

Used Nuclear Fuel Dry Storage Cask Materials Monitoring System

A Proof of Concept to Deploy and Retrieve Monitoring Equipment

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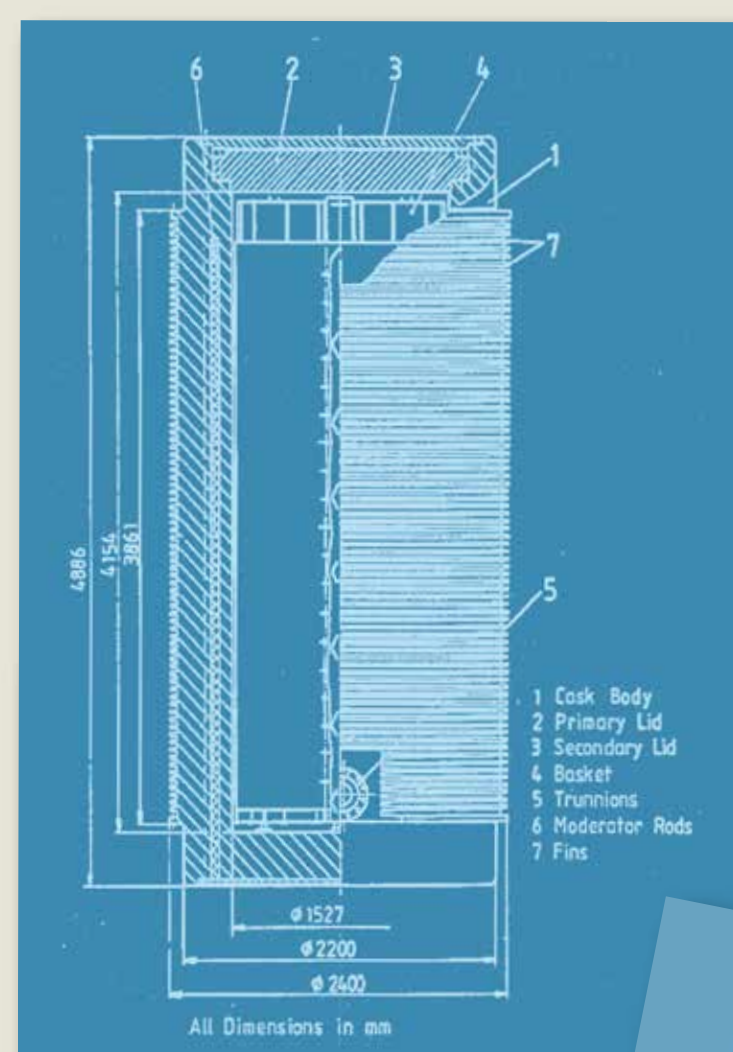


OBJECTIVES

In the "Gap Analysis to Support the Extended Storage of Nuclear Fuel," Rev. 0 (PNNL-20509, 2012), several technology needs were identified to close the technology gaps to allow extended storage in existing transportation and storage casks.

The cask materials monitoring system addresses three of the gaps identified:

- (1) Develop systems for early detection of confinement boundary degradation, monitor cask environmental changes, and transmit data without compromising cask or canister boundary;
- (2) Measure temperatures within the cask; and
- (3) Develop systems for early detection of corrosion.



CASK DESCRIPTION

CASTOR V/21

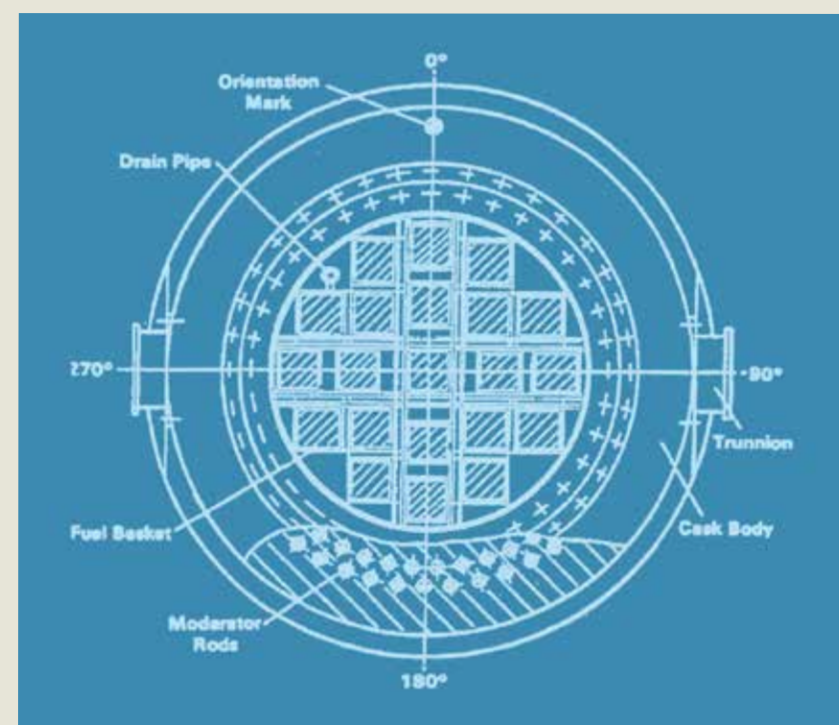
- Previous inspection data
- Various materials of construction
- Constructed of ductile cast iron
- 4.89 m (16 ft) tall
- 2.4 m (8 ft) diameter
- Inner cavity length is 4.15 m (13 ft-7 in)
- Inner cavity diameter is 1.53 m (5 ft)
- Inner surfaces have a galvanic-applied nickel plating

CASTOR V/21 Lid

- Stainless steel
- 1.8 m (6 ft) diameter
- 0.29 m (1 ft) thick

Fill/Drain Port

- 35 mm (1.37 in) diameter
- Sealed with two flanges
- Outer metal o-ring seal
- Inner elastomer o-ring seal



Spent Fuel Basket

- Positions the used nuclear fuel
- Tight spaces
- 55 mm (2.3 in) between top of basket and top of assemblies

Fill/Drain Pipe

- Location corresponds to fill/drain port on lid
- Inner diameter of 40 mm (1.6 in)

CASK MATERIALS MONITORING SYSTEM DESIGN

The cask materials monitoring system provides a method to deploy and retrieve monitoring equipment through the cask primary lid fill/drain port. The system consists of:

Monitoring Module

- Contains the equipment for monitoring the cask environment

Sliding Shield Plug

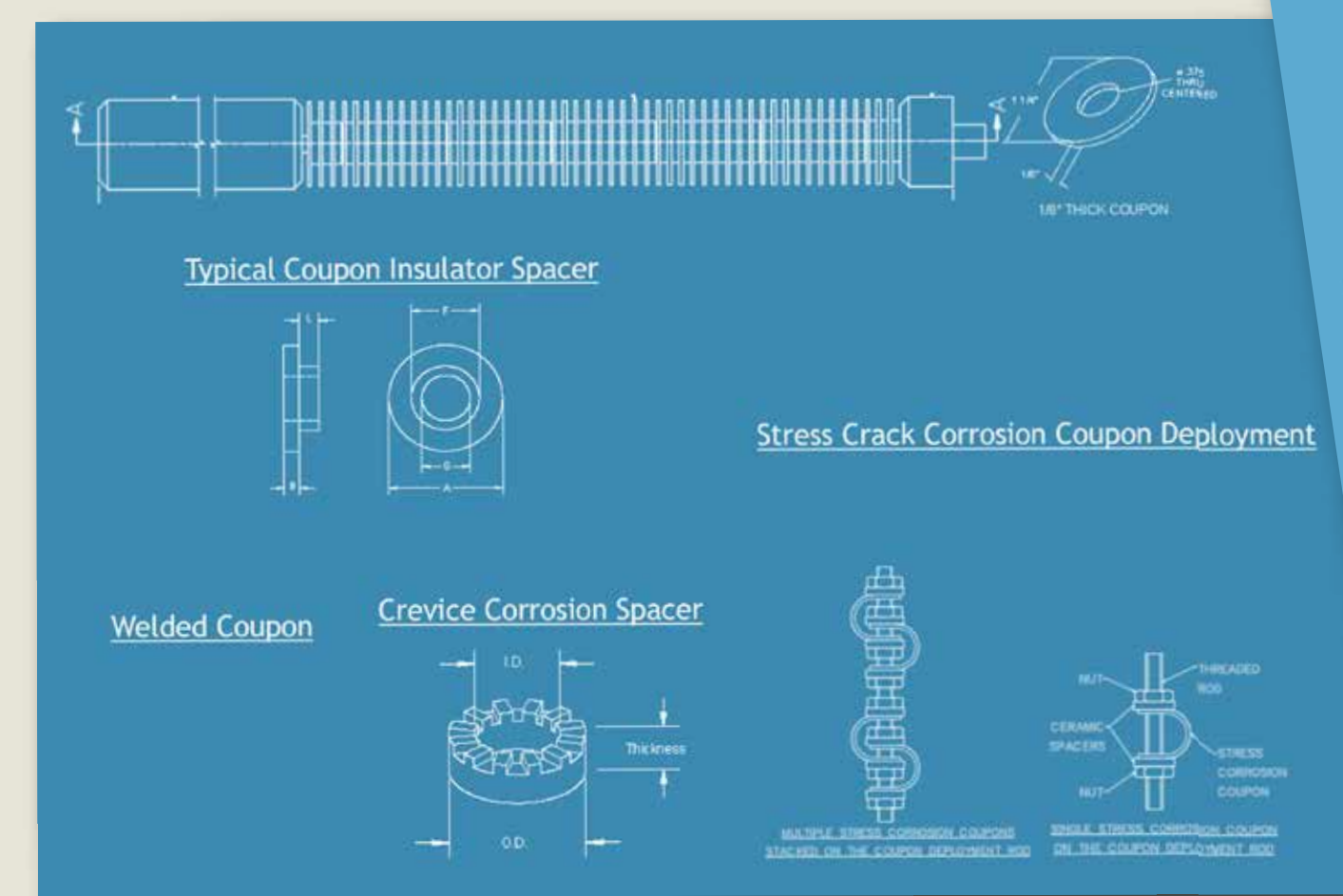
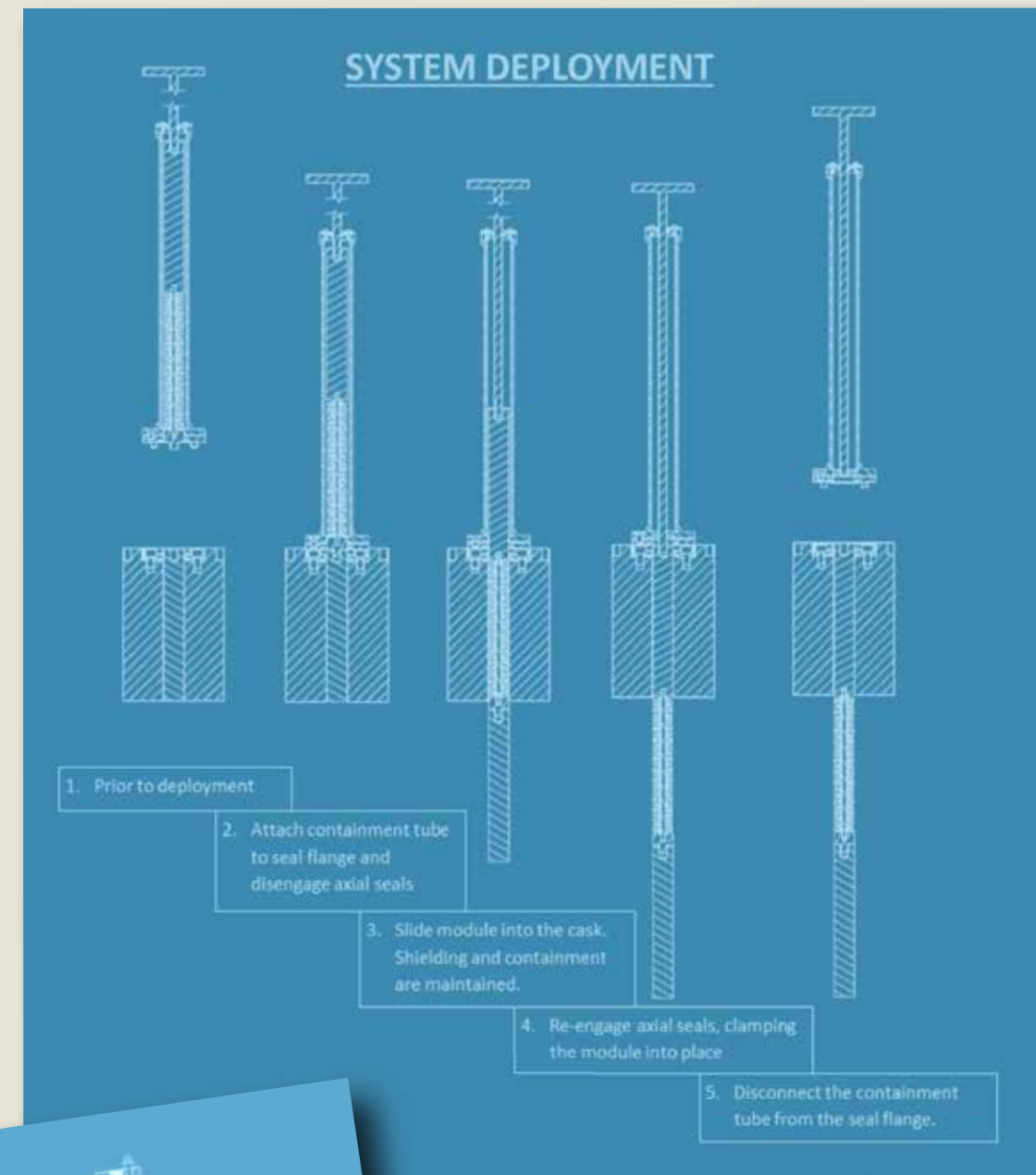
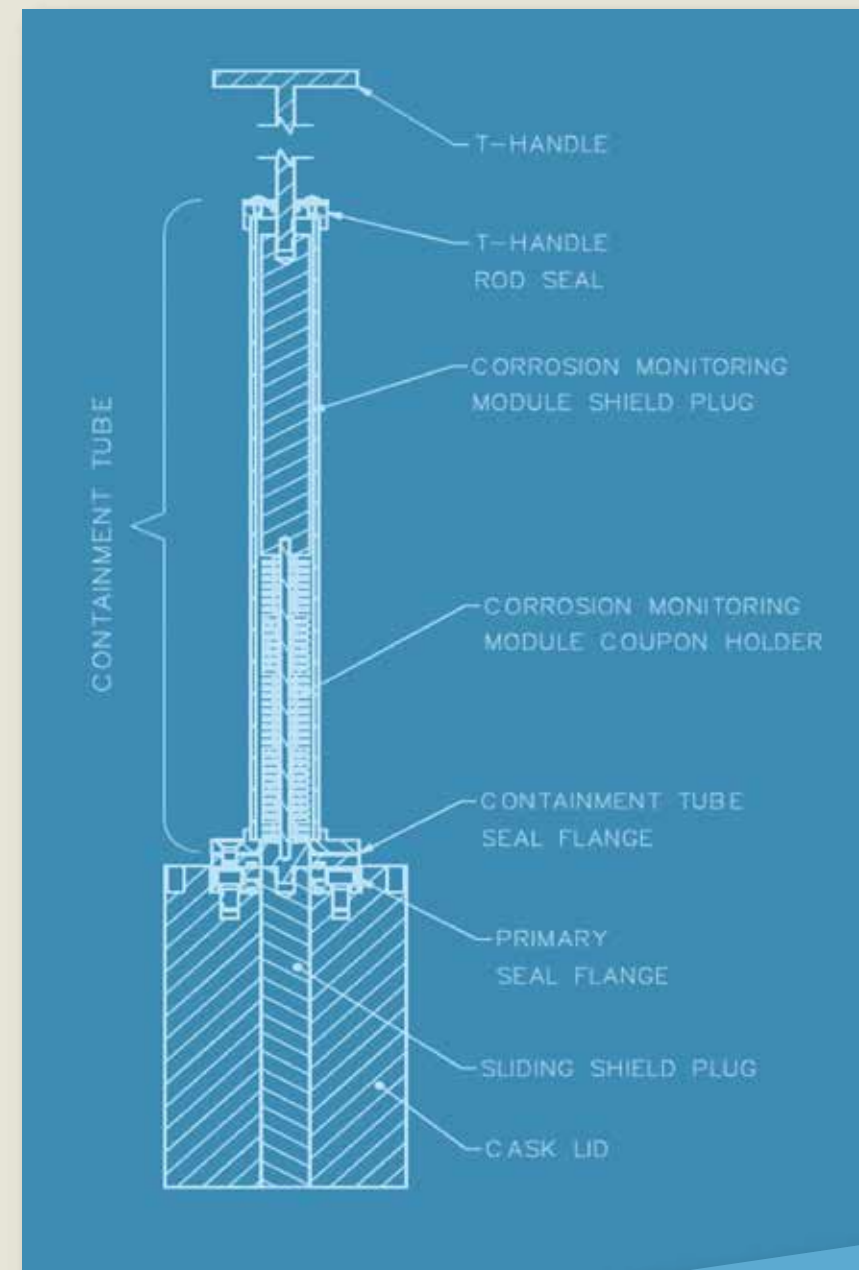
- Provides shielding when module is not deployed
- Slides out of the way for module deployment

Primary Seal Flange

- Bolted directly to cask lid
- Seals cask for long-term storage
- Allows release of seal for module retrieval
- Interfaces with containment tube to provide cask confinement at all times

Containment Tube

- Allows deployment of module without loss of confinement
- Provides containment of monitoring equipment before and after deployment

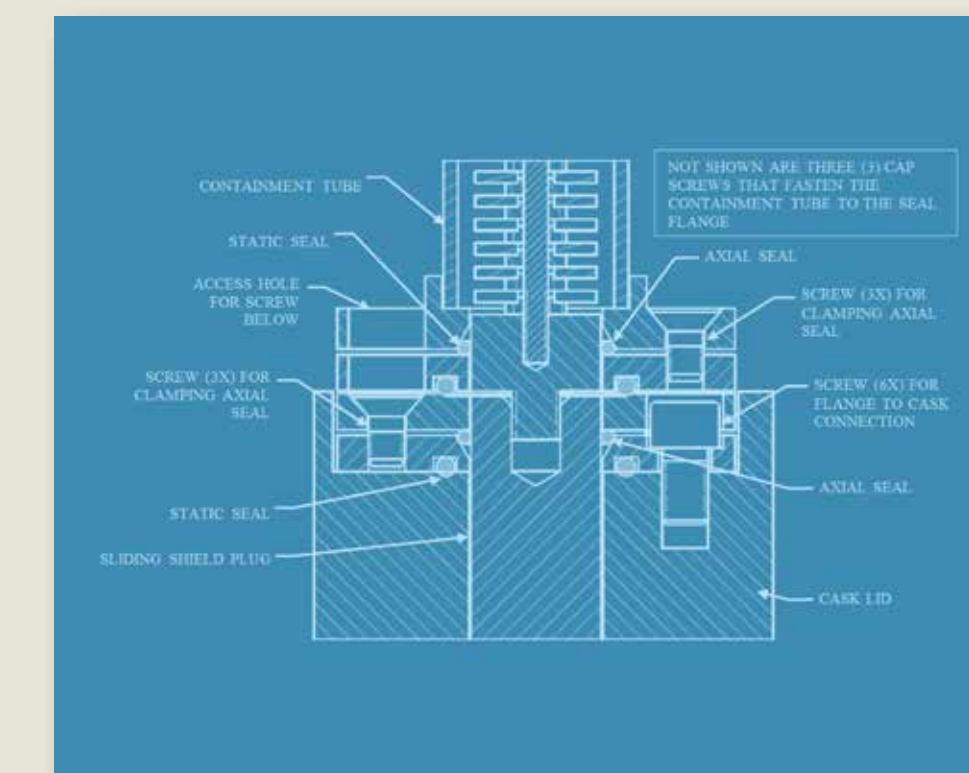


CORROSION MONITORING MODULE

Disc corrosion coupons are standard industry coupons to measure corrosion. Typical disc coupons can be stacked on a rod with insulating corrosion coupons and deployed with the CMMS.

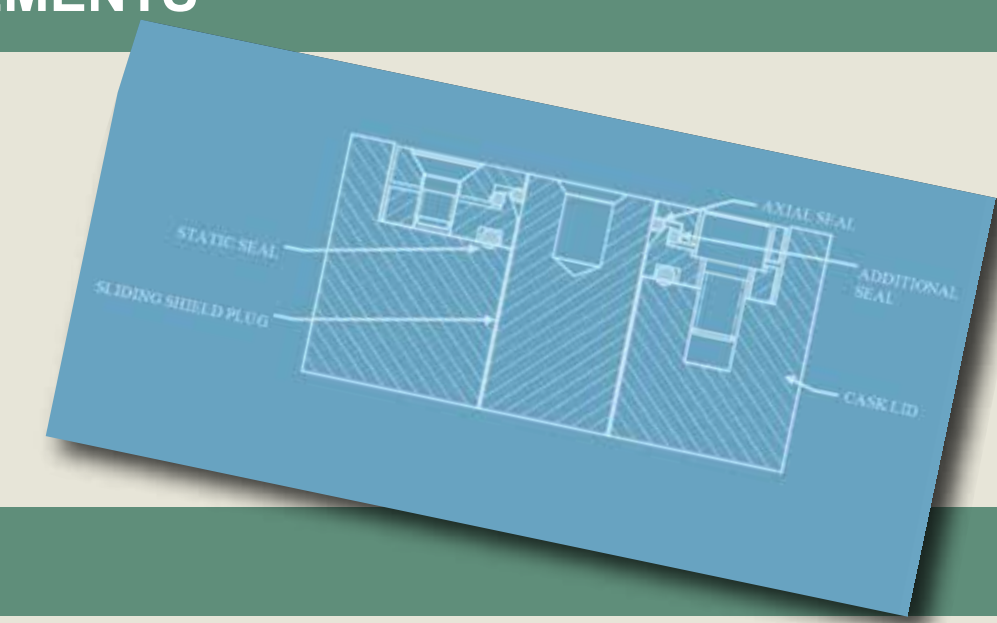
CLAMPING SEAL DESIGN

- Provides positive seal for atmospheric containment
- Clamps the module in place



DESIGN IMPROVEMENTS

- Additional seal required to maintain confinement



ADDITIONAL MODULE CONCEPTS FOR FUTURE WORK

- Potential to integrate the system for:
- Camera deployment
 - Temperature monitoring
 - Moisture monitoring
 - Sample cylinder for gas sampling
 - Gas-adsorbing coupon
 - Active gas sampling when other cask penetrations are not available

CONCLUSIONS

Capabilities of In-Situ Inspections and Monitoring

- Corrosion monitoring: The cask materials monitoring system has the capability to quantify corrosion rates (or lack of corrosion) with actual corrosion coupons located within the cask environment.
- Inspection without disturbing the cask atmosphere: The capability of performing temperature, radiation, and detailed visual inspection without compromising the cask confinement barrier is of great potential.

Limitations to In-Situ Inspections and Monitoring

- Limited access for fuel assembly inspection
- Limited to partial inspections of the fuel storage basket
- Limited to partial inspections of cask body inner surfaces
- Limited inspection of the cask lid seals
- Inability to remove fuel for external examination

Future Work

- Integration of the camera inspection system and CMMS
- Development of a prototype CMMS for deployment on the CASTOR V/21 cask (or other similar cask)
- Development of additional monitoring modules to be used with the CMMS

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