In any notation:

Claim: $D_k^{(i)} = \{ p : q_{k+1} \le P_{(k)}^{(i)}, q_{k+2} \le P_{(k+1)}^{(i)}, \dots q_m \le P_{(m-1)}^{(i)} \}$

as $D_k^{(i)}$: event that $\le k-1$ hypotheses are rejected?

$$\{P_i > q_{\nu+s}\} \cap C_{\nu,s}^{(i)} = \{P_i > q_{\nu+s}\}$$

$$D_u^{(i)} = \left(D_u^{(i)} \cap \{P_i \le q_{\nu+s}\} \right) \cup D_u^{(i)} \cap \{P_i > q_{\nu+s}\}$$

$$= \bigcup_{j \le k} C_j^{(i)} \cap \{P_i \le q_{\nu+s}\} \cup \bigcup_{j \le h} C_j^{(i)} \cap \{P_i > q_{\nu+s}\}$$

$= \{P_{j_0}^{(i)} > q_{\nu+s}\}$

$= \{P_{j_0}^{(i)} > q_{\nu+s}\}$ same $j_0 = 1, 2, \dots, k\}$.

$= \{P_i > q_{\nu+s}\}$