The design duty requirement for the CEDM is a total cumulative CEA travel of 30,480 m (100,000 ft) operation without loss of function.

The test programs performed in support of the CEDM design are described in Subsection 3.9.4.4. and a total number of full-height CEA drops of 1,000. Design duty requirement of 100,000 ft of travel was determined by operational experience taking into account 40-year life time of the active components such as the motor assembly and extension shaft assembly.

3.9.4.1.1 Control Element Drive Mechanism Design Description

The CEDMs are mounted on nozzles on the top of the reactor vessel closure head. A CEDM consists of upper pressure housing, motor housing, motor assembly, coil stack assembly, two reed switch position transmitter (RSPT) assemblies, and an extension shaft assembly (ESA). The CEDM is shown in Figure 3.9-7. The drive power is supplied by the coil stack assembly, which is positioned around the motor housing. Two RSPT assemblies are supported by the upper shroud which encloses the upper pressure housing assembly.

The lifting operation consists of a series of magnetically operated step movements. Two sets of mechanical latches are used to engage an ESA. The magnetic force is obtained from the coil stack assembly mounted on the outside of the motor housing.

The CEDM control system actuates the stepping cycle and moves the CEA by a withdrawal or insertion stepping sequence. CEDM-hold is obtained by energizing a latch coil at a reduced current, while all other coils are de-energized. The CEAs are tripped upon interruption of electrical power to all coils. Each CEDM is connected to the CEAs by an ESA.

The axial position of a CEA in the core is indicated by three independent readout systems. One system counts the CEDM steps electronically, and the other two consist of magnetically actuated reed switches located at regular intervals along the upper pressure housing.

3.9.4.1.1.1 Control Element Drive Mechanism Pressure Housing

The CEDM pressure housing consists of the motor housing assembly and the upper pressure housing assembly. The motor housing assembly is attached to the reactor vessel

The dynamic analysis models for the faulted condition are developed using the dynamic characteristics measured in the test of the prototype.

3.9.2.7 Dynamic System Analysis of the CEDM

The pressure-retaining components of the control element drive mechanism (CEDM) are designed to the appropriate stress criteria of ASME Section III for all loadings specified. The structural integrity of the CEDM for the seismic loadings is verified by combination of test and analysis. Methods of dynamic analysis using response spectrum analysis or time-history analysis are supported with experimentally obtained information.

3.9.2.7.1 Input Excitation Data

For the dynamic analyses, response spectra or time-history definition of the excitation at the base of the CEDM nozzle is obtained from the seismic analysis of the RCS. The excitation is applied simultaneously in three mutually perpendicular directions (two horizontal and one vertical).

3.9.2.7.2 Analysis

A dynamic analysis of the mathematical structural model is performed using one or more of the computer programs described in Subsection 3.9.1.2.

3.9.2.7.3 Functional Test

~~A functional test using a minimum drop weight was performed to verify that drop characteristics meet the input design requirements. Results from this test are compared to the calculated CEDM deflections under seismic loading for the individual site. Verification of the proper function is thus established based on both analytical and test results.~~

Scram test using a minimum drop weight was performed by applying an incremental static deflection to the CEDM. From the test, the minimum radius of curvature of 2,025 inches for the upper pressure housing was obtained as the most critical criterion to ensure scramability. Deflection of the CEDM under seismic loading calculated by structural dynamic analysis was compared with the test result to verify scramability.