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Failure mechanism and consolidation of the compensation bellows of the LHC cryogenic distribution line

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Beginning of year 2013, after the first three years of operation, the Large Hadron Collider (LHC) was progressively emptied from helium and warmed up to the ambient temperature in order to perform during its first long shutdown all necessary consolidation and maintenance of different technical systems. During the warm-up, six helium leaks were declared on the cryogenic distribution line (QRL). All the leaks were detected on main header supplying supercritical helium at 4.5 K during normal LHC operation. Following complex investigation based on combination of time-of-flight leak detection over 400-m long vacuum sub-sectors and X-rays, the leaks have been localized on the compensation bellows required for longitudinal thermal contraction. During the investigation, some compensation bellows were found damaged but not leaky yet, amounting to the total number of 16 bellows to be repaired.

This paper will present the investigation method for the localization of damaged bellows, the failure mechanism and the applied improvements in the bellows design. The QRL repair procedures and the final leak-tightness validation campaign will be also described.

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