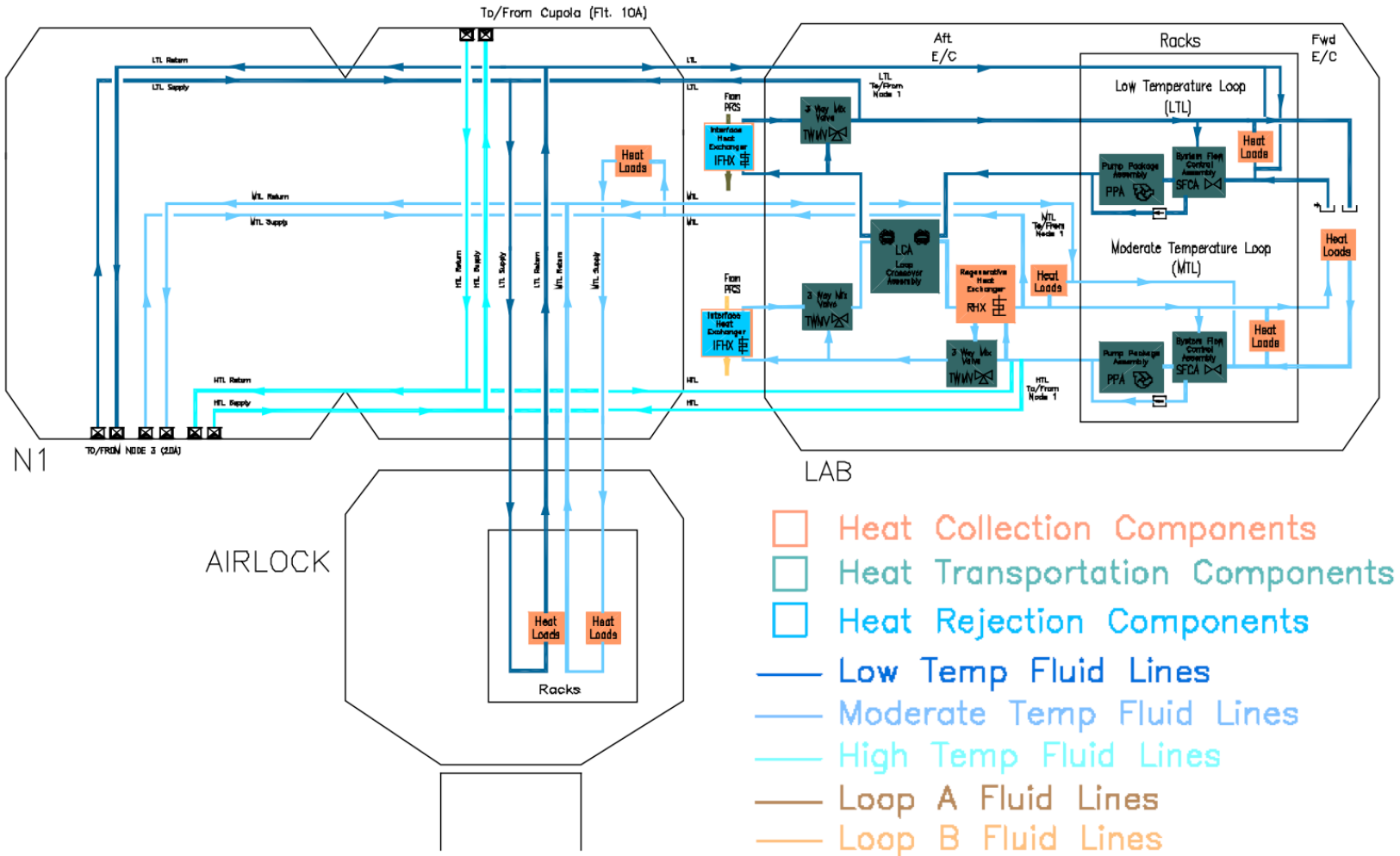
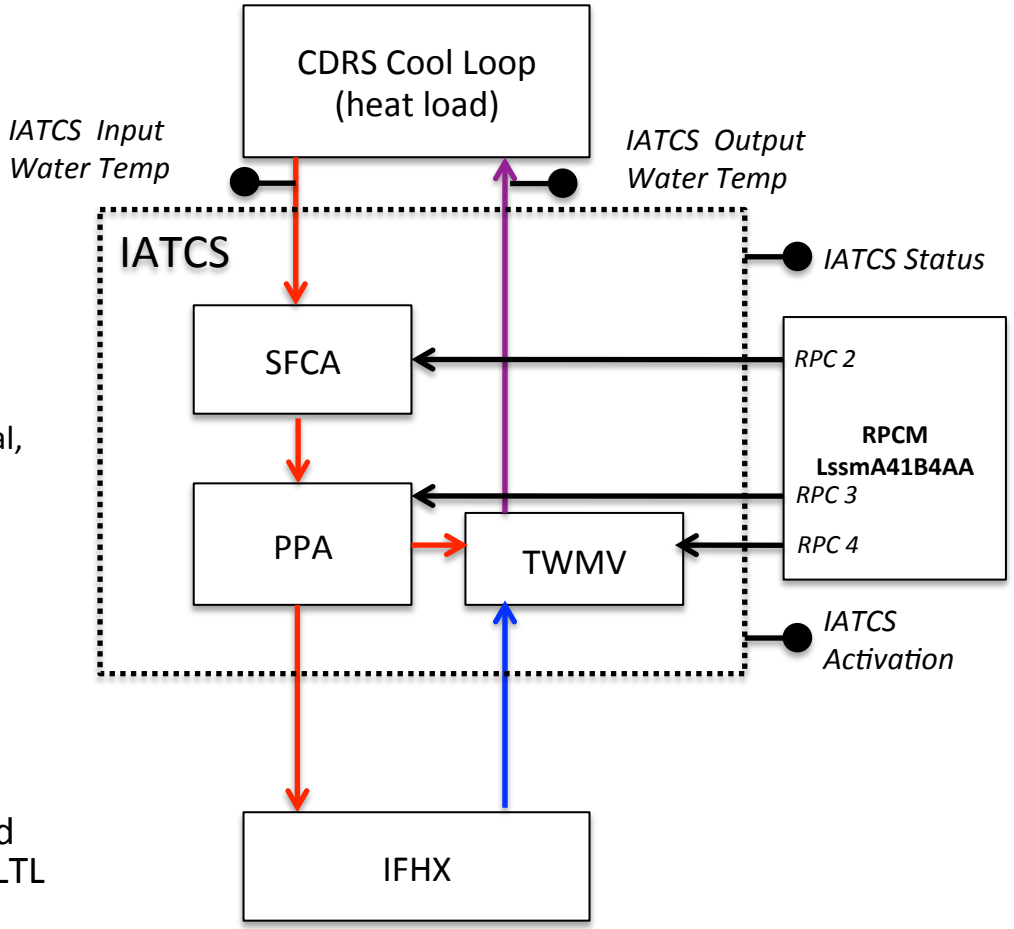
ISS Internal Active Thermal Control System

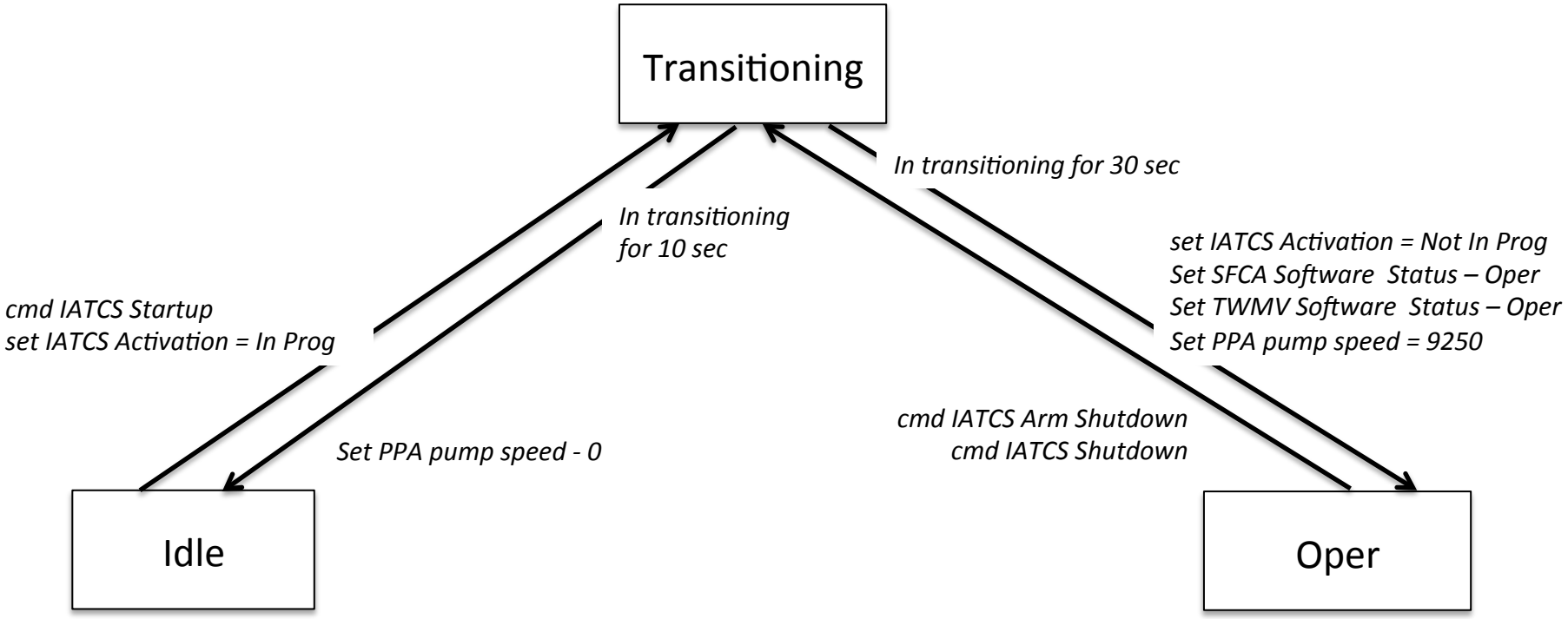


IATCS LTL Schematic for BioSim

- Heat Load
  - CDRS
- IATCS
  - SFCA - System Flow Control Assembly
    - Maintains coolant pressure
    - Provides pump isolation
  - PPA – Pump Package Assembly
    - Provides coolant pumping, gas removal, and coolant filtration
  - TWMV – Three way mixing valve
    - Controls and mixes coolant flows from different heat loads
- IFHX – Interface Heat Exchanger
  - Removes heat from coolant
  - Ammonia to water transfer mounted external to US Lab endcone
  - Note – I think these are outside ISS and thus must be heated when shutdown LTL IATCS



LTL IATCS Status



Cmd: issued from procedure
Set: performed by simulation at the state transition

IATCS Input/Output Water Temp

- IATCS Input Water Temp (IWT)
  - If (CDRS state == dual_bed || CDRS state == single_bed || CDRS state == standby)

    then IWT = 30 deg C

    else IWT == 22 deg C
    - 22 deg C is the typical temperature inside ISS
    - Internal temperature in CDRA runs 20-36 deg C
- IATCS Output Water Temp (OWT)
  - If (IATCS state == Oper && IFHX Bypass Valve Position == Flothru && IFHX Isolation Valve Position == Opened)

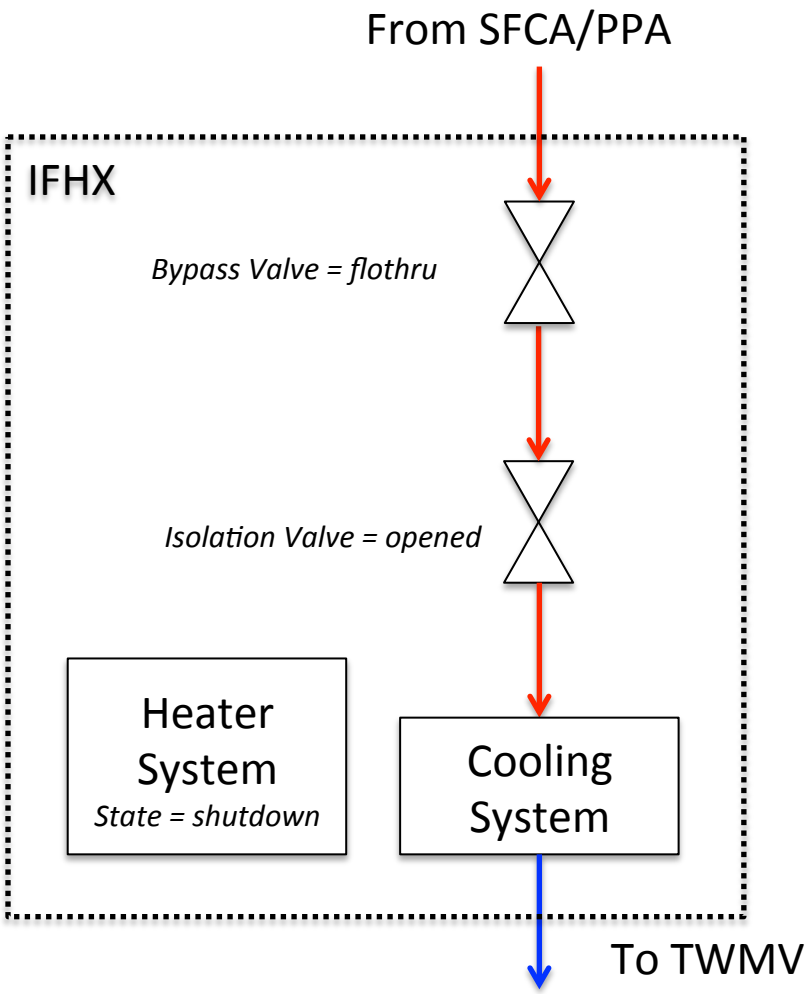
    then OWT = 10 deg C

    else OWT == IWT

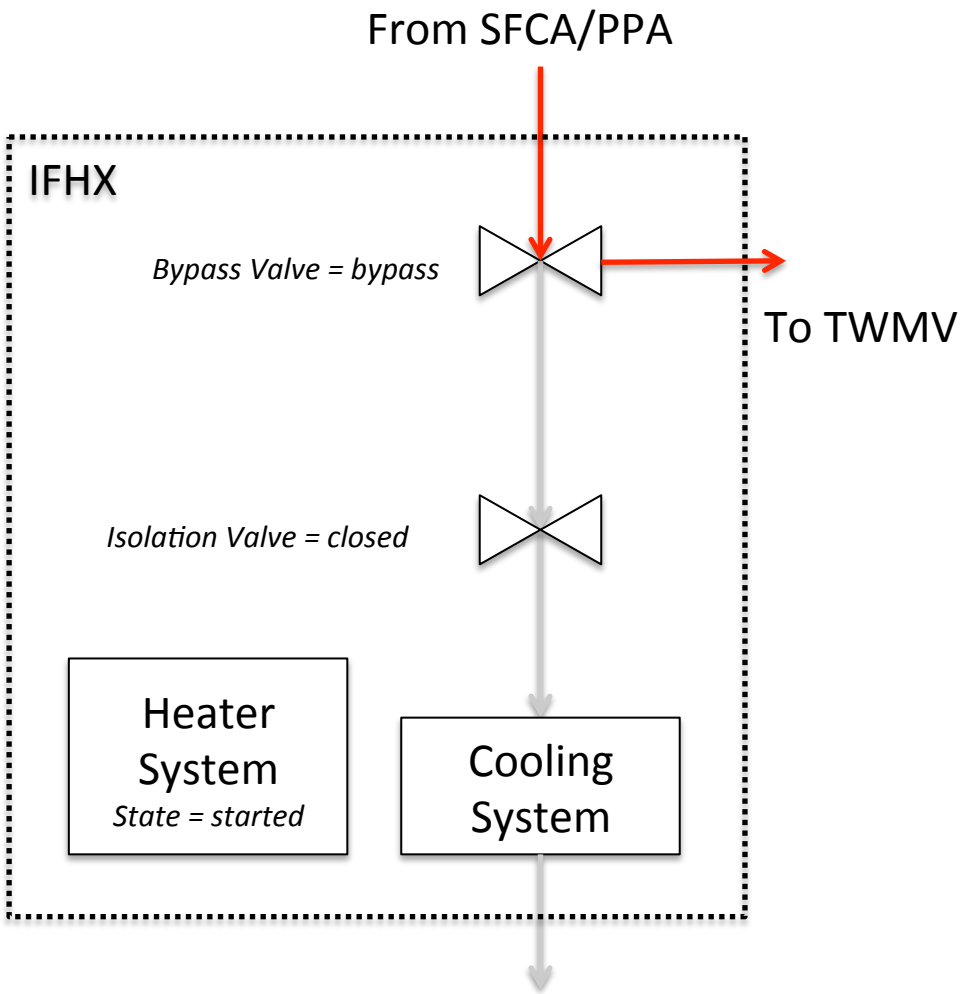
IATCS Commands and Telemetry

- Commands
  - IATCS Arm Shutdown
  - IATCS Shutdown
  - IATCS Startup
  - SFCA Arm Software Shutdown
  - SFCA Software Shutdown
  - SFCA Software Startup
  - TWMV Arm Software Shutdown
  - TWMV Software Shutdown
  - TWMV Software Startup
  - PPA arm pump speed command
  - Set PPA pump speed – 9250
  - Set PPA pump speed - 0
- Telemetry
  - IATCS Status: Idle, Oper, Armed, Transitioning
  - IATCS Activation: In Prog, Not In Prog
  - SFCA Software Status: Shutdown, Armed, Oper
  - TWMV Software Status: Shutdown, Armed, Oper
  - PPA pump speed command: Armed, Not Armed
  - PPA pump speed: 0-9250 rpm
  - IATCS Input Water Temp
  - IATCS Output Water Temp

IFHX Model



IFHX in Use



IFHX Bypassed

IATCS Input Water Buffer Volume

Water Buffer Volume	Isolation Valve = Opened	Isolation Valve = Closed
Bypass Valve = Flothru	1. IATCS Input Water Buffer Volume constant; flow in = flow out	1. IATCS Input Water Buffer Volume increasing: no flow out
Bypass Valve = Bypass	1. IATCS Input Water Buffer Volume constant; flow in = flow out	1. IATCS Input Water Buffer Volume constant: flow in = flow out

IFHX Commands and Telemetry

- Bypass Valve
  - Commands
    - IFHX Bypass Valve Cntl Avail Bypass Ena
    - IFHX Bypass Valve Cntl Avail Flothru Ena
  - Telemetry
    - IFHX Bypass Valve Cntl Avail: Ena, Inh?????
  - Commands
    - IFHX Bypass Valve Position Byp
    - IFHX Bypass Valve Position Flothru
  - Telemetry
    - IFHX Bypass Valve Position: Bypass, Flothru
- Isolation Valve
  - Commands
    - IFHX Isolation Valve Cntl Avail Open Ena
    - IFHX Isolation Valve Cntl Avail Close Ena
  - Telemetry
    - IFHX Isolation Valve Cnt Avail: Ena, Inh?????
  - Commands
    - IFHX Isolation Valve Position Open
    - IFHX Isolation Valve Position Close
  - Telemetry
    - IFHX Isolation Valve Position: Opened, Closed
- Heater
  - Commands
    - IFHX Htr System Software Armed
    - IFHX Htr Sys Software Startup
    - IFHX Htr Sys Software Shutdown
  - Telemetry
    - IFHX Htr Sys Software – Armed, Started, Shutdown

The "Cntl Avail" commands seem to be similar to the "RPC enable/inhibit" commands. Cntl Avail must be enabled before a command can be sent. Cntl Avail does not, however, model an Inhibit state. If it is easier to model Cntl Avail in the same way as RPC enable/inhibit, that is fine. Just let me know how the model works so I can write the procedure correctly.

Procedures

- Procedure 1.7021 LSSM LTL Activation
- Procedure 1.7031 LSSM LTL Shutdown

Procedure 1.7021 LSSM LTL Activation

Activate IATCS

- Step 1. Verify RPC positions
  - Verify RpcmLssmA41B4AA_RPC_2 – Cl
  - Verify RpcmLssmA41B4AA_RPC_3 – Cl
  - Verify RpcmLssmA41B4AA_RPC_4 – Cl
- Step 2. Integrate LSSM LTL IFHX
  - If Isolation valve = closed
    - Cmd IFHX Isolation Valve Cntl Avail Open – Ena
    - Verify IFHX Isolation Valve Cnt Avail – Ena
    - Cmd IFHX Isolation Valve Position – Open
    - Verify IFHX Isolation Valve Position – Opened
  - If Bypass valve = bypass
    - Cmd IFHX Bypass Valve Cntl Avail Flothru – Ena
    - Verify IFHX Bypass Valve Cnt Avail – Ena
    - Cmd IFHX Bypass Valve Position – Flothru
    - Verify IFHX Bypass Valve Position - Flothru
- Step 3 Shutdown IFHX Heater software
  - If Heater software = started
    - Cmd IFHX Htr Sys Software Arm
    - Verify IFHX Htr Sys Software – Armed
    - Cmd IFHX Htr Sys Software Shutdown
    - Verify IFHX Htr Sys Software – Shutdown

Procedure 1.7021 LSSM LTL Activation

Activate IATCS

- Step 4. Send IATCS activation command
  - Verify IATCS Status - Idle
  - Cmd IATCS Startup
  - Verify IATCS Activation – In Prog
  - Wait up to 30 seconds
  - Verify IATCS status - Oper
  - Verify IATCS Activation – Not In Prog
- Step 5. Set PPA pump speed
  - Cmd PPA arm pump speed command
  - Verify PPA pump speed command – armed
  - Cmd Set PPA pump speed – 9250
  - Verify PPA pump speed – 9250
- Step 6. Verify IATCS software component config
  - Verify SFCA Software Status – Oper
  - Verify TWMV Software Status – Oper

Procedure 1.7031 LSSM LTL Shutdown

Shutdown IATCS

- Step 1. Send shutdown command to IATCS software (Internal Active Thermal Control System)
  - Cmd IATCS Arm Shutdown
  - Verify IATCS Status - Armed
  - Cmd IATCS Shutdown
  - Verify IATCS Status – Transitioning
  - Wait up to 10 seconds
  - Verify IATCS status – Idle
- Step 2. Send shutdown command to IATCS component software
  - Substep 2.1 Shutdown SFCA
    - Cmd SFCA Arm Software Shutdown
    - Verify SFCA Software Status - Armed
    - Cmd SFCA Software Shutdown
    - Verify SFCA Software Status – Shutdown
  - Substep 2.2 Shutdown TWMV
    - Cmd TWMV Arm Software Shutdown
    - Verify TWMV Software Status - Armed
    - Cmd TWMV Software Shutdown
    - Verify TWMV Software Status – Shutdown

Procedure 1.7031 LSSM LTL Shutdown Bypass IFHX

- Step 3 Bypass LSSM LTL IFHX
  - Note – Once commanded, if the valve does not reach the commanded position the operator is allowed to issue the same position command up to 10 additional time. If the desired position is still not reached, notify MCC-H.
  - Step 3.1 Command IFHX bypass valve to Bypass
    - Cmd IFHX Bypass Valve Cntl Avail Bypass – Ena
    - Verify IFHX Bypass Valve Cnt Avail – Ena
    - Cmd IFHX Bypass Valve Position – Byp
    - Verify IFHX Bypass Valve Position - Bypass

    Bypass Valve States – Bypass, Flothru
  - Step 3.2 Close IFHX isolation valve
    - Cmd IFHX Isolation Valve Cntl Avail Close – Ena
    - Verify IFHX Isolation Valve Cnt Avail – Ena
    - Cmd IFHX Isolation Valve Position – Close
    - Verify IFHX Isolation Valve Position – Closed

    Isolation Valve States – Opened, Closed
- Step 4. Start IFHX Heater software
  - Cmd IFHX Htr Sys Software Startup
  - Verify IFHX Htr Sys Software – Started