Let the nonlocal variables be $x, y: \text{int}$. Write a program to refine specification $\neg ok$. Prove your refinement.

Proof:

$\neg ok \iff x := x + 1$

Proof by cases. First case:

(a) Insert appropriate time increments according to the recursive measure, and write an appropriate timing specification and refinement.

$b$ Using your timing specification from part (a), prove the timing refinement.

Proof by cases. First case:

(c) Using your timing specification from part (a), prove the timing refinement.

$\forall x', y'. (\exists y: L y < x') \iff (x := y + 1)$

The specification

$\text{var } x: \text{nat} \ x := -1$

introduces a local variable and then assigns it a value that is out of bounds. Is this specification implementable? (Proof required.)

Let the nonlocal variables be $\sigma$.

$\exists x, x': \text{nat} \ x' := -1 \land \sigma' = \sigma$

local axiom $x': \text{nat}$ conflicts with $x' := -1$

so it is unimplementable.