$$(x\ \rho\ \Sigma\ \phi\ K) \longrightarrow (\text{lookup-}\rho[\![\rho, x]\!]\ \rho\ \Sigma\ \phi\ K)$$

$$((\lambda\ x\ e)\ \rho\ \Sigma\ \phi\ K) \longrightarrow ((\lambda\ \rho\ x\ e)\ \rho\ \Sigma\ \phi\ K)$$

$$((\text{rec}\ x_f\ x_a\ e)\ \rho\ \Sigma\ \phi\ K) \longrightarrow ((\text{rec}\ \rho\ x_f\ x_a\ e)\ \rho\ \Sigma\ \phi\ K)$$

$$(number\ \rho\ \Sigma\ \phi\ K) \longrightarrow ((\text{val}\ number)\ \rho\ \Sigma\ \phi\ K)$$

$$((e_1\ e_2)\ \rho\ (\sigma\ \ldots)\ \phi\ K) \longrightarrow (e_1\ \rho\ ([\text{arg}\ e_2\ \rho]\ \sigma\ \ldots)\ \phi\ K)$$

$$((op\ e)\ \rho\ (\sigma\ \ldots)\ \phi\ K) \longrightarrow (e\ \rho\ ([\text{do}\ op]\ \sigma\ \ldots)\ \phi\ K)$$

$$((prim\ e_1\ e_2)\ \rho\ (\sigma\ \ldots)\ \phi\ K) \longrightarrow (e_1\ \rho\ ([\text{prim-l}\ prim\ e_2\ \rho]\ \sigma\ \ldots)\ \phi\ K)$$

$$((\text{if}\ e_{cond}\ e_{then}\ e_{else})\ \rho\ (\sigma\ \ldots)\ \phi\ K) \longrightarrow (e_{cond}\ \rho\ ([\text{if}\ e_{then}\ e_{else}\ \rho]\ \sigma\ \ldots)\ \phi\ K)$$

$$((\text{handle}\ e\ hs\ ret)\ \rho\ \Sigma\ \phi\ (\kappa\ \ldots)) \longrightarrow (e\ \rho\ ()\ (\text{handle}\ hs\ ret\ \rho)\ ([\Sigma\ \phi]\ \kappa\ \ldots))$$

$$((\text{lift}\ op\ e)\ \rho\ \ \Sigma\ \phi\ (\kappa\ \ldots)) \longrightarrow (e\ \rho\ ()\ (\text{lift}\ op)\ ([\Sigma\ \phi]\ \kappa\ \ldots))$$

$$(V\ \rho_1\ ([\text{arg}\ e\ \rho_2]\ \sigma\ \ldots)\ \phi\ K) \longrightarrow (e\ \rho_2\ ([\text{app}\ V]\ \sigma\ \ldots)\ \phi\ K)$$

$$(V\ \rho_1\ ([\text{prim-l}\ prim\ e\ \rho_2]\ \sigma\ \ldots)\ \phi\ K) \longrightarrow (e\ \rho_2\ ([\text{prim-r}\ prim\ V]\ \sigma\ \ldots)\ \phi\ K)$$

$$(V\ \rho_2\ ([\text{app}\ (\lambda\ \rho_1\ x\ e)]\ \sigma\ \ldots)\ \phi\ K) \longrightarrow (e\ \text{extend}[\![\rho_1, x, V]\!]\ (\sigma\ \ldots)\ \phi\ K)$$

$$(V\ \rho\ ([\text{app}\ (\kappa_1\ \ldots)]\ \sigma\ \ldots)\ \phi\ (\kappa_2\ \ldots)) \longrightarrow (V\ \rho\ (\kappa_1\ \ldots\ [(\sigma\ \ldots)\ \phi]\ \kappa_2\ \ldots))$$

$$(V\ \rho_2\ ([\text{app}\ (\text{rec}\ \rho_1\ x_f\ x_a\ e)]\ \sigma\ \ldots)\ \phi\ K) \longrightarrow (e\ \text{extend}[\![\text{extend}[\![\rho_1, x_f, (\text{rec}\ \rho_1\ x_f\ x_a\ e)]\!], x_a, V]\!]\ (\sigma\ \ldots)\ \phi\ K)$$

$$((\text{val}\ number_2)\ \rho\ ([\text{prim-r}\ prim\ (\text{val}\ number_1)]\ \sigma\ \ldots)\ \phi\ K) \longrightarrow ((\text{val}\ \text{prim-apply}[\![prim, number_1, number_2]\!])\ \rho\ (\sigma\ \ldots)\ \phi\ K)$$

$$((\text{val true})\ \rho_1\ ([\text{if}\ e\ any\ \rho]\ \sigma\ \ldots)\ \phi\ K) \longrightarrow (e\ \rho\ (\sigma\ \ldots)\ \phi\ K)$$

$$((\text{val false})\ \rho_1\ ([\text{if}\ any\ e\ \rho]\ \sigma\ \ldots)\ \phi\ K) \longrightarrow (e\ \rho\ (\sigma\ \ldots)\ \phi\ K)$$

$$(V\ \rho\ ([\text{do}\ op]\ \sigma\ \ldots)\ \phi\ (\kappa\ \ldots)) \longrightarrow (op\ V\ 0\ ([(\sigma\ \ldots)\ \phi]\ \kappa\ \ldots)\ ())$$

$$(op\ V\ n\ ([\Sigma\ (\text{lift}\ op)]\ \kappa_1\ \ldots)\ (\kappa_2\ \ldots)) \longrightarrow (op\ V\ (+\ n\ \ 1)\ (\kappa_1\ \ldots)\ (\kappa_2\ \ldots\ [\Sigma\ (\text{lift}\ op)]))$$

$$(op_1\ V\ n\ ([\Sigma\ (\text{lift}\ op_2)]\ \kappa_1\ \ldots)\ (\kappa_2\ \ldots)) \longrightarrow (op\ V\ (+\ n\ \ 1)\ (\kappa_1\ \ldots)\ (\kappa_2\ \ldots\ [\Sigma\ (\text{lift}\ op)]))$$
$$\text{where}\ op_1 = op_{!\_1}, op_2 = op_{!\_1}$$

$$(op\ V\ n\ ([\Sigma\ (\text{handle}\ hs\ ret\ \rho)]\ \kappa_1\ \ldots)\ (\kappa_2\ \ldots)) \longrightarrow (op\ V\ (-\ n\ \ 1)\ (\kappa_1\ \ldots)\ (\kappa_2\ \ldots\ [\Sigma\ (\text{handle}\ hs\ ret\ \rho)]))$$
$$\text{where in}[\![op, \text{ops}[\![hs]\!]]\!], (>\ n\ \ 0)$$

$$(op\ V\ n\ ([\Sigma\ (\text{handle}\ hs\ ret\ \rho)]\ \kappa_1\ \ldots)\ (\kappa_2\ \ldots)) \longrightarrow (op\ V\ n\ (\kappa_1\ \ldots)\ (\kappa_2\ \ldots\ [\Sigma\ (\text{handle}\ hs\ ret\ \rho)]))$$
$$\text{where not-in}[\![op, \text{ops}[\![hs]\!]]\!]$$

$$(op\ V\ 0\ ([\Sigma\ (\text{handle}\ hs\ ret\ \rho)]\ [\Sigma_2\ \phi]\ \kappa_1\ \ldots)\ (\kappa_2\ \ldots)) \longrightarrow (e\ \text{extend}[\![\text{extend}[\![\rho, x_1, V]\!], x_2, (\kappa_2\ \ldots\ [\Sigma\ (\text{handle}\ hs\ ret\ \rho)])]\!]\ \Sigma_2\ \phi\ (\kappa_1\ \ldots))$$
$$\text{where get-handler}[\![op, hs, (x_1\ x_2\ e)]\!]$$

$$(V\ \rho_1\ ()\ (\text{handle}\ hs\ (\text{return}\ x\ e)\ \rho)\ ([\Sigma\ \phi]\ \kappa\ \ldots)) \longrightarrow (e\ \text{extend}[\![\rho, x, V]\!]\ \Sigma\ \phi\ (\kappa\ \ldots))$$

$$(V\ \rho\ ()\ (\text{lift}\ op)\ ([\Sigma\ \phi]\ \kappa\ \ldots)) \longrightarrow (V\ \rho\ \Sigma\ \phi\ (\kappa\ \ldots))$$

$$(V\ \rho\ ()\ \text{done}\ ()) \longrightarrow V$$