Let $\phi_{1s}(r) = \frac{1}{\sqrt{\pi a_0^3}} e^{-r/a_0}$ be 1-s hydrogen orbital

Wave function of e-p system is

$$f(\vec{x},\vec{y},t) = e^{-iEt}\,\phi_{1s}(|\vec{x}-\vec{y}|)\,e^{i\vec{P}\cdot\vec{r}_{CM}},$$

where

$$\vec{r}_{CM} = \frac{m_e\vec{x} + m_p\vec{y}}{m_e + m_p}$$

$$E = \frac{P^2}{2(m_e+m_p)} - E_0,$$

where E_0 = binding energy of 1-s state.

$$|f\rangle = \int d^3\vec{x}\int d^3\vec{y}\;\psi_e^\dagger(\vec{x},t)\,\psi_p^\dagger(\vec{y},t)|0\rangle\, f(\vec{x},\vec{y},t).$$

No symmetrization is needed since the particles are distinguishable. A normalization integral involves

$$\langle 0|\,\psi_p(\vec{y},t)\,\psi_e(\vec{x},t)\,\psi_e^\dagger(\vec{x}',t)\,\psi_p^\dagger(\vec{y}',t)|0\rangle$$

$$= \langle 0|\psi_p(\vec{y},t)\,\{\psi_e(\vec{x},t),\psi_e^\dagger(\vec{x}',t)\}\,\psi_p^\dagger(\vec{y}',t)|0\rangle$$

$$+ \langle 0|\psi_p(\vec{y},t)\,\psi_e^\dagger(\vec{x}',t)\,\psi_p^\dagger(\vec{y}',t)\,\psi_e(\vec{x},t)|0\rangle$$

(since ψ_e & $\psi_p^\dagger$ anticommute at equal time).

$$= \delta^{(3)}(\vec{x}-\vec{x}')\,\langle 0|\,\psi_p(\vec{y},t)\,\psi_p^{\dagger}(\vec{y}',t)\,|0\rangle \;+0$$

$$= \delta^{(3)}(\vec{x}-\vec{x}')\,\delta^{(3)}(\vec{y}-\vec{y}').$$

There is no δ-fn between $\vec{x}$ & $\vec{y}'$ or $\vec{y}$ & $\vec{x}'$, since fields for different types of particle (anti) commute.