Returning from procedure calls

(0) $(S,\ E,\ M,\ nil,\ (E',\ C',\ D')) \rightarrow (S,\ E',\ M,\ C',\ D')$

Evaluating applications of closures

(1) $([\ E'\ \lambda^{(2)} u\ e_b\ ] : {e_a}^t : S,\ E,\ \overline{@}^{(2|0)} : M,\ C,\ D)$
$\rightarrow (S,\ < u\ e_a >: E', M,\ e_b : nil,\ (E,\ C,\ ; D))$

(2) $([\ E'\ \lambda^{(n-i+2)} u_i \ldots u_n\ e_b\ ] : e_a^t : S,\ E,\ \overline{@}^{(j)} : M,\ C,\ D) \mid j = (n-i+2) > 2$
$\rightarrow (\ [\ < u_i\ e_a\ >: E'\ \lambda^{(n-i+1)} u_{i+1} \ldots u_n\ e_b\ ]\ :\ S,\ E,\ \overline{@}^{(j-1|0)} : M,\ C,\ D\ )$

$(2a)$ $(\ [\ E'\ \lambda^{(n+1)} u_1 \ldots u_n\ e_b\ ] : e_1^t : \ldots : e_m^t : S,\ E,\ \overline{@}^{(m+1|0)} : M,\ C,\ D\ ) \mid n = m$
$\rightarrow (\ S,\ < u_n\ e_n >: \ldots :< u_1\ e_1 >: E',\ M,\ e_b : nil,\ (\ E,\ C,\ D\ )\ )$

$(2b)$ $(\ [\ E'\ \lambda^{(n+1)} u_1 \ldots u_n\ e_b\ ] : e_1^t : \ldots : e_m^t : S,\ E,\ \overline{@}^{(m+1|0)} : M,\ C,\ D\ ) \mid n \neq m$
$\rightarrow (\ error\_message,\ nil,\ nil,\ nil,\ nil\ )$

Substituting bound variables while traversing expressions from C to S

(3) $(S,\ E,\ nil,\ v : C,\ D)$
$\rightarrow (lookup(\ v,\ E\ ) : S,\ E,\ nil,\ C,\ D)$

(4) $(S,\ E,\ \overline{@}^{(n|i)} : M,\ v : C,\ D) \mid (i > 0)$
$\rightarrow (lookup(\ v,\ E\ ) : S,\ E,\ \overline{@}^{(n|i-1)} : M,\ C,\ D)$

Creating closures on S for abstractions on E

(5) $(S,\ E,\ nil,\ \lambda^{(n+1)} u_1 \ldots u_n\ e_b : C,\ D)$
$\rightarrow ([\ E\ \lambda^{(n+1)} u_1 \ldots u_n\ e_b\ ] : S,\ E,\ nil,\ C,\ D)$

(6) $(S,\ E,\ \overline{@}^{(m|i)} : M,\ \lambda^{(n+1)} u_1 \ldots u_n\ e_b : C,\ D) \mid (i > 0)$
$\rightarrow ([\ E\ \lambda^{(n+1)} u_1 \ldots u_n\ e_b\ ] : S,\ E,\ \overline{@}^{(m|i-1)} : M,\ C,\ D)$

Traversing expressions from C to S

(7) $(S,\ E,\ M,\ \kappa^{(n)} : C,\ D) \rightarrow\ (S,\ E,\ \kappa^{(n|n)} : M,\ C,\ D)$

$(8a)$ $(S,\ E,\ nil,\ atom : C,\ D) \mid (i > 0) \rightarrow\ (atom : S,\ E,\ nil,\ C,\ D)$

$(8b)$ $(S,\ E,\ \kappa^{(n|i)} : M,\ atom : C,\ D) \mid (i > 0)$
$\rightarrow\ (atom : S,\ E,\ ap^{(n|i-1)} : M,\ C,\ D)$

(9) $(S,\ E,\ \kappa^{(n|0)} : nil,\ C,\ D) \rightarrow\ (\kappa^{(n)} : S,\ E,\ nil,\ C,\ D)$

(10) $(S,\ E,\ \kappa^{(n|0)} : \kappa^{(m|i)} : M,\ C,\ D) \mid (i > 0)$
$\rightarrow\ (\kappa^{(n)} : S,\ E,\ \kappa^{(m|i-1)} : M,\ C,\ D)$

$$
\begin{array}{rcl}
nil & | & S \\
nil & | & E \\
nil & | & M \\
\overline{@}^{(3)} : b : a : \lambda^{(3)}\ u\ v : \overline{@}^{(3)} : v : w : \lambda^{(3)}\ w\ z\ \overline{@}^{(4)} : z : w : u : v : nil & | & C \\
nil & | & D
\end{array}
$$

twice rule $8b$, and then rule 6 $\Downarrow$

$$
\begin{array}{rcl}
[\ nil\ \lambda^{(3)}\ u\ v : \overline{@}^{(3)} : v : u : \lambda^{(3)}\ w\ z\ \ldots\ ] : a : b : nil & | & S \\
nil & | & E \\
\overline{@}^{(3|0)} : nil & | & M \\
nil & | & C \\
nil & | & D
\end{array}
$$

rule $2a$ $\Downarrow$

$$
\begin{array}{rcl}
nil & | & S \\
< v\ b >:< u\ a >: nil & | & E \\
nil & | & M \\
\overline{@}^{(3)} : v : u : \lambda^{(3)}\ w\ z\ \overline{@}^{(4)} : z : w : u : v : nil & | & C \\
(\ nil,\ nil,\ nil) & | & D
\end{array}
$$

twice rule $8b$, and then rule 6 $\Downarrow$

$$
\begin{array}{rcl}
[\ < v\ b >:< u\ a >: nil\ \lambda^{(3)}\ w\ z\ \overline{@}^{(4)} : z : w : u : v\ ] : a : b & | & S \\
< v\ b >:< u\ a >: nil & | & E \\
\overline{@}^{(3|0)} : nil & | & M \\
nil & | & C \\
(\ nil,\ nil,\ nil) & | & D
\end{array}
$$

rule $2a$ $\Downarrow$

$$
\begin{array}{rcl}
nil & | & S \\
< w\ a >:< z\ b >:< v\ b >:< u\ a >: nil & | & E \\
nil & | & M \\
\overline{@}^{(4)} : z : w : u : v : nil & | & C \\
(\ < v\ b >:< u\ a >: nil,\ nil,\ (\ nil,\ nil,\ nil)) & | & D
\end{array}
$$

$$\text{repeatedly rule 4} \quad \Downarrow$$

$$
\begin{array}{rcl}
\overline{@}^{(4)} : b : a : a : b : nil & | & S \\
< w\ a >:< z\ b >:< v\ b >:< u\ a >: nil & | & E \\
nil & | & M \\
nil & | & C \\
(\ < v\ b >:< u\ a >: nil,\ nil,\ (\ nil,\ nil,\ nil)) & | & D
\end{array}
$$

$$\text{rule 0} \quad \Downarrow$$

$$
\begin{array}{rcl}
\overline{@}^{(4)} : b : a : a : b : nil & | & S \\
< v\ b >:< u\ a >: nil & | & E \\
nil & | & M \\
nil & | & C \\
(\ nil,\ nil,\ nil) & | & D
\end{array}
$$

$$\text{again rule 0} \quad \Downarrow$$

$$
\begin{array}{rcl}
\overline{@}^{(4)} : b : a : a : b : nil & | & S \\
nil & | & E \\
nil & | & M \\
nil & | & C \\
nil & | & D
\end{array}
$$