1. $e_1 \le e_2$

$$\frac{\begin{array}{c} E \vdash e_1 \Downarrow v_1 \\ E \vdash e_2 \Downarrow v_2 \\ v_1 \le v_2 \end{array}}{E \vdash e_1 \le e_2 \Downarrow \text{True}} \qquad \frac{\begin{array}{c} E \vdash e_1 \Downarrow v_1 \\ E \vdash e_2 \Downarrow v_2 \\ v_1 > v_2 \end{array}}{E \vdash e_1 \le e_2 \Downarrow \text{False}}$$

2.

$$\cfrac{\cfrac{\text{Int } 2}{E \vdash 2 \Downarrow 2}\text{(E-Int)} \quad \cfrac{\cfrac{\text{Ident } x \quad E[x \triangleleft 2](x) = 2}{E[x \triangleleft 2] \vdash x \Downarrow 2}\text{(E-Ident)} \quad \cfrac{\text{Int } 1}{E \vdash 1 \Downarrow 1}\text{(E-int)}}{E[x \triangleleft 2] \vdash (1+x) \Downarrow 3}\text{(E-plus)}}{E \vdash \text{Let } x = 2 \text{ in } (1+x) \Downarrow 3}\text{(E-let)}$$

3.

$$\frac{\begin{array}{c} E \vdash e_1 \Downarrow v_1 \\ E \vdash v_1 < 0 \\ E \vdash e_2 \Downarrow v_2 \end{array}}{E \vdash \text{testsign } e_1 e_2 e_3 e_4 \Downarrow v_2} \qquad \frac{\begin{array}{c} E \vdash e_1 \Downarrow v_1 \\ E \vdash v_1 == 0 \\ E \vdash e_3 \Downarrow v_2 \end{array}}{E \vdash \text{testsign } e_1 e_2 e_3 e_4 \Downarrow v_3} \qquad \frac{\begin{array}{c} E \vdash e_1 \Downarrow v_1 \\ E \vdash v_1 > 0 \\ E \vdash e_4 \Downarrow v_2 \end{array}}{E \vdash \text{testsign } e_1 e_2 e_3 e_4 \Downarrow v_4}$$

4.

$$\frac{\langle e_1, E \rangle \;\rightarrow\; \langle e_1', E \rangle}{\langle \text{testsign } e_1\, e_2\, e_3\, e_4, E \rangle \;\rightarrow\; \langle \text{testsign } e_1'\, e_2\, e_3\, e_4, E' \rangle}$$

$$\frac{e_1 < 0}{\langle \text{testsign } e_1\, e_2\, e_3\, e_4, E \rangle} \;\rightarrow\; \langle e_2, E \rangle$$

$$\frac{e_1 == 0}{\langle \text{testsign } e_1\, e_2\, e_3\, e_4, E \rangle} \;\langle e_3, E \rangle$$

$$\frac{e_1 > 0}{\langle \text{testsign } e_1\, e_2\, e_3\, e_4, E \rangle} \;\langle e_4, E \rangle$$