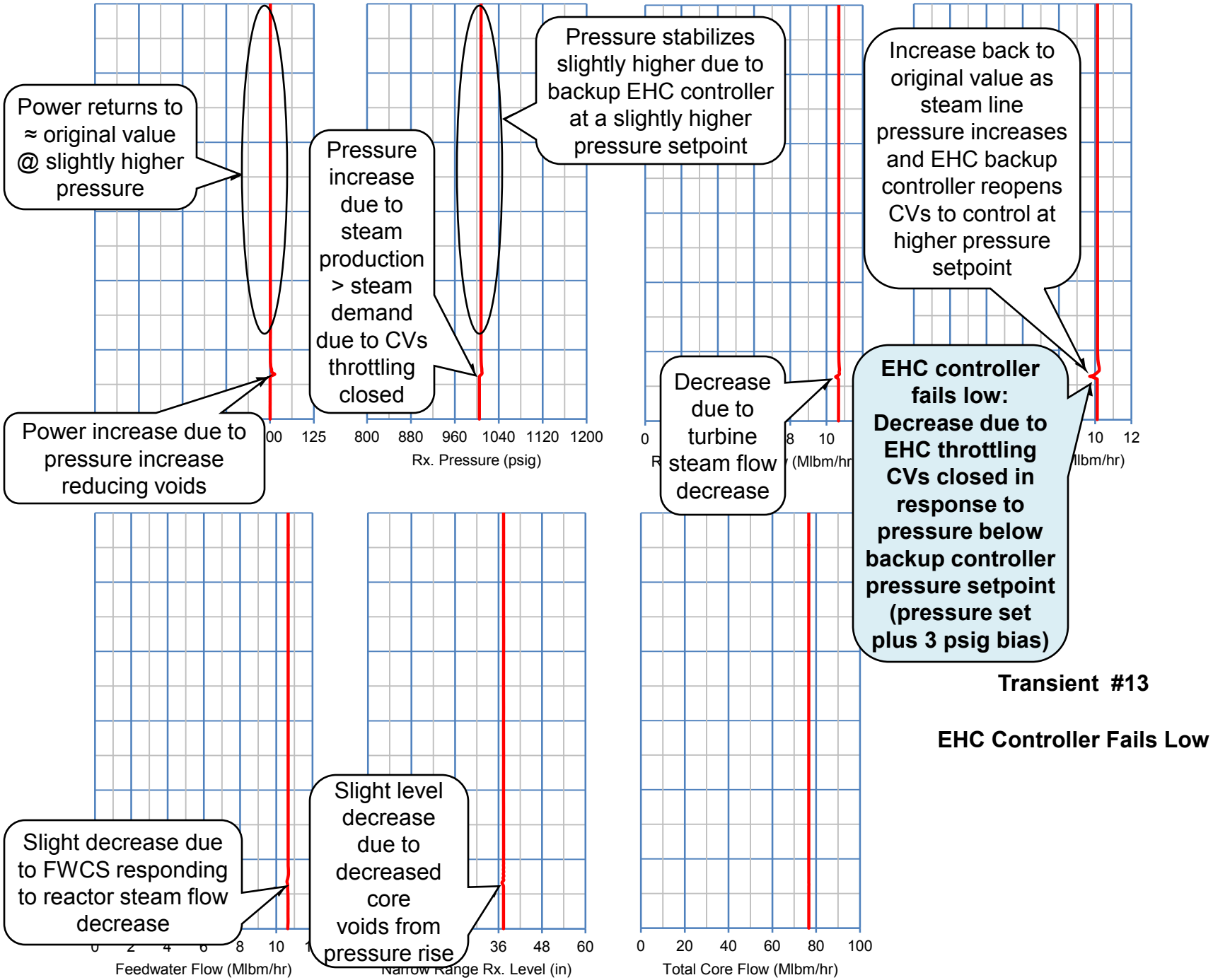


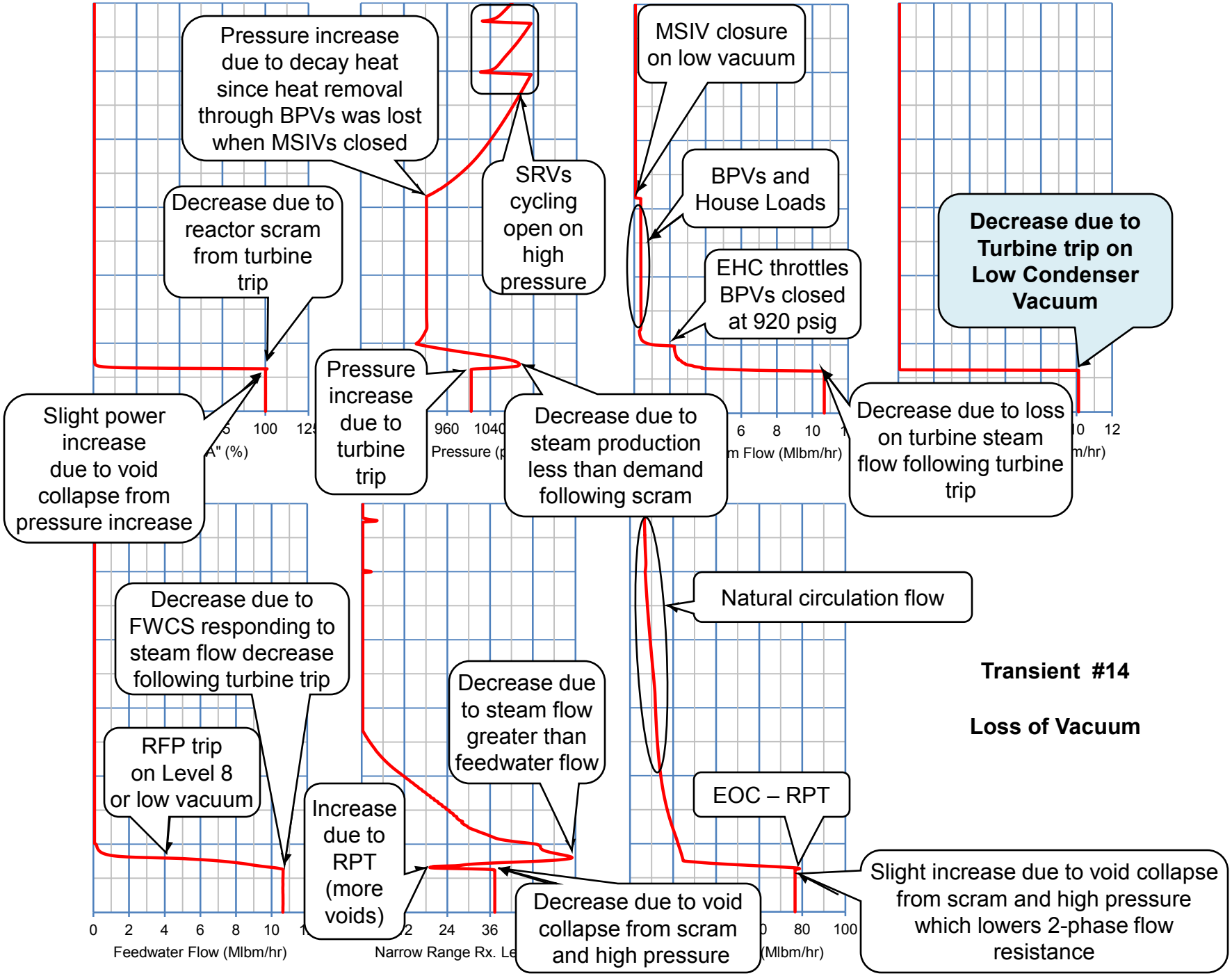
Transient #10

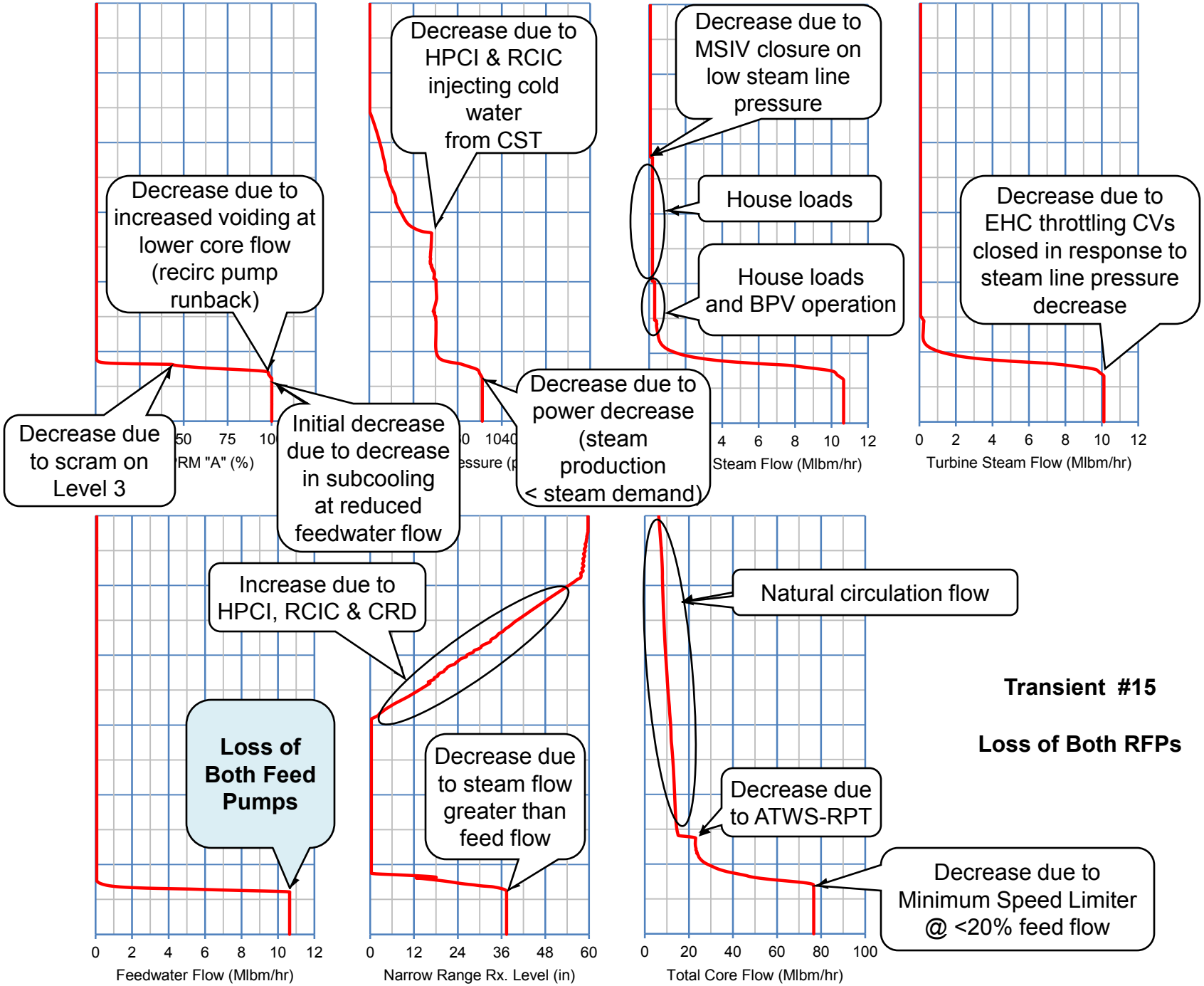
SRV Fails Open

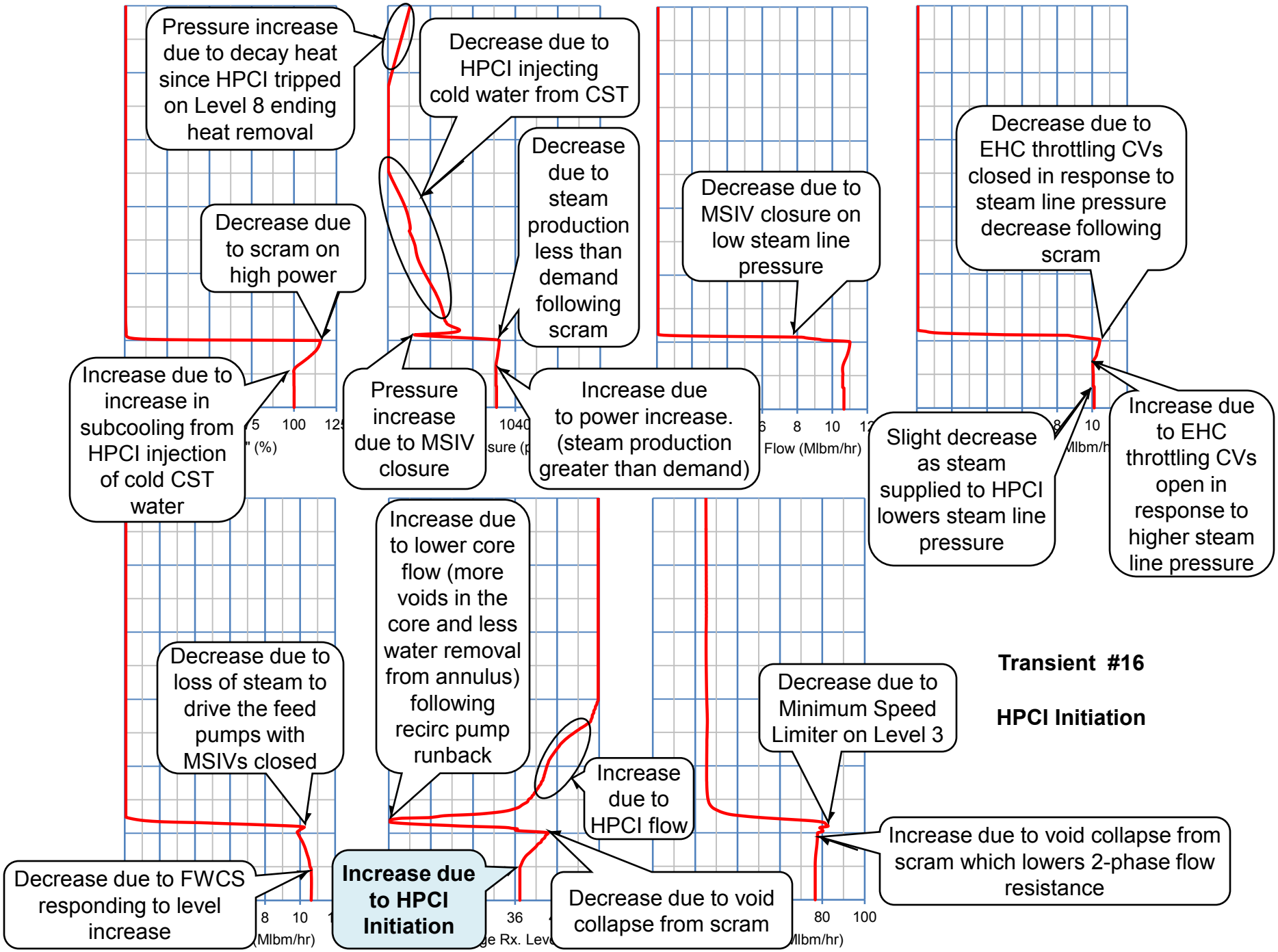

SRVs cycling ("saw tooth affect"
Decrease due to reactor scram from MSIV closure
Increase from MSIV closure
MSIV closure on low steam header pressure
Decrease due to loss of steam flow following MSIV closure
Decrease flow due to decreased reactor pressure (CVs remain full open)
Power increase due to void collapse from pressure increase
Decrease from increased core voiding as pressure drops
EHC Fails High: Pressure decrease due to steam removal > production due to BPVs opening
Increase due to CVs and BPVs open to maximum allowed by EHC Max Combined Flow Limiter
Level spikes up as SRVs open causing increased voiding
Both recirc pumps @ Minimum Speed Limiter
Transient #11
EHC Controller Fails High
Decrease due to loss of steam to drive the feed pumps
Decrease due to void collapse (scram and high pressure)
Decrease due runback to Minimum Speed Limiter from Level 3
Slight increase due to reactor steam flow increase and pressure decrease
Increase due to lower core flow (more voids)
Slight increase due to increase voiding from pressure decrease
Increase due to void collapse from scram and high pressure which lowers 2-phase flow resistance
50
75
10
APRM "A" (%)
10
36
e Rx. Lev
80
100
(Mlbm/hr)
12

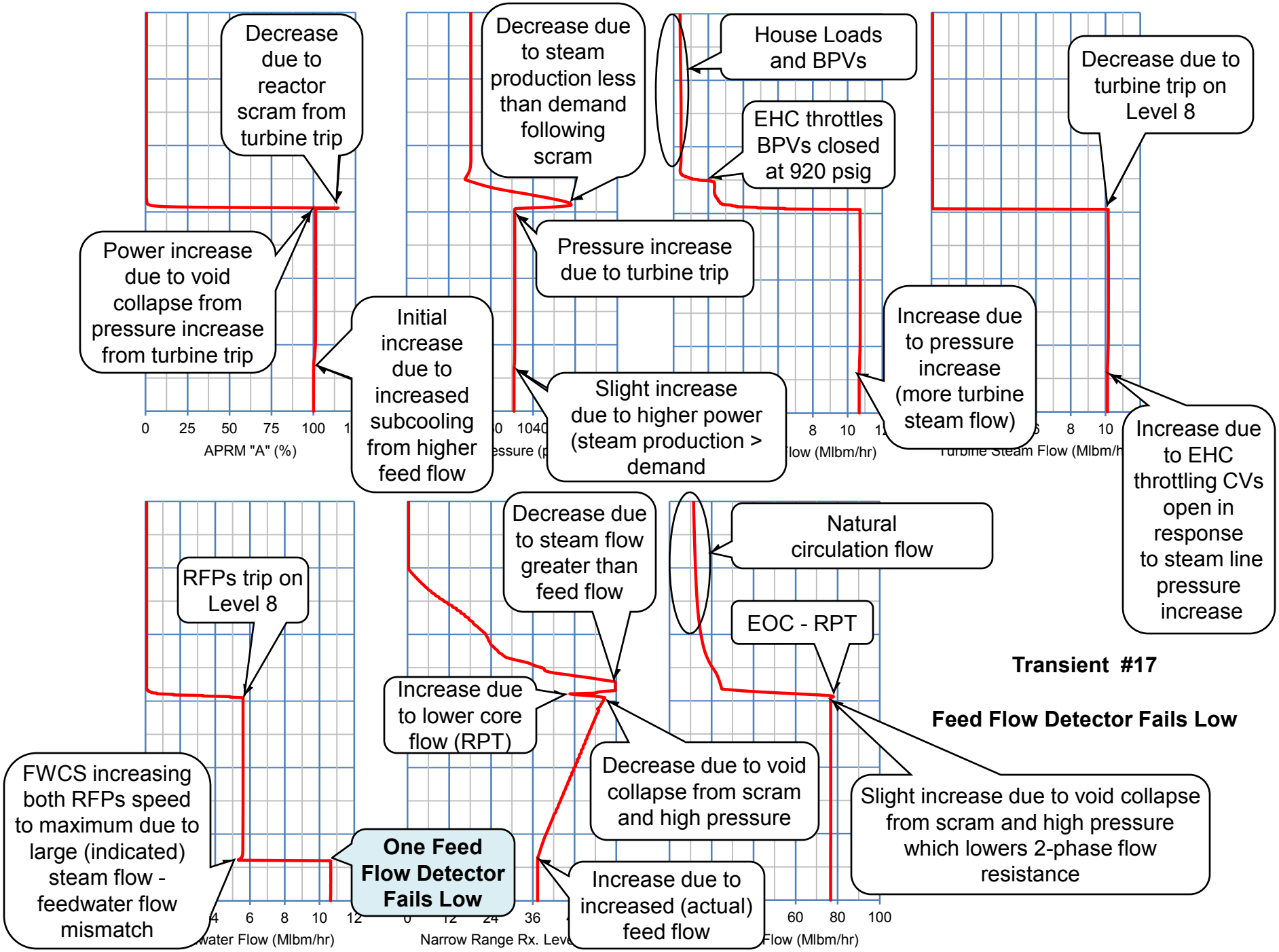

Decrease due to reactor scram from turbine trip
Slight power increase due to void collapse from pressure increase
Decrease due to steam production less than demand following scram
Pressure increase due to turbine trip
BPVs and House Loads
EHC closes down on BPVs at < 920#
Decrease due to loss on turbine steam flow following turbine trip
Turbine Trip
Natural circulation flow
Decrease due to FWCS responding to steam flow decrease
RFP trip on Level 8
Decrease due to steam flow greater than feed flow
Increase due to RPT (more voids)
Decrease due to void collapse from scram and high pressure
EOC – RPT
Slight increase due to void collapse from scram and high pressure which lowers 2-phase flow resistance
Transient #12
Turbine Trip
Pressure (psig)
Reactor Steam Flow (Mlbm/hr)
Feedwater Flow (Mlbm/hr)

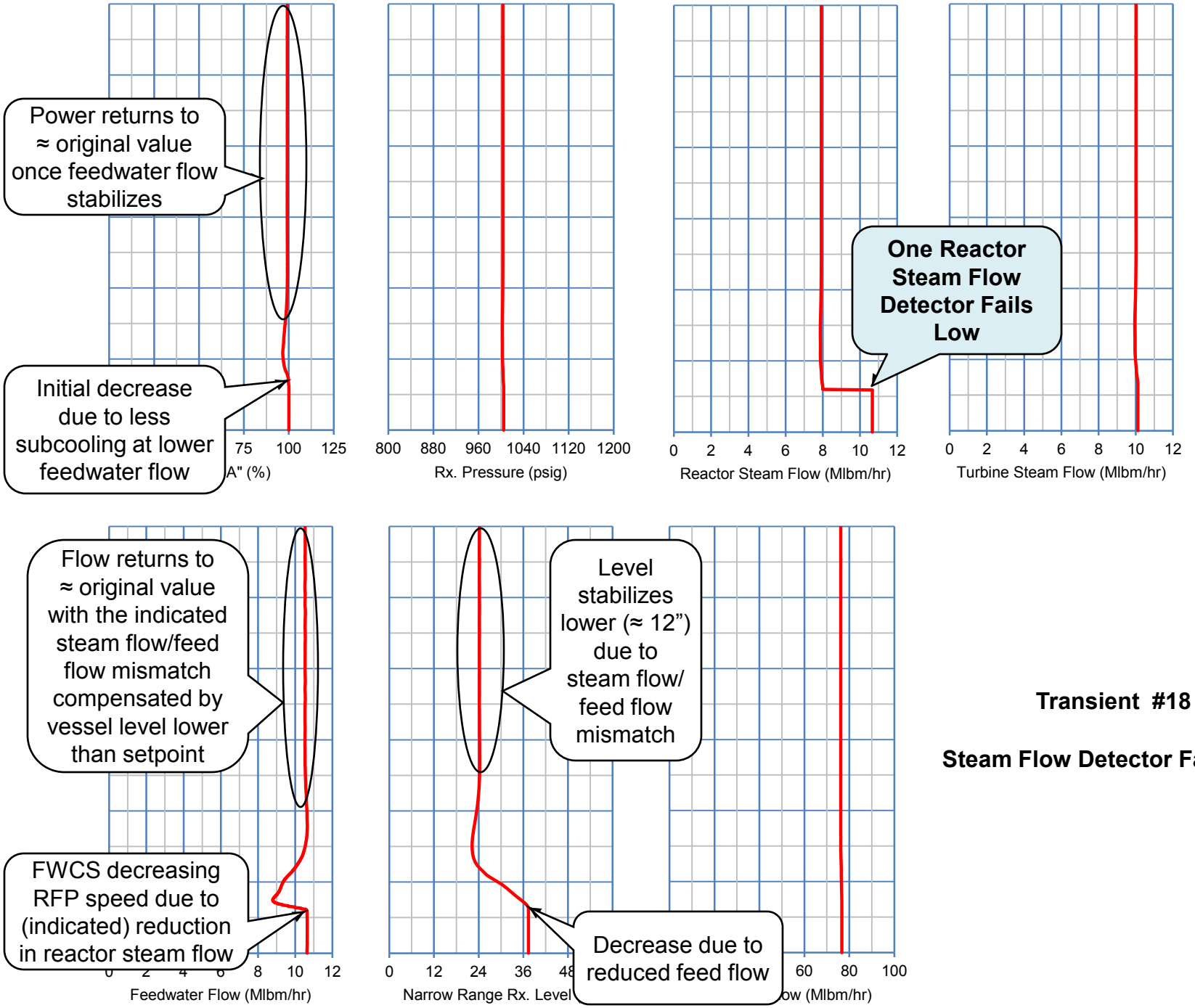

Power returns to ≈ original value @ slightly higher pressure
Pressure increase due to steam production > steam demand due to CVs throttling closed
Pressure stabilizes slightly higher due to backup EHC controller at a slightly higher pressure setpoint
Increase back to original value as steam line pressure increases and EHC backup controller reopens CVs to control at higher pressure setpoint
Power increase due to pressure increase reducing voids
Decrease due to turbine steam flow decrease
EHC controller fails low: Decrease due to EHC throttling CVs closed in response to pressure below backup controller pressure setpoint (pressure set plus 3 psig bias)
Transient #13
EHC Controller Fails Low
Slight decrease due to FWCS responding to reactor steam flow decrease
Slight level decrease due to decreased core voids from pressure rise
125
800 880 960 1040 1120 1200
Rx. Pressure (psig)
0
8 10
(Mlbm/hr
10 12
Mlbm/hr)
8 10
Feedwater Flow (Mlbm/hr)
36 48 60
Narrow Range Rx. Level (in)
0 20 40 60 80 100
Total Core Flow (Mlbm/hr)


Pressure increase due to decay heat since heat removal through BPVs was lost when MSIVs closed
MSIV closure on low vacuum
SRVs cycling open on high pressure
BPVs and House Loads
Decrease due to reactor scram from turbine trip
EHC throttles BPVs closed at 920 psig
Decrease due to Turbine trip on Low Condenser Vacuum
Pressure increase due to turbine trip
Slight power increase due to void collapse from pressure increase
Decrease due to steam production less than demand following scram
Decrease due to loss on turbine steam flow following turbine trip
Natural circulation flow
Decrease due to FWCS responding to steam flow decrease following turbine trip
Transient #14
Loss of Vacuum
Decrease due to steam flow greater than feedwater flow
RFP trip on Level 8 or low vacuum
EOC – RPT
Increase due to RPT (more voids)
Decrease due to void collapse from scram and high pressure
Slight increase due to void collapse from scram and high pressure which lowers 2-phase flow resistance
Feedwater Flow (Mlbm/hr)
Narrow Range Rx. Le
Pressure (p
m Flow (Mlbm/hr)
m/hr)
(Mlbm/hr)


Decrease due to increased voiding at lower core flow (recirc pump runback)
Decrease due to scram on Level 3
Initial decrease due to decrease in subcooling at reduced feedwater flow
Decrease due to HPCI & RCIC injecting cold water from CST
Decrease due to power decrease (steam production < steam demand)
Decrease due to MSIV closure on low steam line pressure
House loads
House loads and BPV operation
Decrease due to EHC throttling CVs closed in response to steam line pressure decrease
Steam Flow (Mlbm/hr)
Turbine Steam Flow (Mlbm/hr)
Increase due to HPCI, RCIC & CRD
Loss of Both Feed Pumps
Decrease due to steam flow greater than feed flow
Natural circulation flow
Decrease due to ATWS-RPT
Decrease due to Minimum Speed Limiter @ <20% feed flow
Transient #15
Loss of Both RFPs
Feedwater Flow (Mlbm/hr)
Narrow Range Rx. Level (in)
Total Core Flow (Mlbm/hr)


Pressure increase due to decay heat since HPCI tripped on Level 8 ending heat removal
Decrease due to HPCI injecting cold water from CST
Decrease due to steam production less than demand following scram
Decrease due to MSIV closure on low steam line pressure
Decrease due to EHC throttling CVs closed in response to steam line pressure decrease following scram
Decrease due to scram on high power
Increase due to increase in subcooling from HPCI injection of cold CST water
Pressure increase due to MSIV closure
Increase due to power increase. (steam production greater than demand)
Slight decrease as steam supplied to HPCI lowers steam line pressure
Increase due to EHC throttling CVs open in response to higher steam line pressure
Increase due to lower core flow (more voids in the core and less water removal from annulus) following recirc pump runback
Decrease due to loss of steam to drive the feed pumps with MSIVs closed
Decrease due to Minimum Speed Limiter on Level 3
Increase due to HPCI flow
Increase due to void collapse from scram which lowers 2-phase flow resistance
Decrease due to FWCS responding to level increase
Increase due to HPCI Initiation
Decrease due to void collapse from scram
Transient #16
HPCI Initiation
Flow (Mlbm/hr)
(%)
(Mlbm/hr)


Decrease due to reactor scram from turbine trip
Power increase due to void collapse from pressure increase from turbine trip
Initial increase due to increased subcooling from higher feed flow
0 25 50 75 100
APRM "A" (%)
Decrease due to steam production less than demand following scram
Pressure increase due to turbine trip
Slight increase due to higher power (steam production > demand
House Loads and BPVs
EHC throttles BPVs closed at 920 psig
Increase due to pressure increase (more turbine steam flow)
8 10
Decrease due to turbine trip on Level 8
Increase due to EHC throttling CVs open in response to steam line pressure increase
RFPs trip on Level 8
FWCS increasing both RFPs speed to maximum due to large (indicated) steam flow - feedwater flow mismatch
One Feed Flow Detector Fails Low
6 8 10 12
Decrease due to steam flow greater than feed flow
Increase due to lower core flow (RPT)
Decrease due to void collapse from scram and high pressure
Increase due to increased (actual) feed flow
36
Natural circulation flow
EOC - RPT
Slight increase due to void collapse from scram and high pressure which lowers 2-phase flow resistance
60 80 100
Transient #17
Feed Flow Detector Fails Low



Transient #18

Steam Flow Detector Fails Low