```
tc_wp  THM

⊢  ∀A:ioa{i:l}(), Q:Fmla, de:sig(), a:Label.
|  tc_ioa(A;de)
|  ⇒
|  single_valued_decls(A.ds)
|  ⇒
|  tc_pred(Q;A.ds;dec_lookup(A.da;a);de)
|  ⇒
|  tc_pred(wp(A;a;Q);A.ds;dec_lookup(A.da;a);de)
| by Auto THEN Unfold ‘wp‘ 0•
|
1. A : ioa{i:l}()
2. Q : Fmla
3. de : sig()
4. a : Label
5. tc_ioa(A;de)
6. single_valued_decls(A.ds)
7. tc_pred(Q;A.ds;dec_lookup(A.da;a);de)
⊢  tc_pred(smts_eff_pred(action_effect(a;A.eff;A.frame);Q);...;...;de)
| by ...
|
1. A : ioa{i:l}()
2. Q : Fmla
3. de : sig()
4. a : Label
5. tc_ioa(A;de)
6. single_valued_decls(A.ds)
7. tc_pred(Q;A.ds;dec_lookup(A.da;a);de)
8. r : rel()
9. r ∈ smts_eff_pred(action_effect(a;A.eff;A.frame);Q)
⊢  tc(r;A.ds;dec_lookup(A.da;a);de)
| by Unfold ‘smts_eff_pred‘ (-1) THEN
Using [‘T’,rel()
|    ] (FwdThruLemma ‘member_col_accum‘ [(-1)])
THENM ExRepD

|    THENM Unfold ‘smts_eff_rel‘ (-1)

|    THENM RWW "member_col_subst" (-1)
THENM ExRepD

|    THENM HypSubst (-1) 0

|    THENA (Auto THEN Try (Fold ‘pred‘ 0 THEN Auto))
|
1. A : ioa{i:l}()
2. Q : Fmla
3. de : sig()
4. a : Label
5. tc_ioa(A;de)
6. single_valued_decls(A.ds)
7. tc_pred(Q;A.ds;dec_lookup(A.da;a);de)
8. r : rel()
9. r ∈ (∪r∈Q.smts_eff_rel(action_effect(a;A.eff;A.frame);r))
```

```
10. r1 : rel()
11. r1 ∈ Q
12. as : (Label×Term) List
13. 1of(unzip(as)) = rel_vars(r1)
14. ∀i:ℕ.
|   i<||as||
|   ⇒
|   2of(as[i]) ∈ (λx.smts_eff(action_effect(a;A.eff;A.frame);x))
|                (1of(as[i]))
15. r = rel_subst(as;r1)
⊢  tc(rel_subst(as;r1);A.ds;dec_lookup(A.da;a);de)
| by BackThruLemma ‘rel_subst_tc‘ THEN Auto
|
|\
| 1. A : ioa{i:l}()
| 2. Q : Fmla
| 3. de : sig()
| 4. a : Label
| 5. tc_ioa(A;de)
| 6. single_valued_decls(A.ds)
| 7. tc_pred(Q;A.ds;dec_lookup(A.da;a);de)
| 8. r : rel()
| 9. r ∈ (∪r∈Q.smts_eff_rel(action_effect(a;A.eff;A.frame);r))
| 10. r1 : rel()
| 11. r1 ∈ Q
| 12. as : (Label×Term) List
| 13. 1of(unzip(as)) = rel_vars(r1)
| 14. ∀i:ℕ.
|     i<||as||
|     ⇒
|     2of(as[i]) ∈ (λx.smts_eff(action_effect(a;A.eff;A.frame);x))
|                  (1of(as[i]))
| 15. r = rel_subst(as;r1)
| ⊢  tc(r1;A.ds;dec_lookup(A.da;a);de)
|   by AllHyps (\i. Unfolds ‘‘closed_pred tc_pred‘‘ i THEN InstHyp [r1
|      ] i THEN Complete Auto)•
|
.\
. 1. A : ioa{i:l}()
. 2. Q : Fmla
. 3. de : sig()
. 4. a : Label
. 5. tc_ioa(A;de)
. 6. single_valued_decls(A.ds)
. 7. tc_pred(Q;A.ds;dec_lookup(A.da;a);de)
. 8. r : rel()
. 9. r ∈ (∪r∈Q.smts_eff_rel(action_effect(a;A.eff;A.frame);r))
. 10. r1 : rel()
. 11. r1 ∈ Q
. 12. as : (Label×Term) List
. 13. 1of(unzip(as)) = rel_vars(r1)
. 14. ∀i:ℕ.
. |   i<||as||
. |   ⇒
. |   2of(as[i]) ∈ (λx.smts_eff(action_effect(a;A.eff;A.frame);x))
```

```
. |                (1of(as[i]))
. 15. r = rel_subst(as;r1)
. 16. x : Label
. 17. (x ∈ rel_vars(r1))
. 18. t : SimpleType
. 19. mk_dec(x, t) ∈ A.ds
. ⊢  t ∈ term_types(A.ds;dec_lookup(A.da;a);de;apply_alist(as;x;x))
. | by BackThruLemma ‘tc_ioa_lemma‘ THEN Auto
. |
. 1. A : ioa{i:l}()
. 2. Q : Fmla
. 3. de : sig()
. 4. a : Label
. 5. tc_ioa(A;de)
. 6. single_valued_decls(A.ds)
. 7. tc_pred(Q;A.ds;dec_lookup(A.da;a);de)
. 8. r : rel()
. 9. r ∈ (∪r∈Q.smts_eff_rel(action_effect(a;A.eff;A.frame);r))
. 10. r1 : rel()
. 11. r1 ∈ Q
. 12. as : (Label×Term) List
. 13. 1of(unzip(as)) = rel_vars(r1)
. 14. ∀i:ℕ.
.     i<||as||
.     ⇒
.     2of(as[i]) ∈ (λx.smts_eff(action_effect(a;A.eff;A.frame);x))
.                (1of(as[i]))
. 15. r = rel_subst(as;r1)
. 16. x : Label
. 17. (x ∈ rel_vars(r1))
. 18. t : SimpleType
. 19. mk_dec(x, t) ∈ A.ds
. 20. i : ℕ
. 21. i<||as||

. ⊢  2of(as[i]) ∈ smts_eff(action_effect(a;A.eff;A.frame);1of(as[i]))
.   by All Reduce THEN BackThruSomeHyp THEN Auto
END
```