

SEQUOYAH NUCLEAR PLANT  
UNITS 1 AND 2

ENGINEERING REPORT

INSPECTION DEVICE IN LIEU OF  
INSPECTION PORTS

8103090203

## PROBLEM

Provide a camera inspection device which can be inserted into the existing six-inch inspection ports, located between the tubesheet and the lower support plate, to provide an additional method of monitoring tube support plate degradation in the Model 51 steam generators at Sequoyah Nuclear Plant.

An alternative to this camera inspection device is to install inspection ports just above the upper support plate and in line with the tube lane.

## DISCUSSION

The two main problems encountered when designing the inspection device as mentioned above were space limitations and rigidity of the mast which transports the camera upward as much as 28 feet. The space limitation was overcome by careful selection and positioning of gears and related components. The rigidity problem was mitigated by the use of square tubing sections with close fitting joints. The "mast" consists of twenty-nine 1 1/2-inch effective length joints which are added or removed by hand, one at a time, for raising or lowering the camera.

## DESCRIPTION

The inspection device consists of the following six basic subassemblies. See drawing CNM-S-0041-C, sheet 1 (reference 2) and photographs.

1. Cantilever Beam - is a welded carbon-steel assembly which fits through and bolts to the handhole face, forming a cantilever beam support for the welded barrel, subassembly 3.
2. Support Tube - is an assembly of short (approximately 1 1/2-inch effective length) sections of 2-inch square aluminum tubing which snap-locks together to form a "mast" to support the TV camera or other remote inspection device.
3. Welded Barrel - is a welded carbon-steel assembly that provides the base for the drive mechanism and a barrel to guide the support tube, subassembly 2.
4. Drive Crank - is an assembly consisting of a speed handle, extension, and 3/8-inch universal. It is used to turn the drive mechanism worm from outside the handhole.

DESCRIPTION (cont'd)

5. Camera Adapter - is an assembly made of 2-inch square aluminum tubing similar to the support tube, subassembly 2, and has a brass adapter to accept the TV camera.
6. Drive Mechanism - is a worm gear type speed reducer and gear train, integral with the welded barrel, with two traction rollers which drive the support tubes in the vertical direction.
7. Camera, Controls, and Monitor - the camera is a Telespec TS 35F including an integral light source. The camera control console includes control for light intensity, rotation of the camera head, and lense focus. The video monitor is a Hitachi VM 910U.

Operation of the inspection device is initiated by bolting the cantilever beam into the handhole with the camera adapter and TV camera installed in the horizontal position. The camera cable will drape out through the handhole. The welded barrel is then pivoted and locked in the vertical position. The drive crank is used to turn a worm gear in the drive mechanism which drives traction rollers through a gear train.

The traction rollers drive the support tube up or down depending on the direction the worm is turned. When driving the camera up, the support tube must be advanced until the snap-lock button which holds the sections together is just below the drive mechanism; then a new section of support tube can be threaded through the handhole over the wire by hand and snap-locked into position. The support tube is advanced upward again and the process of adding support tube sections is repeated as required to add height. Disassembly and removal is in the reverse order of assembly, starting by lowering the support tube mast by turning the worm until the snap lock button of the first support tube section appears below the drive mechanism. By pushing the snap-lock button, the support tube sections can be disassembled by pulling down. The loose section is then threaded over the wire and out the generator handhole. This process is repeated until the camera adapter appears. Then the welded barrel is pivoted back into the horizontal position and the cantilever beam is unbolted and removed from the handhole.

## TEST RESULTS

The inspection device and camera were installed in a mockup, specially built for testing and training purposes (see photographs), in approximately four minutes. The 29 support tube or "mast" sections were then installed one at a time. At this point the camera head was actually in contact with the simulated first row tube bend area. The hand crank was replaced with an electric 110 volt, reversible drill motor to reduce the time required for driving the gear train. The total time for installing the device and placing the camera near the first row tube bend area is approximately 30 minutes. Photographs were taken of the TV monitor at various stages of the camera removal operation (see photographs).

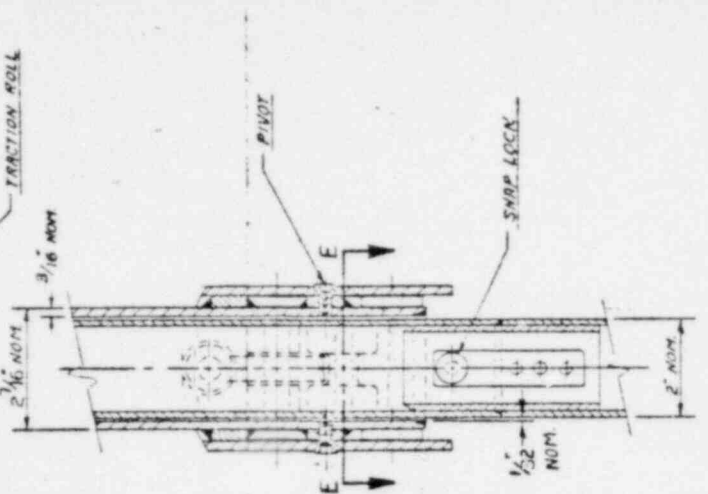
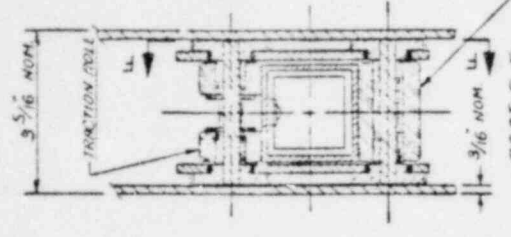
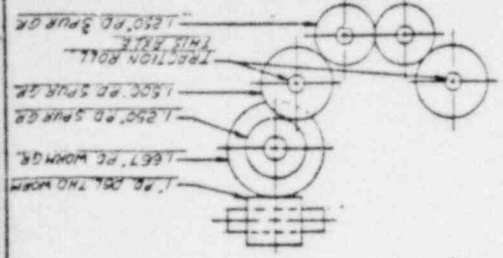
A combination of viewing equipment could be used with this device such as:

1. 90-degree camera lenses.
2. Straight camera lenses.
3. Fiber optics positioning.

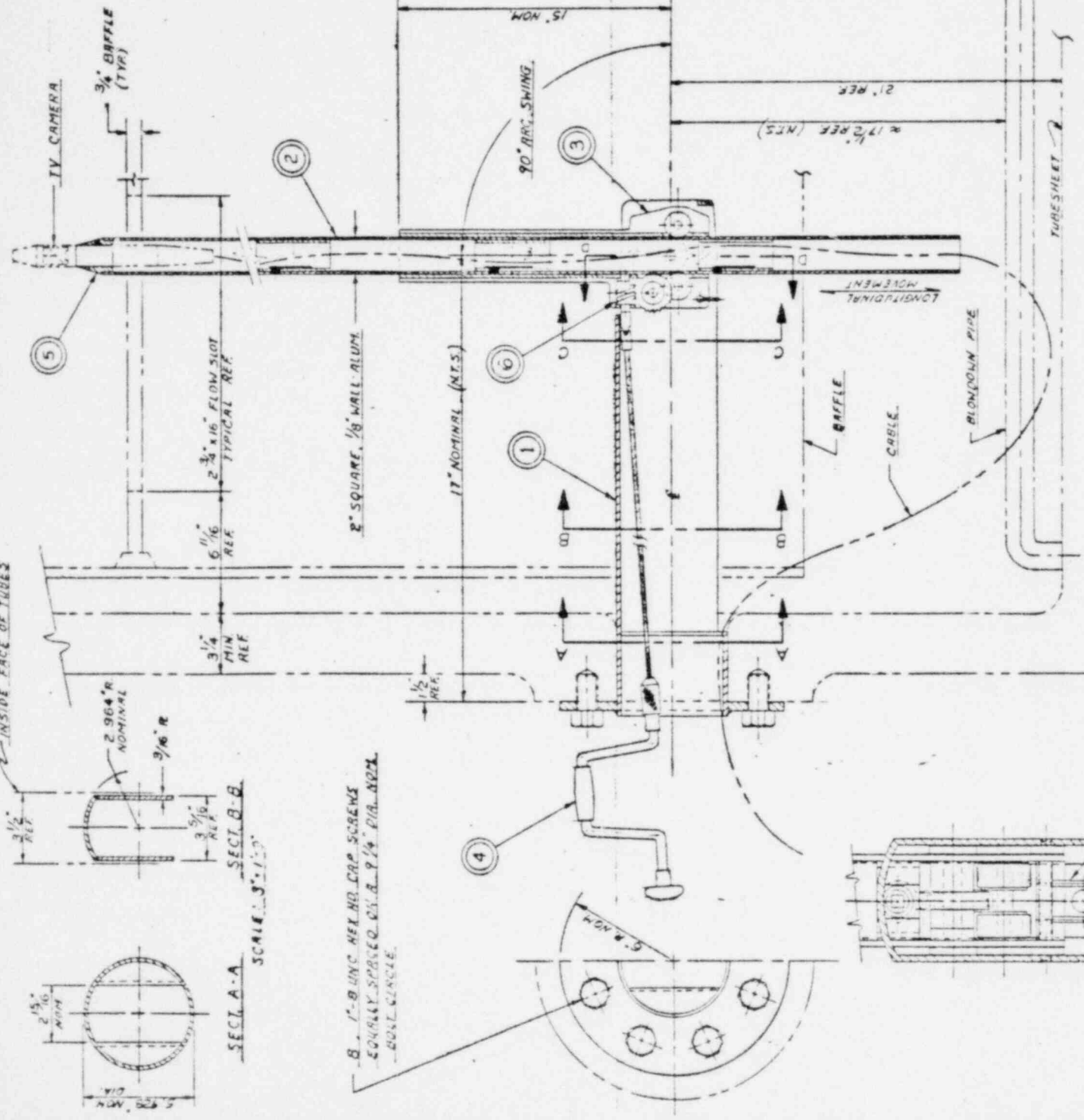
## CONCLUSIONS

The goals which were established for the inspection device were to provide the capability of visually inspecting representative portions of the support plates in the Model 51 steam generators as a backup to multifrequency and profilometry. These goals were accomplished with the device previously described. Therefore, adequate assessment and monitoring of the potential tube support plate degradation can be accomplished with the camera inspection device mentioned and addition of inspection ports above the upper support plate in the Model 51 steam generators at Sequoyah Nuclear Plant are unnecessary.

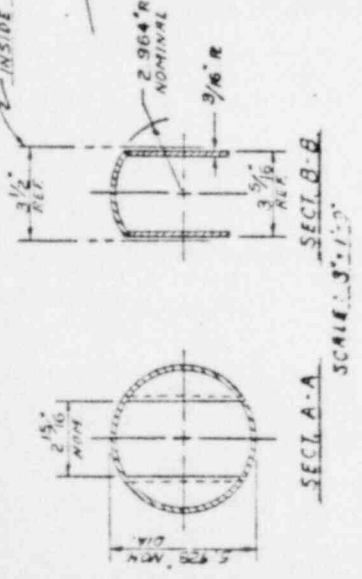
Multifrequency eddy current testing and profilometry are the primary methods of detecting and monitoring tube support plate degradation. These methods are used routinely during intensive inspections required at each outage. The inspection device described herein can be used to enhance the above inspection methods.



SCALE: 6" = 1'-0"



SCALE: 3" = 1'-0"



8. 1"-Ø UNC. HEX. HD. CAP. SCREWS  
EQUALLY SPACED ON A 9 1/4" DIA. CIRC.  
-BOLT CIRCLES

SCALE: 6" = 1'-0"

TENNESSEE VALLEY AUTHORITY  
 DIVISION OF OPERATIONS  
 SEQUOYAH STEAM GENERATOR  
 INSPECTION DEVICE ASSEMBLY  
 DATE: 11/16/78  
 DRAWN BY: [Signature]  
 CHECKED BY: [Signature]  
 APPROVED BY: [Signature]  
 REV: 1