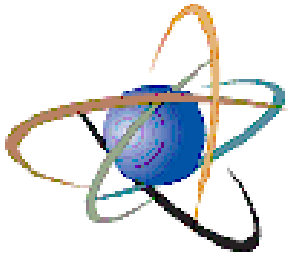


Control Rod Drive Mechanism-Construction

Chapter 6.1
B&W Cross-Training Course
R-326C

HRTD
Human Resources
Training & Development

OBJECTIVES

1. List the two types of control rod drive mechanisms.
2. Explain the functions of the following:
   a) rotor assembly
   b) leadscrew
   c) torque taker
   d) snubber assembly
   e) leadscrew guide assembly
3. Describe the operation of the control rod drive mechanism following a reactor trip signal, including the action of the leadscrew guide assembly and hydraulic dampening.

Control Rods

- Rods inserted or withdrawn for S/U, S/D, power operations and Rx trip.
- Rods operated in auto by ICS or in manual by operator.
- 76 electrically driven control rods.
  - 68 Control Rod Assemblies (CRAs).
    - Safety rods (Groups 1- 4) (36 rods)
    - Regulating rods (Groups 5 - 7) (32 rods)
  - 8 Axial Power Shaping Rods (APSRs).
    - Group 8

CRDM-Construction

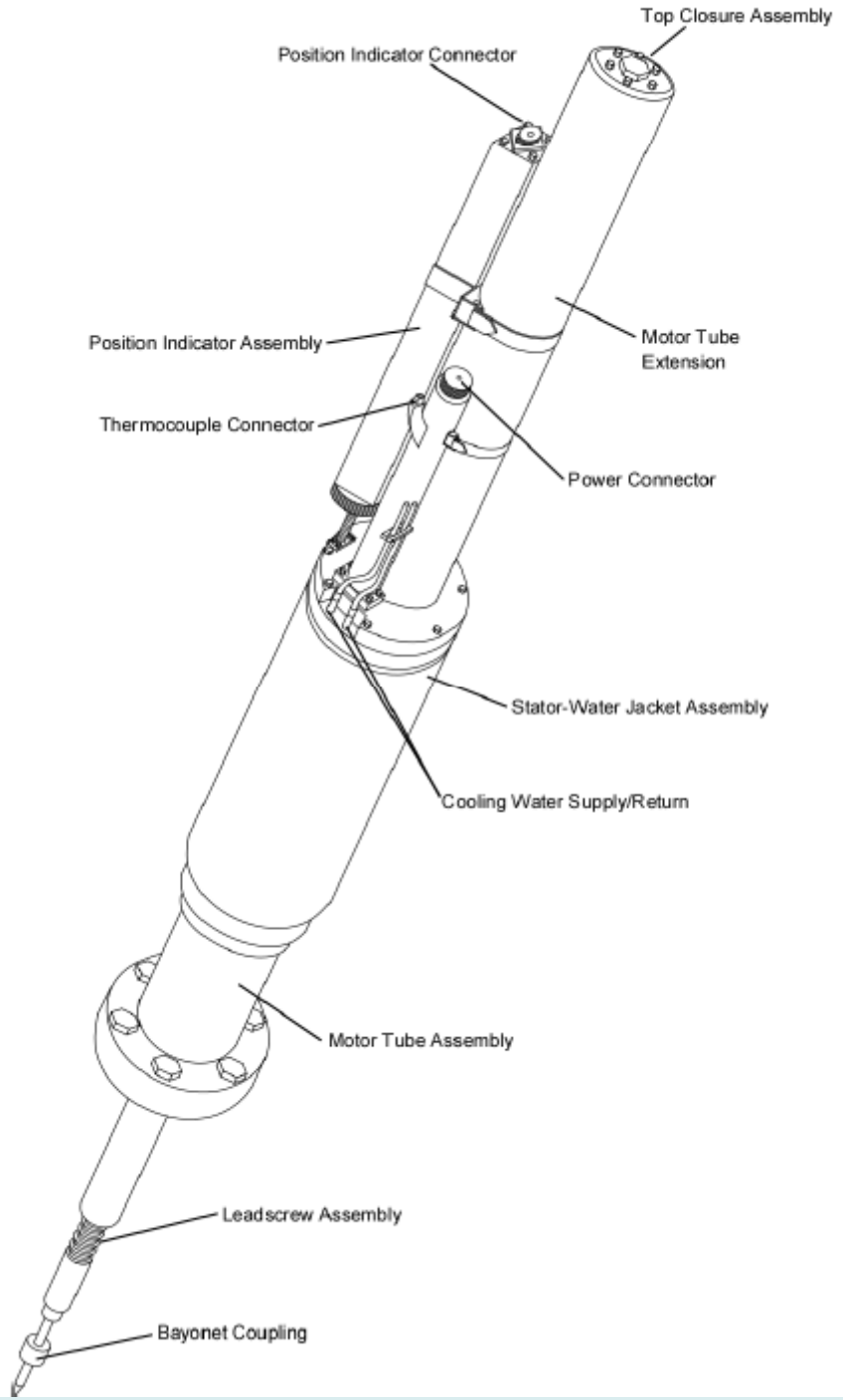
- Major components:
  - o Stator motor (4 pole, 6 phase).
  - o Motor tube (the pressure boundary).
  - o Rotor assembly (rotates).
  - o Leadscrew (attached to CRA).
  - o Torque tube & torque taker (prevents rotation of leadscrew)
  - o Snubber
  - o Leadscrew Guide Assembly
  - o Rod Position Indicator

CRDM Stator Motor

- 4-pole, 6-phase, synchronous, reluctance stator motor.
  - Mounted externally & surrounds the motor tube.
  - Power to windings controlled by motor control system.
  - Integral water jacket cooling system.

Motor Tube

- Part of RCS pressure boundary
- Houses:
  - rotor assembly
  - leadscrew
  - snubber
  - torque tube & torque taker
  - leadscrew guide assembly



Control Rod Drive Mechanism Illustration Fig.6.1-1

Rotor Assembly (1)

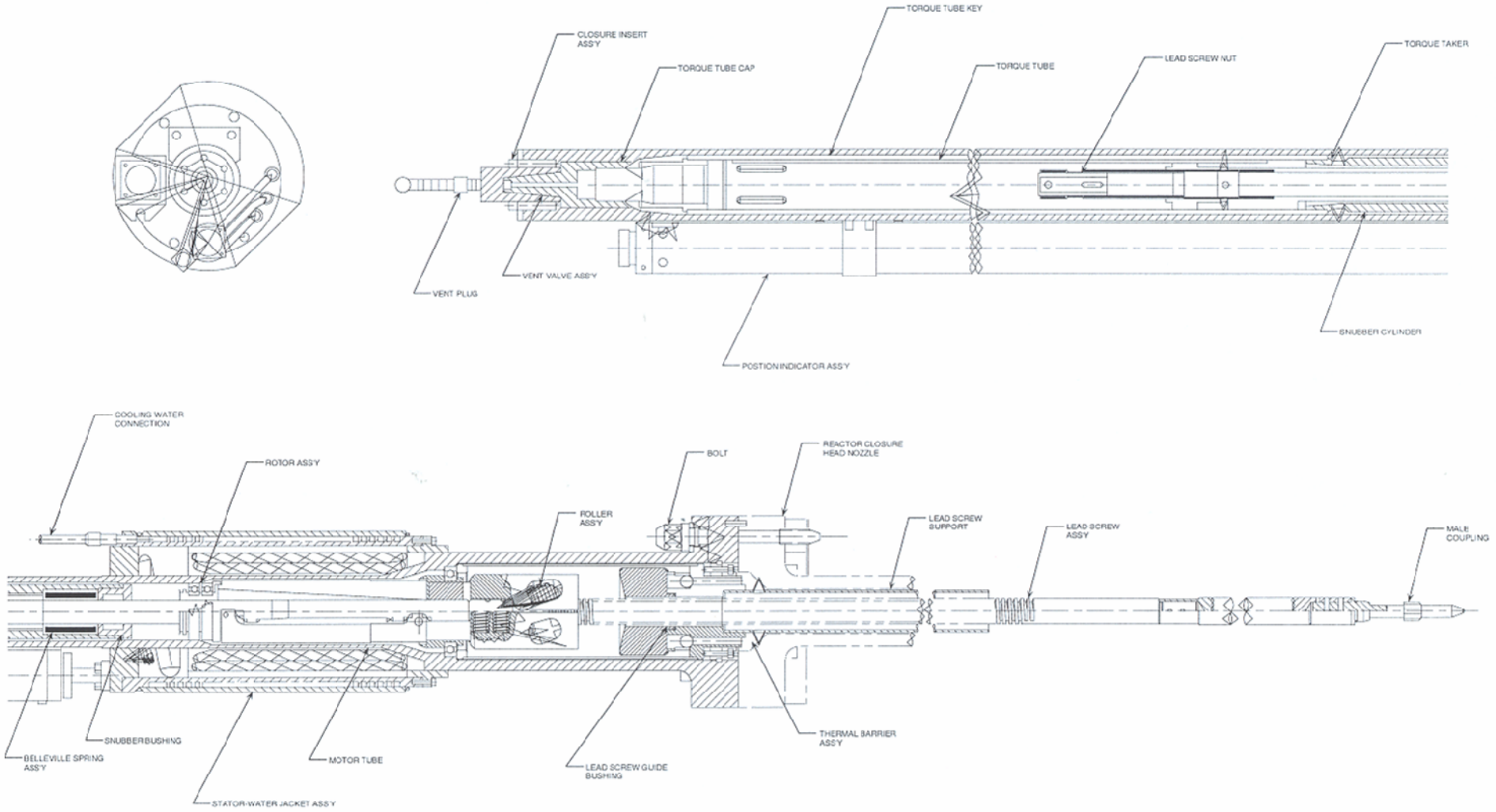
- A pair of segmented arms.
- Supported by a pivot ring w/ bearings.
- Upper portion of arms will pivot outward when stator motor is energized.

Rotor Assembly (2)

- Lower end of arms contains separating roller nut assembly. Two roller nuts per arm segment.
  - o Pivot inward & engage the leadscrew when the stator motor is energized.
  - o 4 springs mounted in lower end keep the rollers disengaged when the stator windings are de-energized.
- The APSRs do NOT disengage when the Rx trips.
  - o Mechanical interference prevents roller nut assembly from disengaging. (small stud/button)

Rotor Assembly (3)

- The rotor assembly is split so that when power is applied to the stator, the segment arms pivot to mechanically engage the roller nuts w/ the leadscrew threads.
- The rotational motion of the rotor assembly is translated to the non-rotating leadscrew which is coupled to the control rod causing the leadscrew to move vertically.
- One rotation of rotor assembly is ¾ in of travel.



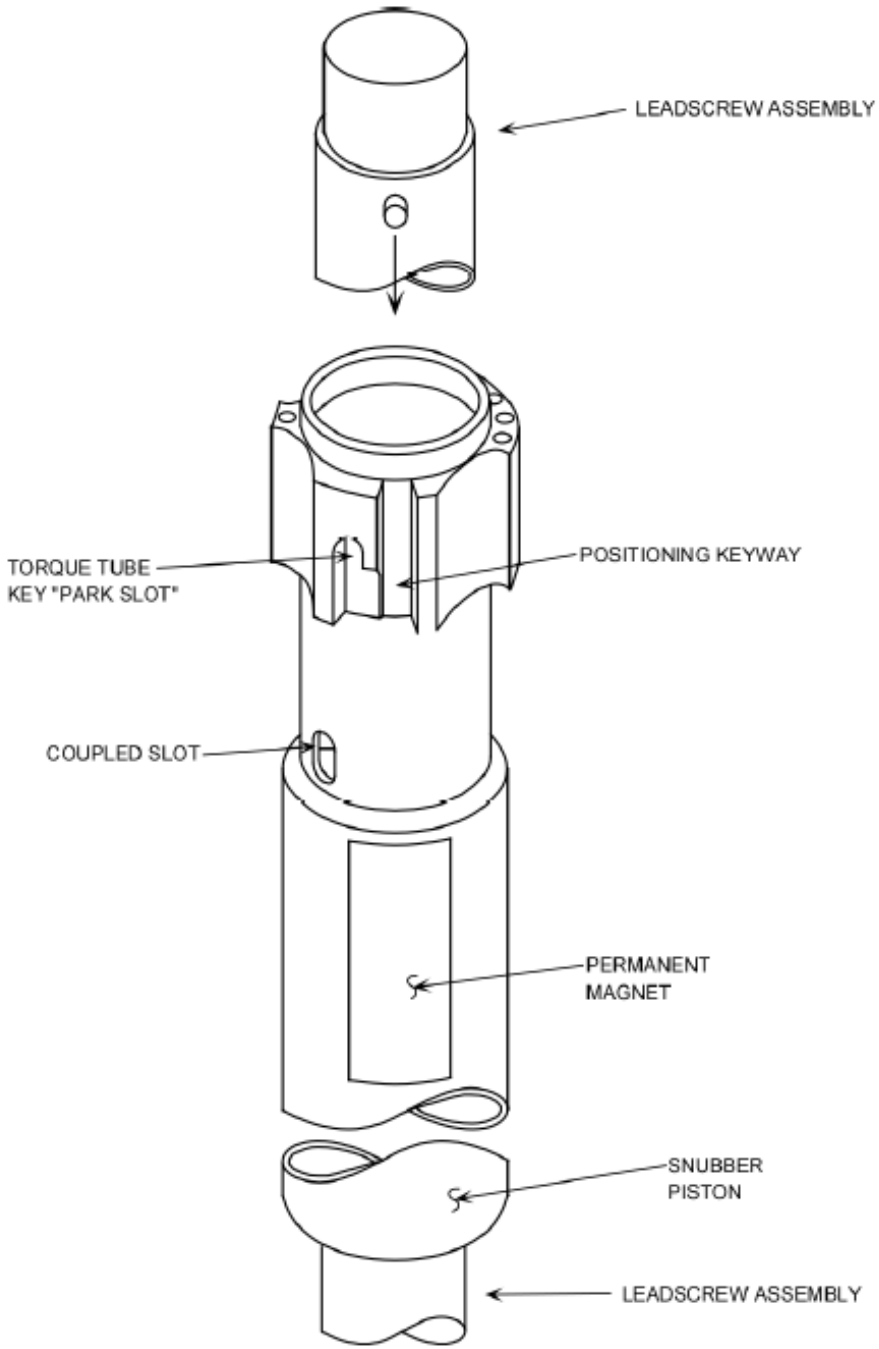
Control Rod Drive Mechanism (Fig. 6.1-2)

Torque Tube & Torque Taker (1)

- Torque tube – separate tube mounted to the inside of the motor tube.
  - o Torque tube extends full length of leadscrew travel inside of the motor tube.
  - o Has a key that works w/ torque taker to prevent rotation of leadscrew.
    - ❑Key on torque tube extends full length of leadscrew travel.

Torque Tube & Torque Taker (2)

- Torque taker attached to unthreaded, upper portion of leadscrew.
  - Has a keyway which mates w/ key on torque tube.
- The torque tube & torque taker provide alignment for the leadscrew and prevent rotation of the leadscrew.
  - Rotation could lead to uncoupling the rod when CRDM is in service.
- Torque taker has a permanent magnet on one side for rod position indication



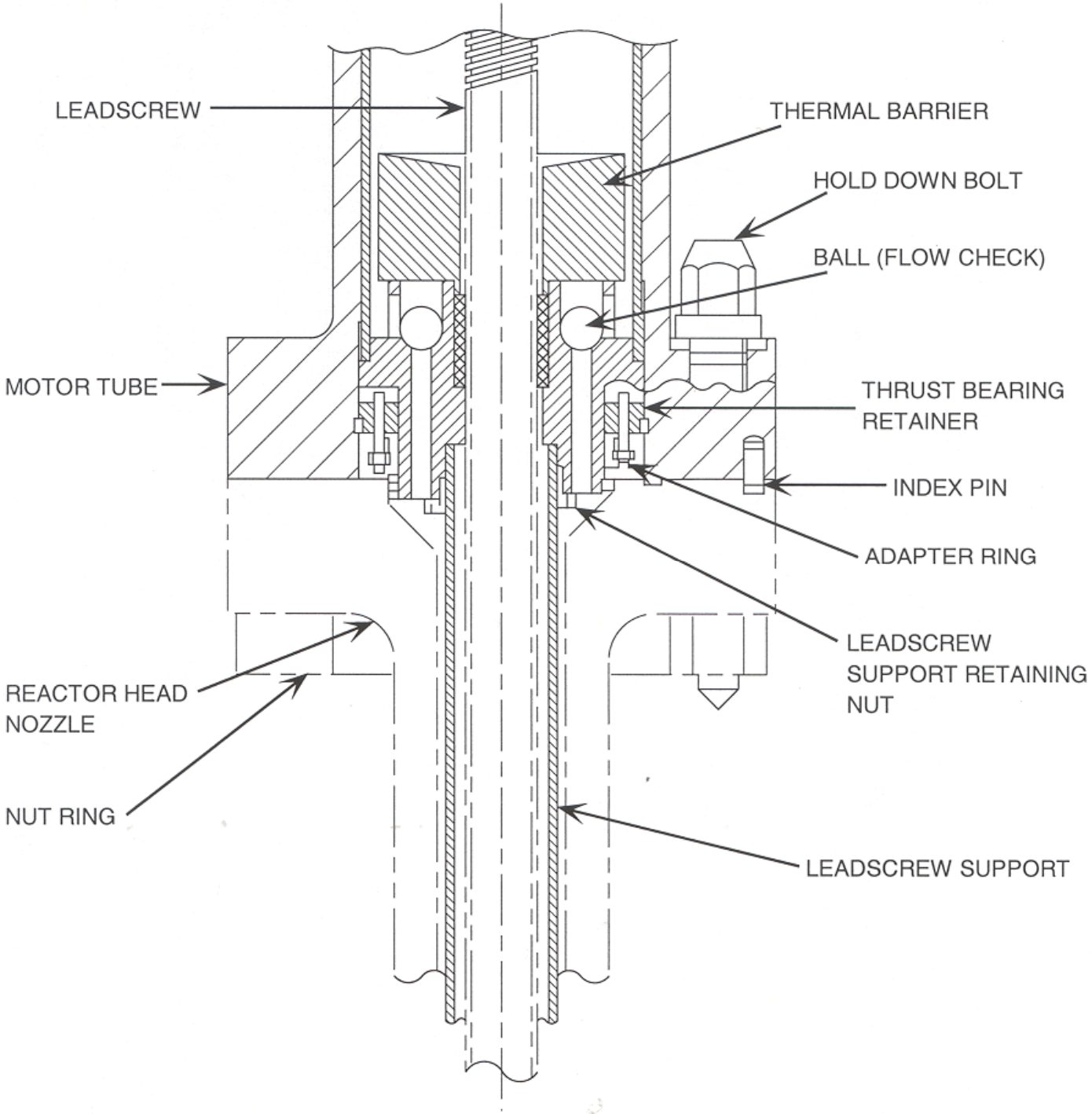
Torque Taker Assembly
Fig. 6.1-3

Hydraulic Snubber Assembly

- A buffer (snubber) piston attached to bottom of torque taker and a snubber cylinder inside of the torque tube.
- Designed to decelerate the lead screw/CRA following a Rx trip.
- Any excess K.E. remaining after hydraulic dampening is absorbed by a belleville spring assembly.
  - Attached to torque tube below snubber cylinder area.

Leadscrew Guide Assembly

- Leadscrew guide bushing:
  - Acts as a thermal barrier.
    - Limits flow between RCS and motor tube.
  - Acts as leadscrew guide.
- Helps prevent hydraulic lock and obtain acceptable CRA insertion times after a trip.
  - On trip, area in top of motor tube empty when leadscrew inserts.
  - 4 ball check valves provide additional flow path around the bushing to prevent formation of a low pressure area above the leadscrew shaft as it leaves the motor tube.



Leadscrew Guide Assembly Fig. 6.1-4

CRDM Operation (1)

- Energizing the stator windings establishes a magnetic field which causes the rotor assembly segment arms to pivot.
- This mechanically engages the roller nuts to the leadscrew threads.
- The rotating magnetic field produced (by the motor control system) causes the roller nut assembly to rotate.
- The rotational motion of the rotor assembly is translated to the non-rotating leadscrew.
- Leadscrew converts the rotary motion of the roller nut assembly to the linear travel of the leadscrew & CRA.

CRDM Operation (2)

- On a Rx trip, power is interrupted to CRDMs.
  - Loss of the magnetic field allows mechanical springs to force the segment arms apart, disengaging the roller nut halves from the leadscrew.
  - Leadscrew & CRAs drop into the core.
- The leadscrew is decelerated by action of hydraulic snubber assembly.
  - Belleville spring assembly absorbs excess K.E.
- Hydraulic lock is prevented by 4 ball check valves in leadscrew guide assembly.