MILLSTONE NUCLEAR POWER STATION, UNIT NO. 3

DESCRIPTION OF

LOOSE PARTS MONITORING SYSTEM

AND

LOOSE PARTS DETECTION PROGRAM

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1.0 System Description

The Millstone Unit No. 3 Loose Parts Monitoring System (LPMS) is an integrated system supplied by Rockwell International for the detection of loose parts within the reactor primary coolant system. The system consists of piezoelectric sensors, preamplifiers, a signal processor unit, an alarm light display, a loudspeaker, a magnetic tape recorder, and a strip chart recorder. Table 1 gives equipment specifications for the sensors, preamplifiers and tape recorder.

The sensors are piezoelectric accelerometers which detect vibration such as that indicative of a loose part in the reactor coolant system. Vibration is translated into a voltage and transmitted to the signal processor unit where it is compared to preset levels to generate alarms when abnormal conditions are detected.

Automatic and manual start-up capability of data acquisition equipment is included with the LPMS. Each sensor is connected to a loose parts channel with a latching alarm light on the front of the panel. When a sensor signal exceeds a preset level, an alarm light and a solid state switch, that latches in the signal, will be activated. While in the automatic mode, the first alarm detected will be indicated by a blinking alarm light. All subsequent alarms, prior to operator reset, will be indicated by nonblinking lamps.

Also while the LPMS is in the automatic mode, an alarming signal will automatically start a four channel tape recorder. Four of the loose parts channels will be simultaneously recorded. The selection of channels to be recorded in the event of an alarm has been predetermined and is dependent upon the location of the sensor detecting the alarming signal, i.e., if a lower vessel sensor signal exceeds the preset level, all upper and lower vessel sensor signals will be switched into the tape recorder for recording; if a steam generator sensor signal exceeds the preset level, one upper vessel sensor signal, one lower vessel sensor signal, the affected steam generator signal, and the second steam generator signal will be switched into the recorder. If an operator desires to record another configuration of channels other than those indicated above, the LPMS must first be placed in the manual mode, then the four channels desired to be recorded can be switched into the recorder using the tape recorder channel selector switches located on the front panel.

Each channel can be directed to an audio amplifier, where it can be heard over a front panel speaker. Previously recorded information from a particular channel can also be played back over the front panel speaker. Direct and recorded signals can be played simultaneously over the speaker.

A three pen strip chart recorder is available to allow the operator to obtain a hard copy printout of data.

1.1 Sensor Location and Mounting

1.1.1 Reactor Vessel Sensors

Two sensors are located on the upper vessel on the lifting lugs as shown in Figure 1. The sensors will be attached to the lifting lugs using stud mounting as shown in Figure 4.

Two sensors are located on the lower vessel on the instrumentation guide tubes (Nos. 51 and 53). Refer to Figure 2 for the relative locations of these sensors. The sensors are attached just below the guide tube taper using clamp type mounts provided by the system manufacturer.

1.1.2 Steam Generator Sensors

One sensor is located on the hot leg inlet plenum of each steam generator and is attached to the channel head using stud mounting as shown in Figure 4. A second sensor will be installed on the support ring of the steam generator tube sheet by the end of the first refueling outage. Figures 3A through 3D show the current and future steam generator sensor configurations.

2.0 Plant Operator Instructions for Use of the LPMS

Plant operations will be responsible for the routine operation of the system, for routine system checks and for logging LPMS alarms.

Alarm conditions which are abnormal will be reported to Plant Engineering for investigation and evaluation.

During all periods when the LPMS is operational the operator shall, upon illumination of the LPMS control room event light,

- check the Loose Parts Monitoring Panel to verify the alarm,
- record which channel(s) alarmed and forward information to Plant Engineering, and
- note if any valve testing or other transient conditions occurred concurrent with the alarm.

If the LPMS has alarmed for known reasons (stop valve testing for example) the operator may reset the alarms, verify that the alarms do not immediately return and listen to all previously alarmed channels to verify that no unusual sounds are present.

If one or more channels has alarmed and no reason can be identified (such as stop valve testing) then the operator will forward all information to plant engineering for resolution.

If one or more channels are in alarm and cannot be successfully reset or unusual sounds are present on any channel, an engineering evaluation will be performed.

3.0 Calibration of the LPMS and System Operability Checks

3.1 Initial Calibration

Initial calibration of the LPMS will involve simulation of a small loose part (i.e. 4 oz. metal object exhibiting a kinetic energy of 0.5 ft-lbs) by impacting the exterior of the reactor coolant system boundary at a distance of three feet from the sensor and verifying that each channel alarms.

As mentioned in Section 2.4, above, the actual alarm setpoints may vary slightly once the plant has begun operation and background noise levels have been determined.

Automatic actuation of the tape recorder and channel recording logic will also be verified during the initial calibration.

3.2 Routine Calibration

Subsequent calibrations will be conducted each refueling or every 18 months, whichever is greater. These calibrations will be conducted in the same manner described above for the initial system calibration, (i.e. impact exterior of the RCS boundary and verify alarm response) with the exception of the sensors located on the lower reactor vessel. To preclude excessive radiation exposure to personnel, alarm responses for these channels will be verified by inputting a test signal at the preamplifiers and observing that the channel alarms.

3.3 System Operability Checks

The following system checks will be conducted on a routine basis in accordance with the appropriate operating procedures to verify system operability.

1. At least once every 24 hours, a Channel Check will be performed by listening to each channel on the audio monitor and verifying that no alarms are present.

2. At least once every 31 days, a Channel Functional Check will be performed by depressing the system test button on the LPMS instrument panel and observing that all channels alarm. Automatic actuation of the tape recorder will also be verified.

4.0 Evaluation of Conformance to Regulatory Guide 1.133

4.1 Loose Parts Detection Program

The alarm setpoints will be selected so as to minimize the number of false alarms. Depending upon the background vibration levels which each of the 12 transducers is subjected to under normal operating conditions this alarm setpoint may be higher than that associated with a 4 oz. object impacting 3 ft. from a transducer with 0.5 ft.-lb. of Kinetic energy. Exact setpoints cannot be determined with any certainty until after the operation of the reactor plant commences.

4.2 Loose Parts Detection System

The LPMS at Millstone Unit No. 3 conforms to Regulatory Guide 1.133 (Revision 1, May 1981) with the following exceptions:

1. Only one sensor is located on each steam generator inlet plenum.

   Justification

   The system specifications were issued and the orders were placed prior to the issuance of Regulatory Guide 1.133. However, Northeast Nuclear Energy Company (NNECO) intends to install a second channel for each steam generator by the end of the first refueling outage, at which time, Position C.1.a will have been satisfied.

2. The LPMS is not qualified for an OBE.

   Justification

   NNECO has reviewed the qualifications of the LPMS to an OBE with the following results:

   A. The original eight (8) channels are installed in conduit that is not seismically designed, except those sections at the Reactor Vessel which are seismic. However, the conduits are attached to concrete and structural steel with spans less than eight (8) feet between conduit supports. In our judgment the conduits, as installed, will be able to perform their function following an OBE. The remaining four (4) channels (2nd Steam Generator channels) will be designed and installed to OBE criteria and will, therefore, meet RG 1.133.

   B. The accelerometers have been successfully tested to "g" levels which exceed the Millstone OBE. The accelerometer junction box and unsupported cable have not been specifically seismically designed. However, the junction boxes are securely mounted to the vessel. Therefore, considering the weight of the junction box and attached cable, it is our judgment that these assemblies will function following an OBE.

Based on the above NNECO considers that the Millstone Unit 3 LPMS meets the intent of RG 1.133, Section C.1.g.

3. A technical specification for the LPMS has not been provided.

Justification

The LPMS is not a safety related system. The LPMS is not used to support any of the safety analyses provided in Chapter 15 of the FSAR. Therefore, NNECO believes that a technical specification for the LPMS is inappropriate.

System checks and calibration requirements for the LPMS outlined in Regulatory Guide 1.133 will be conducted in accordance with plant operating procedures.

Table 1

LPMS Equipment Specifications

Sensors

Type: Piezoelectric Accelerometers
Manufacturer: Endevco Model 2273AMI
Sensitivity (Charge): 10.0 ± 1 pC/g
Temperature Range: -65°F to 700°F

Acceleration Limits: Vibration 500 g pk in any direction
Shock 3000 g pk in any direction

Humidity: Hermetically sealed by welding and by ceramic/metal seal in connector

Radiation: Integrated Gamma Flux accelerometers of similar design have been subjected to 6.2×10^{10} rad without functional degradation

Integrated Neutron Flux accelerometers of similar design have been subjected to 3.7×10^{18} n/cm^2 without functional degradation

Type: Piezoelectric Accelerometers
Manufacturer: Rockwell Model 76M1
Temperature Range: 0°F to 650°F
Vibration: 100g
Humidity: 0 to 100%
Radiation: Integrated Gamma Flux 1×10^{10} rad
Integrated Neutron Flux 1×10^{18} n/cm^2

Preamplifier

Type: Remote Charge Converter (Installed outside containment)
Manufacturer: B&K 2634
Conversion Gain: Adjustable 0.9 to 10 mV/pC
Temperature Range: -40°C to 55°C
Harmonic Distortion: Less than 1%

Magnetic Tape Recorder

Reel Capacity: Up to 10 1/2" Reel
Tape Speed: 7 1/2 and 3 3/4 ips (±0.7%)

Frequency Response: 30 to 21,000 Hz ± 3 dB at 7 1/2 ips
30 to 15,000 Hz ± 3 dB at 3 3/4 ips

Signal to Noise Ratio: Greater than 54 dB (measured via tape with peak recording level of +6 VU)

FIGURE 1

REACTOR VESSEL SENSOR LOCATIONS (UPPER VESSEL)

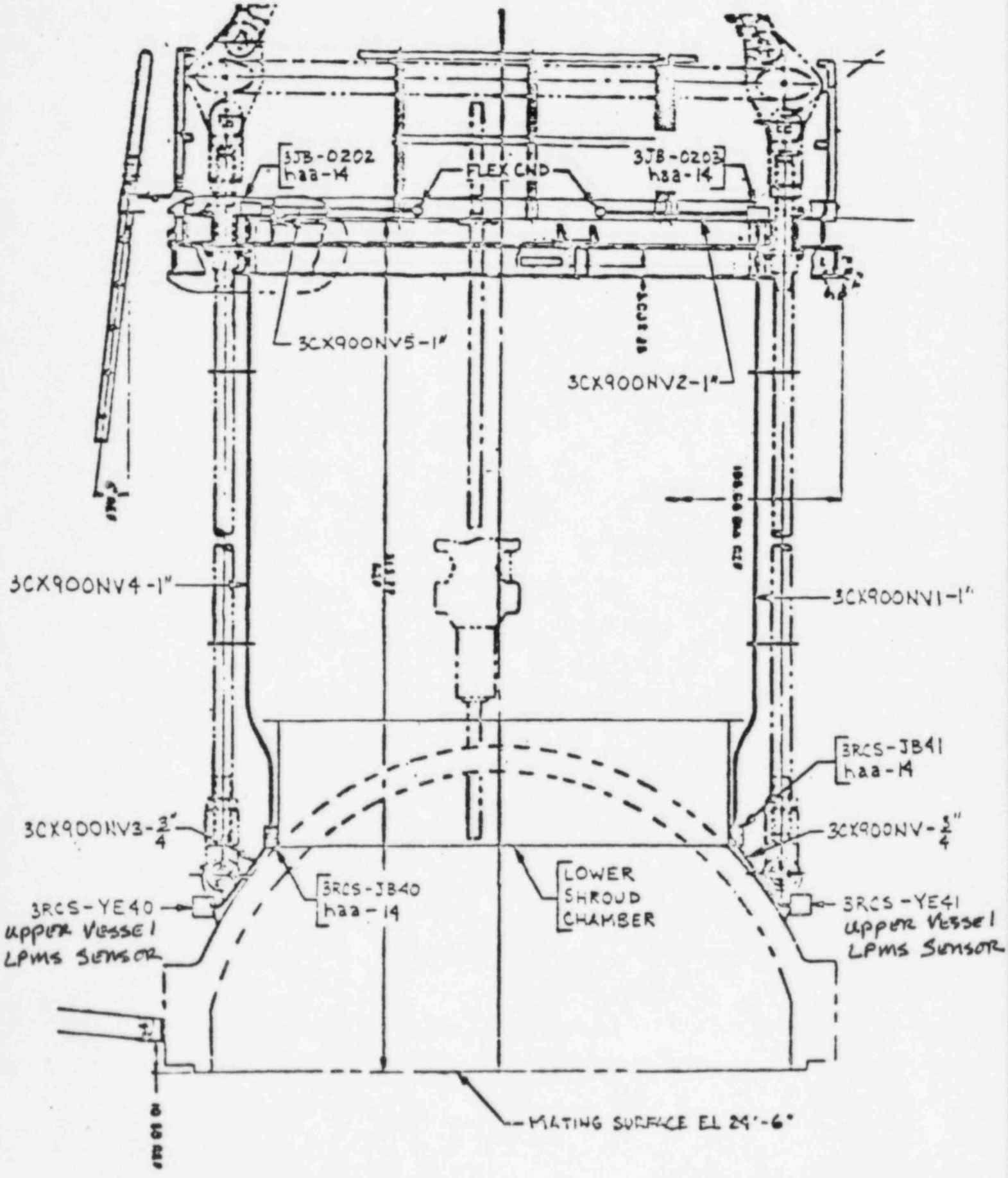
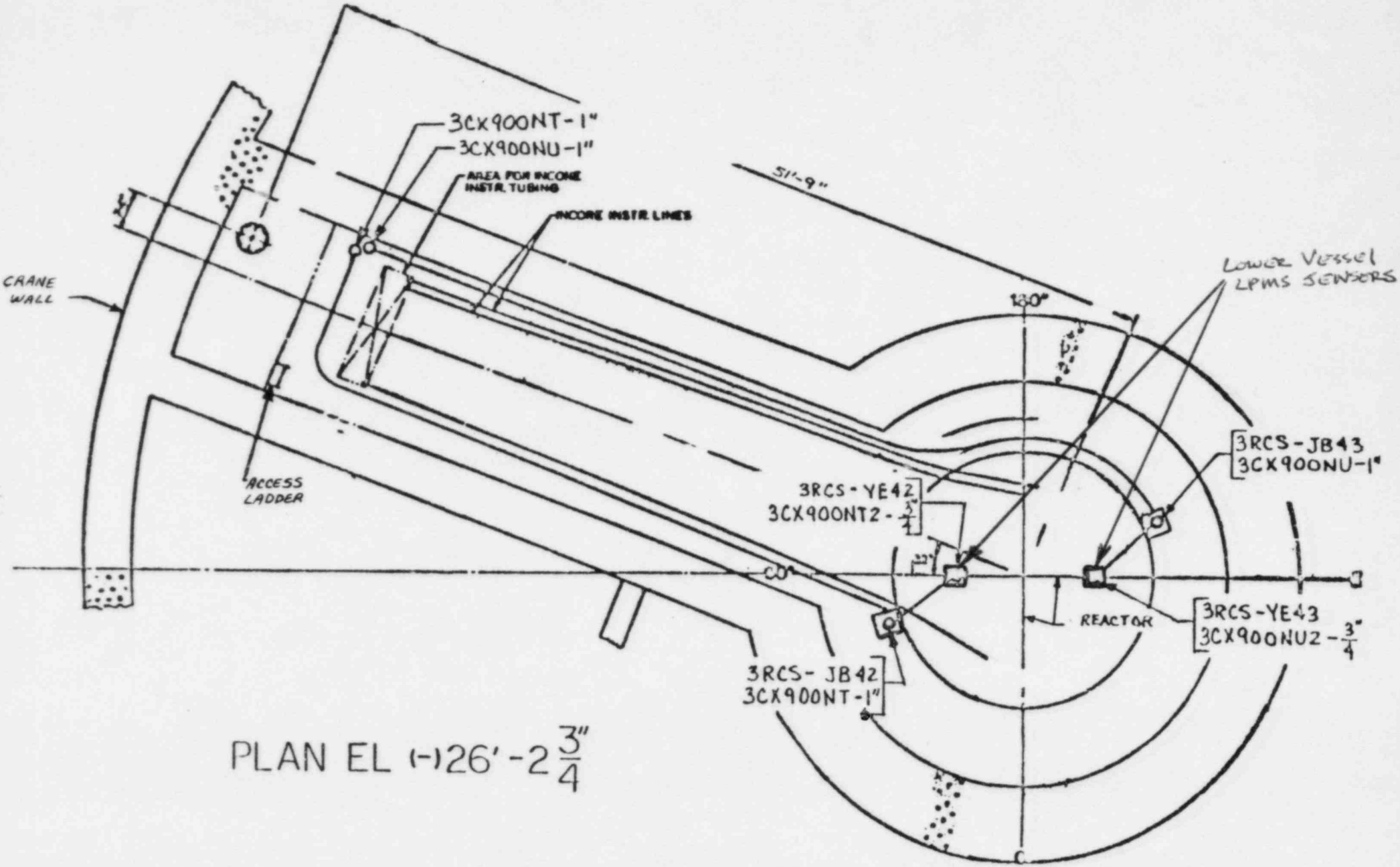


FIGURE 2

REACTOR VESSEL SENSOR LOCATIONS (LOWER VESSEL)



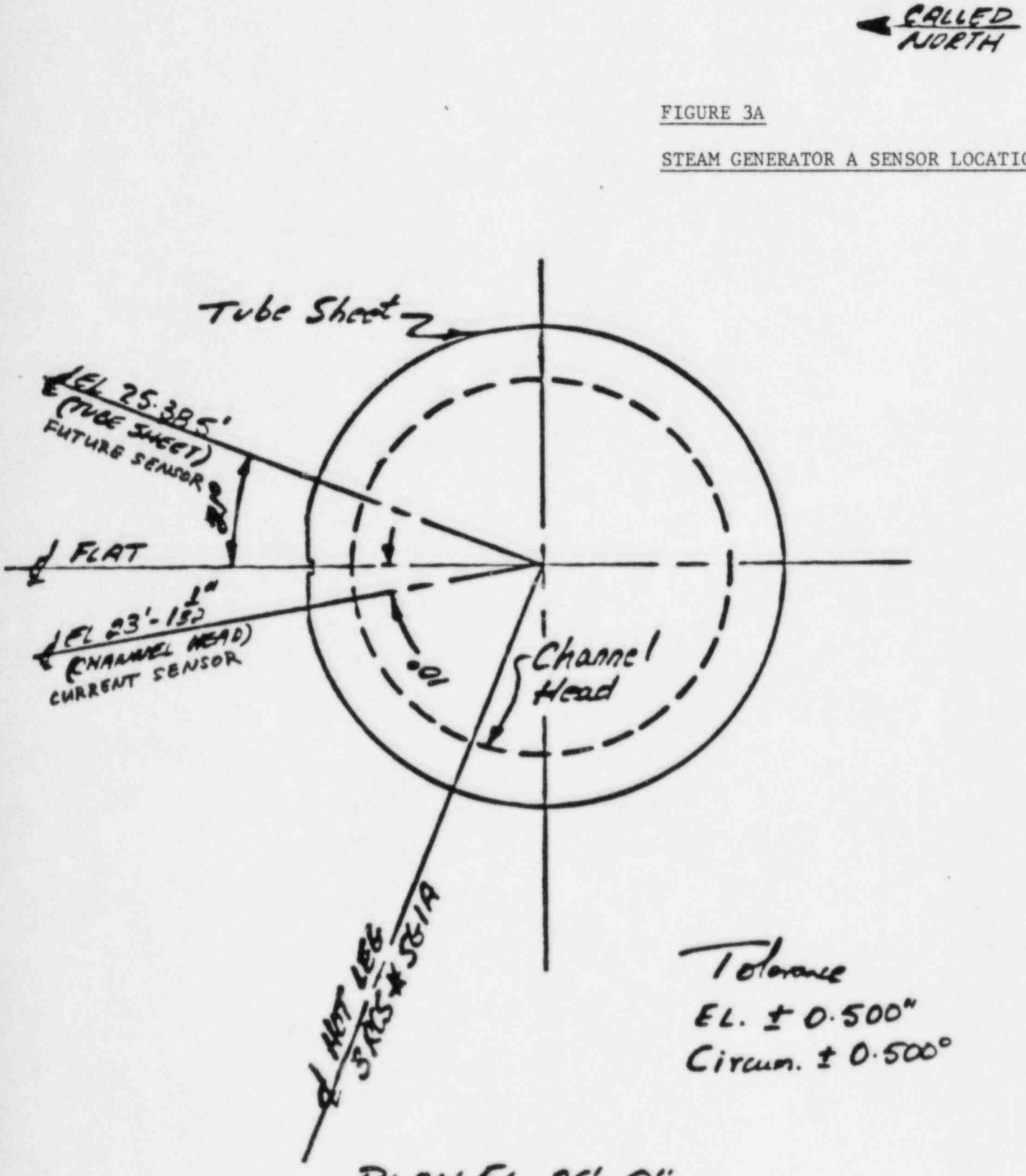


FIGURE 3A

STEAM GENERATOR A SENSOR LOCATION

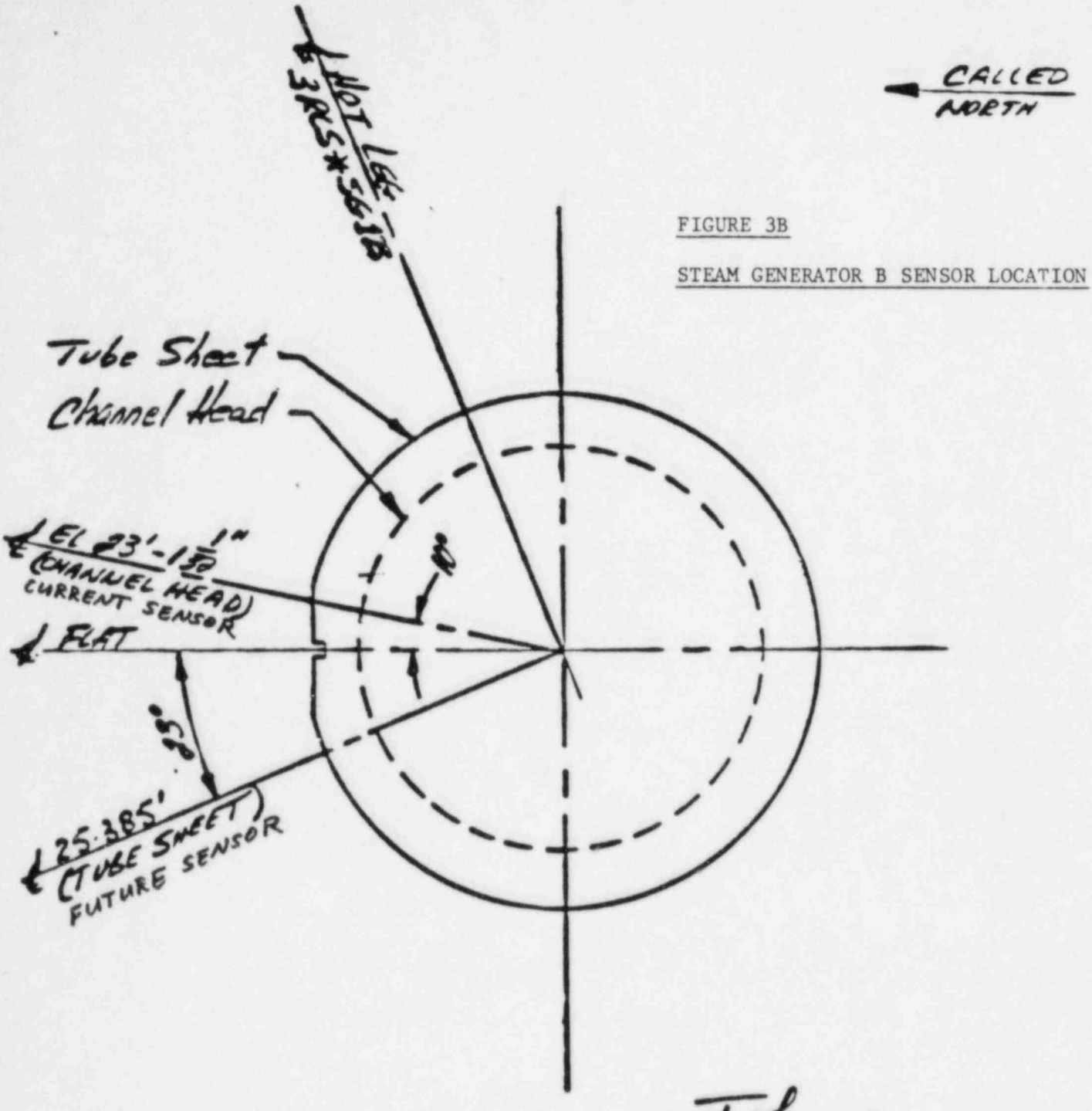
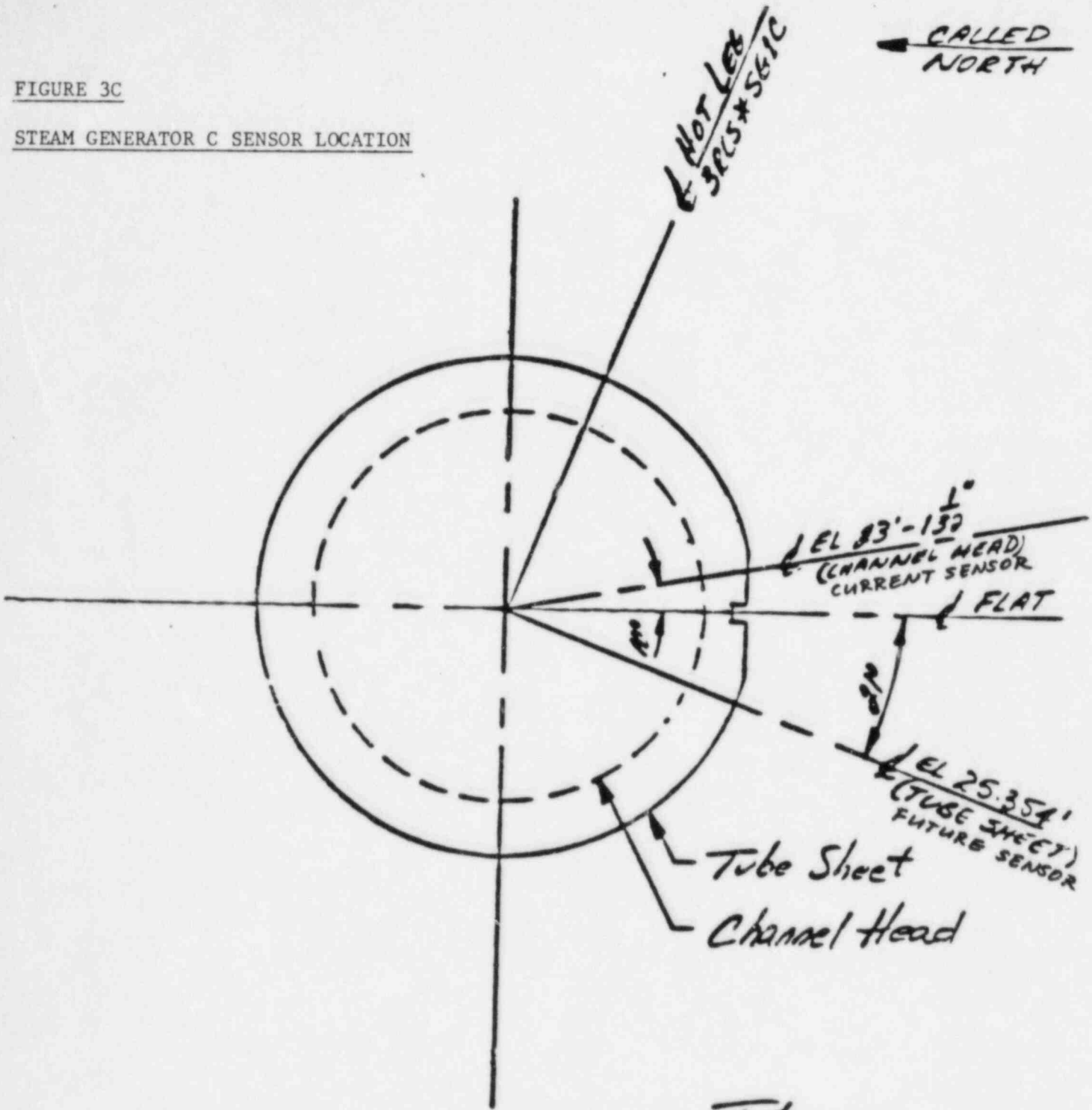


FIGURE 3B

STEAM GENERATOR B SENSOR LOCATION

FIGURE 3C

STEAM GENERATOR C SENSOR LOCATION



PLAN EL 26'-0"

Tolerance
EL. ± 0.500"
Circum. ± 0.500"

FIGURE 3D

STEAM GENERATOR D SENSOR LOCATION

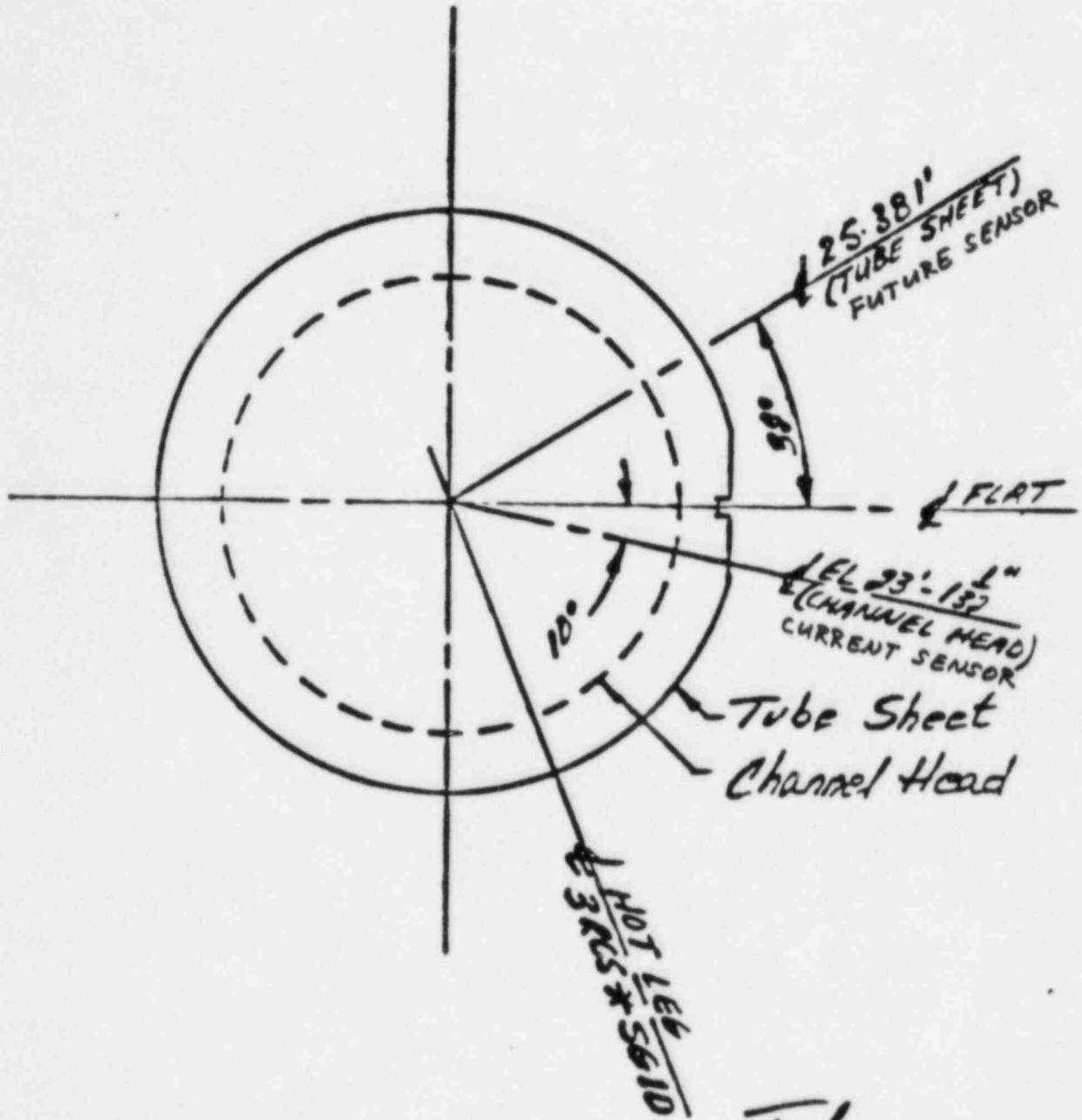


FIGURE 4

STUD MOUNTING CROSS SECTION