From step (1) to step (2) we applied the previous transformation:

$$
\begin{aligned}
\mathbb{E}_{q_\psi(\mathbf{z}|x^l)}[f(\mathbf{z})] &= \mathbb{E}_{q_\psi(\mathbf{z}|\mathbf{x})}[\lim_{k\to\infty} \hat{f}_k(\mathbf{z})] \\
&= \lim_{k\to\infty} \mathbb{E}_{q_\psi(\mathbf{z}|\mathbf{x})}[\hat{f}_k(\mathbf{z})] \qquad (1) \\
&= \lim_{k\to\infty} \mathbb{E}_{p(\boldsymbol{\epsilon})}[\hat{f}_k(g(\boldsymbol{\epsilon}, x^l; \psi))] \qquad (2) \\
&= \mathbb{E}_{p(\boldsymbol{\epsilon})}[\lim_{k\to\infty} \hat{f}_k(g(\boldsymbol{\epsilon}, x^l; \psi))] \\
&= \mathbb{E}_{p(\boldsymbol{\epsilon})}[f(g(\boldsymbol{\epsilon}, x^l; \psi))]
\end{aligned}
$$

As you can see so far we didn't need g to be a bijection. But in practice we want to explicitly calculate the inverse.