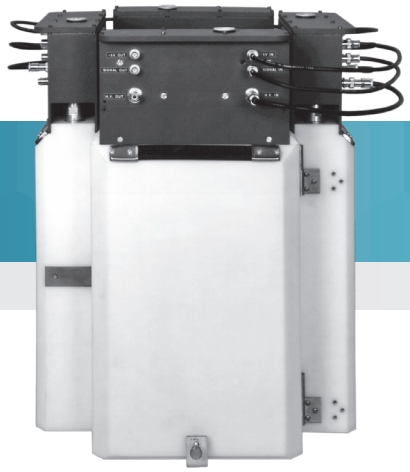
MIRION TECHNOLOGIES

JCC-71™/JCC-72™/JCC-73™

Neutron Coincidence Collars



JCC-71 Collar (Passive)

KEY FEATURES

- Designed for neutron coincidence measurement of uranium in PWR, BWR and CANDU fuel assemblies, or plutonium in MOX fuel assemblies
- Variable sample cavity size (Model JCC-71 unit)
- Fast Amptek electronics
- ^{3}He detectors
- Transportable
- Optional transport container
- Authorized for routine inspection use by the International Atomic Energy Agency (IAEA) as the Uranium Neutron Collar (UNCL and UNCL II)

DESCRIPTION

The Model JCC-71 Neutron Coincidence Collar is a passive/active neutron counter for the measurement of the ^{235}U content per unit length in fresh PWR, BWR and CANDU fuel assemblies. The JCC-71 unit can also be used to measure the plutonium content of MOX fuel. The system design is based on technology transfer from the Los Alamos National Laboratory.

The JCC-71 system is made up of four counter banks, each composed of high-density polyethylene for the moderation of the fission neutrons. Each bank contains several ^{3}He detectors for the detection of neutrons. The counter can operate in both an active mode and a passive mode. For the passive mode, all four counter banks are used around the fuel assembly. If operated in the active mode, one bank of detectors is replaced with a polyethylene bank containing only an Americium-Lithium (AmLi) interrogating source. (The AmLi source must be ordered separately.)

In the active mode, the AmLi source is required to interrogate the fuel, and coincidence counting of the induced fission neutrons from ^{235}U is performed. The AmLi source is contained in a tungsten source bottle and placed inside the polyethylene bank. The AmLi neutrons are thermalized in the polyethylene and induce fission in the ^{235}U. The average energy from the induced fission is higher than the moderated AmLi neutrons and gives fast neutron multiplication which allows the measurement to penetrate into the interior of the fuel assemblies. For HEU fuel, cadmium liners can be added to improve neutron penetrability.

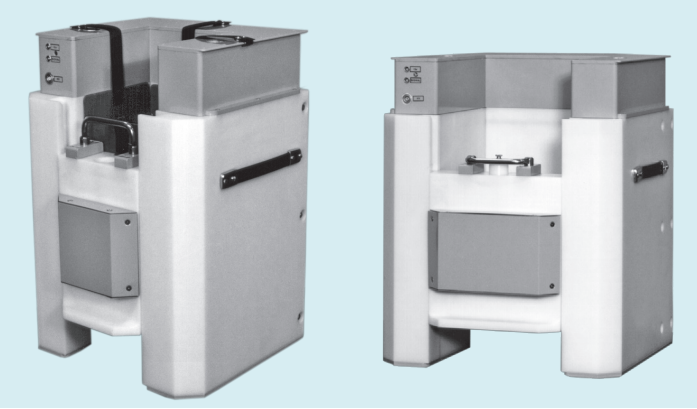
To measure the ^{238}U content, the bank with the AmLi source is replaced by the fourth bank of ^{3}He detectors, and the counter is operated in a passive mode, counting the coincidence neutrons from spontaneous fission of ^{238}U. The collar measures the ^{235}U and ^{238}U content along the axis of the assembly, not the enrichment. Since the ^{235}U content is of primary interest for safeguard purposes, only the active measurement is typically necessary. Pu-containing fuel rods are measured in the passive mode because of the relatively high spontaneous fission rate.

The JCC-71 Neutron Coincidence Collar is designed to allow modification of the geometry to closely couple the detectors with the fuel type. For the smaller BWR fuel, the side detector banks are moved into the inner screw-hole position. The fourth bank of ^{3}He detectors (used in passive mode) is hinged in order to facilitate placing the counter around fuel assemblies.

The Neutron Coincidence Collar is designed to be insensitive to parameters such as open channels for control rods, enrichments, angular orientation of the fuel in the Collar, fuel pellet density, and any protective bagging. Cladding type (zinc alloy or stainless steel), different fuel pellet diameters, and neutron absorbers (Gd2O3) can affect the measurement.

A Neutron Coincidence Analyzer (or shift register), a computer, and analysis software are required for coincidence counting and must be purchased separately from the JCC-71 collar.

The increased use of neutron collars at various facilities for measuring designated fuel types (BWR or PWR), led to two additional designs by Los Alamos National Laboratory. The two additional neutron collar counters are the JCC-72 collar for BWR and CANDU fuel assemblies, and the JCC-73 collar for PWR fuel assemblies.



JCC-72 Collar (Active)

JCC-73 Collar (Active)

SPECIFICATIONS

PERFORMANCE

- HV Setting – 1680 V.
- Required AmLi Source Strength – JCC-71 collar, 5×10^4 n/s; JCC-72 and JCC-73 collars, 1×10^5 n/s. (not included with counter).
- Gate Setting – 64 µs.
- Efficiency – JCC-71 Collar (Passive, PWR Configuration), 11.5% ±10%; JCC-72 Collar (Active), 13.5% ±10%; JCC-73 Collar (Active) 12.5% ±10%.
- Sensitivity (JCC-71 collar)[1,2] – 2.2 rods for iron substitution; 2.8 rods for empty substitution.

2. Sensitivity is defined as the minimum number of rods that can be substituted and detected in a 1000 second count at a confidence level of 2 sigma.

PHYSICAL

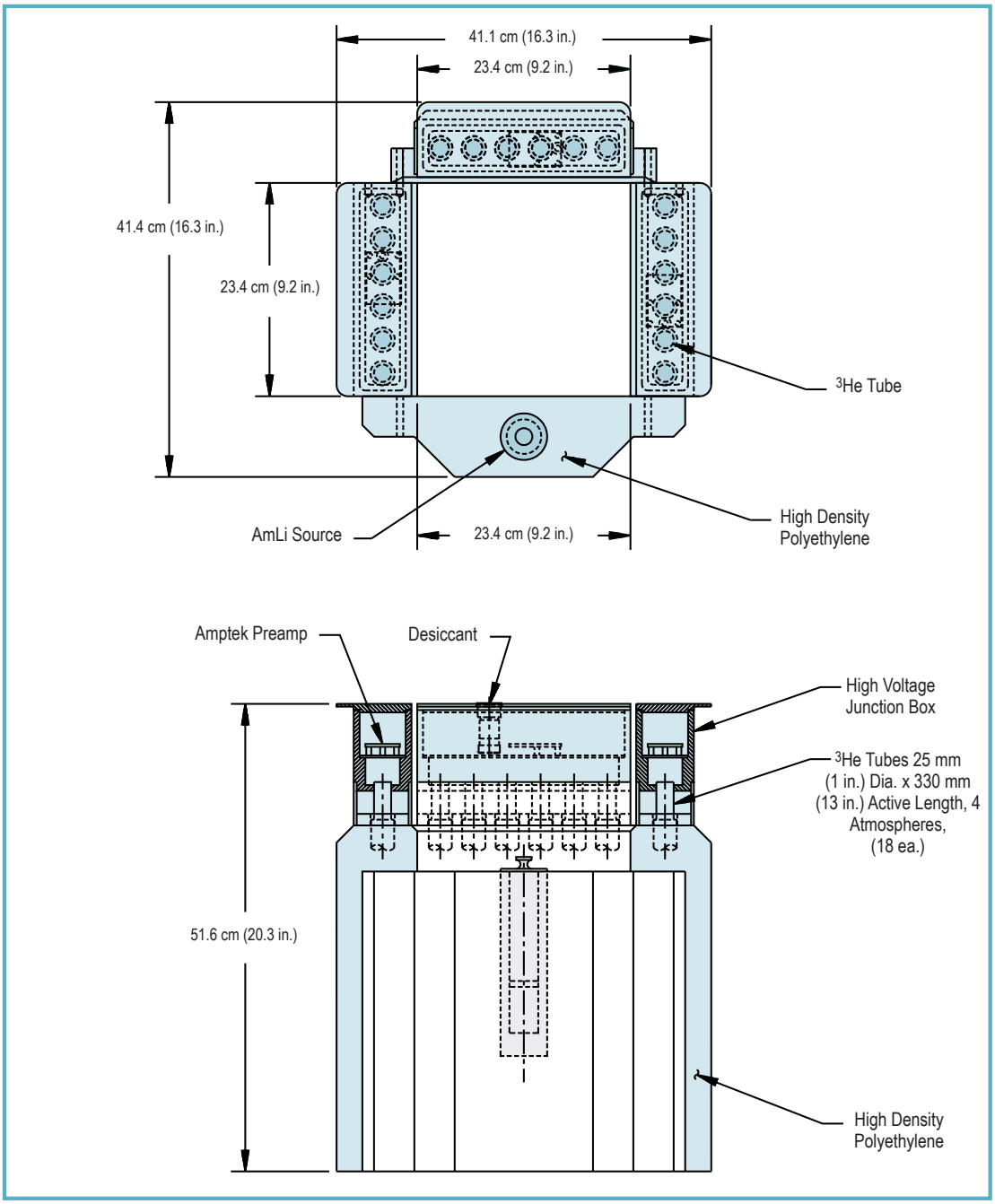
- Weight – JCC-71 collar, 38 kg (84 lb).
- Sample Cavity Size
  - PWR Assemblies – 41.4 x 23.4 x 23.4 cm (16.30 x 9.21 x 9.21 in.) H x L x W.
  - BWR/CANDU Assemblies – 41.4 x 16.5 x 23.4 cm (16.30 x 6.5 x 9.21 in.) H x L x W.
- ^{3}He Tubes
  - JCC-71 (Passive Mode) Collar – 24.
  - JCC-71 (Active Mode) Collar – 18.
  - JCC-72 (Active Mode) Collar – 16.
  - JCC-73 (Active Mode) Collar – 20.
- ^{3}He Active Length – 33 x 2.54 cm (13 x 1 in.) L x Dia.
- Cladding – Aluminum.

OPTIONS

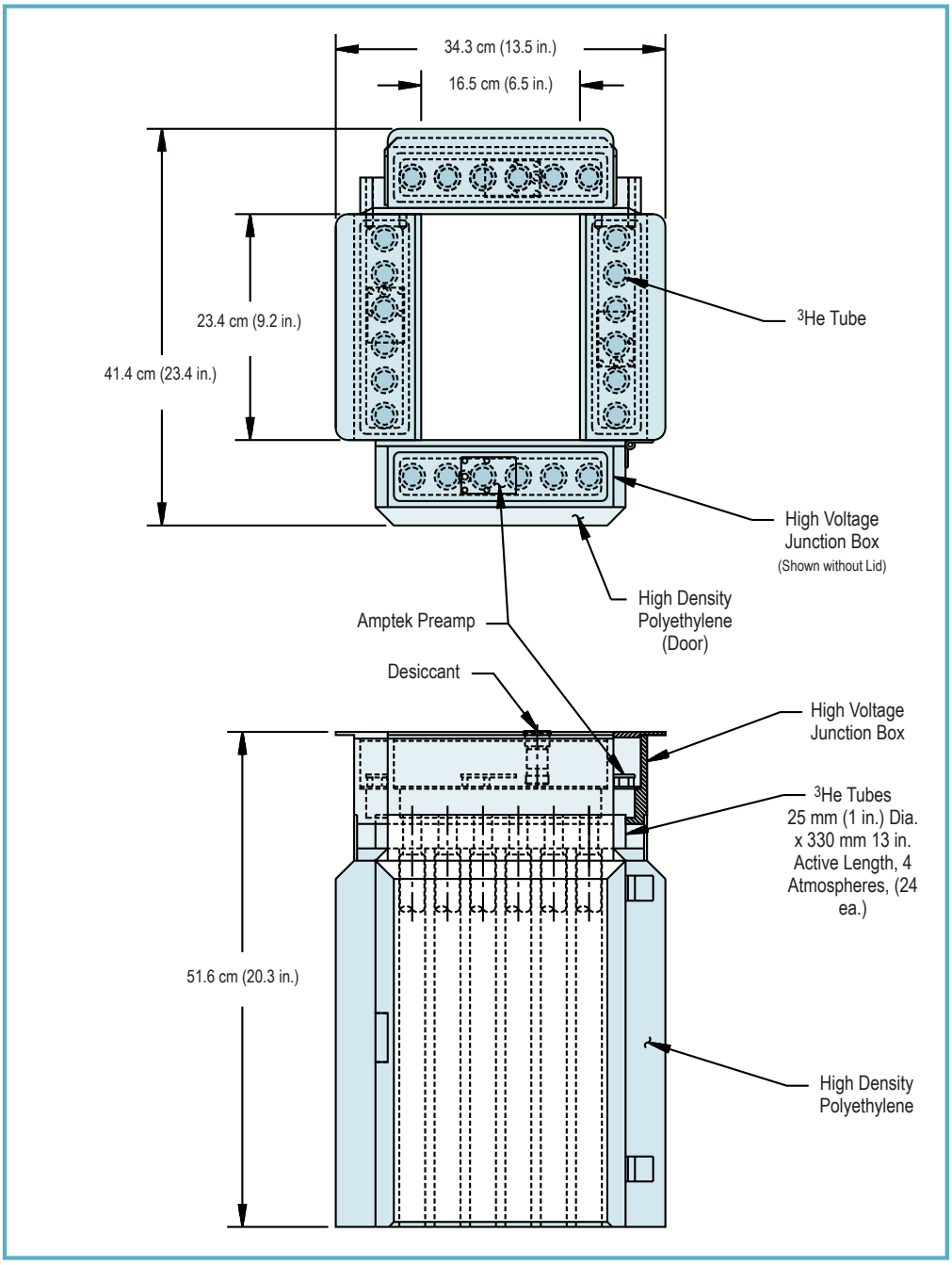
- Passive fourth bank for JCC-72 and JCC-73 collars.
- ^{252}Cf neutron source for verifying proper operation.
- Cart to vary the vertical and horizontal position of the counter.

REFERENCES

1. Menlove, Howard A. (1981). Description and Performance Characteristics for the Neutron Coincidence Collar for the Verification of Reactor Fuel Assemblies. *Los Alamos National Laboratory Report LA-8939-MS*. Los Alamos, New Mexico.



JCC-71 Collar, PWR Active Configuration



JCC-71 Collar, PWR Passive Configuration

ISO 9001 SYSTEM CERTIFIED
MERIDEN CT
SMYRNA GA
OAK RIDGE TN
CONCORD ON

CANBERRA