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A DETAILED DESCRIPTION OF THE KNOWLEDGE-BASED SYSTEM FOR PHYSICAL DATABASE DESIGN - VOLUME II

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ABSTRACT

Volume II of this report lists the rules of the Knowledge-Based System for Physical Database Design. The volume consists of five Appendices containing rules; one for each of the major knowledge bases. A table of contents is provided to locate the Appendix for each knowledge base as well as to locate specific rule groups within knowledge bases. Volume I of this report contains explanatory text for each knowledge base and for each rule group.

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APPENDIX A

RULES FOR THE CONTROL MODULE KNOWLEDGE BASE

RULES FOR SECTION 3.1 --> CONTROL MODULE ACTION RULE GROUP.

PART A OF SECTION 3.1 --> DETERMINING BASIC CONTROL MODULE ACTIONS.

THIS RULE STARTS INITIAL PROCESSING BY INVOKING THE ENTITY RELATIONSHIP CHARACTERIZATION KNOWLEDGE BASE AND REPRESENTATION SELECTION KNOWLEDGE BASE.

*** RULE CM_ACTION_1 ***

IF (USER-MESSAGE START PROCESSING)

THEN (CLUSTER-ACTION INVOKE_INITIAL_RULE_GROUPS INITIAL-CG INITIAL-SET)

CERTAINTY FACTOR = 0.9

THE NEXT TWO RULES DETERMINE WHICH CLUSTER TO WORK ON NEXT, REQUESTING AN INITIAL OR FOLLOW-UP DECISION FOR A DESIGN ACTION TO PERFORM. THIS WILL RESULT IN INVOCATION OF THE CLUSTER DECISION RULE GROUP.

*** RULE CM_ACTION_2 ***

IF (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID DECISION_ACTIVE NONE)
(CLUSTER_PRIORITY ?CLUSTER_ID ?CLUSTER_SET_ID)

THEN (CLUSTER-ACTION GET_INITIAL_DECISION ?CLUSTER_ID ?CLUSTER_SET_ID)

COMPUTED CERTAINTY FACTOR

*** RULE CM_ACTION_3 ***

IF (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID DECISION_ACTIVE RESTRICT-COMPLETE)
(CLUSTER_PRIORITY ?CLUSTER_ID ?CLUSTER_SET_ID)

THEN (CLUSTER-ACTION GET_FOLLOW_UP_DECISION ?CLUSTER_ID ?CLUSTER_SET_ID)

COMPUTED CERTAINTY FACTOR

THE NEXT FIVE RULES DETERMINE WHAT ACTION TO TAKE ON A CLUSTER BASED ON THE CONCLUSIONS OF THE CLUSTER DECISION RULE GROUP. THE CLUSTER_STATUS FACT EXPRESSION REFLECTS THE DECISION WHICH HAS BEEN MADE FOR THE CLUSTER.

*** RULE CM_ACTION_4 ***

IF (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID DECISION_ACTIVE RESTRICT_REPRESENTATIONS)

THEN (CLUSTER-ACTION RESTRICT_REPRESENTATIONS ?CLUSTER_ID ?CLUSTER_SET_ID)

COMPUTED CERTAINTY FACTOR

*** RULE CM_ACTION_5 ***

IF (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID DECISION_ACTIVE ENUMERATE_SKELETONS)

THEN (CLUSTER-ACTION ENUMERATE_SKELETONS ?CLUSTER_ID ?CLUSTER_SET_ID)

CERTAINTY FACTOR = 0.8

*** RULE CM_ACTION_6 ***

IF (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID DECISION_ACTIVE SELECTIVELY_GENERATE_SKELETONS)

THEN (CLUSTER-ACTION SELECTIVELY_GENERATE_SKELETONS ?CLUSTER_ID ?CLUSTER_SET_ID)

CERTAINTY FACTOR = 0.7

*** RULE CM_ACTION_7 ***

IF (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID DECISION_ACTIVE DIVIDE_CLUSTER)
(USER-MESSAGE ALL-CLUSTERS BREAK-DIVIDE)

THEN (CLUSTER-ACTION DETERMINE_BREAKPOINTS_AND_FORM_CLUSTERS ?CLUSTER_ID ?CLUSTER_SET_ID)

CERTAINTY FACTOR = 0.9

```
 *** RULE CM_ACTION_8 ***

IF   (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID IN_DIVIDE_PROCESS *DIVISION_UNSUCCESSFUL* )
     (USER-MESSAGE ALL-CLUSTERS BREAK-DIVIDE )
     (COULD_NOT_CONCLUDE (INVOKE_BREAKPOINT_GROUP ?CLUSTER_ID RULE_GROUP_4) )

THEN (CLUSTER-ACTION DETERMINE_BREAKPOINTS_AND_FORM_CLUSTERS ?CLUSTER_ID ?CLUSTER_SET_ID)

     CERTAINTY FACTOR = 0.9
```

THIS RULE STATES THAT IF NEW CLUSTERS WERE CREATED AFTER A SUCCESSFUL DIVIDE OPERATION, THEN ADD THE NEW CLUSTERS TO THE DATABASE AND PERFORM OTHER NECESSARY OPERATIONS.

```
 *** RULE CM_ACTION_9 ***

IF   (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID IN_DIVIDE_PROCESS CLUSTERS_FORMED )
     (CLUSTER-SET ?CHILD_CLUSTER_SET ?CLUSTER_SET_ID ?CLUSTER_ID )
     (WORK_ON_DIVIDED_CLUSTERS ?CHILD_CLUSTER_SET ?CLUSTER_SET_ID ?CLUSTER_ID )
     (COULD_NOT_CONCLUDE (PREVENTS-WORK-ON-SET ?CHILD_CLUSTER_SET ?CLUSTER_SET_ID ?CLUSTER_ID) )

THEN (CLUSTER-ACTION COMPUTE_NEW_CLUSTER_INFORMATION ?CLUSTER_ID ?CLUSTER_SET_ID)

     CERTAINTY FACTOR = 0.9
```

THE NEXT TWO RULES DETERMINE WHEN TO END DESIGN ACTIVITY ON A PROBLEM AND INVOKE FILE ORGANIZATION PROGRAMS FOR DETAILED DESIGN.

```
 *** RULE CM_ACTION_10 ***

IF   (CLUSTER_STATUS INITIAL-CG INITIAL-SET WORK_COMPLETE GENERATED_CANONICAL_RECORDS )

THEN (CLUSTER-ACTION INVOKE FILE_ORGANIZATION_MODULES FOR_DETAILED_DESIGN)

     CERTAINTY FACTOR = 0.99
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 *** RULE CM_ACTION_11 ***

IF   (CLUSTER_STATUS INITIAL-CG INITIAL-SET DIVIDE_COMPLETE CLUS-DONE )

THEN (CLUSTER-ACTION INVOKE FILE_ORGANIZATION_MODULES FOR_DETAILED_DESIGN)

     CERTAINTY FACTOR = 0.2
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------------------------------------------------------------------------
PART B OF SECTION 3.1 --> DETERMINING MORE COMPLICATED CONTROL MODULE ACTIONS.
------------------------------------------------------------------------

THE FIRST FIVE RULES PERTAIN TO DETERMINING TO REVISIT A CLUSTER FOR FURTHER SKELETON GENERATION.

THIS RULE DETERMINES THE OF NUMBER OF EXTRA SKELETONS LEFT TO GENERATE AMONG THE CLUSTERS OF THE
PARENT CLUSTER SET.  THESE ARE "EXTRA" SKELETONS LEFT OVER FROM SELECTIVE SKELETON GENERATION.
THESE "EXTRA" SKELETONS CAN SUBSEQUENTLY BE ALLOCATED TO ONE OF THE CLUSTERS.

 *** RULE CM_ACTION_12 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (NUMBER-SKELETONS-GENERATED ?CLUSTER_ID ?NUMBER_GENERATED )
     (NUMBER_SKELETONS_TO_GENERATE_SELECTIVELY ?CLUSTER_ID ?EXTRA_NUMBER )
     (FUNCTION-CALL SUBTRACT2 ?EXTRA_NUMBER ?NUMBER_GENERATED ?LEFT_IN_CLUSTER )
     (FUNCTION-CALL *GET-NUM-GEN* ?CLUSTER_SET_ID ?NUMBER_GENERATED_FOR_SET )
     (CLUSTER-SET ?CLUSTER_SET_ID ?PARENT_CLUSTER_SET ?PARENT-CLUSTER_ID )
     (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?PARENT-CLUSTER_ID ?NUMBER_GENERATED_IN_PARENT )
     (FUNCTION-CALL *>* ?NUMBER_GENERATED_IN_PARENT ?NUMBER_GENERATED_FOR_SET )
     (FUNCTION-CALL SUBTRACT2 ?NUMBER_GENERATED_IN_PARENT ?NUMBER_GENERATED_FOR_SET ?EXTRA_TO_GENERATE )

THEN (CLUSTER-RESERVE ?CLUSTER_ID ?CLUSTER_SET_ID ?LEFT_IN_CLUSTER ?EXTRA_TO_GENERATE)

     NO CERTAINTY FACTOR



DETERMINE THAT CLUSTER ?CLUSTER_ID IS ELIGIBLE TO BE REVISITED FOR ADDITIONAL SKELETON GENERATION.

 *** RULE CM_ACTION_13 ***

IF   (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID WORK_COMPLETE GENERATED_CANONICAL_RECORDS )
     (FUNCTION-CALL *IF-THERE-IS* (CLUSTER-RESERVE ?CLUSTER_ID ?CLUSTER_SET_ID ?CLUS-LEFT ?TOT-LEFT ) )
     (COULD_NOT_CONCLUDE (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID ENUMERATE_SKELETONS) )
     (COULD_NOT_CONCLUDE (FOLLOW-UP-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID ENUMERATE_SKELETONS) )

THEN (ELIGIBLE_FOR_REVISIT ?CLUSTER_ID)

     NO CERTAINTY FACTOR
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THIS RULE DETERMINES TO REVISIT TO CLUSTER ?CLUSTER_ID FOR SKELETON GENERATION IF ALL CLUSTERS
WITHIN A CLUSTER SET HAVE UNDERGONE RECORD FORMATION, THE CLUSTER HAS NOT BEEN REVISITED, AND IT
IS ELIGIBLE TO BE REVISITED.  SEE RULE CM_ACTION_13 FOR DETERMINATION OF ELIGIBILITY TO REVISIT.

 *** RULE CM_ACTION_14 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (FUNCTION-CALL *IF-THERE-IS-NOT* (CLUSTER_SET_INFORMATION ?CLUSTER_SET_ID NO-SKEL-DETERM CHAR) )
     (COULD_NOT_CONCLUDE (MESSAGE ?CLUSTER_ID WILL_NOT_REVISIT) )
     (FUNCTION-CALL *IF-THERE-IS* (ELIGIBLE_FOR_REVISIT ?CLUSTER_ID) )

THEN (CLUSTER-ACTION RETURN-INC-SKEL-GEN ?CLUSTER_ID ?CLUSTER_SET_ID)

    COMPUTED CERTAINTY FACTOR



THIS RULE CONCLUDES THERE IS A CLUSTER WITHIN A CLUSTER SET FOR WHICH RECORD GENERATION
IS NOT YET COMPLETE.

 *** RULE CM_ACTION_15 ***

IF   (CLUSTER-SET ?CLUSTER_SET_ID ?PARENT_CLUSTER_SET ?PARENT-CLUSTER_ID )
     (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID DECISION_ACTIVE ?STAGE )
     (FUNCTION-CALL *IS-ONE-OF* ?STAGE (NONE RESTRICT RESTRICT-COMPLETE DIVIDE INC-SKEL-GEN) )

THEN (CLUSTER_SET_INFORMATION ?CLUSTER_SET_ID RECORD_FORMATION_INCOMPLETE CHAR)

     NO CERTAINTY FACTOR



DETERMINE NOT TO REVISIT TO CLUSTER FOR ADDITIONAL SKELETON GENERATION IF THE CLUSTER IS NOT ELIGIBLE
TO BE REVISITED.  THIS WILL RESULT IN ADDITION OF A MESSAGE TO THE DATABASE STATING THE CLUSTER SHOULD
NOT BE REVISITED.

 *** RULE CM_ACTION_16 ***

IF   (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID WORK_COMPLETE GENERATED_CANONICAL_RECORDS )
     (COULD_NOT_CONCLUDE (MESSAGE ?CLUSTER_ID WILL_NOT_REVISIT) )
     (FUNCTION-CALL *IF-THERE-IS-NOT* (ELIGIBLE_FOR_REVISIT ?CLUSTER_ID) )

THEN (CLUSTER-ACTION ADD-NO-INC-SKEL-GEN ?CLUSTER_ID ?CLUSTER_SET_ID)

     CERTAINTY FACTOR = 1.0
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THE NEXT FOUR RULES PERTAIN TO CLUSTER RECOMBINATION.

THE NEXT THREE RULES CONCLUDE RECOMBINATION IS NECESSARY FOR TWO CLUSTERS IF THEY ARE ELIGIBLE,
A RELATIONSHIP BETWEEN THE CLUSTERS HAS SIGNIFICANT LEVEL OF ACTIVITY, AND A BREAKPOINT WAS SELECTED
BETWEEN THEM. RULES DIFFER ON THE BASIS OF CERTAINTY FACTORS WHICH ARE DETERMINED BY THE LEVEL OF
RESTRICTIVENESS OF THE BREAKPOINT SELECTION RULE.

 *** RULE CM_ACTION_17 ***

IF   (USER-MESSAGE ALL-CLUSTERS BREAK-DIVIDE )
     (INTERSECT-READY-FOR-PROCESS ?REL_ID ?CLUSTER_ID1 ?CLUSTER_ID2 ?CLUSTER_SET_ID )
     (CLUSTER-SET ?CLUSTER_SET_ID ?PARENT_CLUSTER_SET ?PARENT-CLUSTER_ID )
     (THERE_WAS_CONCLUDED (PROPOSED-BREAK ?REL_ID ?PARENT-CLUSTER_ID REGULAR-1 ?REAS) )
     (THERE_IS_ONE_OF (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 ?OPS ?SIZE ?FREQ) )

THEN (CLUSTER-ACTION FORM_INTERSECTION_CLUSTER ?CLUSTER_ID1 ?CLUSTER_ID2)

     CERTAINTY FACTOR = 0.333



 *** RULE CM_ACTION_18 ***

IF   (USER-MESSAGE ALL-CLUSTERS BREAK-DIVIDE )
     (INTERSECT-READY-FOR-PROCESS ?REL_ID ?CLUSTER_ID1 ?CLUSTER_ID2 ?CLUSTER_SET_ID )
     (THERE_IS_ONE_OF (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 ?OPS ?SIZE ?FREQ) )
     (CLUSTER-SET ?CLUSTER_SET_ID ?PARENT_CLUSTER_SET ?PARENT-CLUSTER_ID )
     (THERE_WAS_CONCLUDED (PROPOSED-BREAK ?REL_ID ?PARENT-CLUSTER_ID REGULAR-2 ?REAS) )

THEN (CLUSTER-ACTION FORM_INTERSECTION_CLUSTER ?CLUSTER_ID1 ?CLUSTER_ID2)

     CERTAINTY FACTOR = 0.5



 *** RULE CM_ACTION_19 ***

IF   (USER-MESSAGE ALL-CLUSTERS BREAK-DIVIDE )
     (INTERSECT-READY-FOR-PROCESS ?REL_ID ?CLUSTER_ID1 ?CLUSTER_ID2 ?CLUSTER_SET_ID )
     (THERE_IS_ONE_OF (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 ?OPS ?SIZE ?FREQ) )
     (CLUSTER-SET ?CLUSTER_SET_ID ?PARENT_CLUSTER_SET ?PARENT-CLUSTER_ID )
     (THERE_WAS_CONCLUDED (PROPOSED-BREAK ?REL_ID ?PARENT-CLUSTER_ID ?LEVEL ?REAS) )
     (FUNCTION-CALL *IS-ONE-OF* ?LEVEL (REGULAR-3 REGULAR-4 DESPERATION) )

THEN (CLUSTER-ACTION FORM_INTERSECTION_CLUSTER ?CLUSTER_ID1 ?CLUSTER_ID2)

     CERTAINTY FACTOR = 0.6
```

THIS RULE DETERMINES THAT TWO CLUSTERS ARE ELIGIBLE FOR RECOMBINATION. IT FIRES FOR TWO ADJACENT CLUSTERS WHICH HAVE NOT PREVIOUSLY BEEN RECOMBINED AND WILL NOT BE REVISITED. ALSO, THE CONNECTING RELATIONSHIP BETWEEN THE TWO CLUSTERS MUST HAVE MORE THAN ONE REASONABLE REPRESENTATION.

```
 *** RULE CM_ACTION_20 ***

IF   (ADJACENT_CLUSTERS ?CLUSTER_ID1 ?CLUSTER_ID2 )
     (COULD_NOT_CONCLUDE (MESSAGE ( ?CLUSTER_ID1 ?CLUSTER_ID2 ) INTERSECTION_CLUSTER_FORMED) )
     (COULD_NOT_CONCLUDE (MESSAGE ( ?CLUSTER_ID2 ?CLUSTER_ID1 ) INTERSECTION_CLUSTER_FORMED) )
     (MESSAGE ?CLUSTER_ID1 WILL_NOT_REVISIT )
     (MESSAGE ?CLUSTER_ID2 WILL_NOT_REVISIT )
     (THERE_WAS_CONCLUDED (CONNECTING_RELATIONSHIP ?REL_ID ?CLUSTER_ID1 ?CLUSTER_ID2 ?CLUSTER_SET_ID) )
     (COULD_NOT_CONCLUDE (ONE_REASONABLE_REPRESENTATION ?REL_ID) )

THEN (INTERSECT-READY-FOR-PROCESS ?REL_ID ?CLUSTER_ID1 ?CLUSTER_ID2 ?CLUSTER_SET_ID)

     CERTAINTY FACTOR = 0.5
```

THIS RULE DETERMINES THAT COMPLETE RECOMBINATION IS REQUIRED.

```
 *** RULE CM_ACTION_21 ***

IF   (INTERSECTION_CLUSTERS ?INTNAME ?CLUSTER_ID1 ?CLUSTER_ID2 )
     (LOW_COST_SKELETON_IN_INTERSECTION_CLUSTER ?INTNAME ?S ?REL_ID )

THEN (CLUSTER-ACTION COMPLETELY_RECOMBINE ?INTNAME ( ?REL_ID ?CLUSTER_ID1 ?CLUSTER_ID2 ))

     CERTAINTY FACTOR = 0.9
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RULES FOR SECTION 3.2 --> MAKING DECISIONS ON INDIVIDUAL CLUSTERS.
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PART A OF SECTION 3.2 --> INITIAL DECISION RULES FOR CLUSTERS.
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THE FIRST SIX RULES CONCERN DECISIONS ABOUT CLUSTER DIVISION. THE FIRST THREE RULES DETERMINE WHEN TO
PROHIBIT DIVISION.

 *** RULE CLUSTER_DECISION_1 ***

IF   (CLUSTER ?CLUSTER_ID ?SET )
     (CLUSTER-SET ?SET ?PARENT_CLUSTER_SET ?CLUSTER_ID2 )
     (INVOKE_BREAKPOINT_GROUP ?CLUSTER_ID2 RULE_GROUP_4 )

THEN (REASON_NOT_TO_DIVIDE ?CLUSTER_ID ?SET MOST_RESTRICTIVE_MODE)

     NO CERTAINTY FACTOR



PROHIBIT DIVISION IF THE CLUSTER IS AN INTERSECTION CLUSTER.

 *** RULE CLUSTER_DECISION_2 ***

IF   (CLUSTER ?CLUSTER_ID TEMPORARY_INTERSECTION_CLUSTER )

THEN (REASON_NOT_TO_DIVIDE ?CLUSTER_ID TEMPORARY_INTERSECTION_CLUSTER INTERSECTION_CLUSTER)

     NO CERTAINTY FACTOR



PROHIBIT DIVISION IF A MESSAGE EXISTS SPECIFYING THE CLUSTER MAY NOT BE DIVIDED.

 *** RULE CLUSTER_DECISION_3 ***

IF   (USER-MESSAGE ?CLUSTER_ID DO_NOT_DIVIDE )
     (CLUSTER ?CLUSTER_ID ?CLUSTER_SET )

THEN (REASON_NOT_TO_DIVIDE ?CLUSTER_ID ?CLUSTER_SET USER_SPECIFIED)

     NO CERTAINTY FACTOR
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DIVIDE A CLUSTER IF IT IS CHARACTERIZED AS EXTREMELY LARGE AND CERTAIN CONCLUSIONS PROHIBITING
DIVISION ARE NOT IN FORCE. THIS RULE WILL FIRE UNTIL ALL ATTEMPTS AT DIVISION HAVE FAILED.

 *** RULE CLUSTER_DECISION_4 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID EXTREMELY_LARGE )
     (CLUSTER-SET ?CLUSTER_SET_ID ?PARENT_CLUSTER_SET ?PAR-CG )
     (COULD_NOT_CONCLUDE (REASON_NOT_TO_DIVIDE ?CLUSTER_ID ?CLUSTER_SET_ID USER_SPECIFIED) )
     (COULD_NOT_CONCLUDE (REASON_NOT_TO_DIVIDE ?CLUSTER_ID ?CLUSTER_SET_ID INTERSECTION_CLUSTER) )
     (COULD_NOT_CONCLUDE (REASON_NOT_TO_DIVIDE ?CLUSTER_ID ?CLUSTER_SET_ID AGGREGATE_IN_FORCE) )

THEN (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID DIVIDE_CLUSTER)

     CERTAINTY FACTOR = 0.5



DIVIDE A CLUSTER IF IT IS CHARACTERIZED AS TOO LARGE BUT NOT EXTREMELY LARGE, AND THERE IS NO CONCLUSION
OF ANY KIND PROHIBITING DIVISION.

 *** RULE CLUSTER_DECISION_5 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID OVER-MAXIMUM )
     (COULD_NOT_CONCLUDE (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID EXTREMELY_LARGE) )
     (COULD_NOT_CONCLUDE (REASON_NOT_TO_DIVIDE ?CLUSTER_ID ?CLUSTER_SET_ID ?ANY_REASON) )

THEN (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID DIVIDE_CLUSTER)

     CERTAINTY FACTOR = 0.5



DIVIDE THE INITIAL CLUSTER IF IT HAS MORE THAN ONE ROOT ENTITY AND NO CONCLUSIONS
PROHIBITING DIVISION EXIST.

 *** RULE CLUSTER_DECISION_6 ***

IF   (CLUSTER INITIAL-CG INITIAL-SET )
     (CLUSTER_CHARACTERIZATION INITIAL-CG INITIAL-SET MULTIPLE_ROOT_ENTITIES_IN_CG )
     (COULD_NOT_CONCLUDE (REASON_NOT_TO_DIVIDE INITIAL-CG INITIAL-SET ?ANY_REASON) )

THEN (INITIAL-DECISION INITIAL-CG INITIAL-SET DIVIDE_CLUSTER)

     CERTAINTY FACTOR = 0.9
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THE NEXT FOUR RULES CONCERN INITIAL DECISIONS TO RESTRICT RELATIONSHIP REPRESENTATIONS WITHIN
A CLUSTER.  RESTRICT RELATIONSHIP REPRESENTATIONS FOR A CLUSTER IF THE USER SPECIFIES THIS ACTION.

 *** RULE CLUSTER_DECISION_7 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (USER-MESSAGE ?CLUSTER_ID RESTRICT_REPRESENTATIONS )

THEN (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID RESTRICT_REPRESENTATIONS)

     CERTAINTY FACTOR = 0.5


RESTRICT REPRESENTATIONS IF THE CLUSTER IS NOT TOO LARGE, THERE IS NO SIGNIFICANT WORKLOAD
COMPLEXITY WITHIN THE CLUSTER, AND NUMBER OF POSSIBLE SKELETONS IS MORE THAN THE ALLOTTED
NUMBER TO GENERATE.

 *** RULE CLUSTER_DECISION_8 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (COULD_NOT_CONCLUDE (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID OVER-MAXIMUM) )
     (COULD_NOT_CONCLUDE (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID EXTREMELY_LARGE) )
     (COULD_NOT_CONCLUDE (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID
                              SIGNIFICANT_WORKLOAD_COMPLEXITY) )
     (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?CLUSTER_ID ?NUMBER_TO_GENERATE )
     (NUMBER_OF_POTENTIAL_SKELETONS_FOR ?CLUSTER_ID ?CLUSTER_SET_ID ?POSSIBLE_NUMBER )
     (FUNCTION-CALL *>* ?POSSIBLE_NUMBER ?NUMBER_TO_GENERATE )

THEN (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID RESTRICT_REPRESENTATIONS)

     CERTAINTY FACTOR = 0.5


RESTRICT RELATIONSHIP REPRESENTATIONS IF THE CLUSTER IS LARGE BUT NOT EXTREMELY LARGE,
AND THERE IS A NO CONCLUSION PROHIBITING DIVISION.

 *** RULE CLUSTER_DECISION_9 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID OVER-MAXIMUM )
     (COULD_NOT_CONCLUDE (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID EXTREMELY_LARGE) )
     (REASON_NOT_TO_DIVIDE ?CLUSTER_ID ?CLUSTER_SET_ID ?ANY_REASON )

THEN (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID RESTRICT_REPRESENTATIONS)

     CERTAINTY FACTOR = 0.5
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RESTRICT RELATIONSHIP REPRESENTATIONS FOR AN INTERSECTION CLUSTER WHICH IS LARGE.

 *** RULE CLUSTER_DECISION_10 ***

IF   (CLUSTER ?CLUSTER_ID TEMPORARY_INTERSECTION_CLUSTER )
     (CLUSTER_CHARACTERIZATION ?CLUSTER_ID TEMPORARY_INTERSECTION_CLUSTER OVER-MAXIMUM )

THEN (INITIAL-DECISION ?CLUSTER_ID TEMPORARY_INTERSECTION_CLUSTER RESTRICT_REPRESENTATIONS)

     CERTAINTY FACTOR = 0.5



THE NEXT FOUR RULES CONCERN INITIAL DECISIONS TO GENERATE SKELETONS SELECTIVELY WITHIN A CLUSTER.

 *** RULE CLUSTER_DECISION_11 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (USER-MESSAGE ?CLUSTER_ID SELECTIVELY_GENERATE_SKELETONS )

THEN (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID SELECTIVELY_GENERATE_SKELETONS)

     CERTAINTY FACTOR = 0.5



GENERATE SKELETONS SELECTIVELY IF THE CLUSTER HAS SIGNIFICANT WORKLOAD COMPLEXITY,
IT IS TOO LARGE BUT NOT EXTREMELY LARGE, AND CLUSTER DIVISION IS PROHIBITED.

 *** RULE CLUSTER_DECISION_12 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (THERE_IS_ONE_OF (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID SIGNIFICANT_WORKLOAD_COMPLEXITY)
     (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID OVER-MAXIMUM )
     (COULD_NOT_CONCLUDE (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID EXTREMELY_LARGE) )
     (REASON_NOT_TO_DIVIDE ?CLUSTER_ID ?CLUSTER_SET_ID ?ANY_REASON )

THEN (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID SELECTIVELY_GENERATE_SKELETONS)

     CERTAINTY FACTOR = 0.5
```

GENERATE SKELETONS SELECTIVELY IF THE USER EXPLICITLY PROHIBITS DIVIDING THE CLUSTER AND THE NUMBER OF POSSIBLE SKELETONS IS GREATER THAN THE ALLOTTED NUMBER TO GENERATE.

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 *** RULE CLUSTER_DECISION_13 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (USER-MESSAGE ?CLUSTER_ID DO_NOT_DIVIDE )
     (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?CLUSTER_ID ?NUMBER_TO_GENERATE )
     (NUMBER_OF_POTENTIAL_SKELETONS_FOR ?CLUSTER_ID ?CLUSTER_SET_ID ?POSSIBLE_NUMBER )
     (FUNCTION-CALL *>* ?POSSIBLE_NUMBER ?NUMBER_TO_GENERATE )

THEN (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID SELECTIVELY_GENERATE_SKELETONS)

     CERTAINTY FACTOR = 0.5
```

GENERATE SKELETONS SELECTIVELY IF THE CLUSTER IS NOT TOO LARGE BUT THE NUMBER OF POSSIBLE SKELETONS IS GREATER THAN THE ALLOTTED NUMBER TO GENERATE, AND THE NUMBER IS MORE THAN 36.

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 *** RULE CLUSTER_DECISION_14 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (THERE_IS_ONE_OF (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID
                         SIGNIFICANT_WORKLOAD_COMPLEXITY) )
     (COULD_NOT_CONCLUDE (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID OVER-MAXIMUM) )
     (COULD_NOT_CONCLUDE (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID EXTREMELY_LARGE) )
     (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?CLUSTER_ID ?NUMBER_TO_GENERATE )
     (NUMBER_OF_POTENTIAL_SKELETONS_FOR ?CLUSTER_ID ?CLUSTER_SET_ID ?POSSIBLE_NUMBER )
     (FUNCTION-CALL *>* ?POSSIBLE_NUMBER ?NUMBER_TO_GENERATE )
     (FUNCTION-CALL *>* ?POSSIBLE_NUMBER 36 )

THEN (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID SELECTIVELY_GENERATE_SKELETONS)

     CERTAINTY FACTOR = 0.5
```

```
THE NEXT TWO RULES CONCERN INITIAL DECISIONS TO ENUMERATE SKELETONS.


ENUMERATE SKELETONS IF THE CLUSTER IS NOT TOO LARGE BUT THE NUMBER OF POSSIBLE SKELETONS IS
LESS THAN THE ALLOTTED NUMBER TO GENERATE.

 *** RULE CLUSTER_DECISION_15 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?CLUSTER_ID ?NUMBER_TO_GENERATE )
     (NUMBER_OF_POTENTIAL_SKELETONS_FOR ?CLUSTER_ID ?CLUSTER_SET_ID ?POSSIBLE_NUMBER )
     (FUNCTION-CALL *>=* ?NUMBER_TO_GENERATE ?POSSIBLE_NUMBER )

THEN (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID ENUMERATE_SKELETONS)

     CERTAINTY FACTOR = 0.9



ENUMERATE SKELETONS IF THE NUMBER OF POSSIBLE SKELETONS IS LESS THAN OR EQUAL TO 36.

 *** RULE CLUSTER_DECISION_16 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (NUMBER_OF_POTENTIAL_SKELETONS_FOR ?CLUSTER_ID ?CLUSTER_SET_ID ?POSSIBLE_NUMBER )
     (FUNCTION-CALL *>=* 36 ?POSSIBLE_NUMBER )

THEN (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID ENUMERATE_SKELETONS)

     CERTAINTY FACTOR = 0.9



IF THE CLUSTER HAS JUST ONE ENTITY, CONSIDER RECORD GENERATION TO BE COMPLETED.

 *** RULE CLUSTER_DECISION_17 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (NUMBER-OF-ENTITIES-IN-CLUSTER ?CLUSTER_ID ?NUM-ENT )
     (FUNCTION-CALL EQUAL-TERMS 1 ?NUM-ENT )

THEN (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID WORK_COMPLETE)

     CERTAINTY FACTOR = 0.99
```

```
------------------------------------------------------------
PART B OF SECTION 3.2 --> FOLLOW UP DECISION RULES ON A CLUSTER.
------------------------------------------------------------

ENUMERATE SKELETONS FOR CLUSTER ?CLUSTER_ID IF THE NUMBER OF POSSIBLE SKELETONS IN THE CLUSTER
IS LESS THAN OR EQUAL TO 36.

 *** RULE CLUSTER_DECISION_18 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID RESTRICT_REPRESENTATIONS )
     (NUMBER_OF_POTENTIAL_SKELETONS_FOR ?CLUSTER_ID ?CLUSTER_SET_ID ?POSSIBLE_NUMBER )
     (FUNCTION-CALL *>=* 36 ?POSSIBLE_NUMBER )

THEN (FOLLOW-UP-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID ENUMERATE_SKELETONS)

     CERTAINTY FACTOR = 0.5



ENUMERATE SKELETONS IF THE NUMBER OF POSSIBLE SKELETONS IS LESS THAN THE ALLOTTED NUMBER TO GENERATE.

 *** RULE CLUSTER_DECISION_19 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?CLUSTER_ID ?NUMBER_TO_GENERATE )
     (NUMBER_OF_POTENTIAL_SKELETONS_FOR ?CLUSTER_ID ?CLUSTER_SET_ID ?POSSIBLE_NUMBER )
     (FUNCTION-CALL *>=* ?NUMBER_TO_GENERATE ?POSSIBLE_NUMBER )

THEN (FOLLOW-UP-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID ENUMERATE_SKELETONS)

     CERTAINTY FACTOR = 0.25
```

SELECTIVELY GENERATE SKELETONS IF THE INITIAL DECISION FOR THE CLUSTER WAS TO RESTRICT RELATIONSHIP REPRESENTATIONS, THE NUMBER OF POSSIBLE SKELETONS FOR THE CLUSTER IS GREATER THAT THE ALLOTTED NUMBER TO GENERATE, AND THE NUMBER OF POSSIBLE SKELETONS IS MORE THAN 36.

```
 *** RULE CLUSTER_DECISION_20 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (INITIAL-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID RESTRICT_REPRESENTATIONS )
     (NUMBER_OF_POTENTIAL_SKELETONS_FOR ?CLUSTER_ID ?CLUSTER_SET_ID ?POSSIBLE_NUMBER )
     (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?CLUSTER_ID ?NUMBER_TO_GENERATE )
     (FUNCTION-CALL *>* ?POSSIBLE_NUMBER ?NUMBER_TO_GENERATE )
     (FUNCTION-CALL *>* ?POSSIBLE_NUMBER 36 )

THEN (FOLLOW-UP-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID SELECTIVELY_GENERATE_SKELETONS)

     CERTAINTY FACTOR = 0.5
```

```
-----------------------------------------------------------------
RULES FOR SECTION 3.3 --> CHARACTERIZATION OF INDIVIDUAL CLUSTERS.
-----------------------------------------------------------------



-------------------------------------------------------------------------
PART A OF SECTION 3.3 --> CHARACTERIZATIONS OF SIZE AND WORKLOAD COMPLEXITY.
-------------------------------------------------------------------------

CHARACTERIZE A CLUSTER AS "OVER THE LIMIT" IF IT HAS MORE THAN 256 SKELETONS, THE NUMBER OF
ENTITIES IS LARGER THAN A USER SPECIFIED MAXIMUM, AND THE CLUSTER HAS AT LEAST 25% OF THE
TOTAL NUMBER OF ENTITIES IN THE PROBLEM.

 *** RULE CLUSTER_CHAR_1 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (NUMBER_OF_POTENTIAL_SKELETONS_FOR ?CLUSTER_ID ?CLUSTER_SET_ID ?POSSIBLE_NUMBER )
     (FUNCTION-CALL *>* ?POSSIBLE_NUMBER 256 )
     (NUMBER-OF-ENTITIES-IN-CLUSTER ?CLUSTER_ID ?NUM_ENT_IN_CLUSTER )
     (USER_SPECIFIED_SIZE MAXIMUM ?MAXIMUM_NUMBER )
     (FUNCTION-CALL *>* ?NUM_ENT1 ?MAXIMUM_NUMBER )
     (NUMBER-OF-ENTITIES-IN-CLUSTER INITIAL-CG ?NUM_ENT_IN_INITIAL )
     (FUNCTION-CALL DIVIDE ?NUM_ENT_IN_CLUSTER ?NUM_ENT2_IN_INITIAL ?QUOTIENT )
     (FUNCTION-CALL *>* ?QUOTIENT 0.25 )

THEN (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID OVER-MAXIMUM)

     NO CERTAINTY FACTOR



CHARACTERIZE A CLUSTER AS HAVING "EXCESSIVE SIZE" IF IT HAS MORE THAN 256 SKELETONS AND HAS
MORE ENTITIES THAN THE NUMBER OF ENTITIES SPECIFIED BY THE USER AS BEING EXTREMELY LARGE.

 *** RULE CLUSTER_CHAR_2 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (NUMBER_OF_POTENTIAL_SKELETONS_FOR ?CLUSTER_ID ?CLUSTER_SET_ID ?POSSIBLE_NUMBER )
     (FUNCTION-CALL *>* ?POSSIBLE_NUMBER 256 )
     (NUMBER-OF-ENTITIES-IN-CLUSTER ?CLUSTER_ID ?NUM_ENT_IN_CLUSTER )
     (USER_SPECIFIED_SIZE EXTREMELY_LARGE ?SUPER_LARGE_NUMBER )
     (FUNCTION-CALL *>* ?NUM_ENT_IN_CLUSTER ?SUPER_LARGE_NUMBER )

THEN (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID EXTREMELY_LARGE)

     NO CERTAINTY FACTOR
```

```
THE NEXT TWO RULES IDENTIFY CLUSTERS AS HAVING SIGNIFICANT WORKLOAD COMPLEXITY BASED ON THE EXISTENCE
OF INDIVIDUAL RELATIONSHIP CHARACTERIZATIONS WITHIN THE CLUSTER.

 *** RULE CLUSTER_CHAR_3 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID ?PROB-TYPE SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (FUNCTION-CALL *IS-ONE-OF* ?PROB-TYPE (2WAY-TRAFFIC-1-M CONTEXT-CONFLICT DESC-USAGE
          MANY_TO_ONE_ACTIVITY_ONLY INDEPENDENT-DESC-COMPONENT-UPDATE) )

THEN (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID SIGNIFICANT_WORKLOAD_COMPLEXITY)

     NO CERTAINTY FACTOR



 *** RULE CLUSTER_CHAR_4 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (NUM-REL-CLUS ?CLUSTER_ID ?CLUSTER_SET_ID ?NUM-REL )
     (NUMBER-OF-ENTITIES-IN-CLUSTER ?CLUSTER_ID ?NUM-ENT )
     (FUNCTION-CALL DIVIDE ?NUM-REL ?NUM-ENT ?RATIO )
     (FUNCTION-CALL *>* ?RATIO 1.2 )

THEN (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID SIGNIFICANT_WORKLOAD_COMPLEXITY)

     NO CERTAINTY FACTOR



THIS A RULE CHARACTERIZING A CLUSTER AS HAVING MORE THAN ONE ROOT ENTITY. THE
FUNCTION "COUNT-E" SUMS THE NUMBER OF ROOT ENTITIES IN THE CLUSTER.

 *** RULE CLUSTER_CHAR_5 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (THERE_IS_ONE_OF (TYPE-OF-ENTITY ?ENTNAME *CLUSTER-ROOT-ENTITY*) )
     (FUNCTION-CALL *NUMBER-CLUSTER-ROOT-ENTITIES* ?CLUSTER_ID ?N )
     (FUNCTION-CALL *>* ?N 1 )

THEN (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID MULTIPLE_ROOT_ENTITIES_IN_CG)

     NO CERTAINTY FACTOR
```

```
--------------------------------------------------------------------------------
PART B OF SECTION 3.3 --> RULES FOR CONCLUDING PRIORITY OF CLUSTERS ON THE BASIS OF
DIFFERENT FACTORS.
--------------------------------------------------------------------------------

CLUSTER PRIORITY IS A NUMERIC VALUE PROVIDED BY THE CERTAINTY FACTOR.  THIS IS A RULE FOR
CONCLUDING PRIORITY FOR A TEMPORARY INTERSECTION CLUSTER.

 *** RULE CLUSTER_CHAR_6 ***

IF   (CLUSTER ?CLUSTER_ID TEMPORARY_INTERSECTION_CLUSTER )

THEN (CLUSTER_PRIORITY ?CLUSTER_ID TEMPORARY_INTERSECTION_CLUSTER)

     CERTAINTY FACTOR = 0.75



THIS IS A RULE FOR CONCLUDING PRIORITY FOR AN EXTREMELY LARGE CLUSTER.

 *** RULE CLUSTER_CHAR_7 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID EXTREMELY_LARGE )

THEN (CLUSTER_PRIORITY ?CLUSTER_ID ?CLUSTER_SET_ID)

     CERTAINTY FACTOR = 0.75



THE NEXT THREE RULES CONCLUDE PRIORITIES FOR CLUSTERS WITH SIGNIFICANT WORKLOAD COMPLEXITY ALONG
RELATIONSHIPS.  THE ASSOCIATED CERTAINTY FACTORS DIFFER BY THE PERCENTAGE OF THE TOTAL RELATIONSHIPS IN
THE ENTIRE PROBLEM WHICH ARE WITHIN THE CLUSTERS.

 *** RULE CLUSTER_CHAR_8 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (NUM-REL-CLUS ?CLUSTER_ID ?CLUSTER_SET_ID ?NUMBER_REL_IN_CLUS )
     (NUM-REL-CLUS-SET ?CLUSTER_SET_ID ?NUM_REL_IN_SET )
     (FUNCTION-CALL DIVIDE ?NUMBER_REL_IN_CLUS ?NUM_REL_IN_SET ?QUOTIENT )
     (FUNCTION-CALL *>* ?QUOTIENT 0.5 )

THEN (CLUSTER_PRIORITY ?CLUSTER_ID ?CLUSTER_SET_ID)

     CERTAINTY FACTOR = 0.6
```

```
 *** RULE CLUSTER_CHAR_9 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (NUM-REL-CLUS ?CLUSTER_ID ?CLUSTER_SET_ID ?NUMBER_REL_IN_CLUS )
     (NUM-REL-CLUS-SET ?CLUSTER_SET_ID ?NUM_REL_IN_SET )
     (FUNCTION-CALL DIVIDE ?NUMBER_REL_IN_CLUS ?NUM_REL_IN_SET ?QUOTIENT )
     (FUNCTION-CALL *>* ?QUOTIENT 0.2 )
     (FUNCTION-CALL *>=* 0.5 ?QUOTIENT )

THEN (CLUSTER_PRIORITY ?CLUSTER_ID ?CLUSTER_SET_ID)

     CERTAINTY FACTOR = 0.333



 *** RULE CLUSTER_CHAR_10 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (NUM-REL-CLUS ?CLUSTER_ID ?CLUSTER_SET_ID ?NUMBER_REL_IN_CLUS )
     (NUM-REL-CLUS-SET ?CLUSTER_SET_ID ?NUM_REL_IN_SET )
     (FUNCTION-CALL DIVIDE ?NUMBER_REL_IN_CLUS ?NUM_REL_IN_SET ?QUOTIENT )
     (FUNCTION-CALL *>=* 0.2 ?QUOTIENT )

THEN (CLUSTER_PRIORITY ?CLUSTER_ID ?CLUSTER_SET_ID)

     CERTAINTY FACTOR = 0.25



THIS IS A RULE CONCLUDING A LOW PRIORITY FOR A CLUSTER IF IT HAS SIGNIFICANT WORKLOAD COMPLEXITY ALONG
ONE OF ITS RELATIONSHIPS. THIS RULE WILL FIRE ONCE FOR EACH SUCH RELATIONSHIP WITHIN A CLUSTER,
INCREASING THE TOTAL PRIORITY FOR THE CLUSTER.

 *** RULE CLUSTER_CHAR_11 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (RELATIONSHIP_IN_CLUSTER ?REL ?CLUSTER_ID )
     (RELATIONSHIP_CHARACTERIZATION ?REL ?CHAR SIGNIFICANT_WORKLOAD_COMPLEXITY )

THEN (CLUSTER_PRIORITY ?CLUSTER_ID ?CLUSTER_SET_ID)

     CERTAINTY FACTOR = 0.2
```

```
--------------------------------------------------------------------------------
PART C OF SECTION 3.3 --> FOUR RULES FOR DETERMINING NUMBER OF SKELETONS TO GENERATE WITHIN
A CLUSTER.
--------------------------------------------------------------------------------

IF THE NUMBER OF RELATIONSHIPS IN THE CLUSTER IS THREE OR LESS, GENERATE ONLY TWO SKELETONS.

 *** RULE CLUSTER_CHAR_12 ***

IF   (CLUSTER ?CLUSTER_ID TEMPORARY_INTERSECTION_CLUSTER )
     (NUM-REL-CLUS ?CLUSTER_ID TEMPORARY_INTERSECTION_CLUSTER ?NUMBER_RELATIONSHIPS )
     (FUNCTION-CALL *>* 3 ?NUMBER_RELATIONSHIPS )

THEN (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?CLUSTER_ID ?NUMBER_RELATIONSHIPS)

     NO CERTAINTY FACTOR



FOR AN INTERSECTION CLUSTER, GENERATE 1.5 TIMES THE NUMBER OF RELATIONSHIPS IN THE CLUSTER.

 *** RULE CLUSTER_CHAR_13 ***

IF   (CLUSTER ?CLUSTER_ID TEMPORARY_INTERSECTION_CLUSTER )
     (NUM-REL-CLUS ?CLUSTER_ID TEMPORARY_INTERSECTION_CLUSTER ?NUMBER_RELATIONSHIPS )
     (FUNCTION-CALL *>=* ?NUMBER_RELATIONSHIPS 3 )
     (FUNCTION-CALL MULTIPLY-VALUES ?NUMBER_RELATIONSHIPS 1.5 ?NUMBER_TO_GENERATE )

THEN (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?CLUSTER_ID ?NUMBER_TO_GENERATE)

     NO CERTAINTY FACTOR
```

```
FOR A NON-INTERSECTION CLUSTER ?CLUSTER_ID WITH NO SIGNIFICANT WORKLOAD COMPLEXITY, THE ALLOTTED NUMBER
OF SKELETONS TO GENERATE SHOULD BE PROPORTIONAL TO:
     (NUMBER OF RELATIONSHIPS IN ?CLUSTER_ID /
      TOTAL NUMBER IN THE PROBLEM, E.G. THE INITIAL CLUSTER).

 *** RULE CLUSTER_CHAR_14 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER-SET )
     (FUNCTION-CALL NOT-EQUAL ?CLUSTER-SET TEMPORARY_INTERSECTION_CLUSTER )
     (COULD_NOT_CONCLUDE (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER-SET
                          SIGNIFICANT_WORKLOAD_COMPLEXITY) )
     (NUM-REL-CLUS ?CLUSTER_ID ?CLUSTER-SET ?NUM-REL )
     (NUM-REL-CLUS ?CLUSTER_ID INITIAL-CG ?NUM-REL-INIT-CLUS )
     (FUNCTION-CALL DIVIDE ?NUM-REL ?NUM-REL-INIT-CLUS ?PROPORTION )
     (FUNCTION-CALL INTMULT2 ?NUM-REL-INIT-CLUS ?PROPORTION ?NUMBER_TO_GENERATE )

THEN (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?CLUSTER_ID ?NUMBER_TO_GENERATE)

     NO CERTAINTY FACTOR



FOR A NON-INTERSECTION CLUSTER WITH SIGNIFICANT WORKLOAD COMPLEXITY, THE NUMBER OF
SKELETONS TO BE GENERATED SHOULD BE 1.5 TIMES THE PROPORTION:
     (NUMBER OF RELATIONSHIPS IN ?CLUSTER_ID /
      TOTAL NUMBER IN THE PROBLEM, E.G. THE INITIAL CLUSTER).

 *** RULE CLUSTER_CHAR_15 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER-SET )
     (FUNCTION-CALL NOT-EQUAL ?CLUSTER-SET TEMPORARY_INTERSECTION_CLUSTER )
     (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER-SET SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (NUM-REL-CLUS ?CLUSTER_ID ?CLUSTER-SET ?NUM-REL )
     (NUM-REL-CLUS INITIAL-CG INITIAL-SET ?NUM-REL-INIT-CLUS )
     (FUNCTION-CALL DIVIDE ?NUM-REL ?NUM-REL-INIT-CLUS ?PROPORTION )
     (FUNCTION-CALL MULTIPLY-VALUES ?NUM-REL-INIT-CLUS ?PROPORTION ?FIRST_NUM )
     (FUNCTION-CALL INTMULT2 1.5 ?FIRST_NUM ?NUMBER_TO_GENERATE )

THEN (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?CLUSTER_ID ?NUMBER_TO_GENERATE)

     NO CERTAINTY FACTOR
```

APPENDIX B

RULES FOR THE ENTITY RELATIONSHIP ANALYSIS KNOWLEDGE BASE

```
-----------------------------------------------------------------
RULES FOR SECTION 4.4 --> STRUCTURAL CHARACTERIZATION RULE GROUP.
-----------------------------------------------------------------


-------------------------------------------------------------------------------
PART A OF SECTION 4.4 --> PARTIALLY IDENTIFYING RELATIONSHIPS AND ENTITY DEPENDENCY.
-------------------------------------------------------------------------------

THIS IS A RULE FOR CONCLUDING THAT A RELATIONSHIP DESCRIPTOR IS A PARTIAL IDENTIFIER OF AN ENTITY.

 *** RULE STRUCT_1 ***

IF   (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (IDENTIFIER ?ENT2 PRIMARY ?REL_DESC_NAME )

THEN (PARTIAL_ID_RELATIONSHIP ?ENT2 ?REL_ID)

     NO CERTAINTY FACTOR



THIS RULE CONCLUDES AN ENTITY HAS TWO DIFFERENT PARTIALLY IDENTIFYING RELATIONSHIPS.

 *** RULE STRUCT_2 ***

IF   (PARTIAL_ID_RELATIONSHIP ?ENTITY ?REL_ID1 )
     (PARTIAL_ID_RELATIONSHIP ?ENTITY ?REL_ID2 )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID1 ?REL_ID2 )

THEN (TWO-PRIMARY-IDENTIFYING-RELATIONSHIPS ?ENTITY ?REL_ID1 ?REL_ID2)

     NO CERTAINTY FACTOR
```

THIS RULE CONCLUDES THAT AN ENTITY IS DEPENDENT ON ANOTHER ENTITY ON THE BASIS OF A PARTIALLY IDENTIFYING RELATIONSHIP.

```
 *** RULE STRUCT_3 ***

IF   (PARTIAL_ID_RELATIONSHIP ?ENT1 ?REL_ID )
     (DEGREE-OF ?REL_ID ?ENT2 ?ENT1 1 ?N )

THEN (DEPENDS-ON ?ENT1 ?ENT2)

     CERTAINTY FACTOR = 0.5
```

THIS RULE CONCLUDES AN ENTITY IS DEPENDENT ON ANOTHER ON THE BASIS OF A NUMERIC DEPENDENCY FACTOR.

```
 *** RULE STRUCT_4 ***

IF   (RELATIONSHIP-INFORMATION ?REL_ID ?ENT1 ?ENT2 ENTITY-DEPENDENCY-FACTOR ?STR )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )
     (FUNCTION-CALL *>* ?STR 0.75 )

THEN (DEPENDS-ON ?ENT2 ?ENT1)

     CERTAINTY FACTOR = 0.75
```

THIS RULE CONCLUDES AN ENTITY IS DEPENDENT ON ANOTHER BASED ON INFORMATION EXPLICITLY PROVIDED IN THE PROBLEM STATEMENT.

```
 *** RULE STRUCT_5 ***

IF   (GIVEN-DEPENDENT-ON ?ENT1 ?ENT2 )

THEN (DEPENDS-ON ?ENT1 ?ENT2)

     CERTAINTY FACTOR = 0.5
```

```
--------------------------------------------------------------------------------
PART B OF SECTION 4.4 --> ENTITY TYPES AND ENTITY CHARACTERIZATIONS BASED ON TYPES.
--------------------------------------------------------------------------------

THIS RULE CONCLUDES AN INDEPENDENT TYPE ENTITY. AN INDEPENDENT ENTITY IS DEFINED BY HAVING AN
IDENTIFIER COMPOSED OF ONE OR MORE OF ITS OWN ATTRIBUTES, WITH AT LEAST ONE ENTITY ATTRIBUTE THAT
IS NOT PART OF THE IDENTIFIER.  IN ADDITION, THE ENTITY MUST HAVE NO PARTIALLY IDENTIFYING
RELATIONSHIPS.

 *** RULE STRUCT_6 ***

IF   (ATTRIBUTE-IS-PRIMARY-IDENTIFIER ?ENTITY ?ATTRIBUTE_NAME )
     (COULD_NOT_CONCLUDE (ALL-ITEMS-FORM-IDENTIFIER-FOR ?ENTITY) )
     (COULD_NOT_CONCLUDE (PARTIAL_ID_RELATIONSHIP ?ENTITY ?REL_ID) )

THEN (TYPE-OF-ENTITY ?ENTITY *INDEPENDENT-ENTITY*)

     NO CERTAINTY FACTOR



CONCLUDE AN ENTITY ATTRIBUTE IS PART OF THE IDENTIFIER.

 *** RULE STRUCT_7 ***

IF   (IDENTIFIER ?ENTITY PRIMARY ?ATTRIBUTE_NAME )
     (ATTRIBUTE-INFORMATION ?ENTITY ?ATTRIBUTE_NAME ?ITEM_BYTE_LENGTH ?VOCAB_SIZE ?UPDATE )

THEN (ATTRIBUTE-IS-PRIMARY-IDENTIFIER ?ENTITY ?ATTRIBUTE_NAME)

     NO CERTAINTY FACTOR



CONCLUDE THAT ALL OF THE ATTRIBUTES OF AN ENTITY FORM ITS IDENTIFIER, WITH NO ATTRIBUTES WHICH
ARE NOT PART OF THE IDENTIFIER.

 *** RULE STRUCT_8 ***

IF   (IDENTIFIER ?ENTITY PRIMARY ?ATTR1 )
     (ATTRIBUTE-INFORMATION ?ENTITY ?ATTR1 ?ITEM_BYTE_LENGTH ?VOCAB_SIZE ?UPDATE )
     (COULD_NOT_CONCLUDE (NON-IDENTIFIER-ATTRIBUTE ?ENTITY ?ATTR2) )

THEN (ALL-ITEMS-FORM-IDENTIFIER-FOR ?ENTITY)

     NO CERTAINTY FACTOR
```

```
CONCLUDE AN ENTITY HAS AT LEAST ONE ATTRIBUTE WHICH IS NOT IN THE IDENTIFIER,
E.G. A NON-IDENTIFYING ATTRIBUTE.

 *** RULE STRUCT_9 ***

IF   (ATTRIBUTE-INFORMATION ?ENTITY ?ATTR ?ITEM_BYTE_LENGTH ?VOCAB_SIZE ?UPDATE )
     (COULD_NOT_CONCLUDE (IDENTIFIER ?ENTITY PRIMARY ?ATTR) )

THEN (NON-IDENTIFIER-ATTRIBUTE ?ENTITY ?ATTR)

     NO CERTAINTY FACTOR



THIS IS A RULE CHARACTERIZING A ROOT ENTITY, E.G. AN INDEPENDENT ENTITY WITH AT LEAST
ONE DEPENDENT ENTITY.

 *** RULE STRUCT_10 ***

IF   (TYPE-OF-ENTITY ?ENTITY *INDEPENDENT-ENTITY* )
     (THERE_IS_ONE_OF (DEPENDS-ON ?ANOTHER-ENTITY ?ENTITY) )

THEN (TYPE-OF-ENTITY ?ENTITY *CLUSTER-ROOT-ENTITY*)

     NO CERTAINTY FACTOR



THIS RULE CONCLUDES AN AGGREGATE TYPE ENTITY. AN AGGREGATE ENTITY IS DEFINED BY HAVING AN IDENTIFIER
COMPOSED OF ALL OF ITS ATTRIBUTES WITH NO ATTRIBUTES WHICH ARE NOT PART OF THE IDENTIFIER.
IN ADDITION, THE ENTITY MUST HAVE NO PARTIALLY IDENTIFYING RELATIONSHIPS.

 *** RULE STRUCT_11 ***

IF   (ALL-ITEMS-FORM-IDENTIFIER-FOR ?ENTITY )
     (COULD_NOT_CONCLUDE (PARTIAL_ID_RELATIONSHIP ?ENTITY ?REL_ID) )

THEN (TYPE-OF-ENTITY ?ENTITY *AGGREGATE-ENTITY*)

     NO CERTAINTY FACTOR
```

```
THIS RULE PROVIDES A CHARACTERIZATION FOR AN AGGREGATE ENTITY WHICH RECEIVES
DIRECT RETRIEVAL ACTIVITY.

 *** RULE STRUCT_12 ***

IF   (TYPE-OF-ENTITY ?ENTITY *AGGREGATE-ENTITY* )
     (RETRIEVE-CONTEXT ?QUERY 1 ?ENTITY INITIAL ?PROPORTION ?FREQUENCY ?CODE ?FORWARD )

THEN (TYPE-OF-ENTITY ?ENTITY *AGGREGATE-WITH-DIRECT-ACTIVITY*)

     NO CERTAINTY FACTOR



THIS RULE CONCLUDES A DEPENDENT TYPE ENTITY. A DEPENDENT ENTITY IS DEFINED BY HAVING AN IDENTIFIER
COMPOSED OF AT LEAST ONE OF ITS ATTRIBUTES AND ONE AND ONLY ONE PARTIALLY IDENTIFYING RELATIONSHIP.

 *** RULE STRUCT_13 ***

IF   (PARTIAL_ID_RELATIONSHIP ?ENTITY ?REL_ID1 )
     (ATTRIBUTE-IS-PRIMARY-IDENTIFIER ?ENTITY ?ATTRIBUTE_NAME )
     (COULD_NOT_CONCLUDE (TWO-PRIMARY-IDENTIFYING-RELATIONSHIPS ?ENTITY ?REL_ID1 ?REL_ID2) )

THEN (TYPE-OF-ENTITY ?ENTITY *DEPENDENT-ENTITY*)

     NO CERTAINTY FACTOR



THIS RULE CONCLUDES A INTERSECTION TYPE ENTITY. AN INTERSECTION ENTITY IS DEFINED BY HAVING AN IDENTIFIER
WITH TWO OR MORE PARTIALLY IDENTIFYING RELATIONSHIPS.

 *** RULE STRUCT_14 ***

IF   (PARTIAL_ID_RELATIONSHIP ?ENTITY ?REL_ID1 )
     (PARTIAL_ID_RELATIONSHIP ?ENTITY ?REL_ID2 )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID1 ?REL_ID2 )

THEN (TYPE-OF-ENTITY ?ENTITY *INTERSECTION-ENTITY*)

     NO CERTAINTY FACTOR
```

```
THIS IS A RULE CHARACTERIZING AN ENTITY AS BEING AN INTERSECTION ENTITY WITH NO ATTRIBUTES OF ITS OWN.

 *** RULE STRUCT_15 ***

IF   (TYPE-OF-ENTITY ?ENTITY *INTERSECTION-ENTITY* )
     (COULD_NOT_CONCLUDE (ATTRIBUTE-INFORMATION ?ENTITY ?ATTRIBUTE_NAME ?ITEM_BYTE_LENGTH ?VOCAB_SIZE
                          ?UPDATE) )

THEN (TYPE-OF-ENTITY ?ENTITY *INTERSECTION-NO-ATTRIBUTES*)

     NO CERTAINTY FACTOR



IDENTIFYING RELATIONSHIP FOR AN INTERSECTION ENTITY. THIS CONCLUSION IS USED BY THE
CLUSTER DIVISION EXPERT TO PREVENT USING REL_ID AS A BREAK POINT.

 *** RULE STRUCT_16 ***

IF   (TYPE-OF-ENTITY ?ENTITY *INTERSECTION-ENTITY* )
     (PARTIAL_ID_RELATIONSHIP ?ENTITY ?REL_ID )

THEN (RELATIONSHIP_CHARACTERIZATION ?REL_ID *INTERSECTION* CHARACTERIZATION)

     NO CERTAINTY FACTOR



THIS RULE CHARACTERIZES A LEAF ENTITY AS BEING AN INDEPENDENT OR DEPENDENT ENTITY WHICH HAS ONLY
ONE RELATIONSHIP.  IT IS THEREFORE AT THE "FRINGE" WHERE IT IS A LEAF OF THE LDS.

 *** RULE STRUCT_17 ***

IF   (DEGREE-OF ?REL_ID1 ?ENT1 ?ENTITY 1 ?M )
     (TYPE-OF-ENTITY ?ENTITY ?TYPE )
     (FUNCTION-CALL *IS-ONE-OF* ?TYPE (*INDEPENDENT-ENTITY* *DEPENDENT-ENTITY*) )
     (COULD_NOT_CONCLUDE (DEGREE-OF ?REL_ID2 ?ENTITY ?ENT2 1 M) )
     (COULD_NOT_CONCLUDE (DEGREE-OF ?REL_ID2 ?ENTITY ?ENT2 1 1) )

THEN (TYPE-OF-ENTITY ?ENTITY LEAF_ENTITY)

     NO CERTAINTY FACTOR
```

THIS RULE CHARACTERIZES A DEPENDENT ENTITY WHICH IS THE FOCUS OF DIRECT LARGE SUBSET ACTIVITY, WHERE THE PARTIALLY IDENTIFYING RELATIONSHIP DESCRIPTOR IS IN THE SELECTION CRITERIA OF THE LARGE SUBSET RETRIEVAL. THIS IS IMPORTANT BECAUSE THE IDENTIFIER ATTRIBUTES MUST BE EXPLICITLY REPRESENTED IN THE RECORD TO MAKE THE RETRIEVAL POSSIBLE.

```
 *** RULE STRUCT_18 ***

IF   (DEPENDS-ON ?ENTITY ?ENT2 )
     (RETRIEVE-CONTEXT ?QUERY 1 ?ENTITY INITIAL ?PROPORTION ?FREQUENCY ?CODE ?FORWARD )
     (FUNCTION-CALL *>=* ?PROPORTION 0.1 )
     (CONTEXT-SELECTION-CRITERIA ?QUERY 1 ?ENTITY ?SELECT_CRIT )
     (PARTIAL_ID_RELATIONSHIP ?ENTITY ?REL_ID )
     (RELATIONSHIP ?REL_ID ?ENT2 ?ENTITY ?DESC )
     (FUNCTION-CALL EQUAL-TERMS ?SELECT_CRIT ?DESC )

THEN (TYPE-OF-ENTITY ?ENTITY *DEPENDENT-ENTITY-HAS-LG-SUB-ACTIVITY-WITH-SELECTION*)

     NO CERTAINTY FACTOR
```

```
-------------------------------------------
PART C OF SECTION 4.4 -->  RELATIONSHIP DEGREE.
-------------------------------------------

THE FOLLOWING SIX RULES REPRESENT GENERALIZATIONS ABOUT RELATIONSHIP DEGREE FOR RELATIONSHIPS
BASED ON THE ACTUAL RATIOS OF ENTITIES IN THE RELATIONSHIP E.G. 1 TO MANY ETC.

 *** RULE STRUCT_19 ***

IF   (RELATIONSHIP-CARDINALITY ?REL_ID ?ENT1 ?ENT2 1 1 )

THEN (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 1)

     NO CERTAINTY FACTOR



 *** RULE STRUCT_20 ***

IF   (RELATIONSHIP-CARDINALITY ?REL_ID ?ENT1 ?ENT2 1 1 )

THEN (DEGREE-OF ?REL_ID ?ENT2 ?ENT1 1 1)

     NO CERTAINTY FACTOR



 *** RULE STRUCT_21 ***

IF   (RELATIONSHIP-CARDINALITY ?REL_ID ?ENT1 ?ENT2 1 ?N )
     (FUNCTION-CALL *>* ?N 1 )

THEN (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M)

     NO CERTAINTY FACTOR



 *** RULE STRUCT_22 ***

IF   (RELATIONSHIP-CARDINALITY ?REL_ID ?ENT1 ?ENT2 1 ?N )
     (FUNCTION-CALL *>* ?N 1 )

THEN (DEGREE-OF ?REL_ID ?ENT2 ?ENT1 M 1)

     NO CERTAINTY FACTOR
```

```
 *** RULE STRUCT_23 ***

IF   (RELATIONSHIP-CARDINALITY ?REL_ID ?ENT1 ?ENT2 0 ?N )
     (FUNCTION-CALL *>* ?N 1 )

THEN (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 0 M)

     NO CERTAINTY FACTOR



 *** RULE STRUCT_24 ***

IF   (RELATIONSHIP-CARDINALITY ?REL_ID ?ENT1 ?ENT2 0 ?N )
     (FUNCTION-CALL *>* ?N 1 )

THEN (DEGREE-OF ?REL_ID ?ENT2 ?ENT1 M 0)

     NO CERTAINTY FACTOR
```

```
-------------------------------------------------------------------------
PART D OF SECTION 4.4 --> STRUCTURAL CHARACTERIZATIONS FOR RELATIONSHIPS.
-------------------------------------------------------------------------

THIS RULE STATES THAT IF A RECORD RESULTING FROM THE ABSORPTION OF ?ENT2 INTO ?ENT1 ALONG
ONE TO MANY RELATIONSHIP ?REL_ID HAS A LENGTH LESS THAN 5% OF THE LENGTH OF THE TRACK, THEN
A CHARACTERIZATION OF TRIVIAL RECORD SIZE FOR A MANY ENTITY SHOULD BE MADE FOR ?REL_ID.  THIS
RULE APPLIES ONLY TO NON-LEAF ENTITIES.

 *** RULE STRUCT_25 ***

IF   (DEVICE_LENGTH ?SYSTEM ?TR-LEN )
     (RELATIONSHIP-CARDINALITY ?REL_ID ?ENT1 ?ENT2 1 ?DEG )
     (FUNCTION-CALL *>* ?DEG 1 )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY) )
     (ENTITY_LENGTH_FOR_ATTRIBUTES ?ENT1 ?LENGTH_IN_BYTES1 )
     (ENTITY_LENGTH_FOR_ATTRIBUTES ?ENT2 ?LENGTH_IN_BYTES2 )
     (FUNCTION-CALL MULTIPLY-VALUES ?DEG ?LENGTH_IN_BYTES2 ?DEG-LEN2-PROD )
     (FUNCTION-CALL SUM2 ?LENGTH_IN_BYTES1 ?DEG-LEN2-PROD ?REC-LENGTH_IN_BYTES )
     (FUNCTION-CALL DIVIDE ?REC-LENGTH_IN_BYTES ?TR-LEN ?QUOT )
     (FUNCTION-CALL *>* 0.05 ?QUOT )

THEN (RELATIONSHIP_CHARACTERIZATION ?REL_ID TRIVIAL_SIZE_MANY_ENTITY CHARACTERIZATION)

     NO CERTAINTY FACTOR



THIS RULE STATES THAT IF A LEAF ENTITY WITH A CORRESPONDING REPEATING GROUP IS LESS THAN 5% OF TRACK,
CONCLUDE THAT A SMALL RECORD WOULD BE FORMED FROM THE LEAF ENTITY.

 *** RULE STRUCT_26 ***

IF   (DEVICE_LENGTH ?SYSTEM ?TR-LEN )
     (RELATIONSHIP-CARDINALITY ?REL_ID ?ENT1 ?ENT2 1 ?DEG )
     (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY )
     (ENTITY_LENGTH_FOR_ATTRIBUTES ?ENT1 ?LENGTH_IN_BYTES1 )
     (ENTITY_LENGTH_FOR_ATTRIBUTES ?ENT2 ?LENGTH_IN_BYTES2 )
     (FUNCTION-CALL MULTIPLY-VALUES ?DEG ?LENGTH_IN_BYTES2 ?DEG-LEN2-PROD )
     (FUNCTION-CALL SUM2 ?LENGTH_IN_BYTES1 ?DEG-LEN2-PROD ?REC-LENGTH_IN_BYTES )
     (FUNCTION-CALL DIVIDE ?REC-LENGTH_IN_BYTES ?TR-LEN ?QUOT )
     (FUNCTION-CALL *>* 0.05 ?QUOT )

THEN (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_SIZE_SMALL_&_LEAF_ENTITY CHARACTERIZATION)

     NO CERTAINTY FACTOR
```

```
THIS RULE STATES THAT IF A RECORD RESULTING FROM THE ABSORPTION OF ?ENT2 INTO ?ENT1 ALONG
RELATIONSHIP ?REL_ID HAS A LENGTH GREATER THAN THE LENGTH OF A TRACK, THEN A CHARACTERIZATION
OF RECORD SIZE EXCEEDING DEVICE LENGTH SHOULD BE MADE FOR ?REL_ID.

 *** RULE STRUCT_27 ***

IF   (DEVICE_LENGTH ?SYSTEM ?TR-LEN )
     (RELATIONSHIP-CARDINALITY ?REL_ID ?ENT1 ?ENT2 1 ?DEG )
     (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY )
     (ENTITY_LENGTH_FOR_ATTRIBUTES ?ENT1 ?LENGTH_IN_BYTES1 )
     (ENTITY_LENGTH_FOR_ATTRIBUTES ?ENT2 ?LENGTH_IN_BYTES2 )
     (FUNCTION-CALL MULTIPLY-VALUES ?DEG ?LENGTH_IN_BYTES2 ?DEG-LEN2-PROD )
     (FUNCTION-CALL SUM2 ?LENGTH_IN_BYTES1 ?DEG-LEN2-PROD ?REC-LENGTH_IN_BYTES )
     (FUNCTION-CALL *>* ?REC-LENGTH_IN_BYTES ?TR-LEN )

THEN (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_EXCEEDS_DEVICE_LENGTH CHARACTERIZATION)

     NO CERTAINTY FACTOR


THIS IS A RULE WHICH CONCLUDES THE LENGTH OF AN ENTITY BASED ON ITS ATTRIBUTES ONLY. IT CALLS A
SUMMATION FUNCTION TO SUM THE LENGTH.

 *** RULE STRUCT_28 ***

IF   (ENTITY ?ENTITY )
     (FUNCTION-CALL SUM-VALS ATTRIBUTE-INFORMATION ?ENTITY 2 4 ?LENGTH_IN_BYTES )

THEN (ENTITY_LENGTH_FOR_ATTRIBUTES ?ENTITY ?LENGTH_IN_BYTES)

     NO CERTAINTY FACTOR
```

```
-----------------------------------------------------------------
PART E OF SECTION 4.4 --> MISCELLANEOUS STRUCTURAL IDENTIFICATIONS.
-----------------------------------------------------------------

THE NEXT THREE RULES CONCLUDE THAT ATTRIBUTES ARE PART OF RELATIONSHIP DESCRIPTORS FOR INDEPENDENT
AND DEPENDENT ENTITIES. THE RULES PROPAGATE ATTRIBUTES THROUGH TWO LEVELS OF CHAINS OF DEPENDENT
ENTITIES. THE INFORMATION CONCLUDED BY THESE RULES IS USED TO DETERMINE THE IDENTIFIERS OF CANONICAL
RECORDS BASED ON DEPENDENT ENTITIES.

 *** RULE STRUCT_29 ***

IF   (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (ATTRIBUTE-IS-PRIMARY-IDENTIFIER ?ENT2 ?ATTRIBUTE_NAME )

THEN (DESCRIPTOR-COMPONENT ?REL_DESC_NAME ?REL_ID ?ATTRIBUTE_NAME)

     NO CERTAINTY FACTOR



 *** RULE STRUCT_30 ***

IF   (TYPE-OF-ENTITY ?ENTITY *DEPENDENT-ENTITY* )
     (RELATIONSHIP ?REL_ID ?PARENT_ENT ?ENTITY ?REL_DESC_NAME )
     (PARTIAL_ID_RELATIONSHIP ?ENTITY ?REL_ID )
     (ATTRIBUTE-IS-PRIMARY-IDENTIFIER ?PARENT_ENT ?ATTRIBUTE_NAME )

THEN (DESCRIPTOR-COMPONENT ?REL_DESC_NAME ?REL_ID ?ATTRIBUTE_NAME)

     NO CERTAINTY FACTOR



 *** RULE STRUCT_31 ***

IF   (TYPE-OF-ENTITY ?ENTITY *DEPENDENT-ENTITY* )
     (RELATIONSHIP ?REL_ID1 ?PARENT_ENT ?ENTITY ?REL_DESC_NAME1 )
     (TYPE-OF-ENTITY ?PARENT_ENT *DEPENDENT-ENTITY* )
     (PARTIAL_ID_RELATIONSHIP ?ENTITY ?REL_ID1 )
     (RELATIONSHIP ?REL_ID2 ?GRAND_PAR_ENT ?PARENT_ENT ?REL_DESC_NAME2 )
     (PARTIAL_ID_RELATIONSHIP ?PARENT_ENT ?REL_ID2 )
     (ATTRIBUTE-IS-PRIMARY-IDENTIFIER ?GRAND_PAR_ENT ?ATTRIBUTE_NAME )

THEN (DESCRIPTOR-COMPONENT ?REL_DESC_NAME2 ?REL_ID1 ?ATTRIBUTE_NAME)

     NO CERTAINTY FACTOR
```

```
THE FOLLOWING RULES CONCLUDE WHETHER AN ATTRIBUTE BELONGS IN A PRIMARY SEGMENT OR A SECONDARY
SEGMENT. THE FACT EXPRESSION "CALC-PRIM-SEG-ITEM" IS COMPUTED BY A ROUTINE INVOKED BY THE
CONTROL MODULE AT THE BEGINNING OF A SESSION. THE ROUTINE USES THE "EIGHTY-TWENTY" RULE FOR
FREQUENCY TO DETERMINE PRIMARY SEGMENT NON-IDENTIFYING ATTRIBUTES.

 *** RULE STRUCT_32 ***

IF   (ATTRIBUTE-INFORMATION ?ENTITY ?ATTRIBUTE_NAME ?ITEM_BYTE_LENGTH ?VOCAB_SIZE ?UPDATE )
     (CALC-PRIM-SEG-ITEM ?ENTITY ?ATTRIBUTE_NAME ?PRIM_FREQ ?TOTAL_FREQ )

THEN (PRIM-SEG-ITEM ?ENTITY ?ATTRIBUTE_NAME EIGHTY-TWENTY)

     NO CERTAINTY FACTOR



THE NEXT RULE CONCLUDES MEMBERSHIP IN THE PRIMARY SEGMENT OF AN IDENTIFYING ATTRIBUTE.

 *** RULE STRUCT_33 ***

IF   (ATTRIBUTE-INFORMATION ?ENTITY ?ATTRIBUTE_NAME ?ITEM_BYTE_LENGTH ?VOCAB_SIZE ?UPDATE )
     (IDENTIFIER ?ENTITY PRIMARY ?ATTRIBUTE_NAME )

THEN (PRIM-SEG-ITEM ?ENTITY ?ATTRIBUTE_NAME EIGHTY-TWENTY)

     NO CERTAINTY FACTOR



THE NEXT RULE CONCLUDES MEMBERSHIP IN THE SECONDARY SEGMENT.

 *** RULE STRUCT_34 ***

IF   (ATTRIBUTE-INFORMATION ?ENTITY ?ATTRIBUTE_NAME ?ITEM_BYTE_LENGTH ?VOCAB_SIZE ?UPDATE )
     (COULD_NOT_CONCLUDE (PRIM-SEG-ITEM ?ENTITY ?ATTRIBUTE_NAME EIGHTY-TWENTY) )

THEN (SEC-SEG-ITEM ?ENTITY ?ATTRIBUTE_NAME EIGHTY-TWENTY)

     NO CERTAINTY FACTOR
```

```
-------------------------------------------------------------------------
RULES FOR SECTION 4.5 --> THE ENTITY ACTIVITY CHARACTERIZATION RULE GROUP.
-------------------------------------------------------------------------


-------------------------------------------------
PART A OF SECTION 4.5 --> THE CHARACTERIZATION RULES.
-------------------------------------------------

THIS RULE CONCLUDES A SIGNIFICANT LEVEL OF UPDATE ACTIVITY FOR AN ENTITY IF THE FREQUENCY OF INSERTS
AND DELETES IS ABOVE A MINIMUM CUTOFF LEVEL, AND EXCEEDS 10% OF FREQUENCY OF DIRECT ACTIVITY ON ENTITY.

 *** RULE ENTACT_1 ***

IF   (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME INSERT SINGLE ?UP-FREQ1 )
     (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME DELETE SINGLE ?UP-FREQ2 )
     (FUNCTION-CALL SUM2 ?UP-FREQ1 ?UP-FREQ2 ?UP-FREQ-SUM )
     (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME RETRIEVAL ALL-SIZE ?RET-FREQ )
     (FUNCTION-CALL DIVIDE ?UP-FREQ-SUM ?RET-FREQ ?QUOTIENT )
     (FUNCTION-CALL *>* ?QUOTIENT 0.1 )
     (ACTIVITY-CUTOFF-POINT-FOR-ENTITY UPDATE SINGLE ?CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?UP-FREQ-SUM ?CUTOFF_FREQ )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?ENTNAME UPDATE SINGLE SIGNIFICANT)

     NO CERTAINTY FACTOR



THIS IS A RULE FOR CORRESPONDINGLY HEAVIER LEVELS OF ACTIVITY. THE FUNCTION *SCALE* IS USED TO
DETERMINE THE CHARACTERIZATION.

 *** RULE ENTACT_2 ***

IF   (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME INSERT SINGLE ?UP-FREQ1 )
     (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME DELETE SINGLE ?UP-FREQ2 )
     (FUNCTION-CALL SUM2 ?UP-FREQ1 ?UP-FREQ2 ?UP-FREQ-SUM )
     (ACTIVITY-CUTOFF-POINT-FOR-ENTITY UPDATE SINGLE ?CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?UP-FREQ-SUM ?CUTOFF_FREQ )
     (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME RETRIEVAL ALL-SIZE ?RET-FREQ )
     (FUNCTION-CALL DIVIDE ?UP-FREQ-SUM ?RET-FREQ ?QUOTIENT )
     (FUNCTION-CALL *SCALE* ?QUOTIENT ?ACTIVITY_LEVEL (0.1 HEAVY-0 0.2 HEAVY-1
                                                       0.4 HEAVY-2 0.8 HEAVY-3 1.6 HEAVY-4) )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?ENTNAME UPDATE SINGLE ?ACTIVITY_LEVEL)

     NO CERTAINTY FACTOR
```

```
CONCLUDE THERE IS A SIGNIFICANT DEGREE OF DIRECT SMALL SUBSET RETRIEVAL ACTIVITY ON ENTITY ?ENTNAME
IF THE FREQUENCY OF THIS ACTIVITY EXCEEDS 10% OF TOTAL ACTIVITY FORWARDED TO ?ENTNAME THROUGH THE
RELATIONSHIPS ?ENTNAME IS IN, AND THE SMALL SUBSET ACTIVITY IS ABOVE A MINIMUM CUTOFF LEVEL.

 *** RULE ENTACT_3 ***

IF   (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME RETRIEVAL SMALL-SUBSET ?SM-SUB_FREQ )
     (CARDINALITY ?ENTNAME ?CARDNUM )
     (FUNCTION-CALL MULTIPLY-VALUES ( ?CARDNUM ?SM-SUB_FREQ  0.05) ?TOTAL )
     (REL_ACTIVITY_FORWARDED_TO_ENTITY ?ENTNAME ?REL-FREQ )
     (FUNCTION-CALL DIVIDE ?TOTAL ?REL-FREQ ?QUOTIENT )
     (FUNCTION-CALL *>=* ?QUOTIENT 0.1 )
     (ACTIVITY-CUTOFF-POINT-FOR-ENTITY RETRIEVAL SMALL-SUBSET ?SM_SUB_CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?SM-SUB_FREQ ?SM_SUB_CUTOFF_FREQ )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?ENTNAME RETRIEVAL SMALL-SUBSET SIGNIFICANT)

     NO CERTAINTY FACTOR



THIS IS A RULE FOR CORRESPONDINGLY HEAVIER LEVELS OF ACTIVITY. IT USES THE *SCALE* FUNCTION.

 *** RULE ENTACT_4 ***

IF   (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME RETRIEVAL SMALL-SUBSET ?SM-SUB_FREQ )
     (CARDINALITY ?ENTNAME ?CARDNUM )
     (FUNCTION-CALL MULTIPLY-VALUES ( ?CARDNUM  ?SM-SUB_FREQ 0.05) ?TOTAL )
     (REL_ACTIVITY_FORWARDED_TO_ENTITY ?ENTNAME ?REL-FREQ )
     (FUNCTION-CALL DIVIDE ?TOTAL ?REL-FREQ ?QUOTIENT )
     (ACTIVITY-CUTOFF-POINT-FOR-ENTITY RETRIEVAL SMALL-SUBSET ?SM_SUB_CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?SM-SUB_FREQ ?SM_SUB_CUTOFF_FREQ )
     (FUNCTION-CALL *SCALE* ?QUOTIENT ?ACTIVITY_LEVEL (0.1 HEAVY-0 0.4 HEAVY-1
                                                       0.8 HEAVY-2 3.2 HEAVY-3 6.4 HEAVY-4) )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?ENTNAME RETRIEVAL SMALL-SUBSET ?ACTIVITY_LEVEL)

     NO CERTAINTY FACTOR
```

```
CONCLUDE THERE IS A SIGNIFICANT LEVEL OF DIRECT LARGE SUBSET RETRIEVAL ACTIVITY ON ENTITY
?ENTNAME IF ( FREQUENCY OF LARGE SUBSET ACTIVITY * CARDINALITY OF ENTNAME) EXCEEDS 5% OF
THE TOTAL ACTIVITY FORWARDED TO ?ENTNAME BY ALL THE RELATIONSHIPS ?ENTNAME IS IN, AND
THE LARGE SUBSET ACTIVITY IS ABOVE A MINIMUM CUTOFF LEVEL.

 *** RULE ENTACT_5 ***

IF   (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME RETRIEVAL LARGE-SUBSET ?LG-SUB_FREQUENCY )
     (CARDINALITY ?ENTNAME ?CARDNUM )
     (FUNCTION-CALL MULTIPLY-VALUES ?CARDNUM ?LG-SUB_FREQUENCY ?NUM-ACCESSED )
     (REL_ACTIVITY_FORWARDED_TO_ENTITY ?ENTNAME ?REL-FREQ )
     (FUNCTION-CALL DIVIDE ?NUM-ACCESSED ?REL-FREQ ?QUOTIENT )
     (FUNCTION-CALL *>=* ?QUOTIENT 0.05 )
     (ACTIVITY-CUTOFF-POINT-FOR-ENTITY RETRIEVAL LARGE-SUBSET ?LG_SUB_CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?LG-SUB_FREQUENCY ?LG_SUB_CUTOFF_FREQ )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?ENTNAME RETRIEVAL LARGE-SUBSET SIGNIFICANT)

     NO CERTAINTY FACTOR



THIS IS A CORRESPONDING RULE FOR HEAVIER LEVELS OF ACTIVITY. IT USES THE *SCALE* FUNCTION.

 *** RULE ENTACT_6 ***

IF   (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME RETRIEVAL LARGE-SUBSET ?LG-SUB_FREQUENCY )
     (CARDINALITY ?ENTNAME ?CARDNUM )
     (FUNCTION-CALL MULTIPLY-VALUES ?CARDNUM ?LG-SUB_FREQUENCY ?NUM-ACCESSED )
     (REL_ACTIVITY_FORWARDED_TO_ENTITY ?ENTNAME ?REL-FREQ )
     (ACTIVITY-CUTOFF-POINT-FOR-ENTITY RETRIEVAL LARGE-SUBSET ?LG_SUB_CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?LG-SUB_FREQUENCY ?LG_SUB_CUTOFF_FREQ )
     (FUNCTION-CALL DIVIDE ?NUM-ACCESSED ?REL-FREQ ?QUOT )
     (FUNCTION-CALL *SCALE* ?QUOT ?ACTIVITY_LEVEL (0.05 HEAVY-0 0.4 HEAVY-1
                                                   0.8 HEAVY-2 3.2 HEAVY-3 6.4 HEAVY-4) )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?ENTNAME RETRIEVAL LARGE-SUBSET ?ACTIVITY_LEVEL)

     NO CERTAINTY FACTOR
```

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--------------------------------------------------------------------------------
PART B OF SECTION 4.5 --> RULES CONCLUDING FREQUENCY TOTALS FOR DIRECT ACTIVITY ON ENTITIES.
--------------------------------------------------------------------------------

THE NEXT RULE CALLS A FUNCTION *TOTAL_RELATIONSHIP_ACTIVITY* TO TOTAL ACTIVITY FOCUSING ON ENTITY
ALONG ALL RELATIONSHIPS THE ENTITY IS IN.

 *** RULE ENTACT_7 ***

IF   (ENTITY ?ENTITY_NAME )
     (FUNCTION-CALL *TOTAL_RELATIONSHIP_ACTIVITY* ?ENTITY_NAME ?TOTAL_FREQUENCY )

THEN (REL_ACTIVITY_FORWARDED_TO_ENTITY ?ENTITY_NAME ?TOTAL_FREQUENCY)

     NO CERTAINTY FACTOR


THE NEXT FOUR RULES CONCLUDE TOTAL FREQUENCIES OF DIRECT ACTIVITY ON ENTITIES FOR DIFFERENT SUBSET SIZES
AND TOTAL ACTIVITY. THEY CALL FUNCTIONS TO GET THE TOTAL.

 *** RULE ENTACT_8 ***

IF   (ENTITY ?ENTNAME )
     (FUNCTION-CALL TOTAL-ENTITY-RETRIEVAL-FREQ ?ENTNAME SINGLE ?FREQUENCY )

THEN (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME RETRIEVAL SINGLE ?FREQUENCY)

     NO CERTAINTY FACTOR


 *** RULE ENTACT_9 ***

IF   (ENTITY ?ENTNAME )
     (FUNCTION-CALL TOTAL-ENTITY-RETRIEVAL-FREQ ?ENTNAME SMALL-SUBSET ?FREQUENCY )

THEN (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME RETRIEVAL SMALL-SUBSET ?FREQUENCY)

     NO CERTAINTY FACTOR
```

```
 *** RULE ENTACT_10 ***

IF   (ENTITY ?ENTNAME )
     (FUNCTION-CALL TOTAL-ENTITY-RETRIEVAL-FREQ ?ENTNAME LARGE-SUBSET ?FREQUENCY )

THEN (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME RETRIEVAL LARGE-SUBSET ?FREQUENCY)

     NO CERTAINTY FACTOR



 *** RULE ENTACT_11 ***

IF   (ENTITY ?ENTNAME )
     (FUNCTION-CALL TOTAL-ENTITY-RETRIEVAL-FREQ ?ENTNAME ALL-SIZE ?FREQUENCY )

THEN (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME RETRIEVAL ALL-SIZE ?FREQUENCY)

     NO CERTAINTY FACTOR



THE NEXT TWO RULES CONCLUDE TOTAL FREQUENCIES OF INSERTS AND DELETES.
THEY ALSO CALL FUNCTIONS TO GET THE TOTAL.

 *** RULE ENTACT_12 ***

IF   (ENTITY ?ENTNAME )
     (FUNCTION-CALL TOTAL-ENTITY-INSERTION-FREQUENCY ?ENTNAME ?FREQUENCY )

THEN (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME INSERT SINGLE ?FREQUENCY)

     NO CERTAINTY FACTOR



 *** RULE ENTACT_13 ***

IF   (ENTITY ?ENTNAME )
     (FUNCTION-CALL TOTAL-ENTITY-DELETION-FREQUENCY ?ENTNAME ?FREQUENCY )

THEN (DIRECT_ACTIVITY_ON_ENTITY ?ENTNAME DELETE SINGLE ?FREQUENCY)

     NO CERTAINTY FACTOR
```

RULES FOR DETERMINING MINIMUM LEVELS OF DIRECT ACTIVITY ON ENTITIES FOR DIFFERENT TYPES OF ACTIVITIES.

```
 *** RULE ENTACT_14 ***
IF   (FUNCTION-CALL *FIND-REC-ACT-CUT* RETRIEVAL SINGLE ?CUTPOINT )
THEN (ACTIVITY-CUTOFF-POINT-FOR-ENTITY RETRIEVAL SINGLE ?CUTPOINT)
     NO CERTAINTY FACTOR


 *** RULE ENTACT_15 ***
IF   (FUNCTION-CALL *FIND-REC-ACT-CUT* RETRIEVAL LARGE-SUBSET ?CUTPOINT )
THEN (ACTIVITY-CUTOFF-POINT-FOR-ENTITY RETRIEVAL LARGE-SUBSET ?CUTPOINT)
     NO CERTAINTY FACTOR


 *** RULE ENTACT_16 ***
IF   (FUNCTION-CALL *FIND-REC-ACT-CUT* RETRIEVAL SMALL-SUBSET ?CUTPOINT )
THEN (ACTIVITY-CUTOFF-POINT-FOR-ENTITY RETRIEVAL SMALL-SUBSET ?CUTPOINT)
     NO CERTAINTY FACTOR


 *** RULE ENTACT_17 ***
IF   (FUNCTION-CALL *FIND-REC-ACT-CUT* INSERT SINGLE ?CUTPOINT ).
THEN (ACTIVITY-CUTOFF-POINT-FOR-ENTITY UPDATE SINGLE ?CUTPOINT)
     NO CERTAINTY FACTOR
```

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-------------------------------------------------------------------------
RULES FOR SECTION 4.6 --> RELATIONSHIP ACTIVITY CHARACTERIZATION RULE GROUP.
-------------------------------------------------------------------------


-------------------------------------------------------------------------------------------
PART A OF SECTION 4.6 --> RULES FOR CONCLUDING CHARACTERIZATIONS ABOUT ABSOLUTE ACTIVITY LEVELS
FOR A RELATIONSHIP.
-------------------------------------------------------------------------------------------

THE NEXT SIX RULES CHARACTERIZE ABSOLUTE ACTIVITY LEVELS FOR BOTH FORWARDING AND NONFORWARDING ACTIVITY.
FORWARDING ACTIVITY IS OF THE TYPE "RETRIEVAL", NONFORWARDING IS "NON_FORWARDING_CONTEXT_ACTIVITY".


THIS RULE CONCLUDES A SIGNIFICANT LEVEL OF SINGLE RECORD RETRIEVAL ACTIVITY ALONG RELATIONSHIP ?REL_ID
FROM ?ENT1 TO ?ENT2 IF FREQUENCY OF ACTIVITY EXCEEDS A MINIMUM CUTOFF LEVEL.

 *** RULE RELACT_1 ***

IF   (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 ?TYPE SINGLE ?FREQUENCY )
     (FUNCTION-CALL *IS-ONE-OF* ?TYPE (RETRIEVAL NON_FORWARDING_CONTEXT_ACTIVITY) )
     (MINIMUM_CUTOFF_FOR RETRIEVAL ?CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?FREQUENCY ?CUTOFF_FREQ )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 ?TYPE SINGLE SIGNIFICANT)

     NO CERTAINTY FACTOR


THIS IS A RULE FOR CONCLUDING HEAVIER LEVELS OF ACTIVITY OF SINGLE RECORD RETRIEVAL ALONG RELATIONSHIP
?REL_ID. SINGLE RECORD ACTIVITY ALONG THE RELATIONSHIP IS COMPARED WITH THE LEVEL OF THE TOTAL
DIRECT ACTIVITY FOCUSING ON BOTH ENTITIES IN THE RELATIONSHIP.  THE *SCALE* FUNCTION IS USED.

 *** RULE RELACT_2 ***

IF   (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 ?TYPE SINGLE ?SINGLE_FREQ )
     (FUNCTION-CALL *IS-ONE-OF* ?TYPE (RETRIEVAL NON_FORWARDING_CONTEXT_ACTIVITY) )
     (MINIMUM_CUTOFF_FOR RETRIEVAL ?CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?SINGLE_FREQ ?CUTOFF_FREQ )
     (TOTAL_DIRECT_ACTIVITY_ON_ENTITIES_IN ?REL_ID ?ENT1 ?ENT2 ?DIRECT_FREQUENCY )
     (FUNCTION-CALL DIVIDE ?SINGLE_FREQ ?DIRECT_FREQUENCY ?QUOTIENT )
     (FUNCTION-CALL *SCALE* ?QUOTIENT ?ACTIVITY_LEVEL (0.1 HEAVY-0.2 HEAVY-1
                                                       0.4 HEAVY-2 0.6 HEAVY-3 0.8 HEAVY-4) )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 ?TYPE SINGLE ?ACTIVITY_LEVEL)

     NO CERTAINTY FACTOR
```

```
THIS IS A RULE FOR CONCLUDING A SIGNIFICANT LEVEL OF SMALL SUBSET RETRIEVAL ACTIVITY FOR
RELATIONSHIP ?REL_ID.  THE PRODUCT ( 0.05 * SMALL SUBSET FREQUENCY * ENTITY CARDINALITY ) IS
COMPARED WITH THE LEVEL OF TOTAL DIRECT ACTIVITY FOCUSING ON BOTH ENTITIES IN THE RELATIONSHIP.
THE SMALL SUBSET FREQUENCY MUST ALSO EXCEED A MINIMUM CUTOFF LEVEL.

 *** RULE RELACT_3 ***

IF   (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 ?TYPE SMALL-SUBSET ?SM_SUB_FREQ )
     (FUNCTION-CALL *IS-ONE-OF* ?TYPE (RETRIEVAL NON_FORWARDING_CONTEXT_ACTIVITY) )
     (TOTAL_DIRECT_ACTIVITY_ON_ENTITIES_IN ?REL_ID ?ENT1 ?ENT2 ?DIRECT_FREQUENCY )
     (CARDINALITY ?ENT2 ?CARDNUM )
     (FUNCTION-CALL MULTIPLY-VALUES ( ?CARDNUM ?SM_SUB_FREQ  0.05) ?NUM-ACCESSED )
     (FUNCTION-CALL DIVIDE ?NUM-ACCESSED ?DIRECT_FREQUENCY ?QUOTIENT )
     (FUNCTION-CALL *>=* ?QUOTIENT 0.075 )
     (MINIMUM_CUTOFF_FOR RETRIEVAL ?CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?SM_SUB_FREQ ?CUTOFF_FREQ )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 ?TYPE SMALL-SUBSET SIGNIFICANT)

     NO CERTAINTY FACTOR


THIS IS A RULE FOR CORRESPONDINGLY HIGHER LEVELS OF SMALL SUBSET RETRIEVAL ACTIVITY FOR A RELATIONSHIP.
THE *SCALE* FUNCTION IS USED.

 *** RULE RELACT_4 ***

IF   (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 ?TYPE SMALL-SUBSET ?SM_SUB_FREQ )
     (FUNCTION-CALL *IS-ONE-OF* ?TYPE (RETRIEVAL NON_FORWARDING_CONTEXT_ACTIVITY) )
     (CARDINALITY ?ENT2 ?CARDNUM )
     (FUNCTION-CALL MULTIPLY-VALUES ( ?CARDNUM ?SM_SUB_FREQ 0.05) ?NUM-ACCESSED )
     (MINIMUM_CUTOFF_FOR RETRIEVAL ?CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?SM_SUB_FREQ ?CUTOFF_FREQ )
     (TOTAL_DIRECT_ACTIVITY_ON_ENTITIES_IN ?REL_ID ?ENT1 ?ENT2 ?DIRECT_FREQUENCY )
     (FUNCTION-CALL DIVIDE ?NUM-ACCESSED ?DIRECT_FREQUENCY ?QUOTIENT )
     (FUNCTION-CALL *SCALE* ?QUOTIENT ?ACTIVITY_LEVEL (0.075 HEAVY-0 0.6 HEAVY-1
                                                       1.2 HEAVY-2 2.4 HEAVY-3 4.8 HEAVY-4) )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 ?TYPE SMALL-SUBSET ?ACTIVITY_LEVEL)

     NO CERTAINTY FACTOR
```

```
CONCLUDE THERE IS A SIGNIFICANT LEVEL OF LARGE SUBSET RETRIEVAL ACTIVITY ALONG RELATIONSHIP
?REL_ID FROM ?ENT1 TO ?ENT2 IF THE PRODUCT ( FREQUENCY OF ACTIVITY * CARDINALITY OF ENT2) EXCEEDS 20%
OF THE TOTAL DIRECT ACTIVITY FOCUSING ON THE ENTITIES IN THE RELATIONSHIP. LARGE SUBSET ACTIVITY MUST
BE ABOVE A MINIMUM CUTOFF LEVEL.

 *** RULE RELACT_5 ***

IF   (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 ?TYPE LARGE-SUBSET ?LG-SUB_FREQUENCY )
     (FUNCTION-CALL *IS-ONE-OF* ?TYPE (RETRIEVAL NON_FORWARDING_CONTEXT_ACTIVITY) )
     (CARDINALITY ?ENT2 ?CARDNUM )
     (FUNCTION-CALL MULTIPLY-VALUES ?CARDNUM ?LG-SUB_FREQUENCY ?NUM-ACCESSED )
     (TOTAL_DIRECT_ACTIVITY_ON_ENTITIES_IN ?REL_ID ?ENT1 ?ENT2 ?DIRECT_FREQUENCY )
     (FUNCTION-CALL DIVIDE ?NUM-ACCESSED ?DIRECT_FREQUENCY ?QUOTIENT )
     (FUNCTION-CALL *>=* ?QUOTIENT 0.2 )
     (MINIMUM_CUTOFF_FOR RETRIEVAL ?CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?NUM-ACCESSED ?CUTOFF_FREQ )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 ?TYPE LARGE-SUBSET SIGNIFICANT)

     NO CERTAINTY FACTOR



THIS IS A RULE FOR CORRESPONDINGLY HIGHER LEVELS OF LARGE SUBSET ACTIVITY ALONG
A RELATIONSHIP.  THE *SCALE* FUNCTION IS USED TO DETERMINE THE ACTIVITY LEVEL.

 *** RULE RELACT_6 ***

IF   (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 ?TYPE LARGE-SUBSET ?LG-SUB_FREQUENCY )
     (FUNCTION-CALL *IS-ONE-OF* ?TYPE (RETRIEVAL NON_FORWARDING_CONTEXT_ACTIVITY) )
     (CARDINALITY ?ENT2 ?CARDNUM )
     (FUNCTION-CALL MULTIPLY-VALUES ?CARDNUM ?LG-SUB_FREQUENCY ?NUM-ACCESSED )
     (MINIMUM_CUTOFF_FOR RETRIEVAL ?CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?NUM-ACCESSED ?CUTOFF_FREQ )
     (TOTAL_DIRECT_ACTIVITY_ON_ENTITIES_IN ?REL_ID ?ENT1 ?ENT2 ?DIRECT_FREQUENCY )
     (FUNCTION-CALL DIVIDE ?NUM-ACCESSED ?DIRECT_FREQUENCY ?QUOTIENT )
     (FUNCTION-CALL *SCALE* ?QUOTIENT ?ACTIVITY_LEVEL (0.2 HEAVY-0 1.6 HEAVY-1
                                                       3.2 HEAVY-2 4.8 HEAVY-3 9.6 HEAVY-4) )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 ?TYPE LARGE-SUBSET ?ACTIVITY_LEVEL)

     NO CERTAINTY FACTOR
```

```
THIS RULE CONCLUDES A SIGNIFICANT LEVEL OF UPDATE ACTIVITY FOR RELATIONSHIP ?REL_ID IF THE FREQUENCY OF
RELATIONSHIP MODIFICATION FOR ?REL_ID EXCEEDS 10% OF THE COMBINED FREQUENCY OF RETRIEVAL ALONG ?REL_ID.
THE FREQUENCY OF RELATIONSHIP MODIFICATION MUST ALSO BE GREATER THAN A MINIMUM CUTOFF LEVEL.

*** RULE RELACT_7 ***

IF   (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 RELATIONSHIP-UPDATE ALL-SIZE ?FREQUENCY1 )
     (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ALL-SIZE ?FREQUENCY2 )
     (FUNCTION-CALL DIVIDE ?FREQUENCY1 ?FREQUENCY2 ?QUOTIENT )
     (FUNCTION-CALL *>=* ?QUOTIENT 0.1 )
     (MINIMUM_CUTOFF_FOR RELATIONSHIP-UPDATE ?CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?FREQUENCY1 ?CUTOFF_FREQ )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 UPDATE ALL-SIZE SIGNIFICANT)

     NO CERTAINTY FACTOR


*** RULE RELACT_8 ***

IF   (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 RELATIONSHIP-UPDATE ALL-SIZE ?FREQUENCY1 )
     (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ALL-SIZE ?FREQUENCY2 )
     (FUNCTION-CALL DIVIDE ?FREQUENCY1 ?FREQUENCY2 ?QUOTIENT )
     (MINIMUM_CUTOFF_FOR RELATIONSHIP-UPDATE ?CUTOFF_FREQ )
     (FUNCTION-CALL *>* ?FREQUENCY1 ?CUTOFF_FREQ )
     (FUNCTION-CALL *SCALE* ?QUOTIENT ?ACTIVITY_LEVEL (0.1 HEAVY-0. 0.2 HEAVY-1 0.
                                                       0.4 HEAVY-2 0.8 HEAVY-3 1.6 HEAVY-4) )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 UPDATE ALL-SIZE ?ACTIVITY_LEVEL)

     NO CERTAINTY FACTOR
```

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--------------------------------------------------------------------------------
PART B OF SECTION 4.6 --> RULES FOR CONCLUDING CHARACTERIZATIONS ABOUT FORWARDING PERCENTAGE.
--------------------------------------------------------------------------------

THIS RULE CONCLUDES A SIGNIFICANT LEVEL OF FORWARDING ACTIVITY ALONG RELATIONSHIP ?REL_ID FROM ?ENT1 TO
?ENT2 IF OVER 50% OF ACTIVITY ON ?ENT1 IS FORWARDED TO ?ENT2

 *** RULE RELACT_9 ***

IF   (FORWARDING_PERCENTAGE_FOR ?REL_ID ?ENT1 ?ENT2 ?SUBSET-SIZE ?E1-ACT ?E2-ACT ?PERCENT_THRU )
     (FUNCTION-CALL *>=* ?PERCENT_THRU 0.5 )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET-SIZE
                                    SIGNIFICANT_FORWARDING_%)

     NO CERTAINTY FACTOR



THIS RULE CONCLUDES A MARGINAL LEVEL OF FORWARDING ACTIVITY ALONG RELATIONSHIP ?REL_ID FROM ?ENT1 TO
?ENT2 IF BETWEEN 25% AND 50% OF ACTIVITY ON ?ENT1 IS FORWARDED TO ?ENT2.

 *** RULE RELACT_10 ***

IF   (FORWARDING_PERCENTAGE_FOR ?REL_ID ?ENT1 ?ENT2 ?SUBSET-SIZE ?E1-ACT ?E2-ACT ?PERCENT_THRU )
     (FUNCTION-CALL *>* 0.5 ?PERCENT_THRU )
     (FUNCTION-CALL *>=* ?PERCENT_THRU 0.25 )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET-SIZE MARGINAL)

     NO CERTAINTY FACTOR



THIS RULE CONCLUDES HIGHER LEVELS OF FORWARDING ACTIVITY FOR RELATIONSHIP ?REL_ID.

 *** RULE RELACT_11 ***

IF   (FORWARDING_PERCENTAGE_FOR ?REL_ID ?ENT1 ?ENT2 ?SUBSET-SIZE ?E1-ACT ?E2-ACT ?PERCENT_THRU )
     (FUNCTION-CALL *SCALE* ?PERCENT_THRU ?FORWARDING_LEVEL (0.5 HIGH-THRU-ACT-0.6 HIGH-THRU-ACT-1
                                                             0.7 HIGH-THRU-ACT-2 0.85 HIGH-THRU-ACT-3) )

THEN (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET-SIZE ?FORWARDING_LEVEL)

     NO CERTAINTY FACTOR
```

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-------------------------------------------------------------------------------
PART C OF SECTION 4.6 --> RULES FOR DETERMINING FREQUENCY TOTALS FOR RELATIONSHIP ACTIVITY.
-------------------------------------------------------------------------------


THIS IS A RULE FOR DETERMINING TOTAL DIRECT ACTIVITY FOCUSING ON THE TWO ENTITIES IN A RELATIONSHIP.

 *** RULE RELACT_12 ***

IF   (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (FUNCTION-CALL *TOTAL_DIRECT_ACTIVITY* ?ENT1 ?ENT2 ?TOTAL_DIRECT_FREQUENCY )

THEN (TOTAL_DIRECT_ACTIVITY_ON_ENTITIES_IN ?REL_ID ?ENT1 ?ENT2 ?TOTAL_DIRECT_FREQUENCY)

     NO CERTAINTY FACTOR



THE NEXT NINE RULES ARE RESPONSIBLE FOR ACTIVITY TOTALS ALONG RELATIONSHIPS. THE FIRST FIVE RULES
(NUMBERS 13-17) CONCERN RETRIEVAL ACTIVITY, THE NEXT RULE (NUMBER 18) ADDRESSES UPDATE ACTIVITY,
AND THE LAST THREE (NUMBERS 19-21) ARE FOR COMPUTATION OF FORWARDING PERCENTAGE. FUNCTIONS ARE
CALLED TO PERFORM THE COMPUTATIONS.

 *** RULE RELACT_13 ***

IF   (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (FUNCTION-CALL TOTAL-RELATIONSHIP-RETRIEVAL-FREQ ?REL_ID ?ENT2 SMALL-SUBSET ?NUM1 )

THEN (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 RETRIEVAL SMALL-SUBSET ?NUM1)

     NO CERTAINTY FACTOR



 *** RULE RELACT_14 ***

IF   (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (FUNCTION-CALL TOTAL-RELATIONSHIP-RETRIEVAL-FREQ ?REL_ID ?ENT2 LARGE-SUBSET ?NUM1 )

THEN (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 RETRIEVAL LARGE-SUBSET ?NUM1)

     NO CERTAINTY FACTOR
```

```
 *** RULE RELACT_15 ***

IF   (RELATIONSHIP-DESC-NAME-PROJECTION ?REL_DESC_NAME ?PROJ-DESC )
     (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )

THEN (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 NON_FORWARDING_CONTEXT_ACTIVITY SMALL-SUBSET
                            ?PROJ-DESC)

     NO CERTAINTY FACTOR



 *** RULE RELACT_16 ***

IF   (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (FUNCTION-CALL TOTAL-RELATIONSHIP-RETRIEVAL-FREQ ?REL_ID ?ENT2 ALL-SIZE ?NUM1 )

THEN (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ALL-SIZE ?NUM1)

     NO CERTAINTY FACTOR


THIS IS A RULE FOR DETERMINING TOTAL NONFORWARDING ACTIVITY ON A RELATIONSHIP DESCRIPTOR.

 *** RULE RELACT_17 ***

IF   (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?DESC-NAME )
     (THERE_IS_ONE_OF (RETRIEVE-CONTEXT ?Q ?C ?TARGET-ENT ?REL_ID ?PROPORTION ?FREQUENCY ?SUBSET_SIZE DESC)
     (FUNCTION-CALL TOTAL-RELATIONSHIP-DESCRIPTOR-PROJECTION-FREQUENCY ?REL_ID ?ENT2 UNKNOWN ?NF_FREQUENCY )

THEN (RELATIONSHIP-DESC-NAME-PROJECTION ?DESC-NAME ?NF_FREQUENCY)

     NO CERTAINTY FACTOR



 *** RULE RELACT_18 ***

IF   (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (FUNCTION-CALL TOTAL-RELATIONSHIP-MOD-FREQ ?REL_ID ?NUM1 )

THEN (RELATIONSHIP_ACTIVITY ?REL_ID ?ENT1 ?ENT2 RELATIONSHIP-UPDATE ALL-SIZE ?NUM1)

     NO CERTAINTY FACTOR
```

```
 *** RULE RELACT_19 ***

IF   (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (FUNCTION-CALL *TOT-THRU-ACT* ?ENT1 ?REL_ID SINGLE ?E1-ACT ?E2-ACT ?PER )

THEN (FORWARDING_PERCENTAGE_FOR ?REL_ID ?ENT1 ?ENT2 SINGLE ?E1-ACT ?E2-ACT ?PER)

     NO CERTAINTY FACTOR


 *** RULE RELACT_20 ***

IF   (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (FUNCTION-CALL *TOT-THRU-ACT* ?ENT1 ?REL_ID SMALL-SUBSET ?E1-ACT ?E2-ACT ?PER )

THEN (FORWARDING_PERCENTAGE_FOR ?REL_ID ?ENT1 ?ENT2 SMALL-SUBSET ?E1-ACT ?E2-ACT ?PER)

     NO CERTAINTY FACTOR


 *** RULE RELACT_21 ***

IF   (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (FUNCTION-CALL *TOT-THRU-ACT* ?ENT1 ?REL_ID LARGE-SUBSET ?E1-ACT ?E2-ACT ?PER )

THEN (FORWARDING_PERCENTAGE_FOR ?REL_ID ?ENT1 ?ENT2 LARGE-SUBSET ?E1-ACT ?E2-ACT ?PER)

     NO CERTAINTY FACTOR
```

THE LAST TWO RULES DETERMINE MINIMUM CUTOFF POINTS FOR RETRIEVAL AND UPDATE ACTIVITY RESPECTIVELY.

```
 *** RULE RELACT_22 ***

IF   (FUNCTION-CALL *FIND-REL-ACT-CUT* RETRIEVAL ?CUTPOINT )

THEN (MINIMUM_CUTOFF_FOR RETRIEVAL ?CUTPOINT)

     NO CERTAINTY FACTOR



 *** RULE RELACT_23 ***

IF   (FUNCTION-CALL *FIND-REL-ACT-CUT* RELATIONSHIP-UPDATE ?CUTPOINT )

THEN (MINIMUM_CUTOFF_FOR RELATIONSHIP-UPDATE ?CUTPOINT)

     NO CERTAINTY FACTOR
```

```
-----------------------------------------------------------------
RULES FOR SECTION 4.7 --> RELATIONSHIP CHARACTERIZATION RULE GROUP.
-----------------------------------------------------------------




-------------------------------------------------------------------------------------------------
PART A OF SECTION 4.7 --> RULES WHICH IDENTIFY RELATIONSHIPS WITH IMPORTANT CHARACTERISTICS ON THE
BASIS OF ACTIVITY TYPE AND LEVEL.
-------------------------------------------------------------------------------------------------

THIS RULE CHARACTERIZES RELATIONSHIP ?REL_ID AS HAVING A LOW FORWARDING PERCENTAGE FOR ALL
TYPES OF ACTIVITY.

 *** RULE RELCH_1 ***

IF   (FIRST-ENT ?REL_ID ?ENT )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE1
                          MARGINAL) )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTB ?ENTA RETRIEVAL ?SUBSET_SIZE2
                          SIGNIFICANT_FORWARDING_%) )

THEN (RELATIONSHIP_CHARACTERIZATION ?REL_ID LOW_FORWARDING_% CHARACTERIZATION)

     NO CERTAINTY FACTOR



THIS RULE CHARACTERIZES A RELATIONSHIP AS HAVING SIGNIFICANT LEVEL OF ACTIVITY IN BOTH DIRECTIONS.

 *** RULE RELCH_2 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE1 SIGNIFICANT )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT2 ?ENT1 RETRIEVAL ?SUBSET_SIZE2 SIGNIFICANT )

THEN (RELATIONSHIP_CHARACTERIZATION ?REL_ID BIDIRECTIONAL_ACTIVITY SIGNIFICANT_WORKLOAD_COMPLEXITY)

     NO CERTAINTY FACTOR
```

```
THIS RULE CHARACTERIZES A RELATIONSHIP AS HAVING ACTIVITY ONLY IN THE MANY TO ONE DIRECTION.

 *** RULE RELCH_3 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT2 ?ENT1 RETRIEVAL ?SUBSET_SIZE1 SIGNIFICANT )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE2
                                  SIGNIFICANT) )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTA ?ENTB UPDATE ALL-SIZE SIGNIFICANT) )

THEN (RELATIONSHIP_CHARACTERIZATION ?REL_ID MANY_TO_ONE_ACTIVITY_ONLY
                                  SIGNIFICANT_WORKLOAD_COMPLEXITY)

     NO CERTAINTY FACTOR


THIS RULE CONCLUDES A PROBLEM CHARACTERIZATION FOR RELATIONSHIP ?REL_ID IF SIGNIFICANT NONFORWARDING
CONTEXT ACTIVITY EXISTS IN ONE TO MANY DIRECTION.

 *** RULE RELCH_4 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 NON_FORWARDING_CONTEXT_ACTIVITY
                                  ?SUBSET_SIZE SIGNIFICANT )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?ANY-DEGREE )

THEN (RELATIONSHIP_CHARACTERIZATION ?REL_ID NON_FORWARDING_CONTEXT_ACTIVITY
                                   SIGNIFICANT_WORKLOAD_COMPLEXITY)

     NO CERTAINTY FACTOR


THIS RULE CHARACTERIZES A RELATIONSHIP ?REL_ID AS HAVING ONLY DESCRIPTOR UPDATE ACTIVITY AND
NO RETRIEVAL ACTIVITY.

 *** RULE RELCH_5 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 UPDATE ALL-SIZE SIGNIFICANT )
     (COULD_NOT_CONCLUDE  (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE
                                        SIGNIFICANT) )

THEN (RELATIONSHIP_CHARACTERIZATION ?REL_ID RELATIONSHIP-UPDATE SIGNIFICANT_WORKLOAD_COMPLEXITY)

     NO CERTAINTY FACTOR
```

```
THIS RULE IDENTIFIES RELATIONSHIP ?REL_ID AS HAVING ATTRIBUTE COMPONENTS OF THE DESCRIPTOR WHICH ARE
MODIFIED DIRECTLY AND INDEPENDENTLY, AND ARE NOT MODIFIED AS PART OF A RELATIONSHIP UPDATE ACTIVITY.

 *** RULE RELCH_6 ***

IF   (MODIFICATION-CONTEXT ?QUERY ?CON-NUM ?ENT-NAME ?REL_ID ?ATTRIBUTE_NAME ?FREQUENCY ?CODE )
     (DESCRIPTOR-COMPONENT ?REL_DESC_NAME ?REL_ID ?ATTRIBUTE_NAME )
     (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (ACTIVITY-CUTOFF-POINT-FOR-ENTITY UPDATE SINGLE ?CUTOFF_FREQ )
     (FUNCTION-CALL *>=* ?FREQUENCY ?CUTOFF_FREQ )

THEN (RELATIONSHIP_CHARACTERIZATION ?REL_ID INDEPENDENT-DESC-COMPONENT-UPDATE
                                    SIGNIFICANT_WORKLOAD_COMPLEXITY)

     NO CERTAINTY FACTOR


THE NEXT TWO RULES IDENTIFY RELATIONSHIP ?REL_ID AS HAVING A "MANY" ENTITY WHICH CAN BE ABSORBED ALONG TWO
DIFFERENT RELATIONSHIPS BASED ON ACTIVITY FORWARDED ALONG BOTH RELATIONSHIPS.

 *** RULE RELCH_7 ***

IF   (RELATIONSHIP_CHARACTERIZATION ?REL_ID1 ENTITY_IS_IN_TWO_M_RELATIONSHIPS CHARACTERIZATION )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID1 ?ENTA ?ENT2 RETRIEVAL ?SUBSET_SIZE1 SIGNIFICANT )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID2 ?ENTB ?ENT2 RETRIEVAL ?SUBSET_SIZE2 SIGNIFICANT )

THEN (RELATIONSHIP_CHARACTERIZATION ?REL_ID1 ALTERNATE-ABSORPTION CHARACTERIZATION)

     NO CERTAINTY FACTOR



 *** RULE RELCH_8 ***

IF   (DEGREE-OF ?REL_ID1 ?ENTA ?ENT2 1 M )
     (DEGREE-OF ?REL_ID2 ?ENTB ?ENT2 1 M )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID1 ?REL_ID2 )

THEN (RELATIONSHIP_CHARACTERIZATION ?REL_ID1 ENTITY_IS_IN_TWO_M_RELATIONSHIPS CHARACTERIZATION)

     NO CERTAINTY FACTOR
```

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--------------------------------------------------------------------------------
PART B OF SECTION 4.7 --> RULES WHICH CHARACTERIZE RELATIONSHIPS AS HAVING CONFLICTING
RETRIEVAL CONTEXTS.
--------------------------------------------------------------------------------

CHARACTERIZE A RELATIONSHIP AS HAVING SIGNIFICANT WORKLOAD COMPLEXITY BECAUSE IT HAS
CONFLICTING RETRIEVAL CONFLICTS.

 *** RULE RELCH_9 ***

IF   (CONFLICTING-RETRIEVAL-CONTEXTS ?REL_ID ?REL_ID2 DO-NOT-ABSORB ?REL_ID ?ENT2 ?REASON ?STRENGTH )

THEN (RELATIONSHIP_CHARACTERIZATION ?REL_ID CONFLICTING-RETRIEVAL-CONTEXTS
          SIGNIFICANT_WORKLOAD_COMPLEXITY)

     NO CERTAINTY FACTOR



THE NEXT THREE RULES CONCLUDE CONFLICTING CONTEXT SITUATIONS OCCURRING ALONG A PAIR OF
ONE TO MANY RELATIONSHIPS WITH THE SAME "MANY" ENTITY.



CONCLUDE THAT ENTITY ?ENT2 SHOULD NOT BE ABSORBED ALONG ?REL_ID1 BECAUSE ?REL_ID1 HAS NO ACTIVITY,
WHILE ?REL-ID2 HAS AT LEAST A SIGNIFICANT LEVEL OF ACTIVITY.  THE ?STRENGTH VARIABLE INDICATING THE
STRENGTH OF THIS CONCLUSION WILL HAVE A HIGH VALUE.

 *** RULE RELCH_10 ***

IF   (DEGREE-OF ?REL_ID1 ?ENT1 ?ENT2 1 M )
     (DEGREE-OF ?REL_ID2 ?ENTA ?ENT2 1 M )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID1 ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE1
                              SIGNIFICANT) )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID2 ?ENTA ?ENT2 RETRIEVAL ?SUBSET_SIZE2 ?ACTIVITY_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID1 ?REL_ID2 )
     (FUNCTION-CALL *ACTIVITY-DIFFERENCE* ?ACTIVITY_LEVEL NONE ?STRENGTH )

THEN (CONFLICTING-RETRIEVAL-CONTEXTS ?REL_ID1 ?REL_ID2 DO-NOT-ABSORB ?REL_ID1 ?ENT2
                                     RELATIONSHIP-PHASE ?STRENGTH)

     NO CERTAINTY FACTOR
```

```
CONCLUDE THAT CONFLICTING CONTEXTS EXIST AND THAT ENTITY ?ENT2 SHOULD NOT BE ABSORBED ALONG ?REL_ID1
BECAUSE ?REL_ID1 HAS MUCH LESS ACTIVITY THAN ?REL_ID2.  THE ?STRENGTH VARIABLE WILL HAVE A HIGH VALUE.

 *** RULE RELCH_11 ***

IF   (DEGREE-OF ?REL_ID1 ?ENT1 ?ENT2 1 M )
     (DEGREE-OF ?REL_ID2 ?ENTA ?ENT2 1 M )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID1 ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE1 ?ACTIVITY_LEVEL1 )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL1 (HEAVY-0 HEAVY-1) )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID2 ?ENTA ?ENT2 RETRIEVAL ?SUBSET_SIZE2 ?ACTIVITY_LEVEL2 )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL2 (HEAVY-3 HEAVY-4) )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID1 ?REL_ID2 )

THEN (CONFLICTING-RETRIEVAL-CONTEXTS ?REL_ID1 ?REL_ID2 DO-NOT-ABSORB ?REL_ID1 ?ENT2
                                     RELATIONSHIP-PHASE HEAVY-4)

     NO CERTAINTY FACTOR



CONCLUDE THAT ENTITY ?ENT2 SHOULD NOT BE ABSORBED ALONG ?REL_ID1 BECAUSE ?REL_ID1 HAS
ABOUT THE SAME LEVEL OF ACTIVITY AS ?REL_ID2.  THE ?STRENGTH VARIABLE WILL ALSO HAVE A
A LOW VALUE.  THIS RULE WOULD PROBABLY FIRE FOR BOTH ?REL_ID1 AND ?REL_ID2, REDUCING
THE STRENGTH OF ABSORPTION FOR BOTH RELATIONSHIPS.

 *** RULE RELCH_12 ***

IF   (DEGREE-OF ?REL_ID1 ?ENT1 ?ENT2 1 M )
     (DEGREE-OF ?REL_ID2 ?ENTA ?ENT2 1 M )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID1 ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE1 ?ACTIVITY_LEVEL1 )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID2 ?ENTA ?ENT2 RETRIEVAL ?SUBSET_SIZE2 ?ACTIVITY_LEVEL2 )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID1 ?REL_ID2 )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL1 (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL2 (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (FUNCTION-CALL *APPROXIMATE-EQUAL-LEVEL* ?ACTIVITY_LEVEL1 ?ACTIVITY_LEVEL2 )
     (FUNCTION-CALL *ACTIVITY-DIFFERENCE* ?ACTIVITY_LEVEL1 ?ACTIVITY_LEVEL2 ?STRENGTH )

THEN (CONFLICTING-RETRIEVAL-CONTEXTS ?REL_ID1 ?REL_ID2 DO-NOT-ABSORB ?REL_ID1 ?ENT2
                        RELATIONSHIP-PHASE ?STRENGTH)

     NO CERTAINTY FACTOR
```

```
THIS RULE RECOGNIZES CONFLICTING CONTEXTS BETWEEN DIFFERING ORDERING CRITERIA AND RELATIONSHIP
DESCRIPTORS FOR RELATIONSHIP ?REL_ID.  IT RECOMMENDS AGAINST ABSORBING ALONG ?REL_ID.

 *** RULE RELCH_13 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (ORDERING-CRITERIA ?ENT2 ?ATTRIBUTE_NAME ?MEASURE )
     (FUNCTION-CALL NOT-EQUAL ?ATTRIBUTE_NAME ?REL_DESC_NAME )

THEN (CONFLICTING-RETRIEVAL-CONTEXTS ?REL_ID ?ENT2 DO-NOT-ABSORB ?REL_ID ?ENT2
                        ORDERING-CRITERIA HEAVY-2)

     NO CERTAINTY FACTOR



THE NEXT TWO RULES CONCERN CONFLICTING CONTEXT SITUATIONS BETWEEN DIRECT ACTIVITY ON AN ENTITY AND A
ONE TO MANY RELATIONSHIP TO THAT ENTITY.


CONCLUDE THAT ENTITY ?ENT2 SHOULD NOT BE ABSORBED ALONG RELATIONSHIP ?REL_ID BECAUSE ?REL_ID1
HAS ABOUT THE SAME LEVEL OF ACTIVITY AS DIRECT ACTIVITY FOCUSING ON ?ENT2.  THIS DIRECT ACTIVITY
MUST NOT CONTAIN THE DESCRIPTOR OF ?REL_ID AS A SELECTION CRITERIA.  THE ?STRENGTH VARIABLE WILL
HAVE A LOW VALUE.

 *** RULE RELCH_14 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (ACTIVITY_CHARACTERIZATION_FOR ?ENT2 RETRIEVAL LARGE-SUBSET ?ACTIVITY_LEVEL1 )
     (RETRIEVE-CONTEXT ?QUERY 1 ?ENT2 INITIAL ?PROPORTION ?FREQUENCY NON-SING-RET ?FORWARD )
     (FUNCTION-CALL *>=* ?PROPORTION 0.1 )
     (CONTEXT-SELECTION-CRITERIA ?QUERY 1 ?ENT2 ?SELECT_CRIT )
     (COULD_NOT_CONCLUDE (DESCRIPTOR-COMPONENT ?REL_DESC_NAME ?REL_ID ?SELECT_CRIT) )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE1 ?ACTIVITY_LEVEL2 )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL1 (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL2 (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (FUNCTION-CALL *APPROXIMATE-EQUAL-LEVEL* ?ACTIVITY_LEVEL1 ?ACTIVITY_LEVEL2 )
     (FUNCTION-CALL *ACTIVITY-DIFFERENCE* ?ACTIVITY_LEVEL1 ?ACTIVITY_LEVEL2 ?STRENGTH )

THEN (CONFLICTING-RETRIEVAL-CONTEXTS ?REL_ID ?ENT2 DO-NOT-ABSORB ?REL_ID ?ENT2
                                    DIRECT-ACTIVITY ?STRENGTH)

     NO CERTAINTY FACTOR
```

```
THIS RULE CONCLUDES THAT IF ?ENT2 HAS A HIGH LEVEL OF DIRECT LARGE SUBSET RETRIEVAL, ?ENT2 IS IN
RELATIONSHIP ?REL_ID, AND ?REL_ID DOES NOT HAVE SIGNIFICANT ACTIVITY, A CONFLICTING CONTEXT
EXISTS AND ABSORPTION SHOULD NOT TAKE PLACE ALONG ?REL_ID.  THE ?STRENGTH VARIABLE WILL HAVE
A HIGH VALUE.

 *** RULE RELCH_15 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (ACTIVITY_CHARACTERIZATION_FOR ?ENT2 RETRIEVAL LARGE-SUBSET ?ACTIVITY_LEVEL1 )
     (RETRIEVE-CONTEXT ?QUERY 1 ?ENT2 INITIAL ?PROPORTION ?FREQUENCY NON-SING-RET ?FORWARD )
     (FUNCTION-CALL *>=* ?PROPORTION 0.1 )
     (CONTEXT-SELECTION-CRITERIA ?QUERY 1 ?ENT2 ?SELECT_CRIT )
     (COULD_NOT_CONCLUDE (DESCRIPTOR-COMPONENT ?REL_DESC_NAME ?REL_ID ?SELECT_CRIT) )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE1
                                ?ACTIVITY_LEVEL2) )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL1 (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )

THEN (CONFLICTING-RETRIEVAL-CONTEXTS ?REL_ID ?ENT2 DO-NOT-ABSORB ?REL_ID ?ENT2
                                DIRECT-ACTIVITY ?ACTIVITY_LEVEL1)

     NO CERTAINTY FACTOR



THE LAST TWO RULES ADDRESS ACTIVITY ON INTERSECTION ENTITIES ALONG PARTIALLY IDENTIFYING
RELATIONSHIPS.  THEY CONCLUDE STRONG ASSOCIATIONS FOR THE INTERSECTION ENTITY ALONG ONE
OF ITS RELATIONSHIPS ON THE BASIS OF THE EXISTENCE OF LOCAL ACTIVITY (RETRIEVALS WHICH
USE ONLY THIS RELATIONSHIP AND NO OTHER) AND THE EXISTENCE OF HIGH FORWARDING PERCENTAGE.
CERTAINTY FACTORS ARE DETERMINED BY THE FUNCTION *SELECT_INTERSECT_REL* WHICH COMPUTES
RELATIVE FREQUENCIES OF ACTIVITY ALONG THE PARTIALLY IDENTIFYING RELATIONSHIPS.


THIS RULE CONCLUDES AN ASSOCIATION ON THE BASIS OF LOCAL ACTIVITY (SEE ABOVE).

 *** RULE RELCH_16 ***

IF   (TYPE-OF-ENTITY ?INT_ENT *INTERSECTION-ENTITY* )
     (PARTIAL_ID_RELATIONSHIP ?INT_ENT ?REL_ID1 )
     (PARTIAL_ID_RELATIONSHIP ?INT_ENT ?REL_ID2 )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID1 ?REL_ID2 )
     (FUNCTION-CALL *SELECT_INTERSECT_REL* ?INT_ENT ( ?REL_ID1 ?REL_ID2) ?REL_ID
          ?REL_WORKLOAD ?TOTAL_WORKLOAD ?REL%_WORKLOAD ?OTHER_PARTIAL_ID_RELATIONSHIPS LOCAL-ACTIVITY )

THEN (ASSOCIATE-INTERSECT-ENTITY-WITH-REL ?INT_ENT ?REL_ID ?REL_WORKLOAD ?TOTAL_WORKLOAD
               ?REL%_WORKLOAD ?OTHER_PARTIAL_ID_RELATIONSHIPS
               LOCAL-ACTIVITY)

     NO CERTAINTY FACTOR
```

```
THIS RULE CONCLUDES AN ASSOCIATION ON THE BASIS OF FORWARDING PERCENTAGE (SEE ABOVE).

 *** RULE RELCH_17 ***

IF   (TYPE-OF-ENTITY ?INT_ENT *INTERSECTION-ENTITY* )
     (PARTIAL_ID_RELATIONSHIP ?INT_ENT ?REL_ID1 )
     (PARTIAL_ID_RELATIONSHIP ?INT_ENT ?REL_ID2 )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID1 ?REL_ID2 )
     (FUNCTION-CALL *SELECT_INTERSECT_REL* ?INT_ENT ( ?REL_ID1 ?REL_ID2) ?REL_ID
          ?REL_WORKLOAD ?TOTAL_WORKLOAD ?REL%_WORKLOAD ?OTHER_PARTIAL_ID_RELATIONSHIPS
          FORWARDING_PERCENTAGE )

THEN (ASSOCIATE-INTERSECT-ENTITY-WITH-REL ?INT_ENT ?REL_ID ?REL_WORKLOAD ?TOTAL_WORKLOAD
          ?REL%_WORKLOAD ?OTHER_PARTIAL_ID_RELATIONSHIPS FORWARDING_PERCENTAGE)

          NO  CERTAINTY  FACTOR
```

APPENDIX C

RULES FOR THE REPRESENTATION SELECTION KNOWLEDGE BASE

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-------------------------------------------------------------------------------
RULES FOR SECTION 5.4 --> THE STRUCTURAL CHARACTERIZATIONS PROPOSAL RULE GROUP.
-------------------------------------------------------------------------------
```

THE FIRST RULE RECOMMENDS ABSORPTION OF A DEPENDENT LEAF ENTITY IF THE RESULTING RECORD WOULD NOT BE SMALL (SEE ENTITY RELATIONSHIP CHARACTERIZATION KNOWLEDGE BASE).

```
 *** RULE PROP_S_1 ***

IF   (DEPENDS-ON ?ENT2 ?ENT1 )
     (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_SIZE_SMALL_&_LEAF_ENTITY
                          CHARACTERIZATION) )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.6
```

THIS RULE RECOMMENDS ABSORPTION OF A DEPENDENT LEAF ENTITY IF THE ABSORPTION WOULD RESULT IN A SMALL RECORD. THE CERTAINTY FACTOR IS MUCH HIGHER.

```
 *** RULE PROP_S_2 ***

IF   (DEPENDS-ON ?ENT2 ?ENT1 )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_SIZE_SMALL_&_LEAF_ENTITY CHARACTERIZATION )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.9
```

```
FOR A ONE TO MANY RELATIONSHIP, RECOMMEND ABSORPTION OF A DEPENDENT, NON-LEAF, "MANY" ENTITY
ALONG A RELATIONSHIP WITH A MEDIUM CERTAINTY FACTOR.

 *** RULE PROP_S_3 ***

IF   (DEPENDS-ON ?ENT2 ?ENT1 )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.5



FOR A ONE TO MANY RELATIONSHIP, PROPOSE A SYMBOLIC POINTER FOR A DEPENDENT "MANY" ENTITY.

 *** RULE PROP_S_4 ***

IF   (DEPENDS-ON ?ENT2 ?ENT1 )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT2 SYMBOL-POINTS-TO ?ENT1)

     CERTAINTY FACTOR = 0.5



THE NEXT FOUR RULES CONCERN ONE TO MANY RELATIONSHIPS BETWEEN INDEPENDENT ENTITIES. NOTE THE
SPECIFIC EXCLUSION OF AGGREGATE ENTITIES.  THE FOLLOWING RULE RECOMMENDS A MANY TO ONE
DIRECT POINTER WITH A MODERATE CERTAINTY FACTOR.

 *** RULE PROP_S_5 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (COULD_NOT_CONCLUDE (DEPENDS-ON ?ENT2 ?ENT1) )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENT1 *AGGREGATE-ENTITY*) )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT2 DIRECTLY-POINTS-TO ?ENT1)

     CERTAINTY FACTOR = 0.4
```

```
THIS IS SIMILAR TO THE PREVIOUS RULE, BUT RECOMMENDS A SYMBOLIC POINTER WITH A HIGHER CERTAINTY.

 *** RULE PROP_S_6 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (COULD_NOT_CONCLUDE (DEPENDS-ON ?ENT2 ?ENT1) )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENT1 *AGGREGATE-ENTITY*) )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT2 SYMBOL-POINTS-TO ?ENT1)

     CERTAINTY FACTOR = 0.6



THIS RULE RECOMMENDS ABSORPTION OF AN INDEPENDENT "MANY" ENTITY IN A ONE TO MANY RELATIONSHIP
WITH A MEDIUM CERTAINTY FACTOR.

 *** RULE PROP_S_7 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (COULD_NOT_CONCLUDE (DEPENDS-ON ?ENT2 ?ENT1) )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENT1 *AGGREGATE-ENTITY*) )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.5



THIS RULE PROPOSES ABSORPTION OF INDEPENDENT, "MANY", LEAF ENTITY WITH HIGHER CERTAINTY.

 *** RULE PROP_S_8 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (COULD_NOT_CONCLUDE (DEPENDS-ON ?ENT2 ?ENT1) )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_SIZE_SMALL_&_LEAF_ENTITY CHARACTERIZATION )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.8
```

THE NEXT RULE RECOMMENDS A SYMBOLIC POINTER TO AN AGGREGATE ENTITY, IN EFFECT REMOVING IT FROM THE PHYSICAL DESIGN, E.G. THE ENTITY WILL NOT BE REPRESENTED EXPLICITLY IN A RECORD.

```
 *** RULE PROP_S_9 ***

IF   (TYPE-OF-ENTITY ?ENT2 *AGGREGATE-ENTITY* )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENT2 *AGGREGATE-WITH-DIRECT-ACTIVITY*) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 ?N 1 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.7
```

THIS RULE MODIFIES THE PREVIOUS RULE TO USE DIRECT POINTERS IF THE SYMBOLIC POINTER TO AN AGGREGATE ENTITY WOULD BE TOO LONG, RESULTING IN A LARGE RECORD. THE AGGREGATE ENTITY IS EXPLICITLY REPRESENTED AS A PHYSICAL RECORD.

```
 *** RULE PROP_S_10 ***

IF   (TYPE-OF-ENTITY ?ENT2 *AGGREGATE-ENTITY* )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENT2 *AGGREGATE-WITH-DIRECT-ACTIVITY*) )
     (ENTITY_LENGTH_FOR_ATTRIBUTES ?ENT2 ?LENGTH_IN_BYTES )
     (FUNCTION-CALL *>* ?LENGTH_IN_BYTES 250 )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 ?N 1 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 DIRECTLY-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.5
```

```
THE NEXT TWO RULES ADDRESS THE EXCEPTIONAL CASE IN WHICH THE AGGREGATE ENTITY HAS DIRECT
ACTIVITY.  IN THIS CASE, THE AGGREGATE ENTITY WOULD BE EXPLICITLY REPRESENTED AS A PHYSICAL RECORD.

 *** RULE PROP_S_11 ***

IF   (TYPE-OF-ENTITY ?ENT1 *AGGREGATE-WITH-DIRECT-ACTIVITY* )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.5



 *** RULE PROP_S_12 ***

IF   (TYPE-OF-ENTITY ?ENT1 *AGGREGATE-WITH-DIRECT-ACTIVITY* )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT2 ABSORBS ?ENT1)

     CERTAINTY FACTOR = 0.5



THE NEXT THREE RULES CONCERN ONE TO ONE RELATIONSHIPS.  THE FIRST RULE PLACES
A SYMBOLIC POINTER IN THE ENTITY WITH THE HIGHER CARDINALITY.

 *** RULE PROP_S_13 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 1)
     (CARDINALITY ?ENT1 ?CARD1 )
     (CARDINALITY ?ENT2 ?CARD2 )
     (FUNCTION-CALL *>* ?CARD2 ?CARD1 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.6
```

```
THE NEXT RULE AMENDS THE PREVIOUS RULE, ALLOWING FOR A SYMBOLIC POINTER TO BE PLACED IN AN
ENTITY WITH ONLY A SLIGHTLY LARGER CARDINALITY (IN THIS CASE BOTH RULES PROP_S_13 AND
PROP_S_14 WOULD FIRE, PROVIDING AN EXTRA CHOICE FOR REPRESENTING THIS RELATIONSHIP IN
SUBSEQUENT DESIGNS).

 *** RULE PROP_S_14 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 1)
     (CARDINALITY ?ENT1 ?CARD1 )
     (CARDINALITY ?ENT2 ?CARD2 )
     (FUNCTION-CALL *>* ?CARD2 ?CARD1 )
     (FUNCTION-CALL DIVIDE ?CARD1 ?CARD2 ?QUOT )
     (FUNCTION-CALL *>* ?QUOT 0.9 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT2 SYMBOL-POINTS-TO ?ENT1)

     CERTAINTY FACTOR = 0.6



THIS RULE RECOMMENDS A DIRECT POINTER IN THE ENTITY WITH THE LOWER CARDINALITY
TO ACCOUNT FOR HEAVY ACTIVITY ALONG A ONE TO ONE RELATIONSHIP.  THE ENTITIES
MUST NOT BE DEPENDENT ON EACH OTHER AND THE RELATIONSHIP MUST NOT BE UPDATED.

 *** RULE PROP_S_15 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 1)
     (COULD_NOT_CONCLUDE (DEPENDS-ON ?ENT1 ?ENT2) )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE1 SIGNIFICANT )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 UPDATE ?SUBSET_SIZE2
                          SIGNIFICANT) )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 DIRECTLY-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.3
```

```
THE NEXT THREE RULES COVERS THE SPECIAL CASE WHERE THE RELATIONSHIP MAY NOT EXIST E.G. THE
RELATIONSHIP IS 0 TO MANY.

 *** RULE PROP_S_16 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 0 1 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT2 SYMBOL-POINTS-TO ?ENT1)

     CERTAINTY FACTOR = 0.5



 *** RULE PROP_S_17 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 0 1 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.5



 *** RULE PROP_S_18 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 0 M )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT2 SYMBOL-POINTS-TO ?ENT1)

     CERTAINTY FACTOR = 0.7



THIS RULE RECOMMENDS A SYMBOLIC POINTER FOR A ONE TO MANY RELATIONSHIP BETWEEN THE SAME ENTITY.

 *** RULE PROP_S_19 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (FUNCTION-CALL EQUAL-TERMS ?ENT1 ?ENT2 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT2 SYMBOL-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.8
```

```
--------------------------------------------------------------------------------
RULES FOR SECTION 5.5 --> THE STRUCTURAL CHARACTERIZATIONS "DO NOT USE" RULE GROUP.
--------------------------------------------------------------------------------


THIS RULE RECOMMENDS NOT ABSORBING A ONE ENTITY INTO A MANY ENTITY.  IT THUS PREVENTS
REDUNDANT ABSORPTION OF AN ENTITY.

 *** RULE PREV_S_1 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 M 1 )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.9



THIS RULE RECOMMENDS AGAINST ABSORPTION OF AN ENTITY BY ITS DEPENDENT ENTITY.

 *** RULE PREV_S_2 ***

IF   (DEPENDS-ON ?ENT1 ?ENT2 )
     (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.99



SIMILARLY, THIS RULE RECOMMENDS AGAINST USING A SYMBOLIC POINTER TO REPRESENT A RELATIONSHIP
INVOLVING A DEPENDENT LEAF ENTITY.

 *** RULE PREV_S_3 ***

IF   (DEPENDS-ON ?ENT2 ?ENT1 )
     (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY )
     (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2 )
     (FUNCTION-CALL PRODUCE-STRENGTH (PROPOSE_REPRESENTATION ?REL_ID ?ENT1 ABSORBS ?ENT2) ?CERT )
     (FUNCTION-CALL *>* ?CERT 0.7 )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.333
```

```
THE NEXT RULE PROVIDES A COMPLEMENTARY RECOMMENDATION TO RULE PROP_S_10 IN THE
PREVIOUS RULE GROUP.

 *** RULE PREV_S_4 ***

IF   (TYPE-OF-ENTITY ?ENT1 *AGGREGATE-ENTITY* )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 1 )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENT1 *AGGREGATE-WITH-DIRECT-ACTIVITY*) )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.99



THIS RULE IS THE COMPLEMENT TO PROP_S_13.  IT PREVENTS REDUNDANT REPRESENTATION OF A
SYMBOLIC POINTER.

 *** RULE PREV_S_6 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 1 )
     (CARDINALITY ?ENT1 ?CARD1 )
     (CARDINALITY ?ENT2 ?CARD2 )
     (FUNCTION-CALL *>* ?CARD1 ?CARD2 )
     (FUNCTION-CALL DIVIDE ?CARD2 ?CARD1 ?QUOTIENT )
     (FUNCTION-CALL *>=* 0.9 ?QUOTIENT )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.75



THIS RULE RECOMMENDS AGAINST ABSORPTION IF THE RESULTING RECORD WOULD EXCEED A DEVICE LENGTH
RESTRICTION.  IT FIRES ONLY IF THE USER SPECIFIES SUCH RESTRICTIONS ARE IN FORCE.

 *** RULE PREV_S_7 ***

IF   (USER-MESSAGE ALL-CG *ENF-TRACK-LIMITS* )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_EXCEEDS_DEVICE_LENGTH CHARACTERIZATION )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.99
```

THIS RULE RECOMMENDS THAT DIRECT POINTERS SHOULD NOT BE CONSIDERED ALONG PARTIALLY IDENTIFYING RELATIONSHIPS IF THE SIZE OF THE SYMBOLIC POINTER IS NOT LARGE. THE RULE APPLIES TO SELECTION OF GENERIC REPRESENTATIONS.

```
 *** RULE PREV_S_8 ***

IF   (DEPENDS-ON ?ENT2 ?ENT1 )
     (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (DESCRIPTOR-COMPONENT ?REL_DESC_NAME ?REL_ID ?ATTRIBUTE_NAME )
     (ATTRIBUTE-INFORMATION ?ENTITY ?ATTRIBUTE_NAME ?ITEM_BYTE_LENGTH ?VOCAB_SIZE ?UPDATE )
     (FUNCTION-CALL *>=* 100 ?ITEM_BYTE_LENGTH )

THEN (DBMS-PREVENTS ?REL_ID ?ENT2 ?ENT1 1 M GENERIC)

     CERTAINTY FACTOR = 0.95
```

THIS RULE PROHIBITS ABSORPTION IF THE RELATIONSHIP MAY NOT EXIST IN ALL CASES, E.G. IT IS A ZERO TO ONE OR MANY RELATIONSHIP.

```
 *** RULE PREV_S_9 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 0 ?N )

THEN (ABSOLUTE-PROHIBITS ?REL_ID ?ENT1 ABSORBS ?ENT2)

     NO CERTAINTY FACTOR
```

THIS RULE STATES THE SAME PROHIBITION AS THE PRECEDING RULE, BUT IS BASED ON INFORMATION PROVIDED IN A CODASYL DATABASE DESCRIPTION.

```
 *** RULE PREV_S_10 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )
     (OPTIONAL-IND-REL ?REL_ID ?PERCENT-IN-EXISTENCE )
     (FUNCTION-CALL *>* 0.999 ?PERCENT-IN-EXISTENCE )

THEN (ABSOLUTE-PROHIBITS ?REL_ID ?ENT1 ABSORBS ?ENT2)

     NO CERTAINTY FACTOR
```

```
THIS RULE PROHIBITS ABSORPTION ALONG A RELATIONSHIP IF THE RELATIONSHIP IS BETWEEN THE SAME ENTITY.
THIS RULE MAY BE QUESTIONABLE.

 *** RULE PREV_S_11 ***

IF   (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (FUNCTION-CALL EQUAL-TERMS ?ENT1 ?ENT2 )

THEN (ABSOLUTE-PROHIBITS ?REL_ID ?ENT1 ABSORBS ?ENT2)

     NO CERTAINTY FACTOR
```

```
--------------------------------------------------------------------------
RULES FOR SECTION 5.6 --> THE ACTIVITY CHARACTERIZATION PROPOSAL RULE GROUP.
--------------------------------------------------------------------------
```

THE NEXT FOUR RULES RECOMMEND ABSORPTION FOR RELATIONSHIPS WITH CHARACTERIZATIONS OF HIGH LEVELS OF ABSOLUTE ACTIVITY AND HIGH FORWARDING PERCENTAGE. THE LEVEL OF CERTAINTY IS DETERMINED BY THE FUNCTION *WORK-STRENGTH*. THE VARIABLES ?ACTIVITY_LEVEL AND ?FORWARDING_LEVEL ARE USED TO REPRESENT THE LEVEL OF ABSOLUTE ACTIVITY AND FORWARDING PERCENTAGE RESPECTIVELY. THEY RANGE FROM LEVEL 0 (SIGNIFICANT) TO THE HEAVIEST LEVELS (3 AND 4).

THIS RULE RECOMMENDS ABSORPTION ALONG A ONE TO MANY RELATIONSHIP -- ?REL_ID, IF ?REL_ID DOES NOT INVOLVE AN INTERSECTION OR LEAF ENTITY, AND THERE IS AT LEAST SIGNIFICANT SMALL SUBSET ABSOLUTE ACTIVITY AND SIGNIFICANT FORWARDING PERCENTAGE ALONG ?REL_ID.

*** RULE PROP_A_1 ***

```
IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID *INTERSECTION* CHARACTERIZATION) )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY) )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY RETRIEVAL ?SUBSET_SIZE1 ?FORWARDING_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?FORWARDING_LEVEL (HIGH-THRU-ACT-0 HIGH-THRU-ACT-1
                                                   HIGH-THRU-ACT-2 HIGH-THRU-ACT-3) )
     (FUNCTION-CALL *IS-ONE-OF* ?SUBSET_SIZE1 (SM-SUB SINGLE) )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY RETRIEVAL ?SUBSET_SIZE2 ?ACTIVITY_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (FUNCTION-CALL *FUN-COMP-STR* *WORK-STRENGTH* ?ACTIVITY_LEVEL ?FORWARDING_LEVEL 0.05 0.3 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     COMPUTED CERTAINTY FACTOR
```

```
THIS RULE IS ALMOST THE SAME BUT PROPOSES A HIGHER CERTAINTY FACTOR FOR RELATIONSHIPS WHERE
THE "MANY" ENTITY IS A LEAF ENTITY.

 *** RULE PROP_A_2 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID *INTERSECTION* CHARACTERIZATION) )
     (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY RETRIEVAL ?SUBSET_SIZE1 ?FORWARDING_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?FORWARDING_LEVEL (HIGH-THRU-ACT-0 HIGH-THRU-ACT-1
                                                   HIGH-THRU-ACT-2 HIGH-THRU-ACT-3) )
     (FUNCTION-CALL *IS-ONE-OF* ?SUBSET_SIZE1 (SM-SUB SINGLE) )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY RETRIEVAL ?SUBSET_SIZE2 ?ACTIVITY_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (FUNCTION-CALL *FUN-COMP-STR* *WORK-STRENGTH* ?ACTIVITY_LEVEL ?FORWARDING_LEVEL 0.3 0.7 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     COMPUTED CERTAINTY FACTOR



THE CONDITIONS IN THIS RULE ARE SIMILAR TO RULE PROP_A_1 EXCEPT THAT ONE OF THE ENTITIES
RECEIVES SIGNIFICANT TO HEAVY DIRECT LARGE SUBSET RETRIEVAL WHICH IS FORWARDED ALONG THE
RELATIONSHIP.  THIS RULE IS SPECIALIZED FOR NON-LEAF ENTITIES.

 *** RULE PROP_A_3 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?ENTX RETRIEVAL LARGE-SUBSET ?ACTIVITY_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (FUNCTION-CALL *IS-ONE-OF* ?ENTX (?ENT1 ?ENT2) )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY) )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID *INTERSECTION* CHARACTERIZATION) )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY RETRIEVAL LARGE-SUBSET ?FORWARDING_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?FORWARDING_LEVEL (HIGH-THRU-ACT-0 HIGH-THRU-ACT-1
                                                   HIGH-THRU-ACT-2 HIGH-THRU-ACT-3) )
     (FUNCTION-CALL *FUN-COMP-STR* *WORK-STRENGTH* ?ACTIVITY_LEVEL ?FORWARDING_LEVEL 0.1 0.4 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     COMPUTED CERTAINTY FACTOR
```

```
THIS RULE IS THE SAME AS THE PREVIOUS ONE (PROP_A_3) EXCEPT IT IS SPECIALIZED FOR LEAF ENTITIES
AND THEREFORE HAS A HIGHER ASSOCIATED CERTAINTY FACTOR.

 *** RULE PROP_A_4 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?ENTX RETRIEVAL LARGE-SUBSET ?ACTIVITY_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (FUNCTION-CALL *IS-ONE-OF* ?ENTX (?ENT1 ?ENT2) )
     (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID *INTERSECTION* CHARACTERIZATION) )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY RETRIEVAL LARGE-SUBSET ?FORWARDING_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?FORWARDING_LEVEL (HIGH-THRU-ACT-0 HIGH-THRU-ACT-1
                                                   HIGH-THRU-ACT-2 HIGH-THRU-ACT-3) )
     (FUNCTION-CALL *FUN-COMP-STR* *WORK-STRENGTH* ?ACTIVITY_LEVEL ?FORWARDING_LEVEL 0.4 0.9 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     COMPUTED CERTAINTY FACTOR



THIS RULE RECOMMENDS ABSORPTION ALONG ONE TO ONE RELATIONSHIPS IF ONE OF THE ENTITIES IS DEPENDENT
ON THE OTHER, AND THERE EXISTS SIGNIFICANT TO HEAVY ABSOLUTE ACTIVITY AND FORWARDING PERCENTAGE
ALONG THE RELATIONSHIP.

 *** RULE PROP_A_5 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 1 )
     (DEPENDS-ON ?ENT2 ?ENT1 )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY RETRIEVAL ?SUBSET_SIZE1 ?FORWARDING_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?FORWARDING_LEVEL (HIGH-THRU-ACT-0 HIGH-THRU-ACT-1
                                                   HIGH-THRU-ACT-2 HIGH-THRU-ACT-3) )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY RETRIEVAL ?SUBSET_SIZE2 ?ACTIVITY_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (FUNCTION-CALL *FUN-COMP-STR* *WORK-STRENGTH* ?ACTIVITY_LEVEL ?FORWARDING_LEVEL 0.2 0.5 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     COMPUTED CERTAINTY FACTOR
```

```
THIS RULE RECOMMENDS ABSORPTION OF INTERSECTION ENTITY BASED ON STRENGTH OF ASSOCIATION ALONG A
PARTIALLY IDENTIFYING RELATIONSHIP.  THE ASSOCIATE_INTERSECT_ENTITY_WITH_REL FACT EXPRESSION IS
USED.  THE FUNCTION *FUN-COMP-STR* USES THE BERNOULLI FORMULA TO DETERMINE CERTAINTY.

 *** RULE PROP_A_6 ***

IF   (TYPE-OF-ENTITY ?INT_ENT *INTERSECTION-ENTITY* )
     (DEGREE-OF ?REL_ID ?ENT1 ?INT_ENT 1 M )
     (ASSOCIATE-INTERSECT-ENTITY-WITH-REL ?INT_ENT ?REL_ID ?REL_WORKLOAD
               ?TOTAL_WORKLOAD ?REL%_WORKLOAD ?OTHER_PARTIAL_ID_RELATIONSHIPS LOCAL-ACTIVITY )
     (FUNCTION-CALL *>* ?REL%_WORKLOAD 0.6 )
     (FUNCTION-CALL *FUN-COMP-STR* *BERNOULLI-FORMULA* ?REL%_WORKLOAD )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?INT_ENT)

     COMPUTED CERTAINTY FACTOR



THIS RULE RECOMMENDS A MANY TO ONE  DIRECT POINTER IF THERE IS SUBSTANTIAL ACTIVITY
IN MANY TO 1 DIRECTION ONLY.

 *** RULE PROP_A_7 ***

IF   (RELATIONSHIP_CHARACTERIZATION ?REL_ID MANY_TO_ONE_ACTIVITY_ONLY SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 M 1 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 DIRECTLY-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.5



THIS RULE RECOMMENDS A MANY TO ONE SYMBOLIC POINTER FOR A RELATIONSHIP WHERE THE RESULTING RECORD SIZE
WOULD NOT BE SMALL, THE MANY ENTITY IS NOT A LEAF ENTITY, AND ACTIVITY IS LOW.

 *** RULE PROP_A_8 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_SIZE_SMALL_&_LEAF_ENTITY
                          CHARACTERIZATION) )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY RETRIEVAL ?SUBSET_SIZE
                          SIGNIFICANT) )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT2 SYMBOL-POINTS-TO ?ENT1)

     CERTAINTY FACTOR = 0.3
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-------------------------------------------------------------------------------
RULES FOR SECTION 5.7 --> THE ACTIVITY CHARACTERIZATION "DO NOT USE" RULE GROUP.
-------------------------------------------------------------------------------

THE FIRST THREE RULES RECOMMEND AGAINST USING ABSORPTION WHERE ONE OF THE TWO ENTITIES IN A
RELATIONSHIP RECEIVES AT LEAST A SIGNIFICANT AMOUNT OF DIRECT ACTIVITY AND FORWARDING
PERCENTAGES ARE LOW.  RESULTING RECORD SIZES ARE ALSO TAKEN INTO ACCOUNT.



THE NEXT RULE RECOMMENDS AGAINST ABSORPTION ALONG RELATIONSHIP ?REL_ID IF ?REL_ID IS A 1 TO MANY
RELATIONSHIP, ONE OF THE ENTITIES IN ?REL_ID IS SUBJECT TO DIRECT LARGE SUBSET RETRIEVAL, ?REL_ID
DOES NOT HAVE A SIGNIFICANT FORWARDING PERCENTAGE, AND THE RECORD WHICH WOULD RESULT FROM
ABSORPTION IS NOT TRIVIAL.  THE FUNCTION *WORK-STRENGTH* IS USED TO COMPUTE THE CERTAINTY.

 *** RULE PREV_A_1 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?ENTX RETRIEVAL LARGE-SUBSET ?ACTIVITY_LEVEL )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (FUNCTION-CALL *IS-ONE-OF* ?ENTX (?ENT1 ?ENT2) )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY RETRIEVAL
                          LARGE-SUBSET SIGNIFICANT_FORWARDING_%) )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_SIZE_SMALL_&_LEAF_ENTITY
                          CHARACTERIZATION) )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (FUNCTION-CALL *FUN-COMP-STR* *WORK-STRENGTH* ?ACTIVITY_LEVEL NONE 0.1 0.6 )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     COMPUTED CERTAINTY FACTOR


THIS IS THE SAME AS THE PREVIOUS RULE BUT CONCERNS DIRECT SMALL SUBSET ACTIVITY ON
RELATIONSHIP ?REL_ID.

 *** RULE PREV_A_2 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?ENTX RETRIEVAL SMALL-SUBSET ?ACTIVITY_LEVEL )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (FUNCTION-CALL *IS-ONE-OF* ?ENTX (?ENT1 ?ENT2) )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY RETRIEVAL
                          SMALL-SUBSET SIGNIFICANT_FORWARDING_%) )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_SIZE_SMALL_&_LEAF_ENTITY
                          CHARACTERIZATION) )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (FUNCTION-CALL *FUN-COMP-STR* *WORK-STRENGTH* ?ACTIVITY_LEVEL NONE 0.1 0.4 )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     COMPUTED CERTAINTY FACTOR
```

```
THIS RULE RECOMMENDS NOT USING A SYMBOLIC POINTER FOR A RELATIONSHIP TO A DEPENDENT LEAF ENTITY
WHERE THE LEVEL OF ACTIVITY ALONG THE RELATIONSHIP IS SIGNIFICANT.  THE CERTAINTY FACTOR IS LOW.

 *** RULE PREV_A_3 ***

IF   (TYPE-OF-ENTITY ?ENT1 *DEPENDENT-ENTITY* )
     (DEPENDS-ON ?ENT1 ?ENT2 )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT2 ?ENT1 RETRIEVAL ?SUBSET_SIZE SIGNIFICANT )
     (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.2



THE NEXT RULE ADDRESSES RELATIONSHIPS TO INTERSECTION ENTITIES WITH LOW ACTIVITY.  THE
FACT EXPRESSION ASSOCIATE-INTERSECT-ENTITY-WITH-REL IS USED.

 *** RULE PREV_4 ***

IF   (TYPE-OF-ENTITY ?INT_ENT *INTERSECTION-ENTITY* )
     (DEGREE-OF ?REL_ID ?ENT1 ?INT_ENT 1 M )
     (ASSOCIATE-INTERSECT-ENTITY-WITH-REL ?INT_ENT ?REL_ID2 ?REL_ID2_WORKLOAD
          ?TOTAL_WORKLOAD ?REL%_WORKLOAD ?OTHER_PARTIAL_ID_RELS LOCAL-ACTIVITY )
     (FUNCTION-CALL *>* ?REL%_WORKLOAD 0.5 )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID1 ?REL_ID2 )
     (FUNCTION-CALL *FUN-COMP-STR* *BERNOULLI-FORMULA* ?REL%_WORKLOAD )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID1 ?ENT1 ABSORBS ?INT_ENT)

     COMPUTED CERTAINTY FACTOR



THE NEXT RULE RECOMMENDS AGAINST USING ABSORPTION WHERE A CONFLICTING CONTEXT SITUATION EXISTS TOGETHER
WITH A RECOMMENDATION OF NOT ABSORBING ALONG RELATIONSHIP ?REL_ID.

 *** RULE PREV_A_5 ***

IF   (CONFLICTING-RETRIEVAL-CONTEXTS ?REL_ID ?ABS-REL DO-NOT-ABSORB ?REL_ID ?ENT2 ?REASON ?EXTENT )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_SIZE_SMALL_&_LEAF_ENTITY
                          CHARACTERIZATION) )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID TRIVIAL_SIZE_MANY_ENTITY CHARACTERIZATION) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.3
```

```
DO NOT USE A DIRECT POINTER FROM ?ENT1 TO ?ENT2 UNLESS A SIGNIFICANT LEVEL OF ACTIVITY EXISTS
FROM ?ENT1 TO ?ENT2.

 *** RULE PREV_A_6 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 ?N 1 )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE
                          SIGNIFICANT) )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 DIRECTLY-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.7



DO NOT ABSORB IF RELATIONSHIP ?REL_ID HAS ONLY NONFORWARDING ACTIVITY IN THE ONE TO MANY DIRECTION AND
THE MANY ENTITY IS NOT SMALL. IN THIS CASE, A ONE TO MANY SYMBOLIC POINTER IS BETTER.

 *** RULE PREV_A_7 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY NON_FORWARDING_CONTEXT_ACTIVITY ?SUBSET_SIZE
          SIGNIFICANT )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTA ?ENTB RETRIEVAL ?SUBSET_SIZE
                          SIGNIFICANT) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID TRIVIAL_SIZE_MANY_ENTITY CHARACTERIZATION)
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_SIZE_SMALL_&_LEAF_ENTITY
                          CHARACTERIZATION) )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENT2 *INTERSECTION-NO-ATTRIBUTES*) )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.5



DO NOT USE DIRECT POINTERS IF HEAVY NONFORWARDING ACTIVITY EXISTS. NONFORWARDING ACTIVITY FOCUSES
ONLY ON THE RELATIONSHIP DESCRIPTORS WHICH WILL NOT BE REPRESENTED IF DIRECT POINTERS ARE USED.

 *** RULE PREV_A_8 ***

IF   (RELATIONSHIP_CHARACTERIZATION ?REL_ID NON_FORWARDING_CONTEXT_ACTIVITY
          SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 DIRECTLY-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.9
```

```
THE NEXT THREE RULES RECOMMEND NOT USING ABSORPTION IF RELATIONSHIP UPDATE ACTIVITY EXISTS AND
IS LIKELY TO VIOLATE INTEGRITY CONSTRAINTS. THESE RULES MAY NEED FURTHER ELABORATION AND EXPANSION.

 *** RULE PREV_A_9 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?ENT1 UPDATE SINGLE SIGNIFICANT )
     (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (COULD_NOT_CONCLUDE (DEPENDS-ON ?ENT2 ?ENT1) )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.25



RECOMMEND NOT ABSORBING ALONG A RELATIONSHIP WHICH WILL BE UPDATED IF THE ENTITIES ARE INDEPENDENT
OF EACH OTHER.

 *** RULE PREV_A_10 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX1 ?ENTX2 UPDATE ?SUBSET_SIZE SIGNIFICANT )
     (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (COULD_NOT_CONCLUDE (DEPENDS-ON ?ENT2 ?ENT1) )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.333



RECOMMEND NOT ABSORBING ALONG A RELATIONSHIP WHERE THE ATTRIBUTES OF THE RELATIONSHIP DESCRIPTOR
ARE UPDATED SEPARATELY.

 *** RULE PREV_A_11 ***

IF   (RELATIONSHIP_CHARACTERIZATION ?REL_ID INDEPENDENT-DESC-COMPONENT-UPDATE
          SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.4
```

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-------------------------------------------------------------------------
RULES FOR SECTION 5.8 --> THE COMPLEX REPRESENTATION PROPOSAL RULE GROUP.
-------------------------------------------------------------------------



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PART A OF SECTION 5.8 --> COMPLEX REPRESENTATIONS FOR RELATIONSHIPS WITH CHARACTERIZATIONS
ABOUT WORKLOAD COMPLEXITY BASED ON RELATIONSHIP ACTIVITY AND THE EXISTENCE OR ABSENCE OF
CONFLICTING CONTEXT SITUATIONS.
-------------------------------------------------------------------------------------

RECOMMEND A SYMBOLIC POINTER FOR A RELATIONSHIP CHARACTERIZED AS BEING IN A
CONFLICTING CONTEXT.

 *** RULE PROP_CM_1 ***

IF   (RELATIONSHIP_CHARACTERIZATION ?REL_ID CONFLICTING-RETRIEVAL-CONTEXTS
         SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT2 SYMBOL-POINTS-TO ?ENT1)

     CERTAINTY FACTOR = 0.5



FOR RELATIONSHIPS WITH ACTIVITY IN BOTH DIRECTIONS THAT ARE NOT IN CONFLICTING CONTEXTS,
RECOMMEND ABSORPTION OF THE MANY ENTITY INTO THE ONE ENTITY.

 *** RULE PROP_CM_2 ***

IF   (RELATIONSHIP_CHARACTERIZATION ?REL_ID BIDIRECTIONAL_ACTIVITY
         SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID CONFLICTING-RETRIEVAL-CONTEXTS
                              SIGNIFICANT_WORKLOAD_COMPLEXITY) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.5
```

```
FOR RELATIONSHIPS WITH ACTIVITY IN BOTH DIRECTIONS, RECOMMEND A MANY TO ONE SYMBOLIC AND
DIRECT POINTER.

 *** RULE PROP_CM_3 ***

IF   (RELATIONSHIP_CHARACTERIZATION ?REL_ID BIDIRECTIONAL_ACTIVITY SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT2 SYMB-&-DIR-POINTS-TO ?ENT1)

     CERTAINTY FACTOR = 0.5



FOR A RELATIONSHIP INVOLVED IN A CONFLICTING RETRIEVAL CONTEXT WHICH HAS LITTLE RETRIEVAL
AND UPDATE ACTIVITY, RECOMMEND A MANY TO ONE DIRECT POINTER WITH A MODERATE CERTAINTY FACTOR.

 *** RULE PROP_CM_4 ***

IF   (RELATIONSHIP_CHARACTERIZATION ?REL_ID CONFLICTING-RETRIEVAL-CONTEXTS SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?ENT2 RETRIEVAL LARGE-SUBSET SIGNIFICANT) )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY UPDATE ?SUBSET_SIZE
                          SIGNIFICANT) )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?ENT1 UPDATE SINGLE SIGNIFICANT) )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?ENT2 UPDATE SINGLE SIGNIFICANT) )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT2 DIRECTLY-POINTS-TO ?ENT1)

     CERTAINTY FACTOR = 0.25



FOR RELATIONSHIPS WITH CHARACTERIZATIONS OF SIGNIFICANT ACTIVITY IN BOTH DIRECTIONS BUT WITH NO
SIGNIFICANT UPDATE ACTIVITY, RECOMMEND DIRECT POINTERS IN BOTH DIRECTIONS.

 *** RULE PROP_CM_5 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE1 SIGNIFICANT )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT2 ?ENT1 RETRIEVAL ?SUBSET_SIZE2 SIGNIFICANT )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTX ?ENTY UPDATE ?SUBSET_SIZE
                          SIGNIFICANT) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 1)

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 DIR-POINT-TO-EACH-OTHER ?ENT2)

     CERTAINTY FACTOR = 0.5
```

```
FOR RELATIONSHIPS WITH A ONE TO ONE DEGREE AND SIGNIFICANT LEVEL OF ACTIVITY AND FORWARDING
PERCENTAGE DIRECTED TO THE DEPENDENT ENTITY, RECOMMEND A DIRECT POINTER TO THE DEPENDENT ENTITY
AND A SYMBOLIC POINTER IN THE DEPENDENT ENTITY.

 *** RULE PROP_CM_6 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 1)
     (DEPENDS-ON ?ENT2 ?ENT1 )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE1 ?FORWARDING_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?FORWARDING_LEVEL (HIGH-THRU-ACT-0 HIGH-THRU-ACT-1
                                                   HIGH-THRU-ACT-2 HIGH-THRU-ACT-3) )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE2 ?ACTIVITY_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (FUNCTION-CALL *FUN-COMP-STR* *WORK-STRENGTH* ?ACTIVITY_LEVEL ?FORWARDING_LEVEL 0.2 0.7 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 DIRECTLY-POINTS-TO-&-SYMB-BACK ?ENT2)

     COMPUTED CERTAINTY FACTOR
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-------------------------------------------------------------------------------
PART B OF SECTION 5.8 --> COMPLEX REPRESENTATIONS FOR RELATIONSHIPS WITH NONFORWARDING CONTEXTS.
-------------------------------------------------------------------------------

FOR RELATIONSHIPS WITH SIGNIFICANT NONFORWARDING ACTIVITY IN THE ONE TO MANY DIRECTION, RECOMMEND ABSORPTION.

 *** RULE PROP_CM_7 ***

IF   (RELATIONSHIP_CHARACTERIZATION ?REL_ID NON_FORWARDING_CONTEXT_ACTIVITY SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ABSORBS ?ENT2)

     CERTAINTY FACTOR = 0.2



FOR RELATIONSHIPS WITH SIGNIFICANT NONFORWARDING ACTIVITY, RECOMMEND A ONE TO MANY SYMBOLIC
POINTER TOWARD THE ENTITY RECEIVING THE ACTIVITY.  THE RULE SPECIFICALLY EXCLUDES ZERO TO
ONE OR MANY RELATIONSHIPS.

 *** RULE PROP_CM_8 ***

IF   (RELATIONSHIP_CHARACTERIZATION ?REL_ID NON_FORWARDING_CONTEXT_ACTIVITY SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 NON_FORWARDING_CONTEXT_ACTIVITY
               ?SUBSET_SIZE ?ACTIVITY_LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?ACTIVITY_LEVEL (HEAVY-0 HEAVY-1 HEAVY-2 HEAVY-3 HEAVY-4) )
     (COULD_NOT_CONCLUDE (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 0 ?N) )
     (FUNCTION-CALL *FUN-COMP-STR* *WORK-STRENGTH* ?ACTIVITY_LEVEL NONE 0.2 0.7 )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT2)

     COMPUTED CERTAINTY FACTOR



THE NEXT RULE RECOMMENDS SYMBOLIC POINTERS IN BOTH DIRECTIONS FOR A RELATIONSHIP WITH HEAVY
FORWARDING AND NONFORWARDING ACTIVITY IN THE ONE TO MANY DIRECTION.

 *** RULE PROP_CM_125 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 NON_FORWARDING_CONTEXT_ACTIVITY
               ?SUBSET_SIZE1 SIGNIFICANT )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE2 SIGNIFICANT )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMB-POINT-TO-EACH-OTHER ?ENT2)

     CERTAINTY FACTOR = 0.5
```

```
THE NEXT RULE RECOMMENDS SYMBOLIC POINTERS IN BOTH DIRECTIONS FOR A RELATIONSHIP WITH HEAVY
NONFORWARDING ACTIVITY IN THE ONE TO MANY DIRECTION AND HEAVY FORWARDING ACTIVITY IN THE
MANY TO ONE DIRECTION.

 *** RULE PROP_CM_9 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 NON_FORWARDING_CONTEXT_ACTIVITY ?SUBSET_SIZE1
        SIGNIFICANT )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT2 ?ENT1 RETRIEVAL ?SUBSET_SIZE2 SIGNIFICANT )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMB-POINT-TO-EACH-OTHER ?ENT2)

     CERTAINTY FACTOR = 0.25



THE NEXT RULE RECOMMENDS SYMBOLIC POINTERS IN BOTH DIRECTIONS FOR A RELATIONSHIP WITH HEAVY
NONFORWARDING ACTIVITY IN BOTH DIRECTIONS.

 *** RULE PROP_CM_10 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 NON_FORWARDING_CONTEXT_ACTIVITY ?SUBSET_SIZE
        SIGNIFICANT )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT2 ?ENT1 NON_FORWARDING_CONTEXT_ACTIVITY ?SUBSET_SIZE
        SIGNIFICANT )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMB-POINT-TO-EACH-OTHER ?ENT2)

     CERTAINTY FACTOR = 0.5



THIS RULE PROPOSES A MANY TO ONE SYMBOLIC AND DIRECT POINTER IF HEAVY FORWARDING AND
NONFORWARDING ACTIVITY EXIST IN THE MANY TO ONE DIRECTION, BUT NO NONFORWARDING
ACTIVITY EXISTS IN THE ONE TO MANY DIRECTION.

 *** RULE PROP_CM_11 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 M 1 )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 NON_FORWARDING_CONTEXT_ACTIVITY ?SUBSET_SIZE1
          SIGNIFICANT )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE2 SIGNIFICANT )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT2 ?ENT1
                          NON_FORWARDING_CONTEXT_ACTIVITY ?SUBSET_SIZE1 SIGNIFICANT) )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMB-&-DIR-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.5
```

```
THE NEXT TWO RULES ARE CONCERNED WITH ACTIVITY IN BOTH DIRECTIONS ALONG A RELATIONSHIP AND WITH
NONFORWARDING ACTIVITY.  PROPOSE A SYMBOLIC POINTER IN BOTH DIRECTIONS IF ACTIVITY IN BOTH
DIRECTIONS EXISTS AND HEAVY NONFORWARDING ACTIVITY IN THE ONE TO MANY ACTIVITY ALSO EXISTS.

 *** RULE PROP_CM_12 ***

IF   (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 NON_FORWARDING_CONTEXT_ACTIVITY ?SUBSET_SIZE
        SIGNIFICANT )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID BIDIRECTIONAL_ACTIVITY SIGNIFICANT_WORKLOAD_COMPLEXITY )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMB-POINT-TO-EACH-OTHER ?ENT2)

     CERTAINTY FACTOR = 0.5



IF ACTIVITY IN BOTH DIRECTIONS EXISTS AND HEAVY ONE TO MANY NONFORWARDING ACTIVITY ALSO EXISTS,
RECOMMEND SYMBOLIC POINTERS IN BOTH DIRECTIONS AND A MANY TO ONE DIRECT POINTER.

 *** RULE PROP_CM_13 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 NON_FORWARDING_CONTEXT_ACTIVITY ?SUBSET_SIZE
        SIGNIFICANT )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID BIDIRECTIONAL_ACTIVITY SIGNIFICANT_WORKLOAD_COMPLEXITY )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT2 SYMB-&-DIR-POINTS-TO-&-SYMBOL-BACK ?ENT1)

     CERTAINTY FACTOR = 0.5



FOR AN INTERSECTION ENTITY WITH NO ATTRIBUTES, PROPOSE ONE TO MANY SYMBOLIC POINTERS.  THIS
WILL RESULT IN REMOVAL OF THE INTERSECTION ENTITY FROM THE PHYSICAL DESIGN.

 *** RULE PROP_CM_14 ***

IF   (TYPE-OF-ENTITY ?ENT2 *INTERSECTION-NO-ATTRIBUTES* )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (COULD_NOT_CONCLUDE (DIRECT_ACTIVITY_ON_ENTITY ?ENT2 RETRIEVAL ?SUBSET_SIZE ?FREQUENCY) )

THEN (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT2)

     CERTAINTY FACTOR = 0.2
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-----------------------------------------------------------------------
RULES FOR SECTION 5.9 --> REASONABLE REPRESENTATION SELECTION RULE GROUP.
-----------------------------------------------------------------------



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PART A OF SECTION 5.9 --> RULES FOR INITIAL SELECTION OF REASONABLE REPRESENTATIONS FOR USE IN
SUBSEQUENT DESIGN ACTIONS.
-----------------------------------------------------------------------------------------------

THESE RULES COVER DIFFERENT COMBINATIONS OF PROPOSED_REPRESENTATION, DO_NOT_USE_REPRESENTATION, AND
ABSOLUTE_PREVENTS FACT EXPRESSIONS TO MAKE SELECTIONS.  CERTAINTY FACTORS ARE OBTAINED BY COMBINING
CERTAINTY FACTORS FROM THESE FACT EXPRESSIONS. DBMS_SUPPORT_AVAILABLE FACT EXPRESSIONS INDICATE WHICH
REPRESENTATIONS ARE ALLOWABLE BY THE TARGET DBMS BEING DESIGNED FOR.


 *** RULE REAS_1 ***

IF   (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ?REP-NAME ?ENT2 )
     (COULD_NOT_CONCLUDE (ABSOLUTE-PROHIBITS ?REL_ID ?REP-NAME ?ENT1 ?ENT2) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 ?DEG1 ?DEG2 )
     (DBMS_SUPPORT_AVAILABLE ?DBMS LINK-IMPLEMENTATION ?REP-NAME ?DEG1 ?DEG2 )
     (DBMS-BEING-DESIGNED-FOR ?DBMS SELECT )
     (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ?REP-NAME ?ENT2 )
     (DBMS-PREVENTS ?REL_ID ?REP-NUMBER ?ENT1 ?ENT2 ?DEG1 ?DEG2 ?DBMS )

THEN (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?REP-NAME ?ENT2 ?DBMS)

     COMPUTED CERTAINTY FACTOR



 *** RULE REAS_2 ***

IF   (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ?REP-NAME ?ENT2 )
     (COULD_NOT_CONCLUDE (ABSOLUTE-PROHIBITS ?REL_ID ?ENT1 ?REP-NAME ?ENT2) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 ?DEG1 ?DEG2 )
     (DBMS_SUPPORT_AVAILABLE ?DBMS LINK-IMPLEMENTATION ?REP-NAME ?DEG1 ?DEG2 )
     (DBMS-BEING-DESIGNED-FOR ?DBMS SELECT )
     (COULD_NOT_CONCLUDE (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ?REP-NAME ?ENT2) )
     (DBMS-PREVENTS ?REL_ID ?REP-NUMBER ?ENT1 ?ENT2 ?DEG1 ?DEG2 ?DBMS )

THEN (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?REP-NAME ?ENT2 ?DBMS)

     COMPUTED CERTAINTY FACTOR
```

```
 *** RULE REAS_3 ***

IF   (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ?REP-NAME ?ENT2 )
     (COULD_NOT_CONCLUDE (ABSOLUTE-PROHIBITS ?REL_ID ?ENT1 ?REP-NAME ?ENT2) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 ?DEG1 ?DEG2 )
     (DBMS_SUPPORT_AVAILABLE ?DBMS LINK-IMPLEMENTATION ?REP-NAME ?DEG1 ?DEG2 )
     (DBMS-BEING-DESIGNED-FOR ?DBMS SELECT )
     (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ?REP-NAME ?ENT2 )
     (COULD_NOT_CONCLUDE (DBMS-PREVENTS ?REL_ID ?ENT1 ?REP-NAME ?ENT2 ?DEG1 ?DEG2 ?DBMS) )

THEN (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?REP-NAME ?ENT2 ?DBMS)

     COMPUTED CERTAINTY FACTOR



 *** RULE REAS_4 ***

IF   (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ?REP-NAME ?ENT2 )
     (COULD_NOT_CONCLUDE (ABSOLUTE-PROHIBITS ?REL_ID ?ENT1 ?REP-NAME ?ENT2) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 ?DEG1 ?DEG2 )
     (DBMS-BEING-DESIGNED-FOR ?DBMS SELECT )
     (DBMS_SUPPORT_AVAILABLE ?DBMS LINK-IMPLEMENTATION ?REP-NAME ?DEG1 ?DEG2 )
     (COULD_NOT_CONCLUDE (DO_NOT_USE_REPRESENTATION_FOR ?REL_ID ?ENT1 ?REP-NAME ?ENT2) )
     (COULD_NOT_CONCLUDE (DBMS-PREVENTS ?REL_ID ?REP-NUMBER ?ENT1 ?REP-NAME ?ENT2 ?DEG1 ?DEG2 ?DBMS) )

THEN (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?REP-NAME ?ENT2 ?DBMS)

     COMPUTED CERTAINTY FACTOR



 *** RULE REAS_5 ***

IF   (DBMS-BEING-DESIGNED-FOR ?DBMS SELECT )
     (COULD_NOT_CONCLUDE (PROPOSE_REPRESENTATION_FOR ?REL_ID ?ENT1 ?REP-NAME ?ENT2 )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )

THEN (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT2 SYMBOL-POINTS-TO ?ENT1 ?DBMS)

     CERTAINTY FACTOR = 0.5
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-------------------------------------------------------------------------------
PART B OF SECTION 5.9 --> RULES FOR TRANSLATING INITIAL REASONABLE REPRESENTATIONS INTO
REPRESENTATIONS USED BY TARGET DBMS BEING DESIGNED FOR.
-------------------------------------------------------------------------------

THE FIRST TWO RULES IDENTIFY REPRESENTATIONS FOR USE IN THE UNIVERSITY OF MINNESOTA DESIGN SYSTEM.

 *** RULE DBMSREP_1 ***

IF   (DBMS-BEING-DESIGNED-FOR GENERIC DESIGN )
     (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?REP-NAME ?ENT2 GENERIC )

THEN (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?ENT2 ?REP-NAME ?REP-NAME GENERIC)

     NO CERTAINTY FACTOR



 *** RULE DBMSREP_2 ***

IF   (DBMS-BEING-DESIGNED-FOR GENERIC DESIGN )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 ?N 1 )
     (COULD_NOT_CONCLUDE (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENTX ?REP-NAME ?ENTY GENERIC) )

THEN (DBMS_REASONABLE_REPRESENTATION
          ?REL_ID ?ENT1 ?ENT2 SYMBOL-POINTS-TO SYMBOL-POINTS-TO GENERIC)

     NO CERTAINTY FACTOR



THE NEXT TWELVE RULES PERFORM TRANSLATIONS INTO CODASYL SPECIFIC REPRESENTATIONS.

 *** RULE DBMSREP_3 ***

IF   (DBMS-BEING-DESIGNED-FOR CODASYL DESIGN )
     (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ABSORBS ?ENT2 CODASYL )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (THERE_IS_ONE_OF (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 DIRECTLY-POINTS-TO ?ENT2 CODASYL) )

THEN (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?ENT2 REP-ABSORB MEMBER-CHAIN-NEXT CODASYL)

     NO CERTAINTY FACTOR
```

```
 *** RULE DBMSREP_4 ***

IF   (DBMS-BEING-DESIGNED-FOR CODASYL DESIGN )
     (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ABSORBS ?ENT2 CODASYL )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (THERE_IS_ONE_OF (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 DIR-POINT-TO-EACH-OTHER ?ENT2
                       CODASYL) )

THEN (DBMS_REASONABLE_REPRESENTATION
          ?REL_ID ?ENT1 ?ENT2 REP-ABSORB MEMBER-CHAIN-NEXT-OWNER CODASYL)

     NO CERTAINTY FACTOR



 *** RULE DBMSREP_5 ***

IF   (DBMS-BEING-DESIGNED-FOR CODASYL DESIGN )
     (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 DIRECTLY-POINTS-TO ?ENT2 CODASYL )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?ENT2 UPDATE SINGLE SIGNIFICANT) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?ENT2 SEPARATE MEMBER-CHAIN-NEXT CODASYL)

     NO CERTAINTY FACTOR



 *** RULE DBMSREP_6 ***

IF   (DBMS-BEING-DESIGNED-FOR CODASYL DESIGN )
     (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 DIRECTLY-POINTS-TO ?ENT2 CODASYL )
     (ACTIVITY_CHARACTERIZATION_FOR ?ENT2 UPDATE SINGLE SIGNIFICANT )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?ENT2 SEPARATE SET-INDEX-OWNER CODASYL)

     NO CERTAINTY FACTOR
```

```
 *** RULE DBMSREP_7 ***

IF   (DBMS-BEING-DESIGNED-FOR CODASYL DESIGN )
     (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 DIRECTLY-POINTS-TO ?ENT2 CODASYL )
     (ACTIVITY_CHARACTERIZATION_FOR ?ENT2 UPDATE SINGLE SIGNIFICANT )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (DBMS_REASONABLE_REPRESENTATION
          ?REL_ID ?ENT1 ?ENT2 SEPARATE MEMBER-CHAIN-NEXT-PRIOR CODASYL)

     NO CERTAINTY FACTOR



 *** RULE DBMSREP_8 ***

IF   (DBMS-BEING-DESIGNED-FOR CODASYL DESIGN )
     (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 DIR-POINT-TO-EACH-OTHER ?ENT2 CODASYL )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?ENT2 UPDATE SINGLE SIGNIFICANT) )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (DBMS_REASONABLE_REPRESENTATION
          ?REL_ID ?ENT1 ?ENT2 SEPARATE MEMBER-CHAIN-NEXT-OWNER CODASYL)

     NO CERTAINTY FACTOR



 *** RULE DBMSREP_9 ***

IF   (DBMS-BEING-DESIGNED-FOR CODASYL DESIGN )
     (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 DIR-POINT-TO-EACH-OTHER ?ENT2 CODASYL )
     (ACTIVITY_CHARACTERIZATION_FOR ?ENT2 UPDATE SINGLE SIGNIFICANT )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (DBMS_REASONABLE_REPRESENTATION
          ?REL_ID ?ENT1 ?ENT2 SEPARATE MEMBER-CHAIN-NEXT-OWNER-PRIOR CODASYL)

     NO CERTAINTY FACTOR
```

```
 *** RULE DBMSREP_10 ***

IF   (DBMS-BEING-DESIGNED-FOR CODASYL DESIGN )
     (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 DIR-POINT-TO-EACH-OTHER ?ENT2 CODASYL )
     (ACTIVITY_CHARACTERIZATION_FOR ?ENT2 UPDATE SINGLE SIGNIFICANT )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?ENT2 SEPARATE SET-INDEX-OWNER CODASYL)

     NO CERTAINTY FACTOR



 *** RULE DBMSREP_12 ***

IF   (DBMS-BEING-DESIGNED-FOR CODASYL DESIGN )
     (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT2 CODASYL )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 1 )

THEN (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?ENT2 SEPARATE SYMBOL-POINTS-TO CODASYL)

     NO CERTAINTY FACTOR



 *** RULE DBMSREP_13 ***

IF   (DBMS-BEING-DESIGNED-FOR CODASYL DESIGN )
     (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT2 CODASYL )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (THERE_IS_ONE_OF (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 DIRECTLY-POINTS-TO ?ENT2 CODASYL) )

THEN (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?ENT2 SEPARATE SET-INDEX-SEARCH CODASYL)

     NO CERTAINTY FACTOR



 *** RULE DBMSREP_14 ***

IF   (DBMS-BEING-DESIGNED-FOR CODASYL DESIGN )
     (INITIAL_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 SYMB-&-DIR-POINTS-TO ?ENT2 CODASYL )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?ENT2 SEPARATE SET-INDEX-SEARCH CODASYL)

     NO CERTAINTY FACTOR
```

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-------------------------------------------------------------------------------
RULES FOR SECTION 5.10 --> RULES FOR RESTRICTION OF RELATIONSHIP REPRESENTATIONS.
-------------------------------------------------------------------------------


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PART A OF SECTION 5.10 --> RULES FOR SELECTING RELATIONSHIP REPRESENTATIONS DURING RELATIONSHIP
RESTRICTION.
-------------------------------------------------------------------------------------------

THE FIRST FOUR RULES IDENTIFY RELATIONSHIPS WHICH MAY BE RESTRICTED TO ONE RELATIONSHIP REPRESENTATION
OR FOR WHICH A RELATIONSHIP REPRESENTATION MAY BE ELIMINATED.

 *** RULE RESTRICT_1 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER-ID )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_SIZE_SMALL_&_LEAF_ENTITY CHARACTERIZATION )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE SIGNIFICANT )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )

THEN (RESTRICT_TO_ONE_REPRESENTATION ?REL_ID ?CLUSTER-ID ?ENT1 ABSORBS ?ENT2 LEAF_ENTITY)

     NO CERTAINTY FACTOR



THIS IS A RULE FOR RESTRICTING TO THE SINGLE REPRESENTATION WITH THE HIGHEST CERTAINTY FOR A
RELATIONSHIP TO A NON-LEAF "MANY" ENTITY WITH VERY LOW ACTIVITY LEVELS.

 *** RULE RESTRICT_2 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER-ID )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY) )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTE ?ENTF ?TY ?SUBSET_SIZE SIGNIFICANT) )
     (COULD_NOT_CONCLUDE
          (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENTA ?ENTB RETRIEVAL ?SUBSET_SIZE
               SIGNIFICANT_FORWARDING_%) )
     (FUNCTION-CALL HIGHEST-CERT-RV
          (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENTX ?ENTY ?AB-VAR ?REP-NAME ?DBMS )
               ?REP-NAME ?CERT )
     (FUNCTION-CALL EQUAL-TERMS ?REP-NAME SYMBOL-POINTS-TO )

THEN (RESTRICT_TO_ONE_REPRESENTATION
          ?REL_ID ?CLUSTER-ID ?ENTX ?REP-NAME ?ENTY NON-LEAF-ENTITY)

     NO CERTAINTY FACTOR
```

```
THIS IS A RULE FOR ELIMINATION OF A DIRECT POINTER AS A REPRESENTATION FOR RELATIONSHIPS
WITH NO ACTIVITY IN THE MANY TO ONE DIRECTION.

 *** RULE RESTRICT_3 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER-ID )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT2 ?ENT1 RETRIEVAL ?SUBSET_SIZE
                          SIGNIFICANT) )

THEN (ELIMINATE_REPRESENTATION ?REL_ID ?CLUSTER-ID ?ENT2 DIRECTLY-POINTS-TO ?ENT1 DIRECT-POINTER)

     NO CERTAINTY FACTOR



THIS IS A RULE FOR ELIMINATING ABSORPTION AS A REPRESENTATION FOR RELATIONSHIP ?REL_ID IF DEVICE LENGTH
RESTRICTIONS ARE IN EFFECT AND ABSORPTION ALONG ?REL_ID WOULD CREATE A RECORD EXCEEDING DEVICE LENGTH
LIMITS.

 *** RULE RESTRICT_4 ***

IF   (USER-MESSAGE ALL-CG *ENF-TRACK-LIMITS* )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER-ID )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_EXCEEDS_DEVICE_LENGTH CHARACTERIZATION )

THEN (ELIMINATE_REPRESENTATION
          ?REL_ID ?CLUSTER-ID ?ENT2 ABSORBS ?ENT1 RECORD_EXCEEDS_DEVICE_LENGTH)

     NO CERTAINTY FACTOR
```

THE NEXT FIVE RULES DO THE ACTUAL SELECTION OF RESTRICTED RELATIONSHIP REPRESENTATIONS USING THE CONCLUSIONS OF THE FIRST FOUR RULES.

THIS RULE ALWAYS RESTRICTS TO ABSORPTION IF ABSORPTION IS RECOMMENDED BY RULE RESTRICT_1 FOR A LEAF ENTITY

*** RULE RESTRICT_5 ***

```
IF   (REP-SELECTION-MODE ?CLUSTER-ID RESTRICTED-2 )
     (RESTRICT_TO_ONE_REPRESENTATION ?REL_ID ?CLUSTER-ID ?ENT1 ABSORBS ?ENT2 LEAF_ENTITY )

THEN (SELECTED-REP ?REL_ID ?CLUSTER-ID ?ENT1 ABSORBS ?ENT2 )

     COMPUTED CERTAINTY FACTOR
```

THIS RULE RESTRICTS A RELATIONSHIP TO ONE REPRESENTATION IF A RECOMMENDATION BY EITHER RULES RESTRICT_1 OR RESTRICT_2 EXIST, AND THE RELATIONSHIP DOES NOT HAVE SIGNIFICANT WORKLOAD COMPLEXITY.

*** RULE RESTRICT_6 ***

```
IF   (REP-SELECTION-MODE ?CLUSTER-ID RESTRICTED-2 )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER-ID )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID ?PROB SIGNIFICANT_WORKLOAD_COMPLEXITY) )
     (RESTRICT_TO_ONE_REPRESENTATION ?REL_ID ?CLUSTER-ID ?ENTX ?REP-NAME ?ENTY ?REASON )

THEN (SELECTED-REP ?REL_ID ?CLUSTER-ID ?ENTX ?REP-NAME ?ENTY )

     COMPUTED CERTAINTY FACTOR
```

```
THIS RULE SELECTS (POSSIBLY MORE THAN ONE REPRESENTATION) FOR RELATIONSHIPS WITH SIGNIFICANT
WORKLOAD COMPLEXITY WHICH CAN NOT BE RESTRICTED TO ONE RELATIONSHIP --- ABSORPTION.  THIS
RULE PREVENTS OVER-RESTRICTION FOR RELATIONSHIPS WHICH NEED TO BE WORKED ON.

 *** RULE RESTRICT_7 ***

IF   (REP-SELECTION-MODE ?CLUSTER-ID RESTRICTED-2 )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER-ID )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID ?PROB SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (COULD_NOT_CONCLUDE
          (RESTRICT_TO_ONE_REPRESENTATION ?REL_ID ?CLUSTER-ID ?ENT1 ABSORBS ?ENT2 LEAF_ENTITY) )
     (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?ENT2 ?AB-VAR ?REP-NAME ?DBMS )

THEN (SELECTED-REP ?REL_ID ?CLUSTER-ID ?ENT1 ?REP-NAME ?ENT2 )

     COMPUTED CERTAINTY FACTOR



THIS IS SIMILAR TO RULE RESTRICT_7, BUT FOR RELATIONSHIPS WITHOUT CHARACTERIZATIONS OF
SIGNIFICANT WORKLOAD COMPLEXITY.  IT SELECTS REPRESENTATIONS WHICH HAVE NOT BEEN
ELIMINATED.

 *** RULE RESTRICT_8 ***

IF   (REP-SELECTION-MODE ?CLUSTER-ID RESTRICTED-2 )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER-ID )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID ?PROB SIGNIFICANT_WORKLOAD_COMPLEXITY) )
     (COULD_NOT_CONCLUDE
          (RESTRICT_TO_ONE_REPRESENTATION ?REL_ID ?CLUSTER-ID ?ENTX ?REP-NAMEX ?ENTY ?REASON) )
     (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENT1 ?ENT2 ?AB-VAR ?REP-NAME ?DBMS )
     (COULD_NOT_CONCLUDE (ELIMINATE_REPRESENTATION ?REL_ID ?CLUSTER-ID ?ENT1 ?REP-NAME ?ENT2
          ?REASON) )

THEN (SELECTED-REP ?REL_ID ?CLUSTER-ID ?ENT1 ?REP-NAME ?ENT2 )

     COMPUTED CERTAINTY FACTOR
```

```
THIS IS A RULE SIMILAR TO RESTRICT_8, BUT INTENDED FOR CONNECTING RELATIONSHIPS IN
TEMPORARY INTERSECTION CLUSTERS.  THESE CONNECTING RELATIONSHIPS PREVIOUSLY CONNECTED
THE CLUSTERS FROM WHICH THE TEMPORARY INTERSECTION CLUSTER WAS FORMED AND THEREFORE
SHOULD BE VARIED IN THE TEMPORARY CLUSTER.  IT SELECTS ONLY REPRESENTATIONS WHICH
CANNOT BE ELIMINATED.

 *** RULE RESTRICT_9 ***

IF   (REP-SELECTION-MODE ?CLUSTER-ID RESTRICTED-2 )
     (CLUSTER ?CLUSTER-ID TEMPORARY_INTERSECTION_CLUSTER )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER-ID )
     (THERE_WAS_CONCLUDED (CONNECTING_RELATIONSHIP ?REL_ID ?CG1 ?CG2 ?CGSET) )
     (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENTX ?ENTY ?AB-VAR ?REP-NAME ?DBMS )
     (COULD_NOT_CONCLUDE (ELIMINATE_REPRESENTATION ?REL_ID ?CLUSTER-ID ?ENTX ?REP-NAME ?ENTY
          ?REASON) )

THEN (SELECTED-REP ?REL_ID ?CLUSTER-ID ?ENTX ?REP-NAME ?ENTY)

     COMPUTED CERTAINTY FACTOR
```

```
-------------------------------------------------------------------------------
PART B OF SECTION 5.10 --> RULES FOR SELECTING RELATIONSHIP REPRESENTATIONS TO PRODUCE THE
INITIAL SKELETON FOR SELECTIVE SKELETON GENERATION.
-------------------------------------------------------------------------------


THE NEXT THREE RULES SELECT AN INITIAL SKELETON TO BEGIN SKELETON GENERATION.

 *** RULE INITIAL_SKEL_1 ***

IF   (REP-SELECTION-MODE ?CLUSTER-ID SELECTIVELY_GENERATE_SKELETONS )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER-ID )
     (PREF-ABS ?ENT ?REL_ID ?CERT1 )
     (COULD_NOT_CONCLUDE (SKEL-GEN-PREVENTS ?REL_ID ?ENT1 ?ENT2 INFEASIBLE-RECORD-LENGTH) )
     (FUNCTION-CALL HIGHEST-CERT-2
          (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENTX ?ENTY ?AB-VAR ?REP-NAME
               ?DBMS) ?CERT2 )

THEN (INITIAL_REP_SKEL_1 ?REL_ID ?CLUSTER-ID ?ENTX ?REP-NAME ?ENTY )

     NO CERTAINTY FACTOR




 *** RULE INITIAL_SKEL_2 ***

IF   (REP-SELECTION-MODE ?CLUSTER-ID SELECTIVELY_GENERATE_SKELETONS )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER-ID )
     (PREF-ABS ?ENT ?REL_ID ?CERT1 )
     (SKEL-GEN-PREVENTS ?REL_ID ?ENT1 ?ENT2 INFEASIBLE-RECORD-LENGTH )

THEN (INITIAL_REP_SKEL_1 ?REL_ID ?CLUSTER-ID ?ENT2 SYMBOL-POINTS-TO ?ENT1)

     NO CERTAINTY FACTOR




 *** RULE INITIAL_SKEL_3 ***

IF   (REP-SELECTION-MODE ?CLUSTER-ID SELECTIVELY_GENERATE_SKELETONS )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER-ID )
     (COULD_NOT_CONCLUDE (PREF-ABS ?ENT ?REL_ID ?CERT1) )
     (DBMS_REASONABLE_REPRESENTATION ?REL_ID ?ENTX ?ENTY ?AB-VAR SYMBOL-POINTS-TO ?DBMS )
     (DEGREE-OF ?REL_ID ?ENTX ?ENTY ?X 1 )

THEN (INITIAL_REP_SKEL_1 ?REL_ID ?CLUSTER-ID ?ENTX SYMBOL-POINTS-TO ?ENTY)

     NO CERTAINTY FACTOR
```

APPENDIX D

RULES FOR THE CLUSTER DIVISION KNOWLEDGE BASE

```
-----------------------------------------------------------------
RULES FOR SECTION 6.1 --> THE CLUSTER DIVISION CONTROL RULE GROUP.
-----------------------------------------------------------------
```

THIS RULE STATES THAT BREAKPOINT SELECTION RULE GROUP 1 SHOULD BE APPLIED TO THE INITIAL CLUSTER. THIS IS THE MOST RESTRICTIVE RULE GROUP.

```
 *** RULE DIV_CONTROL_1 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (FUNCTION-CALL EQUAL-TERMS ?CLUSTER_ID INITIAL-CG )

THEN (INVOKE_BREAKPOINT_GROUP ?CLUSTER_ID RULE_GROUP_1)

     NO CERTAINTY FACTOR
```

THE NEXT SIX RULES INSURE PROGRESSIVE INVOCATION OF THE NEXT LEAST MOST RESTRICTIVE RULE GROUP. RULES DIV_CONTROL_2, DIV_CONTROL_4, AND DIV_CONTROL_6 IDENTIFY THE NEXT LEAST MOST RESTRICTIVE RULE GROUP FOR A CLUSTER ON BASIS OF THE RESTRICTIVENESS OF THE RULE GROUP USED TO DIVIDE ITS PARENT CLUSTER. IF DIVISION FAILS FOR A CLUSTER, RULES DIV_CONTROL_3, DIV_CONTROL_5, AND DIV_CONTROL_7 SELECT THE NEXT LEAST MOST RESTRICTIVE RULE GROUP.

```
 *** RULE DIV_CONTROL_2 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER-SET ?CLUSTER_SET_ID ?PAR_CLUSTER_SET ?PARENT_CLUSTER )
     (INVOKE_BREAKPOINT_GROUP ?PARENT_CLUSTER RULE_GROUP_1 )

THEN (INVOKE_BREAKPOINT_GROUP ?CLUSTER_ID RULE_GROUP_2)

     NO CERTAINTY FACTOR
```

```
 *** RULE DIV_CONTROL_3 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID IN_DIVIDE_PROCESS *DIVISION_UNSUCCESSFUL* )
     (PREVIOUS_BREAK_GROUP ?CLUSTER_ID RULE_GROUP_1 )

THEN (INVOKE_BREAKPOINT_GROUP ?CLUSTER_ID RULE_GROUP_2)

     NO CERTAINTY FACTOR



 *** RULE DIV_CONTROL_4 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER-SET ?CLUSTER_SET_ID ?PAR_CLUSTER_SET ?PARENT_CLUSTER )
     (INVOKE_BREAKPOINT_GROUP ?PARENT_CLUSTER RULE_GROUP_2 )

THEN (INVOKE_BREAKPOINT_GROUP ?CLUSTER_ID RULE_GROUP_3)

     NO CERTAINTY FACTOR



 *** RULE DIV_CONTROL_5 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID IN_DIVIDE_PROCESS *DIVISION_UNSUCCESSFUL* )
     (PREVIOUS_BREAK_GROUP ?CLUSTER_ID RULE_GROUP_2 )

THEN (INVOKE_BREAKPOINT_GROUP ?CLUSTER_ID RULE_GROUP_3)

     NO CERTAINTY FACTOR



 *** RULE DIV_CONTROL_6 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER-SET ?CLUSTER_SET_ID ?PAR_CLUSTER_SET ?PARENT_CLUSTER )
     (INVOKE_BREAKPOINT_GROUP ?PARENT_CLUSTER RULE_GROUP_3 )

THEN (INVOKE_BREAKPOINT_GROUP ?CLUSTER_ID RULE_GROUP_4)

     NO CERTAINTY FACTOR
```

```
 *** RULE DIV_CONTROL_7 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (CLUSTER_STATUS ?CLUSTER_ID ?CLUSTER_SET_ID IN_DIVIDE_PROCESS *DIVISION_UNSUCCESSFUL* )
     (PREVIOUS_BREAK_GROUP ?CLUSTER_ID RULE_GROUP_3 )

THEN (INVOKE_BREAKPOINT_GROUP ?CLUSTER_ID RULE_GROUP_4)

     NO CERTAINTY FACTOR
```

```
-----------------------------------------------------------------
RULES FOR SECTION 6.2 --> THE BOND RELATIONSHIP SELECTION RULE GROUP.
-----------------------------------------------------------------


THE FIRST FOUR RULES DECLARE BOND RELATIONSHIPS ON THE BASIS OF CHARACTERIZATIONS INCREASING LEVELS
OF FORWARDING PERCENTAGE.

 *** RULE BOND_RELATIONSHIP_1 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE1 SIGNIFICANT )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE2 ?LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?LEVEL (HIGH-THRU-ACT-3 HIGH-THRU-ACT-2 HIGH-THRU-ACT-1) )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID MODERATE_FORWARDING_%)

     NO CERTAINTY FACTOR



 *** RULE BOND_RELATIONSHIP_2 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE1 SIGNIFICANT )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE2 ?LEVEL )
     (FUNCTION-CALL *IS-ONE-OF* ?LEVEL (HIGH-THRU-ACT-3 HIGH-THRU-ACT-2) )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID HEAVY_FORWARDING_%)

     NO CERTAINTY FACTOR



 *** RULE BOND_RELATIONSHIP_3 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE1 SIGNIFICANT )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL ?SUBSET_SIZE2 HIGH_FORWARDING_%_3 )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID VERY_HEAVY_FORWARDING_%)

     NO CERTAINTY FACTOR
```

```
 *** RULE BOND_RELATIONSHIP_4 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL LARGE-SUBSET SIGNIFICANT_FORWARDING_% )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LG-SUB-FLOW-THRU)

     NO CERTAINTY FACTOR



THE NEXT RULE DECLARES A BOND RELATIONSHIP ON THE BASIS OF HEAVY LARGE SUBSET ACTIVITY.

 *** RULE BOND_RELATIONSHIP_5 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 RETRIEVAL LARGE-SUBSET SIGNIFICANT )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID HEAVY_LARGE_SUBSET_ACTIVITY)

     NO CERTAINTY FACTOR



THE NEXT RULE DECLARES A BOND RELATIONSHIP ON THE BASIS OF A CHARACTERIZATION OF
SIGNIFICANT WORKLOAD COMPLEXITY DUE TO RELATIONSHIP UPDATE ACTIVITY.

 *** RULE BOND_RELATIONSHIP_6 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID RELATIONSHIP-UPDATE SIGNIFICANT_WORKLOAD_COMPLEXITY )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID RELATIONSHIP-UPDATE)

     NO CERTAINTY FACTOR
```

```
THE NEXT RULE CONCLUDES A BOND RELATIONSHIP BECAUSE OF THE EXISTENCE OF A CONTEXT CONFLICT. THE BOND
RELATIONSHIP HAS A "DO NOT TO ABSORB" DETERMINATION IN THE CONFLICTING RETRIEVAL CONTEXTS
FACT EXPRESSION.

 *** RULE BOND_RELATIONSHIP_7 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (CONFLICTING-RETRIEVAL-CONTEXTS ?REL_ID ?REL_TO_ABSORB DO-NOT-ABSORB ?REL_ID ?ENT2 ?REASON ?EXTENT )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID CONFLICTING-RETRIEVAL-CONTEXTS)

     NO CERTAINTY FACTOR



THE NEXT TWO RULES DECLARE BOND RELATIONSHIPS FOR PARTIALLY IDENTIFYING RELATIONSHIPS
OF INTERSECTION ENTITIES.

 *** RULE BOND_RELATIONSHIP_8 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (PARTIAL_ID_RELATIONSHIP ?INT_ENT ?REL_ID )
     (TYPE-OF-ENTITY ?INT_ENT *INTERSECTION-ENTITY* )
     (ASSOCIATE-INTERSECT-ENTITY-WITH-REL ?INT_ENT ?REL_ID ?REL_ID_WORKLOAD ?TOTAL_WORKLOAD
          ?REL_%_WORK ?OTHER_PARTIAL_ID_RELS LOCAL-ACTIVITY )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID INTERSECT-BOND-LOCAL-ACTIVITY)

     NO CERTAINTY FACTOR



 *** RULE BOND_RELATIONSHIP_9 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (PARTIAL_ID_RELATIONSHIP ?INT_ENT ?REL_ID )
     (TYPE-OF-ENTITY ?INT_ENT *INTERSECTION-ENTITY* )
     (ASSOCIATE-INTERSECT-ENTITY-WITH-REL ?INT_ENT ?REL_ID ?REL_ID_WORKLOAD ?TOTAL_WORKLOAD
          ?REL_%_WORK ?OTHER_PARTIAL_ID_RELS HIGH-FLOW-THRU )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID NONE )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID INTERSECT-BOND-HIGH-FLOW-THRU)

     NO CERTAINTY FACTOR
```

```
THE NEXT TWO RULES DECLARE RELATIONSHIPS TO LEAF ENTITIES AS A BOND RELATIONSHIP.
THIS ALSO PREVENTS EXCESSIVE SPLITTING OF THE LDS INTO TINY FRAGMENTS.

 *** RULE BOND_RELATIONSHIP_10 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP)

     NO CERTAINTY FACTOR



 *** RULE BOND_RELATIONSHIP_11 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (TYPE-OF-ENTITY ?ENT1 LEAF_ENTITY )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP)

     NO CERTAINTY FACTOR



THE NEXT RULE CONCLUDES A BOND RELATIONSHIP FOR A RELATIONSHIP IN WHICH ONE ENTITY
IS DEPENDENT ON THE OTHER.

 *** RULE BOND_RELATIONSHIP_12 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )
     (DEPENDS-ON ?ENT2 ?ENT1 )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID DEPENDENCY)

     NO CERTAINTY FACTOR
```

```
THIS RULE CONCLUDES A BOND RELATIONSHIP FOR A NON-LEAF "MANY" ENTITY WHICH WOULD NOT
FORM A SMALL RECORD IF ABSORBED ALONG RELATIONSHIP ?REL_ID.

 *** RULE BOND_RELATIONSHIP_13 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID TRIVIAL_SIZE_MANY_ENTITY CHARACTERIZATION )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID TRIVIAL_SIZE_MANY_ENTITY)

     NO CERTAINTY FACTOR



THIS IS A "CATCH ALL" BOND RULE FOR CHARACTERIZATIONS OF WORKLOAD COMPLEXITY.

 *** RULE BOND_RELATIONSHIP_14 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID ?ANY SIGNIFICANT_WORKLOAD_COMPLEXITY )

THEN (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID ?ANY)

     NO CERTAINTY FACTOR
```

```
-------------------------------------------------------------
RULES FOR SECTION 6.3 --> THE BREAKPOINT SELECTION RULE GROUPS.
-------------------------------------------------------------



-----------------------------------------------------------------
PART A OF SECTION 6.3 --> BREAKPOINT SELECTION RULE GROUP NUMBER ONE.
-----------------------------------------------------------------

THIS IS THE MOST RESTRICTIVE BREAKPOINT SELECTION RULE GROUP.

 *** RULE BREAK_GROUP_ONE_NO_1 ***

IF   (RELATIONSHIP_CHARACTERIZATION ?REL_ID LOW_FORWARDING_% CHARACTERIZATION )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID NON_FORWARDING_CONTEXT_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID CONFLICTING-RETRIEVAL-CONTEXTS) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID BIDIRECTIONAL_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID HEAVY_LARGE_SUBSET_ACTIVITY) )

THEN (RECOMMEND_BREAKPOINT_GROUP_1 ?REL_ID ?CLUSTER_ID LOW_FORWARDING_%)

     NO CERTAINTY FACTOR



 *** RULE BREAK_GROUP_ONE_NO_2 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP) )
     (FUNCTION-CALL *ONE-REASONABLE-REP* ?REL_ID )

THEN (RECOMMEND_BREAKPOINT_GROUP_1 ?REL_ID ?CLUSTER_ID ONE_REASONABLE_REPRESENTATION)

     NO CERTAINTY FACTOR
```

```
 *** RULE BREAK_GROUP_ONE_NO_3 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID ENTITY_IS_IN_TWO_M_RELATIONSHIPS CHARACTERIZATION )
     (CONFLICTING-RETRIEVAL-CONTEXTS ?REL_ID ?REL_TO_ABSORB DO-NOT-ABSORB ?REL_ID ?ENT2 ?REASON ?EXTENT )
     (FUNCTION-CALL *IS-ONE-OF* ?EXTENT (HEAVY-3 HEAVY-4) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID NON_FORWARDING_CONTEXT_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID BIDIRECTIONAL_ACTIVITY) )

THEN (RECOMMEND_BREAKPOINT_GROUP_1 ?REL_ID ?CLUSTER_ID ONE_REASONABLE_REPRESENTATION)

     NO CERTAINTY FACTOR
```

THIS RULE IS THE SAME AS THE PREVIOUS RULE, EXCEPT THAT ABSORPTION IS RULED OUT BECAUSE THE RESULTING RECORD WOULD EXCEED A DEVICE LENGTH. DEVICE LENGTH RESTRICTIONS MUST BE IN EFFECT.

```
 *** RULE BREAK_GROUP_ONE_NO_4 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_EXCEEDS_DEVICE_LENGTH CHARACTERIZATION )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID NON_FORWARDING_CONTEXT_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID BIDIRECTIONAL_ACTIVITY) )

THEN (RECOMMEND_BREAKPOINT_GROUP_1 ?REL_ID ?CLUSTER_ID ONE_REASONABLE_REPRESENTATION)

     NO CERTAINTY FACTOR


 *** RULE BREAK_GROUP_ONE_NO_5 ***

IF   (TYPE-OF-ENTITY ?INT_ENT *INTERSECTION-ENTITY* )
     (PARTIAL_ID_RELATIONSHIP ?INT_ENT ?REL_ID )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (ASSOCIATE-INTERSECT-ENTITY-WITH-REL ?INT_ENT ?REL_ID2
          ?REL_ID2_WORKLOAD ?TOTAL_WORKLOAD ?REL2_%_WORK ?OTHER_PARTIAL_ID_RELS LOCAL-ACTIVITY )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID2 NONE )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID2 ?REL_ID )

THEN (RECOMMEND_BREAKPOINT_GROUP_1 ?REL_ID ?CLUSTER_ID INTERSECTION)

     NO CERTAINTY FACTOR
```

```
 *** RULE BREAK_GROUP_ONE_NO_6 ***

IF   (TYPE-OF-ENTITY ?INT_ENT *INTERSECTION-ENTITY* )
     (PARTIAL_ID_RELATIONSHIP ?INT_ENT ?REL_ID )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (ASSOCIATE-INTERSECT-ENTITY-WITH-REL
          ?INT_ENT NONE ?NO_WORKLOAD ?TOTAL_WORKLOAD ?REL_%_WORK ?OTHER_PARTIAL_ID_RELS LOCAL-ACTIVITY )
     (ASSOCIATE-INTERSECT-ENTITY-WITH-REL ?INT_ENT ?REL_ID2 ?REL_ID2_WORKLOAD ?TOTAL_WORKLOAD2
                                          ?REL_%_WORK2 ?OTHER_PARTIAL_ID_RELS2 HIGH-FLOW-THRU )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID2 ?REL_ID )

THEN (RECOMMEND_BREAKPOINT_GROUP_1 ?REL_ID ?CLUSTER_ID INTERSECTION)

     NO CERTAINTY FACTOR
```

```
-----------------------------------------------------------------
PART B OF SECTION 6.3 --> BREAKPOINT SELECTION RULE GROUP NUMBER TWO.
-----------------------------------------------------------------

THIS IS LESS RESTRICTIVE THAN RULE GROUP NUMBER 1.

 *** RULE BREAK_GROUP_TWO_NO_1 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID MODERATE_FORWARDING_%) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LG-SUB-FLOW-THRU) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID BIDIRECTIONAL_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID HEAVY_LARGE_SUBSET_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID CONFLICTING-RETRIEVAL-CONTEXTS) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID NON_FORWARDING_CONTEXT_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP) )

THEN (RECOMMEND_BREAKPOINT_GROUP_2 ?REL_ID ?CLUSTER_ID LOW_FORWARDING_%)

     NO CERTAINTY FACTOR



THIS RULE APPLIES TO ONE TO ONE RELATIONSHIPS WITH NO SIGNIFICANT ACTIVITY AND A COMBINATION OF ABSENT
WORKLOAD CHARACTERIZATIONS.

 *** RULE BREAK_GROUP_TWO_NO_2 ***

IF   (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 1)
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (CARDINALITY ?ENT1 ?N1 )
     (CARDINALITY ?ENT2 ?N2 )
     (FUNCTION-CALL *>* ?N1 ?N2 )
     (COULD_NOT_CONCLUDE
          (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 NON_FORWARDING_CONTEXT_ACTIVITY ?ANY-SIZE
               SIGNIFICANT) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID NON_FORWARDING_CONTEXT_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID CONFLICTING-RETRIEVAL-CONTEXTS) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP) )

THEN (RECOMMEND_BREAKPOINT_GROUP_2 ?REL_ID ?CLUSTER_ID ONE-TO-ONE)

     NO CERTAINTY FACTOR
```

THIS RULE RECOMMENDS A BREAKPOINT FOR A RELATIONSHIP BETWEEN TWO ROOT ENTITIES WHICH HAS A COMBINATION OF NEGATED BOND RELATIONSHIP CONCLUSIONS.

*** RULE BREAK_GROUP_TWO_NO_3 ***

```
IF   (TYPE-OF-ENTITY ?ENT1 *CLUSTER-ROOT-ENTITY* )
     (FIRST-ENT ?REL_ID ?ENT1 )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?N )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID MODERATE_FORWARDING_%) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID CONFLICTING-RETRIEVAL-CONTEXTS) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID HEAVY_LARGE_SUBSET_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID NON_FORWARDING_CONTEXT_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID BIDIRECTIONAL_ACTIVITY) )
     (TYPE-OF-ENTITY ?ENT2 *CLUSTER-ROOT-ENTITY* )

THEN (RECOMMEND_BREAKPOINT_GROUP_2 ?REL_ID ?CLUSTER_ID ROOT-ENTITY)

     NO CERTAINTY FACTOR
```

```
-----------------------------------------------------------------------
PART C OF SECTION 6.3 --> BREAKPOINT SELECTION RULE GROUP NUMBER THREE.
-----------------------------------------------------------------------

THIS IS LESS RESTRICTIVE THAN RULE GROUP NUMBER 2.

 *** RULE BREAK_GROUP_THREE_NO_1 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?X )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID HEAVY_FORWARDING_%) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID HEAVY_LARGE_SUBSET_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID CONFLICTING-RETRIEVAL-CONTEXTS) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID NON_FORWARDING_CONTEXT_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP) )

THEN (RECOMMEND_BREAKPOINT_GROUP_3 ?REL_ID ?CLUSTER_ID LOW_FORWARDING_%)

     NO CERTAINTY FACTOR



THIS RULE RECOMMENDS RELATIONSHIP ?REL_ID BE A BREAKPOINT IF THE ENTITIES IN THE RELATIONSHIP
ARE ROOT ENTITIES WITH A COMBINATION OF LESS RESTRICTIVE BOND RELATIONSHIP CONCLUSIONS.

 *** RULE BREAK_GROUP_THREE_NO_2 ***

IF   (TYPE-OF-ENTITY ?ENT1 *CLUSTER-ROOT-ENTITY* )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (FIRST-ENT ?REL_ID ?ENT1 )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?X )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID HEAVY_FORWARDING_%) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID HEAVY_LARGE_SUBSET_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID CONFLICTING-RETRIEVAL-CONTEXTS) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID NON_FORWARDING_CONTEXT_ACTIVITY) )
     (TYPE-OF-ENTITY ?ENT2 *CLUSTER-ROOT-ENTITY* )

THEN (RECOMMEND_BREAKPOINT_GROUP_3 ?REL_ID ?CLUSTER_ID ROOT-ENTITY)

     NO CERTAINTY FACTOR
```

```
 *** RULE BREAK_GROUP_THREE_NO_3 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (TYPE-OF-ENTITY ?ENT1 *DEPENDENT-ENTITY* )
     (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (COULD_NOT_CONCLUDE (PARTIAL_ID_RELATIONSHIP ?ANY-ENT ?REL_ID) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID CONFLICTING-RETRIEVAL-CONTEXTS) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID NON_FORWARDING_CONTEXT_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP) )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENT2 *INTERSECTION-ENTITY*) )

THEN (RECOMMEND_BREAKPOINT_GROUP_3 ?REL_ID ?CLUSTER_ID DEPENDENT-ENTITY)

     NO CERTAINTY FACTOR



 *** RULE BREAK_GROUP_THREE_NO_4 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 M )
     (FUNCTION-CALL PRODUCE-STRENGTH (INITIAL_REASONABLE_REPRESENTATION ?REL_ID
                                      ?ENT2 SYMBOL-POINTS-TO ?ENT1) ?CERT )
     (FUNCTION-CALL >= ?CERT 0.5 )
     (FUNCTION-CALL PRODUCE-STRENGTH (INITIAL_REASONABLE_REPRESENTATION ?REL_ID
                                      ?ENT1 ABSORBS ?ENT2) ?CERT )
     (FUNCTION-CALL <= ?CERT -0.25 )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT2 ?ENT1 RETRIEVAL ?SUBSET_SIZE
                          SIGNIFICANT) )
     (COULD_NOT_CONCLUDE (ORDERING-CRITERIA ?ENT2 ?REL_DESC_NAME ?MEASURE2) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID INTERSECT-BOND-LOCAL-ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID HEAVY_LARGE_SUBSET_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID BIDIRECTIONAL_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID NON_FORWARDING_CONTEXT_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP) )

THEN (RECOMMEND_BREAKPOINT_GROUP_3 ?REL_ID ?CLUSTER_ID ONE_REASONABLE_REPRESENTATION)

     NO CERTAINTY FACTOR
```

```
-----------------------------------------------------------------
PART D OF SECTION 6.3 --> BREAKPOINT SELECTION RULE GROUP NUMBER FOUR.
-----------------------------------------------------------------

THIS RULE GROUP IS LESS RESTRICTIVE THAN RULE GROUP NUMBER 3.


 *** RULE BREAK_GROUP_THREE_NO_1 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (DEGREE-OF ?REL_ID ?ENT1 ?ENT2 1 ?X )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LG-SUB-FLOW-THRU) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID CONFLICTING-RETRIEVAL-CONTEXTS) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID NONFORWARDING_CONTEXT_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP) )

THEN (RECOMMEND_BREAKPOINT_GROUP_4 ?REL_ID ?CLUSTER_ID LOW_FORWARDING_%)

     NO CERTAINTY FACTOR



 *** RULE BREAK_GROUP_THREE_NO_2 ***

IF   (RELATIONSHIP_CHARACTERIZATION ?REL_ID CONFLICTING-RETRIEVAL-CONTEXTS SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (RELATIONSHIP ?REL_ID ?ENT1 ?ENT2 ?REL_DESC_NAME )
     (COULD_NOT_CONCLUDE (ORDERING-CRITERIA ?ENT2 ?REL_DESC_NAME ?MEASURE2) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID INTERSECT-BOND-LOCAL-ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID HEAVY_LARGE_SUBSET_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID BIDIRECTIONAL_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID NONFORWARDING_CONTEXT_ACTIVITY) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LG-SUB-FLOW-THRU) )
     (COULD_NOT_CONCLUDE (BOND_RELATIONSHIP ?REL_ID ?CLUSTER_ID LEAF_ENTITY_RELATIONSHIP) )

THEN (RECOMMEND_BREAKPOINT_GROUP_4 ?REL_ID ?CLUSTER_ID LOW-ABSORPTION-LIKELY)

     NO CERTAINTY FACTOR
```

```
-----------------------------------------------------------------
PART E OF SECTION 6.3 --> THE TOP LEVEL BREAKPOINT SELECTION RULES.
-----------------------------------------------------------------

THESE ARE THE TOP LEVEL BREAK RULES. THEY STATE THAT IF A RELATIONSHIP HAS BEEN RECOMMENDED AS A
BREAKPOINT BY ONE OF THE BREAKPOINT RECOMMENDATION RULE GROUPS, AND IF THERE IS NO CONCLUSION OF
EXCESSIVE FRAGMENTATION, THEN SELECT THE RELATIONSHIP AS A BREAKPOINT.


 *** RULE SELECT_BREAKPOINT_1 ***

IF   (INVOKE_BREAKPOINT_GROUP ?CLUSTER_ID RULE_GROUP_1 )
     (RECOMMEND_BREAKPOINT_GROUP_1 ?REL_ID ?CLUSTER_ID ?REASON )
     (COULD_NOT_CONCLUDE (FRAGMENT-PROHIBITS ?REL_ID ?CLUSTER_ID ?PR-REASON) )

THEN (TOP_LEVEL_BREAKPOINT_SELECTION ?REL_ID ?CLUSTER_ID)

     NO CERTAINTY FACTOR



 *** RULE SELECT_BREAKPOINT_2 ***

IF   (INVOKE_BREAKPOINT_GROUP ?CLUSTER_ID RULE_GROUP_2 )
     (RECOMMEND_BREAKPOINT_GROUP_2 ?REL_ID ?CLUSTER_ID ?REASON )
     (COULD_NOT_CONCLUDE (FRAGMENT-PROHIBITS ?REL_ID ?CLUSTER_ID ?PR-REASON) )

THEN (TOP_LEVEL_BREAKPOINT_SELECTION ?REL_ID ?CLUSTER_ID)

     NO CERTAINTY FACTOR



 *** RULE SELECT_BREAKPOINT_3 ***

IF   (INVOKE_BREAKPOINT_GROUP ?CLUSTER_ID RULE_GROUP_3 )
     (RECOMMEND_BREAKPOINT_GROUP_3 ?REL_ID ?CLUSTER_ID ?REASON )
     (COULD_NOT_CONCLUDE (FRAGMENT-PROHIBITS ?REL_ID ?CLUSTER_ID ?PR-REASON) )

THEN (TOP_LEVEL_BREAKPOINT_SELECTION ?REL_ID ?CLUSTER_ID)

     NO CERTAINTY FACTOR
```

```
 *** RULE SELECT_BREAKPOINT_4 ***

IF   (INVOKE_BREAKPOINT_GROUP ?CLUSTER_ID RULE_GROUP_4 )
     (RECOMMEND_BREAKPOINT_GROUP_4 ?REL_ID ?CLUSTER_ID ?REASON )
     (COULD_NOT_CONCLUDE (FRAGMENT-PROHIBITS ?REL_ID ?CLUSTER_ID ?PR-REASON) )

THEN (TOP_LEVEL_BREAKPOINT_SELECTION ?REL_ID ?CLUSTER_ID)

     NO CERTAINTY FACTOR



THE NEXT RULE PREVENTS EXCESSIVE FRAGMENTATION OF THE LDS ALONG RELATIONSHIP ?REL_ID IF ?REL_ID
CHOSEN AS A BREAKPOINT FOR ENTITY ?ENTITY_NAME.  THE REASON IS ?ENTITY_NAME IS IN TWO RELATIONSHIPS,
BOTH OF WHICH HAVE BEEN CHOSEN AS BREAKPOINTS.  THE SELECTION OF ?REL_ID AS A BREAKPOINT WILL BE
OVERRIDDEN TO PREVENT A ONE ENTITY FRAGMENT.

 *** RULE SELECT_BREAKPOINT_5 ***

IF   (MEMBER-ENTITY ?CLUSTER_ID ?ENTITY_NAME )
     (COULD_NOT_CONCLUDE (TYPE-OF-ENTITY ?ENTITY_NAME *INTERSECTION-ENTITY*) )
     (NUMBER_OF_RELATIONSHIPS ?ENTITY_NAME 2 ( ?REL_ID ?REL_ID2 ) )
     (FUNCTION-CALL *IF-THERE-IS* (PROPOSED-BREAK ?REL_ID ?CLUSTER_ID ?BREAK-LEV1 ?REASON1 ) )
     (FUNCTION-CALL *IF-THERE-IS* (PROPOSED-BREAK ?REL_ID2 ?CLUSTER_ID ?BREAK-LEV2 ?REASON2 ) )

THEN (FRAGMENT-PROHIBITS ?REL_ID ?CLUSTER_ID SIMPLE-FRAGMENT)

     NO CERTAINTY FACTOR



THE NEXT RULE IS SIMILAR, BUT IS SPECIALIZED FOR RELATIONSHIPS INVOLVING INTERSECTION ENTITIES.

 *** RULE SELECT_BREAKPOINT_6 ***

IF   (MEMBER-ENTITY ?CLUSTER_ID ?ENTITY_NAME )
     (TYPE-OF-ENTITY ?ENTITY_NAME *INTERSECTION-ENTITY* )
     (NUMBER_OF_RELATIONSHIPS ?ENTITY_NAME 2 ( ?REL_IDX ? REL_IDY ) )
     (RELATIONSHIP ?REL_ID1 ?ENTITY_NAME ?ENT2 ?RELATIONSHIP_NAME1 )
     (RELATIONSHIP ?REL_ID2 ?ENTITY_NAME ?ENT3 ?RELATIONSHIP_NAME2 )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID1 ?REL_ID2 )
     (FUNCTION-CALL *IF-THERE-IS* (PROPOSED-BREAK ?REL_ID1 ?CLUSTER_ID FIRST-LINE INTERSECTION) )
     (FUNCTION-CALL *IF-THERE-IS* (PROPOSED-BREAK ?REL_ID2 ?CLUSTER_ID ?LEVEL2 ?REASON) )
     (FUNCTION-CALL NOT-EQUAL ?LEVEL2 INTERSECTION )

THEN (FRAGMENT-PROHIBITS ?REL_ID2 ?CLUSTER_ID INTERSECTION-FRAGMENT)

     NO CERTAINTY FACTOR
```

APPENDIX E

RULES FOR THE SKELETON GENERATION KNOWLEDGE BASE

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-------------------------------------------------------------------------------
RULES FOR SECTION 7.2 --> RULES FOR CONTROL OF SKELETON GENERATION BY THE CONTROL MODULE.
-------------------------------------------------------------------------------


 *** RULE SK_ACT_1 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* INITIAL-SET-UP )

THEN (ACTION-ON ?CLUSTER-ID DO-INITIAL-SET-UP - -)

     COMPUTED CERTAINTY FACTOR



 *** RULE SK_ACT_1_1 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* INITIAL-SET-UP-ENUM )

THEN (ACTION-ON ?CLUSTER-ID DO-INITIAL-SET-UP-ENUM - -)

     COMPUTED CERTAINTY FACTOR



 *** RULE SK_ACT_3 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* EVALUATED-NEW-SKELETON-FROM ?SKELNAME )

THEN (ACTION-ON ?CLUSTER-ID GET-HIGH-LEVEL-DECISION - -)

     COMPUTED CERTAINTY FACTOR
```

```
 *** RULE SK_ACT_4 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* FAILED-TO-FIND-NEW-SKEL )

THEN (ACTION-ON ?CLUSTER-ID GET-HIGH-LEVEL-DECISION-OUT-SKEL - -)

     COMPUTED CERTAINTY FACTOR
```

THE NEXT RULE CONCLUDES THAT A NEW SKELETON MUST BE SELECTED AFTER INITIAL SET UP OPERATIONS ARE COMPLETE.

```
 *** RULE SK_ACT_9_2 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* INITIAL-SET-UP-ENUM-DONE )
     (CONCLUDE_PHASE ?CLUSTER-ID RELATIONSHIP-PHASE )

THEN (ACTION-ON ?CLUSTER-ID SELECT-SKELETON - -)

     COMPUTED CERTAINTY FACTOR


 *** RULE SK_ACT_5 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* HIGH-LEVEL-DECISION )
     (CONCLUDE_PHASE ?CLUSTER-ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (RECORD RESTRICTED-RECORD) )
     (DECISION ?CLUSTER-ID **CONTINUE** )

THEN (ACTION-ON ?CLUSTER-ID FIND-PHASE - -)

     COMPUTED CERTAINTY FACTOR


 *** RULE SK_ACT_9 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* HIGH-LEVEL-DECISION )
     (COULD_NOT_CONCLUDE (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* FOUND-PHASE) )
     (CONCLUDE_PHASE ?CLUSTER-ID ?PH )
     (FUNCTION-CALL *IS-ONE-OF* ?PH (RELATIONSHIPS COMBINED-PHASE RESTRICTED-RECORD) )
     (DECISION ?CLUSTER-ID **CONTINUE** )

THEN (ACTION-ON ?CLUSTER-ID SELECT-SKELETON - -)

     COMPUTED CERTAINTY FACTOR
```

```
 *** RULE SK_ACT_7 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* FAILED-TO-FIND-REL-GEN-FOR-SKEL ?SKELNAME - )

THEN (ACTION-ON ?CLUSTER-ID SELECT-SKELETON - -)

     COMPUTED CERTAINTY FACTOR



 *** RULE SK_ACT_11 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* FOUND-PHASE )
     (CONCLUDE_PHASE ?CLUSTER-ID RELATIONSHIP-PHASE )
     (PREVIOUS_PHASE ?CLUSTER-ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (RECORD RESTRICTED-RECORD) )

THEN (ACTION-ON ?CLUSTER-ID CHANGE_TO_RELATIONSHIP_PHASE - -)

     COMPUTED CERTAINTY FACTOR



 *** RULE SK_ACT_6 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* HIGH-LEVEL-DECISION )
     (DECISION ?CLUSTER-ID **TERMINATE** )

THEN (ACTION-ON ?CLUSTER-ID TERMINATE-OPERATION - -)

     COMPUTED CERTAINTY FACTOR



 *** RULE SK_ACT_6_1 ***

IF   (MESSAGE ?CLUSTER-ID **NO-DECISION-CONCLUDED** )

THEN (ACTION-ON ?CLUSTER-ID TERMINATE-OPERATION - -)

     COMPUTED CERTAINTY FACTOR
```

```
 *** RULE SK_ACT_12 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* SELECT-SKELETON )
     (CURRENT_SKELETON ?SKELNAME ?CLUSTER-ID )

THEN (ACTION-ON ?CLUSTER-ID SELECT-RELATIONSHIP-FOR-SKEL ?SKELNAME -)

     COMPUTED CERTAINTY FACTOR



 *** RULE SK_ACT_13 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* FAILED-TO-FIND-REP-FOR ?SKELNAME ?REL )

THEN (ACTION-ON ?CLUSTER-ID SELECT-RELATIONSHIP-FOR-SKEL ?SKELNAME -)

     COMPUTED CERTAINTY FACTOR



 *** RULE SK_ACT_15 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* SELECT-RELATIONSHIP-FOR-SKEL ?SKELNAME - )
     (SELECT_FOR_ALTERATION ?REL-ID ?CLUSTER-ID ?SKELNAME ?CRITICALITY )

THEN (ACTION-ON ?CLUSTER-ID SELECT-REPRESENTATION-FOR ?SKELNAME ?REL-ID)

     COMPUTED CERTAINTY FACTOR



 *** RULE SK_ACT_14 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* *ABORTED-NEW-SKEL-FROM-SKEL* ?SKELNAME ?REASON )
     (SELECT_FOR_ALTERATION ?REL-ID ?CLUSTER-ID ?SKELNAME ?CRITICALITY )

THEN (ACTION-ON ?CLUSTER-ID SELECT-REPRESENTATION-FOR ?SKELNAME ?REL-ID)

     COMPUTED CERTAINTY FACTOR
```

```
 *** RULE SK_ACT_16 ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* SELECT-REPRESENTATION-FOR ?SKELNAME ?REL-ID )

THEN (ACTION-ON ?CLUSTER-ID GENERATE-NEW-SKELETON-FROM ?SKELNAME ?REL-ID)

     COMPUTED CERTAINTY FACTOR



 *** RULE SK_ACT_16_A ***

IF   (MESSAGE ?CLUSTER-ID *PREVIOUS-ACTION* GENERATED-NEW-SKELETON-FROM ?SKELNAME )
     (SELECT_FOR_ALTERATION ?REL-ID ?CLUSTER-ID ?SKELNAME ?CRITICALITY )

THEN (ACTION-ON ?CLUSTER-ID EVALUATE-NEW-SKELETON-FROM ?SKELNAME ?REL-ID)

     COMPUTED CERTAINTY FACTOR
```

```
--------------------------------------------------------------------------------
RULES FOR SECTION 7.3 --> CONTROL MODULE SUPPORT RULE GROUP FOR SKELETON GENERATION.
--------------------------------------------------------------------------------



--------------------------------------------------------------------------------
PART A OF SECTION 7.3 --> DETERMINING HOW MANY SKELETONS TO GENERATE DURING SELECTIVE
SKELETON GENERATION.
--------------------------------------------------------------------------------

FOR A CLUSTER WITH LESS THAN 64 ALLOTTED SKELETONS, GENERATE THE SAME NUMBER.

 *** RULE NUM_GEN_1 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?CLUSTER_ID ?NUMBER_TO_GENERATE )
     (FUNCTION-CALL *>* 64 ?NUMBER_TO_GENERATE )

THEN (NUMBER_SKELETONS_TO_GENERATE_SELECTIVELY ?CLUSTER_ID ?NUMBER_TO_GENERATE)

     NO CERTAINTY FACTOR



FOR A CLUSTER WITH AT LEAST 64 BUT LESS THAN 128 ALLOTTED, GENERATE 75% OF THE NUMBER.

 *** RULE NUM_GEN_2 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?CLUSTER_ID ?NUMBER_TO_GENERATE )
     (FUNCTION-CALL *>=* ?NUMBER_TO_GENERATE 64 )
     (FUNCTION-CALL *>* 128 ?NUMBER_TO_GENERATE )
     (FUNCTION-CALL MULTIPLY-VALUES ?NUMBER_TO_GENERATE 0.75 ?PROD )
     (FUNCTION-CALL *ROUND* ?PROD ?ALLOTTED_NUMBER )

THEN (NUMBER_SKELETONS_TO_GENERATE_SELECTIVELY ?CLUSTER_ID ?SELECTIVE_NUMBER)

     NO CERTAINTY FACTOR
```

```
FOR A CLUSTER WITH 128 OR MORE ALLOTTED SKELETONS, GENERATE ONLY 100 SKELETONS.


 *** RULE NUM_GEN_3 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (ALLOTTED_NUMBER_SKELETONS_TO_GENERATE ?CLUSTER_ID ?NUMBER_TO_GENERATE )
     (FUNCTION-CALL *>=* ?NUMBER_TO_GENERATE 128 )

THEN (NUMBER_SKELETONS_TO_GENERATE_SELECTIVELY ?CLUSTER_ID 100)

     NO CERTAINTY FACTOR
```

```
-----------------------------------------
PART B OF SECTION 7.3 --> DETERMINING PHASE.
-----------------------------------------

IF THE NUMBER OF SKELETONS TO GENERATE SELECTIVELY > 6, LESS THAN 66.7% THIS NUMBER HAVE BEEN
GENERATED, THE CLUSTER IS NOT VERY LARGE, AND MORE SKELETONS CAN BE GENERATED, THEN CONCLUDE
THE PHASE SHOULD BE RECORD.

 *** RULE PHASE_1 ***

IF   (NUMBER_SKELETONS_TO_GENERATE_SELECTIVELY ?CLUSTER_ID ?SELECTIVE_NUMBER )
     (FUNCTION-CALL *>=* ?SELECTIVE_NUMBER 6 )
     (NUMBER-SKELETONS-GENERATED ?CLUSTER_ID ?NUMBER_GENERATED )
     (FUNCTION-CALL MULTIPLY-VALUES ?SELECTIVE_NUMBER 0.6667 ?PERCENT_ADJ_NUM )
     (FUNCTION-CALL *>* ?PERCENT_ADJ_NUM ?NUMBER_GENERATED )
     (COULD_NOT_CONCLUDE (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID EXTREMELY_LARGE) )
     (COULD_NOT_CONCLUDE (MESSAGE ?CLUSTER_ID END-OF-RECORD-PHASE) )
     (COULD_NOT_CONCLUDE (MESSAGE ?CLUSTER_ID *PREVIOUS-ACTION* FAILED-TO-FIND-NEW-SKEL) )

THEN (CONCLUDE_PHASE ?CLUSTER_ID RECORD-PHASE)

     NO CERTAINTY FACTOR



IF THE CONDITIONS IN RULE PHASE_1 PREVAIL FOR A CLUSTER WHICH IS EXTREMELY LARGE,
CONCLUDE THE PHASE SHOULD BE RESTRICTED-RECORD.

 *** RULE PHASE_2 ***

IF   (CLUSTER_CHARACTERIZATION ?CLUSTER_ID ?CLUSTER_SET_ID EXTREMELY_LARGE )
     (NUMBER_SKELETONS_TO_GENERATE_SELECTIVELY ?CLUSTER_ID ?SELECTIVE_NUMBER )
     (FUNCTION-CALL *>=* ?SELECTIVE_NUMBER 6 )
     (NUMBER-SKELETONS-GENERATED ?CLUSTER_ID ?NUMBER_GENERATED )
     (FUNCTION-CALL MULTIPLY-VALUES ?SELECTIVE_NUMBER 0.6667 ?PERCENT_ADJ_NUM )
     (FUNCTION-CALL *>* ?PERCENT_ADJ_NUM ?NUMBER_GENERATED )
     (COULD_NOT_CONCLUDE (MESSAGE ?CLUSTER_ID END-OF-RECORD-PHASE) )
     (COULD_NOT_CONCLUDE (MESSAGE ?CLUSTER_ID *PREVIOUS-ACTION* FAILED-TO-FIND-NEW-SKEL) )

THEN (CONCLUDE_PHASE ?CLUSTER_ID RESTRICTED-RECORD)

     NO CERTAINTY FACTOR
```

```
IF AT LEAST 66.7% OF THE NUMBER OF SELECTIVE SKELETONS HAVE BEEN GENERATED,
THE PHASE SHOULD BE RELATIONSHIPS.

 *** RULE PHASE_3 ***

IF   (NUMBER_SKELETONS_TO_GENERATE_SELECTIVELY ?CLUSTER_ID ?SELECTIVE_NUMBER )
     (FUNCTION-CALL *>=* ?SELECTIVE_NUMBER 6 )
     (NUMBER-SKELETONS-GENERATED ?CLUSTER_ID ?NUMBER_GENERATED )
     (FUNCTION-CALL MULTIPLY-VALUES ?SELECTIVE_NUMBER 0.6667 ?PERCENT_ADJ_NUM )
     (FUNCTION-CALL *>=* ?NUMBER_GENERATED ?PERCENT_ADJ_NUM )

THEN (CONCLUDE_PHASE ?CLUSTER_ID RELATIONSHIP-PHASE)

     NO CERTAINTY FACTOR



IF NO MORE NEW SKELETONS CAN BE GENERATED DURING THE RECORD PHASE,
THE PHASE SHOULD BE RELATIONSHIPS.

 *** RULE PHASE_4 ***

IF   (MESSAGE ?CLUSTER_ID *PREVIOUS-ACTION* FAILED-TO-FIND-NEW-SKEL )
     (PREVIOUS_PHASE ?CLUSTER_ID ?PH )
     (FUNCTION-CALL *IS-ONE-OF* ?PH (RECORD RESTRICTED-RECORD) )

THEN (CONCLUDE_PHASE ?CLUSTER_ID RELATIONSHIP-PHASE)

     NO CERTAINTY FACTOR



IF AN EXTERNAL MESSAGE STATES THE RECORD PHASE HAS ENDED,
THE PHASE SHOULD BE RELATIONSHIPS.

 *** RULE PHASE_5 ***

IF   (MESSAGE ?CLUSTER_ID END-OF-RECORD-PHASE )

THEN (CONCLUDE_PHASE ?CLUSTER_ID RELATIONSHIP-PHASE)

     NO CERTAINTY FACTOR
```

```
IF THE NUMBER OF SKELETONS TO GENERATE SELECTIVELY IS LESS THAN OR EQUAL TO 6,
THE PHASE SHOULD BE COMBINED-PHASE.

 *** RULE PHASE_6 ***

IF   (NUMBER_SKELETONS_TO_GENERATE_SELECTIVELY ?CLUSTER_ID ?SELECTIVE_NUMBER )
     (FUNCTION-CALL *>* 6 ?SELECTIVE_NUMBER )

THEN (CONCLUDE_PHASE ?CLUSTER_ID COMBINED-PHASE)

     NO CERTAINTY FACTOR
```

```
--------------------------------------------------------------------------------
PART C OF SECTION 7.3 --> DETERMINING WHETHER OR NOT TO CONTINUE SELECTIVE SKELETON
GENERATION FOR A CLUSTER.
--------------------------------------------------------------------------------


IF THE NUMBER OF SKELETONS TO GENERATE SELECTIVELY EXCEEDS THE NUMBER GENERATED, THERE ARE NEW SKELETONS
WHICH CAN BE GENERATED, THIS IS NOT A TEMPORARY INTERSECTION CLUSTER IN WHICH A SIGNIFICANTLY LOWER COST
SKELETON HAS BEEN FOUND, THEN DETERMINE THAT SKELETON GENERATION SHOULD CONTINUE FOR CLUSTER ?CLUSTER_ID.

 *** RULE GENERATION_DECISION_1 ***

IF   (NUMBER-SKELETONS-GENERATED ?CLUSTER_ID ?NUMBER_GENERATED )
     (NUMBER_SKELETONS_TO_GENERATE_SELECTIVELY ?CLUSTER_ID ?SELECTIVE_NUMBER )
     (FUNCTION-CALL *>* ?SELECTIVE_NUMBER ?NUMBER_GENERATED )
     (COULD_NOT_CONCLUDE (MESSAGE ?CLUSTER_ID *PREVIOUS-ACTION* FAILED-TO-FIND-NEW-SKEL) )
     (COULD_NOT_CONCLUDE (LOW_COST_SKELETON_IN_INTERSECTION_CLUSTER ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID) )

THEN (DECISION ?CLUSTER_ID **CONTINUE**)

     NO CERTAINTY FACTOR



IF DURING THE RECORD PHASE NO MORE NEW SKELETONS CAN BE GENERATED, THE NUMBER OF SKELETONS TO GENERATE
SELECTIVELY EXCEEDS THE NUMBER GENERATED, AND THIS IS NOT A TEMPORARY INTERSECTION CLUSTER IN WHICH A
SIGNIFICANTLY LOWER COST SKELETON HAS BEEN FOUND, THEN DETERMINE THAT SKELETON GENERATION SHOULD CONTINUE
FOR CLUSTER ?CLUSTER_ID.

AT THIS POINT, A NEW DETERMINATION OF PHASE WILL RESULT IN A SWITCH FROM RECORD TO RELATIONSHIP PHASE.
IT SHOULD BE POSSIBLE TO GENERATE MORE SKELETONS IN THE RELATIONSHIP PHASE. SEE RULES PHASE_4 AND
PHASE_5 IN  PART B.

 *** RULE GENERATION_DECISION_2 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (RECORD RESTRICTED-RECORD) )
     (MESSAGE ?CLUSTER_ID *PREVIOUS-ACTION* FAILED-TO-FIND-NEW-SKEL )
     (NUMBER-SKELETONS-GENERATED ?CLUSTER_ID ?NUMBER_GENERATED )
     (NUMBER_SKELETONS_TO_GENERATE_SELECTIVELY ?CLUSTER_ID ?SELECTIVE_NUMBER )
     (FUNCTION-CALL *>* ?SELECTIVE_NUMBER ?NUMBER_GENERATED )
     (COULD_NOT_CONCLUDE (LOW_COST_SKELETON_IN_INTERSECTION_CLUSTER ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID) )

THEN (DECISION ?CLUSTER_ID **CONTINUE**)

     NO CERTAINTY FACTOR
```

IF THE PREVIOUSLY GENERATED SKELETON IN A CLUSTER WHICH IS NOT A TEMPORARY INTERSECTION CLUSTER, HAS RESULTED IN A LOWER COST, THEN CONTINUE TO GENERATE SKELETONS. THIS RULE WILL FIRE EVEN IF THE NUMBER TO GENERATE SELECTIVELY IS EXCEEDED.

```
 *** RULE GENERATION_DECISION_3 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (FUNCTION-CALL NOT-EQUAL ?CLUSTER_SET_ID TEMPORARY_INTERSECTION_CLUSTER )
     (MESSAGE ?CLUSTER_ID LOWER-SKEL-FOUND )

THEN (DECISION ?CLUSTER_ID **CONTINUE**)

     NO CERTAINTY FACTOR
```

IF THE NUMBER OF ALLOTTED SKELETONS IS EQUALED OR EXCEEDED BY THE NUMBER GENERATED, AND THE PREVIOUSLY GENERATED SKELETON DID NOT HAVE A LOWER COST, THEN DETERMINE THAT SKELETON GENERATION SHOULD STOP.

```
 *** RULE GENERATION_DECISION_4 ***

IF   (NUMBER-SKELETONS-GENERATED ?CLUSTER_ID ?NUMBER_GENERATED )
     (COULD_NOT_CONCLUDE (MESSAGE ?CLUSTER_ID LOWER-SKEL-FOUND) )
     (NUMBER_SKELETONS_TO_GENERATE_SELECTIVELY ?CLUSTER_ID ?SELECTIVE_NUMBER )
     (FUNCTION-CALL *>=* ?NUMBER_GENERATED ?SELECTIVE_NUMBER )

THEN (DECISION ?CLUSTER_ID **TERMINATE**)

     NO CERTAINTY FACTOR
```

IF DURING THE RELATIONSHIP OR COMBINED-PHASE NO MORE NEW SKELETONS CAN BE GENERATED, DETERMINE THAT SKELETON GENERATION SHOULD STOP.

```
 *** RULE GENERATION_DECISION_5 ***

IF   (MESSAGE ?CLUSTER_ID *PREVIOUS-ACTION* FAILED-TO-FIND-NEW-SKEL )
     (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (RELATIONSHIPS COMBINED-PHASE) )

THEN (DECISION ?CLUSTER_ID **TERMINATE**)

     NO CERTAINTY FACTOR
```

IF THIS IS A TEMPORARY INTERSECTION CLUSTER IN WHICH A SIGNIFICANTLY LOWER COST SKELETON HAS BEEN FOUND, THEN
DETERMINE THAT SKELETON GENERATION SHOULD STOP. THIS INDICATES THAT COMPLETE RECOMBINATION MUST TAKE PLACE.

*** RULE GENERATION_DECISION_6 ***

IF (LOW_COST_SKELETON_IN_INTERSECTION_CLUSTER ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID)

THEN (DECISION ?CLUSTER_ID **TERMINATE**)

NO CERTAINTY FACTOR

```
-------------------------------------------------------
RULES FOR SECTION 7.4 --> SKELETON SELECTION RULE GROUP.
-------------------------------------------------------


-------------------------------------------------------------------
PART A OF SECTION 7.4 --> SELECTION OF THE NEXT SKELETON TO WORK ON.
-------------------------------------------------------------------

THIS IS THE MAIN RULE FOR SELECTING A SKELETON TO WORK ON.
THE RULE FINDS THE LOWEST COST SKELETON VIA FUNCTION *GET_LEAST_COST_VIABLE_SKELETON*.

 *** RULE SELECT_SKEL_1 ***

IF   (NUMBER-SKELETONS-GENERATED ?CLUSTER_ID ?NUMBER_GENERATED )
     (NUMBER_SKELETONS_TO_GENERATE_SELECTIVELY ?CLUSTER_ID ?SELECTIVE_NUMBER )
     (FUNCTION-CALL *>* ?SELECTIVE_NUMBER ?NUMBER_GENERATED )
     (FUNCTION-CALL *GET_LEAST_COST_VIABLE_SKELETON* ?CLUSTER_ID ?SKEL_ID_NUMBER )

THEN (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID)

     CERTAINTY FACTOR = 0.5



THIS IS A RULE FOR RECOMMENDING SELECTION OF AN ALTERNATIVE SKELETON TO WORK ON IF A POSSIBLE FALSE MINIMUM
HAS BEEN DETECTED. THE SKELETON WOULD NOT BE RECOMMENDED IF THE ALTERNATIVE HAS BEEN TRIED BEFORE.

 *** RULE SELECT_SKEL_2 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (RECORD RESTRICTED-RECORD) )
     (SKELETON_INFORMATION ?CLUSTER_ID ?SKEL_ID_NUMBER LOCAL-MINIMUM-BRANCH ?REL_ID ?VARY-REL_ID )
     (COULD_NOT_CONCLUDE (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID LOCAL-MINIMUM-CHECKED) )

THEN (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID)

     CERTAINTY FACTOR = 0.6
```

```
-------------------------------------------------------------------------------------------
PART B OF SECTION 7.4 --> SELECTION OF SKELETONS FOR FINE-TUNING BY THE DETAILED DESIGN SYSTEM.
-------------------------------------------------------------------------------------------

IF CLUSTER ?CLUSTER_ID IS NOT A TEMPORARY INTERSECTION CLUSTER, THE CLUSTER'S SKELETONS WERE
ENUMERATED AND ORDERED BY COST, SKELETON ?SKEL_ID_NUMBER HAS NOT BEEN DISCARDED BECAUSE IT IS
RANKED ABOVE THE FINE-TUNING QUOTA, THE SKELETON IS NOT A HIGH COST SKELETON, AND DOES NOT
CONTAIN AN INFEASIBLE RECORD, THEN SELECT SKELETON ?SKEL_ID_NUMBER FOR FINE-TUNING.

 *** RULE FINAL_SKEL_SELECT_1 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (FUNCTION-CALL NOT-EQUAL ?CLUSTER_SET_ID TEMPORARY_INTERSECTION_CLUSTER )
     (CG-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID ?WHICH ENUMERATE_SKELETONS )
     (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PAR_ID_NUMBER ?SKEL_COST ?CLUSTER_ID )
     (COULD_NOT_CONCLUDE (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID *OVER_QUOTA_BY_ALGORITHM*) )
     (COULD_NOT_CONCLUDE (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID ENUMERATED_HIGH_COST_SKELETON) )
     (COULD_NOT_CONCLUDE (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID INFEASIBLE_RECORD_STRUCTURE) )

THEN (SKELETON_INFORMATION ?CLUSTER_ID ?SKEL_ID_NUMBER FINAL-SELECTION SELECTED ?SKEL_COST)

     NO CERTAINTY FACTOR



IF CLUSTER ?CLUSTER_ID IS NOT A TEMPORARY INTERSECTION CLUSTER, SELECTIVE SKELETON GENERATION WAS USED,
SKELETON ?SKEL_ID_NUMBER DOES NOT CONTAIN A RECORD WHICH IS STRUCTURALLY INFEASIBLE, AND THE SKELETON IS NO
MORE THAN THREE TIMES AS COSTLY AS THE LEAST COSTLY SKELETON GENERATED, THEN SELECT THE SKELETON FOR
FINE-TUNING.

 *** RULE FINAL_SKEL_SELECT_2 ***

IF   (CLUSTER ?CLUSTER_ID ?CLUSTER_SET_ID )
     (FUNCTION-CALL NOT-EQUAL ?CLUSTER_SET_ID TEMPORARY_INTERSECTION_CLUSTER )
     (CG-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID ?WHICH SELECTIVELY_GENERATE_SKELETONS )
     (FUNCTION-CALL *MIN-SKEL-COST* ?CLUSTER_ID ?LOW_SKEL_ID_NUMBER ?LOW-COST )
     (FUNCTION-CALL MULTIPLY-VALUES ?LOW-COST 3.0 ?CUTOFF )
     (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PARENT_SKEL ?SKEL_COST ?CLUSTER_ID )
     (FUNCTION-CALL *>=* ?CUTOFF ?SKEL_COST )
     (COULD_NOT_CONCLUDE (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID INFEASIBLE_RECORD_STRUCTURE) )

THEN (SKELETON_INFORMATION ?CLUSTER_ID ?SKEL_ID_NUMBER FINAL-SELECTION SELECTED ?SKEL_COST)

     NO CERTAINTY FACTOR
```

```
IF CLUSTER ?CLUSTER_ID IS A TEMPORARY INTERSECTION CLUSTER, SELECTIVE SKELETON GENERATION WAS USED
TO GENERATE CANONICAL RECORDS, SKELETON ?SKEL_ID_NUMBER IS LESS THAN 1.2 TIMES THE LEAST COST SKELETON
GENERATED IN THE CLUSTER, IS NOT THE FIRST SKELETON GENERATED, AND HAS NOT BEEN DISCARDED BECAUSE IT
CONTAINS AN INFEASIBLE RECORD STRUCTURE, THEN SELECT THE SKELETON FOR FINE-TUNING.

 *** RULE FINAL_SKEL_SELECT_3 ***

IF   (CLUSTER ?CLUSTER_ID TEMPORARY_INTERSECTION_CLUSTER )
     (CG-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID ?WHICH SELECTIVELY_GENERATE_SKELETONS )
     (FUNCTION-CALL *MIN-SKEL-COST* ?CLUSTER_ID ?LOW_SKEL_NAME ?MIN_COST )
     (FUNCTION-CALL MULTIPLY-VALUES ?MIN_COST 1.2 ?COST_CEILING )
     (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PAR_ID_NUMBER ?SKEL_COST ?CLUSTER_ID )
     (FUNCTION-CALL *>=* ?COST_CEILING ?SKEL_COST )
     (FUNCTION-CALL NOT-EQUAL ?SKEL_ID_NUMBER 1 )
     (COULD_NOT_CONCLUDE (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID INFEASIBLE_RECORD_STRUCTURE) )

THEN (SKELETON_INFORMATION ?CLUSTER_ID ?SKEL_ID_NUMBER FINAL-SELECTION SELECTED ?SKEL_COST)

     NO CERTAINTY FACTOR



THIS RULE IS SIMILAR TO THE PREVIOUS THREE RULES BUT IS FOR TEMPORARY INTERSECTION CLUSTERS WHERE
SKELETON ENUMERATION WAS USED. NO SKELETON IS SELECTED WHICH IS MORE COSTLY THAN 1.1 TIMES THE LEAST
COST "0" SKELETON IN THE CLUSTER.  SKELETON ENUMERATION IN A TEMPORARY INTERSECTION CLUSTER WILL
RESULT IN FEWER SELECTED SKELETONS THAN IN A REGULAR CLUSTER.

 *** RULE FINAL_SKEL_SELECT_4 ***

IF   (CLUSTER ?CLUSTER_ID TEMPORARY_INTERSECTION_CLUSTER )
     (CG-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID ?WHICH ENUMERATE_SKELETONS )
     (SKELETON-HISTORY 0 NO-PARENT ?LOW_SKEL_COST ?CLUSTER_ID )
     (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PARENT_SKEL_ID ?SKEL_COST ?CLUSTER_ID )
     (FUNCTION-CALL NOT-EQUAL ?SKEL_ID_NUMBER 0 )
     (FUNCTION-CALL MULTIPLY-VALUES ?LOW_SKEL_COST 1.1 ?COST_CEILING )
     (FUNCTION-CALL *>* ?COST_CEILING ?SKEL_COST )
     (COULD_NOT_CONCLUDE (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID ELIMINATED-RECORD) )
     (COULD_NOT_CONCLUDE (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID *OVER_QUOTA_BY_ALGORITHM*) )
     (COULD_NOT_CONCLUDE (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID ENUMERATED_HIGH_COST_SKELETON) )

THEN (SKELETON_INFORMATION ?CLUSTER_ID ?SKEL_ID_NUMBER FINAL-SELECTION SELECTED ?SKEL_COST)

     NO CERTAINTY FACTOR
```

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------------------------------------------------------------
RULES FOR SECTION 7.5 --> RELATIONSHIP SELECTION RULE GROUP.
------------------------------------------------------------

-----------------------------------------------------------------------------------------------
PART A OF SECTION 7.5 --> RULES TO RECOMMEND RELATIONSHIPS TO VARY DURING RECORD OR COMBINED PHASE.
-----------------------------------------------------------------------------------------------

THESE RULES MAY BE APPLIED TO ANY RELATIONSHIP ?REL_ID IN CLUSTER ?CLUSTER_ID FOR THE SKELETON ?SKEL_ID_NUMBER
CURRENTLY SELECTED TO BE WORKED ON. THE VARIABLE ?LIST_OF_REPS IS THE LIST OF RELATIONSHIP REPRESENTATIONS FOR
THE SKELETON. THIS VALUE OF THIS VARIABLE SERVES AS AN INPUT PARAMETER TO THE FUNCTIONS CALLED FROM THE RULES.



THIS RULE STATES THAT IF THE PHASE IS RECORD, RESTRICTED-RECORD, OR COMBINED,  THE SKELETON ?SKEL_ID_NUMBER
IS THE CURRENT SKELETON BEING WORKED ON, AND  THE FUNCTION *MOST-COSTLY-REL* RECOMMENDS RELATIONSHIP ?REL_ID
AS A RELATIONSHIP TO BE VARIED, THEN RECOMMEND RELATIONSHIP ?REL_ID WITH A COMPUTED CRITICALITY.

 *** RULE VARY_REL_1 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (COMBINED-PHASE RECORD RESTRICTED-RECORD) )
     (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (FUNCTION-CALL *MOST-COSTLY-REL* ?CLUSTER_ID ?SKEL_ID_NUMBER ?LIST_OF_REPS ?REL_ID ?REL-COST ?ACTIV
          ?ACTIV-PER )
     (FUNCTION-CALL *COMPUTE_CRITICALITY* ?REL-COST ?SKEL-COST 0.5 ?ACTIV ?ACTIV-PER ?CRITICALITY )

THEN (RECOMMEND_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL-COST ?CRITICALITY)

     NO CERTAINTY FACTOR
```

```
IF THE PHASE IS RECORD, RESTRICTED-RECORD, OR COMBINED, AND THE SKELETON ?SKEL_ID_NUMBER IS THE CURRENT
SKELETON BEING WORKED ON, AND THE FUNCTION *REL-ROOT-ACC-COST* SELECTS RELATIONSHIP ?REL_ID TO
BE VARIED, THEN RECOMMEND RELATIONSHIP ?REL_ID WITH A COMPUTED CRITICALITY.

 *** RULE VARY_REL_2 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (COMBINED-PHASE RECORD RESTRICTED-RECORD) )
     (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (FUNCTION-CALL *REL-ROOT-ACC-COST* ?CLUSTER_ID ?SKEL_ID_NUMBER ?LIST_OF_REPS ?ENT ?REL_ID ?REL-COST
          ?ACTIV ?ACTIV-PER )
     (FUNCTION-CALL *COMPUTE_CRITICALITY* ?REL-COST ?SKEL-COST 0.5 ?ACTIV ?ACTIV-PER ?CRITICALITY )

THEN (RECOMMEND_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL-COST ?CRITICALITY)

     NO CERTAINTY FACTOR



IF THE PHASE IS RECORD, RESTRICTED-RECORD, OR COMBINED, THE SKELETON ?SKEL_ID_NUMBER IS THE CURRENT SKELETON
BEING WORKED ON, THE FUNCTION *ABSORB-ENT-ACC-COST* SELECTS RELATIONSHIP ?REL_ID TO BE VARIED, THEN  RECOMMEND
RELATIONSHIP ?REL_ID WITH A COMPUTED CRITICALITY.

*** RULE VARY_REL_3 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (COMBINED-PHASE RECORD RESTRICTED-RECORD) )
     (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (FUNCTION-CALL *ABSORB-ENT-ACC-COST* ?CLUSTER_ID ?SKEL_ID_NUMBER ?LIST_OF_REPS ?ENT ?REL_ID ?REL-COST
         ?ACTIV ?ACTIV-PER )
     (FUNCTION-CALL *COMPUTE_CRITICALITY* ?REL-COST ?SKEL-COST 0.5 ?ACTIV ?ACTIV-PER ?CRITICALITY )

THEN (RECOMMEND_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL-COST ?CRITICALITY)

     NO CERTAINTY FACTOR
```

```
IF THE PHASE IS RECORD, RESTRICTED-RECORD, OR COMBINED, THE SKELETON ?SKEL_ID_NUMBER IS THE CURRENT
SKELETON BEING WORKED ON, THE FUNCTION *COMPLEX-ABS-REL* SELECTS RELATIONSHIP ?REL_ID TO BE VARIED,
THEN RECOMMEND RELATIONSHIP ?REL_ID WITH A COMPUTED CRITICALITY.

 *** RULE VARY_REL_4 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (COMBINED-PHASE RECORD RESTRICTED-RECORD) )
     (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (FUNCTION-CALL *COMPLEX-ABS-REL* ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID ?REC-ID ?REL-COST ?ACTIV
          ?ACTIV-PER )
     (FUNCTION-CALL *COMPUTE_CRITICALITY* ?REL-COST ?SKEL-COST 0.5 ?ACTIV ?ACTIV-PER ?CRITICALITY )

THEN (RECOMMEND_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL-COST ?CRITICALITY)

     NO CERTAINTY FACTOR



IF THE PHASE IS RECORD, RESTRICTED-RECORD, OR COMBINED, DEVICE LENGTH RESTRICTIONS ARE BEING OBSERVED,
AND THE FUNCTION *OVERSIZE-REC* HAS FOUND A RECORD WITH EXCESSIVE LENGTH AND SELECTED RELATIONSHIP
?REL_ID WITHIN THIS RECORD FOR ALTERATION, THEN RECOMMEND RELATIONSHIP ?REL_ID WITH A VERY HIGH
CRITICALITY OF 5.0.

  *** RULE VARY_REL_5 ***

IF   (USER-MESSAGE ALL-CG *ENF-TRACK-LIMITS* )
     (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (COMBINED-PHASE RECORD RESTRICTED-RECORD) )
     (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (FUNCTION-CALL *OVERSIZE-REC* ?CLUSTER_ID ?SKEL_ID_NUMBER ?REC-VAR ?LENGTH-VAR ?REL_ID )

THEN (RECOMMEND_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER 0.0 5.0)

     NO CERTAINTY FACTOR
```

IF THE PHASE IS RECORD, RESTRICTED-RECORD, OR COMBINED, THE CLUSTER BEING WORKED IS A TEMPORARY INTERSECTION CLUSTER, AND RELATIONSHIP ?REL_ID WAS A CONNECTING RELATIONSHIP BETWEEN THE TWO PARENT CLUSTERS OF THE INTERSECTION CLUSTER, THEN RECOMMEND RELATIONSHIP ?REL_ID WITH THE WITH A HIGH CRITICALITY OF 2.0.

*** RULE VARY_REL_6 ***

```
IF   (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (COMBINED-PHASE RECORD RESTRICTED-RECORD) )
     (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (INTERSECTION_CLUSTERS ?CLUSTER_ID ?CLUSTER_ID1 ?CLUSTER_ID2 )
     (CONNECTING_RELATIONSHIP ?REL_ID ?CLUSTER_ID1 ?CLUSTER_ID2 ?CLUSTER_SET_ID )

THEN (RECOMMEND_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER 0.0 2.0)

     NO CERTAINTY FACTOR
```

THIS RULE RECOMMENDS AN ALTERNATIVE RELATIONSHIP IF A LOCAL MINIMA PROBLEM IS DETECTED. SEE RULE SKEL_ANAL_13 IN SECTION 7.7 FOR EXPLANATION OF THE LOCAL MINIMA PROBLEM.

*** RULE VARY_REL_7 ***

```
IF   (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (RECORD RESTRICTED-RECORD) )
     (THERE_IS_ONE_OF (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID) )
     (SKELETON_INFORMATION ?CLUSTER_ID ?SKEL_ID_NUMBER LOCAL-MINIMUM-BRANCH ?REL_ID ?VARY-REL_ID )

THEN (RECOMMEND_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER 0.0 0.99)

     NO CERTAINTY FACTOR
```

THIS RULE MATCHES ON A RELATIONSHIP CHARACTERIZATION FOR A RELATIONSHIP TO A "MANY" ENTITY WHICH CAN BE ABSORBED ALONG TWO POSSIBLE RELATIONSHIPS. RULE RELCH_7 IN SECTION 3.7 CONCLUDES THE RELATIONSHIP CHARACTERIZATION. IT RECOMMENDS THIS RELATIONSHIP FOR ALTERATION.

```
 *** RULE VARY_REL_8 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID RECORD-PHASE )
     (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID ALTERNATE-ABSORPTION CHARACTERIZATION )

THEN (RECOMMEND_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER 0.0 0.9)

     NO CERTAINTY FACTOR
```

THE NEXT RULE RECOMMENDS A RELATIONSHIP ON THE BASIS OF A SIGNIFICANT ACTIVITY CHARACTERIZATION. A WEAK CRITICALITY ACCOMPANIES THE CONCLUSION.

```
 *** RULE VARY_REL_9 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID RECORD-PHASE )
     (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (THERE_IS_ONE_OF (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 ?ACT-TYPE ?ANY-SIZE SIGNIFICANT) )

THEN (RECOMMEND_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER 0.0 0.25)

     NO CERTAINTY FACTOR
```

THE NEXT RULE RECOMMENDS A RELATIONSHIP ON THE BASIS OF MERE MEMBERSHIP IN CLUSTER ?CLUSTER_ID. THIS RULE IS NECESSARY TO INSURE THAT ANY RELATIONSHIP CAN ULTIMATELY BE ALTERED (IF NECESSARY) DURING THE SEARCH PROCESS. A VERY WEAK CRITICALITY ACCOMPANIES THE CONCLUSION.

```
 *** RULE VARY_REL_10 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID RECORD-PHASE )
     (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 ?ACT-TYPE ?ANY-SIZE SIGNIFICANT)

THEN (RECOMMEND_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER 0.0 0.1)

     NO CERTAINTY FACTOR
```

```
--------------------------------------------------------------------------------
PART B OF SECTION 7.5 --> RECOMMENDING RELATIONSHIPS TO VARY DURING RELATIONSHIP PHASE.
--------------------------------------------------------------------------------

THESE RULES ARE APPLIED TO ALL RELATIONSHIPS IN THE CURRENT SKELETON ?SKEL_ID_NUMBER BEING WORKED ON IN
CLUSTER ?CLUSTER_ID.



IF THE PHASE IS RELATIONSHIPS OR COMBINED, THE SKELETON ?SKEL_ID_NUMBER IS THE CURRENT SKELETON BEING
WORKED ON, THE FUNCTION *MOST-COSTLY-REL* RECOMMENDS ?REL_ID AS HIGH COST RELATIONSHIP, AND THE
RELATIONSHIP HAS A CHARACTERIZATION OF WORKLOAD COMPLEXITY, THEN RECOMMEND RELATIONSHIP ?REL_ID TO BE
VARIED WITH A COMPUTED CRITICALITY.   THE VARIABLE ?LIST_OF_REPS IS THE LIST OF RELATIONSHIP REPRESENTATIONS
FOR THE SKELETON. IT IS AN INPUT PARAMETER TO THE FUNCTION *MOST-COSTLY-REL*.

 *** RULE VARY_REL_11 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (COMBINED-PHASE RELATIONSHIPS) )
     (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (FUNCTION-CALL *MOST-COSTLY-REL* ?CLUSTER_ID ?SKEL_ID_NUMBER ?LIST_OF_REPS ?REL_ID ?REL-COST ?ACTIV
          ?ACTIV-PER )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID ?PROB SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (FUNCTION-CALL *COMPUTE_CRITICALITY* ?REL-COST ?SKEL-COST 0.5 ?ACTIV ?ACTIV-PER ?CRITICALITY )

THEN (RECOMMEND_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL-COST ?CRITICALITY)

     NO CERTAINTY FACTOR
```

```
IF THE PHASE IS RELATIONSHIPS, THE SKELETON ?SKEL_ID_NUMBER IS THE CURRENT SKELETON BEING WORKED ON,
THE FUNCTION *MOST-COSTLY-REL* RECOMMENDS REL_ID AS HIGH COST RELATIONSHIP,  THE CURRENT REPRESENTATION
FOR THE RELATIONSHIP ?REL_ID IN ?SKEL_ID_NUMBER IS NOT ABSORPTION, AND THE RELATIONSHIP IS NOT CHARACTERIZED
AS HAVING SIGNIFICANT INTERDEPENDENCY WORKLOAD COMPLEXITY, THEN RECOMMEND RELATIONSHIP ?REL_ID WITH A COMPUT
CRITICALITY.

 *** RULE VARY_REL_12 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID RELATIONSHIP-PHASE )
     (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (FUNCTION-CALL *MOST-COSTLY-REL* ?CLUSTER_ID ?SKEL_ID_NUMBER ?LIST_OF_REPS ?REL_ID ?REL-COST ?ACTIV
          ?ACTIV-PER )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID ?PROB SIGNIFICANT_WORKLOAD_COMPLEXITY) )
     (FUNCTION-CALL *EXTRACT-CURR-REP* ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 ?LIST_OF_REPS )
     (FUNCTION-CALL NOT-EQUAL ?REPRESENTATION ABSORBS )
     (FUNCTION-CALL *COMPUTE_CRITICALITY* ?REL-COST ?SKEL-COST 0.5 ?ACTIV ?ACTIV-PER ?CRITICALITY )

THEN (RECOMMEND_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL-COST ?CRITICALITY)

     NO CERTAINTY FACTOR



IF THE PHASE IS RELATIONSHIPS, THE SKELETON ?SKEL_ID_NUMBER IS THE CURRENT SKELETON BEING WORKED ON,
THE FUNCTION *MOST-COSTLY-REL* RECOMMENDS ?REL_ID AS HIGH COST RELATIONSHIP, ABSORBING THE "MANY" ENTITY
ALONG RELATIONSHIP ?REL_ID WOULD NOT RESULT IN A TRIVIAL PHYSICAL RECORD, AND THE RELATIONSHIP HAS NOT
PREVIOUSLY BEEN VARIED, THEN RECOMMEND ?REL_ID WITH A COMPUTED CRITICALITY.

 *** RULE VARY_REL_13 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID RELATIONSHIP-PHASE )
     (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (FUNCTION-CALL *MOST-COSTLY-REL* ?CLUSTER_ID ?SKEL_ID_NUMBER ?LIST_OF_REPS ?REL_ID ?REL-COST ?ACTIV
          ?ACTIV-PER )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID TRIVIAL_SIZE_MANY_ENTITY CHARACTERIZATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?ANY-SKEL ?REL_ID ?ENT1 ?REP ?ENT2 ?RES) )
     (FUNCTION-CALL *COMPUTE_CRITICALITY* ?REL-COST ?SKEL-COST 0.25 ?ACTIV ?ACTIV-PER ?CRITICALITY )

THEN (RECOMMEND_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL-COST ?CRITICALITY)

     NO CERTAINTY FACTOR
```

```
-------------------------------------------------------------------------
PART C OF SECTION 7.5 --> CONCLUSION OF PREVENT_ALTERATION FACT EXPRESSIONS.
-------------------------------------------------------------------------

THE FIRST SIX RULES ARE "INITIAL" RULES WHICH FIRE WHEN THE SKELETON IS INITIALLY CREATED. THEY
ARE APPLIED TO RELATIONSHIPS OF A PARTICULAR SKELETON ?SKEL_ID_NUMBER IN CLUSTER ?CLUSTER_ID.



THIS RULE STATES THAT A RELATIONSHIP WHICH CONNECTS TWO CLUSTERS, E.G. A BREAKPOINT,
SHOULD NOT BE VARIED.

 *** RULE PREV_VAR_1 ***

IF   (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (CONNECTING_RELATIONSHIP ?REL_ID ?CLUSTER_ID ?CLUSTER_ID2 ?CGSET )

THEN (PREVENT_ALTERATION INITIAL ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID CONNECTING-REL)

     NO CERTAINTY FACTOR



THIS RULE STATES THAT, DURING RECORD PHASE, A RELATIONSHIP SHOULD NOT BE VARIED IF ABSORPTION
HAS NOT BEEN SELECTED AS A REASONABLE REPRESENTATION.

 *** RULE PREV_VAR_2 ***

IF   (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (RECORD RESTRICTED-RECORD) )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (COULD_NOT_CONCLUDE (SELECTED-REP ?REL_ID ?CLUSTER_ID ?ENTX ABSORBS ?ENTY ) )

THEN (PREVENT_ALTERATION INITIAL ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID NO-ABSORB-REP)

     NO CERTAINTY FACTOR
```

THIS RULE STATES THAT, DURING RECORD PHASES, A LEAF ENTITY RELATIONSHIP SHOULD NOT BE VARIED IF ABSORPTION HAS BEEN SELECTED AS AN INITIAL REASONABLE REPRESENTATION WITH A CERTAINTY OF AT LEAST 0.98. IN THIS SITUATION, IT IS ALMOST CERTAIN THAT ABSORPTION IS THE BEST REPRESENTATION FOR A LEAF ENTITY RELATIONSHIP.

```
 *** RULE PREV_VAR_3 ***

IF   (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (RECORD RESTRICTED-RECORD) )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (TYPE-OF-ENTITY ?ENT2 LEAF_ENTITY )
     (FUNCTION-CALL PRODUCE-STRENGTH (INITIAL_REASONABLE_REPRESENTATION ?REL_ID
                                          ?ENT1 ?REPRESENTATION ?ENT2 ?DBMS) ?CERT1 )
     (FUNCTION-CALL *>* ?CERT1 0.98 )

THEN (PREVENT_ALTERATION INITIAL ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID LEAF-ABSORPTION)

     NO CERTAINTY FACTOR
```

THIS RULE STATES THAT A LEAF ENTITY RELATIONSHIP SHOULD NOT BE VARIED IF THE CURRENT REPRESENTATION IN SKELETON ?SKEL_ID_NUMBER IS ABSORPTION, AND THE RESULTING CANONICAL RECORD WOULD NOT BE LARGE. THE JUSTIFICATION IS THAT VARYING THIS REPRESENTATION IS PROBABLY NOT WORTH THE EFFORT. THE RULE APPLIES TO BOTH RECORD AND RELATIONSHIP PHASES.

```
 *** RULE PREV_VAR_4 ***

IF   (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID RECORD_SIZE_SMALL_&_LEAF_ENTITY CHARACTERIZATION )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (FUNCTION-CALL *EXTRACT-CURR-REP* ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 ?LIST_OF_REPS )
     (FUNCTION-CALL EQUAL-TERMS ?REPRESENTATION ABSORBS )

THEN (PREVENT_ALTERATION INITIAL ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID
               RECORD_SIZE_SMALL_&_LEAF_ENTITY)

     NO CERTAINTY FACTOR
```

```
THIS RULE STATES THAT A RELATIONSHIP REPRESENTATION SHOULD NOT BE VARIED IF THE REPRESENTATION HAS BEEN
DETERMINED TO BE GLOBALLY EFFICIENT FOR CLUSTER ?CLUSTER_ID BY THE DESIGN STRUCTURE EVALUATION RULE GROUP.

 *** RULE PREV_VAR_5 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?COST )
     (FUNCTION-CALL *EXTRACT-CURR-REP* ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 ?LIST_OF_REPS )
     (REPRESENTATION_CONCLUSION ?CLUSTER_ID ALL_SKELETONS ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2
          EFFICIENT_REPRESENTATION )

THEN (PREVENT_ALTERATION INITIAL ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID EFFICIENT_REPRESENTATION_FOUND)

     NO CERTAINTY FACTOR



THIS RULE STATES THAT, DURING RELATIONSHIP PHASE, A RELATIONSHIP REPRESENTED BY ABSORPTION IN THE
CURRENT SKELETON ?SKEL_ID_NUMBER SHOULD NOT BE VARIED IF THERE IS NO CHARACTERIZATION OF SIGNIFICANT
WORKLOAD LEVELS AND NO WORKLOAD COMPLEXITY. THE JUSTIFICATION IS THAT IN THIS CASE THERE IS NO NEED
TO CHANGE THE CURRENT REPRESENTATION IF IT WAS PREVIOUSLY DETERMINED TO BE EFFICIENT IN THE RECORD
PHASE.

 *** RULE PREV_VAR_6 ***

IF   (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?COST )
     (CONCLUDE_PHASE ?CLUSTER_ID RELATIONSHIP-PHASE )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (FUNCTION-CALL *EXTRACT-CURR-REP* ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 ?LIST_OF_REPS )
     (FUNCTION-CALL NOT-EQUAL ?REPRESENTATION ABSORBS )
     (COULD_NOT_CONCLUDE (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 ?ACTIVITY_TYPE ?ANY_SUBSET_SIZE
                          SIGNIFICANT) )
     (COULD_NOT_CONCLUDE (RELATIONSHIP_CHARACTERIZATION ?REL_ID ?ANY SIGNIFICANT_WORKLOAD_COMPLEXITY) )

THEN (PREVENT_ALTERATION INITIAL ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID NO-PROBLEM)

     NO CERTAINTY FACTOR
```

```
THE NEXT THREE RULES ARE "SUBSEQUENT" RULES WHICH FIRE ONLY AFTER AT LEAST ONE RELATIONSHIP HAS BEEN VARIED
IN SKELETON ?SKEL_ID_NUMBER.

THIS RULE STATES THAT RELATIONSHIP ?REL_ID SHOULD NOT BE VARIED IF ALL REASONABLE REPRESENTATIONS
FOR THIS RELATIONSHIP HAVE BEEN ATTEMPTED. THIS RULE APPLIES IN ALL PHASES.

 *** RULE PREV_VAR_7 ***

IF   (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (ALL_REPRESENTATIONS_TRIED ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER ALL-TRIED )

THEN (PREVENT_ALTERATION SUBSEQ ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID CANNOT-CONCLUDE-DIFFERENT-REP)

     NO CERTAINTY FACTOR



THE NEXT TWO RULES APPLY TO THE RECORD "PHASE" ONLY. TOGETHER, THEY STATE THAT RELATIONSHIP ?REL_ID SHOULD
NOT BE VARIED IF ABSORPTION OR A MANY TO ONE SYMBOLIC POINTER HAS BEEN FOUND TO BE LOCALLY INEFFICIENT
IN SKELETON ?SKEL_ID_NUMBER AND ?REL_ID IS CURRENTLY REPRESENTED IN SKELETON ?SKEL_ID_NUMBER WITH A
DIFFERENT REPRESENTATION.

 *** RULE PREV_VAR_8 ***

IF   (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (RECORD RESTRICTED-RECORD) )
     (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER ?REL_ID ?ENT1 ABSORBS ?ENT
          INEFFICIENT_REPRESENTATION )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?COST )
     (FUNCTION-CALL *EXTRACT-CURR-REP* ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 ?LIST_OF_REPS )
     (FUNCTION-CALL EQUAL-TERMS ?REPRESENTATION SYMBOL-POINTS-TO )

THEN (PREVENT_ALTERATION SUBSEQ ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID OK-REP-IN-PLACE)

     NO CERTAINTY FACTOR
```

```
 *** RULE PREV_VAR_9 ***

IF   (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (RECORD RESTRICTED-RECORD) )
     (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
          ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT INEFFICIENT_REPRESENTATION )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?COST )
     (FUNCTION-CALL *EXTRACT-CURR-REP* ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 ?LIST_OF_REPS )
     (FUNCTION-CALL EQUAL-TERMS ?REPRESENTATION ABSORBS )

THEN (PREVENT_ALTERATION SUBSEQ ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID OK-REP-IN-PLACE)

     NO CERTAINTY FACTOR
```

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-----------------------------------------------------------------------
PART D OF SECTION 7.5 --> TOP LEVEL RULES FOR SELECTING RELATIONSHIPS.
-----------------------------------------------------------------------


THIS RULE IS USED TO SUM TOTAL CRITICALITY FOR EACH RELATIONSHIP RECOMMENDED FOR ALTERATION
WITHIN THE SKELETON SELECTED TO BE WORKED ON.

 *** RULE FINAL_REL_SELECT_1 ***

IF   (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (FUNCTION-CALL *IF-THERE-IS* (RECOMMEND-FOR-ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER
                                    ?REL_COST ?CRIT) )
     (FUNCTION-CALL *SUM-TOTAL-CRITICALITY* ?SKEL_ID_NUMBER ?CLUSTER_ID ?REL_ID ?CRITICALITY ?RLIST )

THEN (TOTAL_ALTERATION_CRITICALITY ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER ?CRITICALITY)

     NO CERTAINTY FACTOR



THIS RULE CONCLUDES QUALIFYING_RELATIONSHIP FACT EXPRESSIONS WITHIN THE SELECTED SKELETON.
THE RULE MATCHES ON RELATIONSHIPS FOR WHICH TOTAL_ALTERNATION_CRITICALITY FACT EXPRESSIONS
HAVE BEEN CONCLUDED BY RULE VAR_REL_1 AND FOR WHICH THERE DOES NOT EXIST A DO_NOT_VARY CONCLUSION.

 *** RULE FINAL_REL_SELECT_2 ***

IF   (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (TOTAL_ALTERATION_CRITICALITY ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER ?CRITICALITY )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (COULD_NOT_CONCLUDE (PREVENT_ALTERATION INITIAL ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID ?INIT-REASON) )
     (COULD_NOT_CONCLUDE (PREVENT_ALTERATION SUBSEQ ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID ?SUBSEQ-REASON) )

THEN (QUALIFYING_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER ?CRITICALITY)

     NO CERTAINTY FACTOR
```

```
THIS IS THE TOP LEVEL RULE FOR SELECTING A SINGLE RELATIONSHIP TO VARY. IT INVOKES RULES TO
SUM CRITICALITY, CONCLUDE DO_NOT_VARY FACT EXPRESSIONS, AND TO DETERMINE QUALIFYING_RELATIONSHIPS.
*GET-HIGHEST-CRITICALITY-REL* IS A FUNCTION WHICH CHOOSES A SINGLE RELATIONSHIP WITH A
QUALIFYING_RELATIONSHIP CONCLUSION ON THE BASIS OF THE HIGHEST CRITICALITY.

 *** RULE FINAL_REL_SELECT_3 ***

IF   (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (FUNCTION_CALL *DETERMINE* (TOTAL_ALTERATION_CRITICALITY ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER
          ?CRITICALITY) )
     (FUNCTION_CALL *REDETERMINE* (PREVENT_ALTERATION SUBSEQ ?CLUSTER_ID ?SKEL_ID_NUMBER ?FOR-ALL-RELS
                                       ?REASONS) )
     (FUNCTION_CALL *REDETERMINE* (QUALIFYING_FOR_ALTERATION ?FOR-ALL-RELS ?CLUSTER_ID ?SKEL_ID_NUMBER
                                       ?CRITICALITIES) )
     (FUNCTION-CALL *GET-HIGHEST-CRITICALITY-REL* ?SKEL_ID_NUMBER ?CLUSTER_ID ?REL_ID ?CRITICALITY
          ?FACT_EXPRESSION )

THEN (SELECT_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER ?CRITICALITY)

     NO CERTAINTY FACTOR
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--------------------------------------------------------------------------
RULES FOR SECTION 7.6. --> SELECTION OF ALTERNATE REPRESENTATIONS TO VARY TO.
--------------------------------------------------------------------------


THE FOLLOWING ARE TWO TOP LEVEL RULES FOR SELECTION OF A SINGLE ALTERNATIVE REPRESENTATION FOR RELATIONSHIP
?REL_ID, WHICH HAS BEEN SELECTED TO BE VARIED. THEY SELECT THE RECOMMEND_NEW_REPRESENTATION CONCLUSION WITH
THE HIGHEST CERTAINTY FACTOR. ONE RULE IS FOR RECORD AND COMBINED PHASES AND THE OTHER FOR RELATIONSHIP PHASE

 *** RULE SEL_REP_1 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID ?PH )
     (FUNCTION-CALL *IS-ONE-OF* ?PH (RECORD RESTRICTED-RECORD COMBINED-PHASE) )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (FUNCTION-CALL *IF-THERE-IS* (RECOMMEND_NEW_REPRESENTATION ?CLUSTER_ID ?SKEL_ID_NUMBER
                                        ?REL_ID ?ENT1 ?REPRESENTATION  ?ENT2 ) )
     (FUNCTION-CALL *HIGHEST_CERTAINTY_RECORD_PHASE* ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID ?ENT1
          ?REPRESENTATION ?ENT2 ?CERT )

THEN (SELECT_REPRESENTATION ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2
                    ?CERT)

     NO CERTAINTY FACTOR



 *** RULE SEL_REP_2 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID RELATIONSHIP-PHASE )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (FUNCTION-CALL *IF-THERE-IS* (RECOMMEND_NEW_REPRESENTATION ?CLUSTER_ID ?SKEL_ID_NUMBER
                                        ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 ) )
     (FUNCTION-CALL *HIGHEST_CERTAINTY_RELATIONSHIP_PHASE* ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID ?ENT1
          ?REPRESENTATION ?ENT2 ?CERT )

THEN (SELECT_REPRESENTATION ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2
                    ?CERT)

     NO CERTAINTY FACTOR
```

THE REMAINDER OF THE RULES PERTAIN TO RECOMMENDING INDIVIDUAL OR MULTIPLE RELATIONSHIP REPRESENTATIONS TO VARY. IN THESE RULES, THE VARIABLE ?REP-LIST IS INSTANTIATED WITH A LIST OF RELATIONSHIP REPRESENTATIONS FOR SKELETON ?SKEL_ID_NUMBER

THE NEXT TWO RULES ARE GENERAL RULES FOR SELECTING ABSORPTION AND SYMBOLIC POINTERS DURING THE RECORD PHASE.

THIS RULE STATES THAT IF THE SKELETON ?SKEL_ID_NUMBER IS THE CURRENT SKELETON BEING WORKED ON, ABSORPTION IS A REASONABLE REPRESENTATION IN THIS CLUSTER, ABSORPTION HAS NOT BEEN DETERMINED TO BE A BAD REPRESENTATION FOR RELATIONSHIP ?REL_ID IN SKELETON ?SKEL_ID_NUMBER, IT HAS NOT BEEN FOUND TO BE GLOBALLY INEFFICIENT FOR ALL SKELETONS IN THE CLUSTER, THE CERTAINTY FACTOR OF ABSORPTION IS ABOVE A THRESHOLD - IN THIS CASE -0.9, THE RESULTING SKELETON WILL NOT BE A DUPLICATE, THEN RECOMMEND VARYING TO ABSORPTION ALONG RELATIONSHIP ?REL_ID.

*** RULE SEL_REP_3 ***

```
IF   (SELECTED-REP ?REL_ID ?CLUSTER_ID ?ENTX ABSORBS ?ENTY )
     (FUNCTION-CALL NOT-EQUAL ?ENTX ?ENTY )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
          ?REL_ID ?ENTX ABSORBS ?ENTY INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
          ?REL_ID ?ENTX ABSORBS ?ENTY INEFFICIENT_REPRESENTATION) )
     (FUNCTION-CALL PRODUCE-STRENGTH (SELECTED-REP ?REL_ID ?CLUSTER_ID
          ?ENTX ABSORBS ?ENTY ) ?STR )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (FUNCTION-CALL *CONVERT-NUMBER* ?REL_ID ?ENTX ?ENTY ?NEW-NUMBER )
     (FUNCTION-CALL *>* ?STR -0.9 )
     (FUNCTION-CALL *SKELETON-NOT-DUPLICATE* ?LIST_OF_REPS ?CODE ?REL_ID ?NEW-NUMBER )

THEN (RECOMMEND_NEW_REPRESENTATION ?CLUSTER_ID ?SKEL_ID_NUMBER
     ?REL_ID ?ENTX ABSORBS ?ENTY )

     NO CERTAINTY FACTOR
```

```
THIS RULE IS THE SAME AS SEL_REP_3, EXCEPT THE CHANGE IS TO A SYMBOLIC POINTER INSTEAD OF ABSORPTION.

 *** RULE SEL_REP_4 ***

IF   (DEGREE-OF ?REL_ID ?ENTX ?ENTY M 1 )
     (SELECTED-REP ?REL_ID ?CLUSTER_ID ?ENTX SYMBOL-POINTS-TO ?ENTY )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
          ?REL_ID ?ENTX SYMBOL-POINTS-TO ?ENTY INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                          ?REL_ID ?ENTX SYMBOL-POINTS-TO ?ENTY INEFFICIENT_REPRESENTATION) )
     (FUNCTION-CALL PRODUCE-STRENGTH (SELECTED-REP ?REL_ID ?CLUSTER_ID
                                      ?ENTX SYMBOL-POINTS-TO ?ENTY ) ?STR )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (FUNCTION-CALL *CONVERT-NUMBER* ?REL_ID ?ENTX ?ENTY ?NEW-NUMBER )
     (FUNCTION-CALL *>* ?STR -0.9 )
     (FUNCTION-CALL *SKELETON-NOT-DUPLICATE* ?LIST_OF_REPS ?CODE ?REL_ID ?NEW-NUMBER )

THEN (RECOMMEND_NEW_REPRESENTATION ?CLUSTER_ID ?SKEL_ID_NUMBER
          ?REL_ID ?ENTX SYMBOL-POINTS-TO ?ENTY  )

     NO CERTAINTY FACTOR
```

THE NEXT THREE RULES RECOMMEND VARYING TWO RELATIONSHIPS AT ONCE IF A SWITCH_TWO_REPRESENTATIONS FACT HAS BEEN CONCLUDED FOR THE SELECTED RELATIONSHIP. THE VARIABLE ?SWITCH-RELS IS INSTANTIATED WITH TWO FACTS, ONE FOR EACH NEW RELATIONSHIP REPRESENTATION. SEE THE SWITCH_TWO_REPRESENTATION RULES WHICH FOLLOW.

DURING THE RECORD PHASE, IF THE SKELETON ?SKEL_ID_NUMBER IS THE CURRENT SKELETON BEING WORKED ON, ABSORPTION HAS BEEN DETERMINED TO BE A REASONABLE REPRESENTATION FOR THIS RELATIONSHIP AND IS A SELECTED REPRESENTATION FOR THIS CLUSTER, ABSORPTION HAS NOT BEEN FOUND TO BE INEFFICIENT FOR THIS SKELETON, THE "MANY" ENTITY IN RELATIONSHIP ?REL_ID HAS A SIGNIFICANT LEVEL OF DIRECT LARGE SUBSET RETRIEVAL, A SWITCH_TWO_RELATIONSHIPS FACT HAS BEEN CONCLUDED FOR ?REL_ID AND FOR AN ADJACENT RELATIONSHIP IN THE VARIABLE ?SWITCH-RELS, THE CHANGES CREATED BY THE ?SWITCH-RELS REPRESENTATIONS WERE NOT PREVIOUSLY FOUND TO BE INEFFICIENT IN SKELETON ?SKEL_ID_NUMBER, THE ?SWITCH-RELS REPRESENTATIONS WERE NOT FOUND TO BE GLOBALLY INEFFICIENT FOR CLUSTER ?CLUSTER_ID, AND THE RESULTING SKELETON WILL NOT BE A DUPLICATE, THEN RECOMMEND VARYING THE TWO RELATIONSHIPS IN ?SWITCH-RELS

*** RULE SEL_REP_5 ***

```
IF   (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (SELECTED-REP ?REL_ID ?CLUSTER_ID ?ENTX ABSORBS ?ENTY )
     (ACTIVITY_CHARACTERIZATION_FOR ?ENTY RETRIEVAL LARGE-SUBSET SIGNIFICANT )
     (FUNCTION-CALL *SWITCH-REL* ?REL_ID ?LIST_OF_REPS ?SWITCH-RELS ?REL_ID1 ?REL_ID2 )
     (COULD_NOT_CONCLUDE (PREVENT_ALTERATION INITIAL ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID2 ?REAS) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                          ?REL_ID2 ?ENTA ABSORBS ?ENTB INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
                          ?SWITCH-RELS - - -  INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                          ?SWITCH-RELS - - -  INEFFICIENT_REPRESENTATION) )
     (FUNCTION-CALL *SKELETON-NOT-DUPLICATE* ?LIST_OF_REPS ?CODE ?SWITCH-RELS )

THEN (RECOMMEND_NEW_REPRESENTATION ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID ?SWITCH-RELS - - *SWITCH*)

     CERTAINTY FACTOR = 0.1
```

THIS RULE IS THE SAME AS ABOVE, BUT FOCUSES ON PROBLEM RELATIONSHIPS.

```
 *** RULE SEL_REP_6 ***

IF   (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (RELATIONSHIP_CHARACTERIZATION ?REL_ID ?ANY-TYPE SIGNIFICANT_WORKLOAD_COMPLEXITY )
     (FUNCTION-CALL *SWITCH-REL* ?REL_ID ?LIST_OF_REPS ?SWITCH-RELS ?REL_ID1 ?REL_ID2 )
     (COULD_NOT_CONCLUDE (PREVENT_ALTERATION INITIAL ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID2 ?REAS) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                          ?REL_ID2 ?ENTA ABSORBS ?ENTB INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
                          ?SWITCH-RELS - - -  INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                          ?SWITCH-RELS - - -  INEFFICIENT_REPRESENTATION) )
     (FUNCTION-CALL *SKELETON-NOT-DUPLICATE* ?LIST_OF_REPS ?CODE ?SWITCH-RELS )

THEN (RECOMMEND_NEW_REPRESENTATION ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID ?SWITCH-RELS - - *SWITCH*)

     CERTAINTY FACTOR = 0.1
```

THIS RULE IS THE SAME EXCEPT IT FOCUSES ONLY ON FORMER CONNECTING RELATIONSHIPS IN TEMPORARY INTERSECTION CLUSTERS.

```
 *** RULE SEL_REP_7 ***

IF   (INTERSECTION_CLUSTERS ?CLUSTER_ID ?CLUSTER_ID1 ?CLUSTER_ID2 )
     (CONNECTING_RELATIONSHIP ?REL_ID ?CLUSTER_ID1 ?CLUSTER_ID2 ?CLUSTER_SET_ID )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (FUNCTION-CALL *SWITCH-REL* ?REL_ID ?LIST_OF_REPS ?SWITCH-RELS ?REL_ID1 ?REL_ID2 )
     (COULD_NOT_CONCLUDE (PREVENT_ALTERATION INITIAL ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID2 ?REAS) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                          ?REL_ID2 ?ENTA ABSORBS ?ENTB INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
                          ?SWITCH-RELS - - - INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                          ?SWITCH-RELS - - - INEFFICIENT_REPRESENTATION) )
     (FUNCTION-CALL *SKELETON-NOT-DUPLICATE* ?LIST_OF_REPS ?CODE ?SWITCH-RELS )

THEN (RECOMMEND_NEW_REPRESENTATION ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID ?SWITCH-RELS - - *SWITCH*)

     CERTAINTY FACTOR = 0.1
```

```
THE FOLLOWING TWO RULES APPLY TO THE RELATIONSHIP PHASE.

THIS RULE STATES THAT IF A REPRESENTATION ?REPRESENTATION HAS BEEN SELECTED FOR RELATIONSHIP ?REL_ID
OF CLUSTER ?CLUSTER_ID, SKELETON ?SKEL_ID_NUMBER IS THE CURRENT SKELETON BEING WORKED ON, THIS
REPRESENTATION IS NOT A BAD REPRESENTATION FOR SKELETON ?SKEL_ID_NUMBER, THIS REPRESENTATION HAS
NOT BEEN CONCLUDED TO BE A GLOBALLY INEFFICIENT REPRESENTATION FOR ALL SKELETONS IN THE CLUSTER,
THE CERTAINTY FACTOR OF ABSORPTION IS ABOVE A THRESHOLD - IN THIS CASE -0.9, AND THE RESULTING
SKELETON WILL NOT BE A DUPLICATE, THEN RECOMMEND VARYING TO REPRESENTATION ?REL-NAME FOR ?REL_ID.

 *** RULE SEL_REP_8 ***

IF   (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (SELECTED-REP ?REL_ID ?CLUSTER_ID ?ENTX ?REPRESENTATION ?ENTY  )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
                          ?REL_ID ?ENTX ?REPRESENTATION ?ENTY INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                          ?REL_ID ?ENTX ?REPRESENTATION ?ENTY INEFFICIENT_REPRESENTATION) )
     (FUNCTION-CALL PRODUCE-STRENGTH (SELECTED-REP ?REL_ID ?CLUSTER_ID
                                      ?ENTX ?REPRESENTATION ?ENTY ) ?STR )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (FUNCTION-CALL *CONVERT-NUMBER* ?REL_ID ?ENTX ?ENTY ?NEW-NUMBER )
     (FUNCTION-CALL *>* ?STR -0.9 )
     (FUNCTION-CALL *SKELETON-NOT-DUPLICATE* ?LIST_OF_REPS ?CODE ?REL_ID ?NEW-NUMBER )

THEN (RECOMMEND_NEW_REPRESENTATION ?CLUSTER_ID ?SKEL_ID_NUMBER
          ?REL_ID ?ENTX ?REPRESENTATION ?ENTY )

     NO CERTAINTY FACTOR



THIS RULE STATES THAT IF SKELETON ?SKEL_ID_NUMBER IS THE CURRENT SKELETON BEING WORKED ON,
THE RELATIONSHIP REPRESENTATION ?REPRESENTATION HAS BEEN DECLARED TO BE GOOD FOR ALL SKELETONS, AND
THE RESULTING SKELETON WILL NOT BE A DUPLICATE, THEN RECOMMEND REPRESENTATION ?REPRESENTATION
FOR ?REL_ID.

 *** RULE INC10 ***

IF   (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?CODE )
     (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
          ?REL_ID ?ENTX ?REPRESENTATION ?ENTY EFFICIENT_REPRESENTATION )
     (SELECTED-REP ?REL_ID ?CLUSTER_ID ?ENTX ?REPRESENTATION ?ENTY  )
     (FUNCTION-CALL *CONVERT-NUMBER* ?REL_ID ?ENTX ?ENTY ?NEW-NUMBER )
     (FUNCTION-CALL *SKELETON-NOT-DUPLICATE* ?LIST_OF_REPS ?CODE ?REL_ID ?NEW-NUMBER )

THEN (RECOMMEND_NEW_REPRESENTATION ?CLUSTER_ID ?SKEL_ID_NUMBER
          ?REL_ID ?ENTX ?REPRESENTATION ?ENTY  )

     CERTAINTY FACTOR = 0.8
```

THE FOLLOWING ARE THREE RULES FOR SELECTING TWO RELATIONSHIP REPRESENTATIONS TO VARY, E.G. CONCLUSION OF "SWITCH_TWO_REPRESENTATION" FACT EXPRESSIONS. NOTE THAT THE THIRD VARIABLE CONTAINING PATTERNS FOR TWO REASONABLE_REPRESENTATION FACT EXPRESSIONS CORRESPONDS TO ?SWITCH-RELS IN THE RULES ABOVE. THE CONCLUSIONS OF THESE RULES ARE USED BY RECOMMEND_NEW_REPRESENTATION RULES WHICH RECOMMEND TWO REPRESENTATIONS TO VARY AT ONCE.

*** RULE SEL_REP_11 ***

```
IF   (DEGREE-OF ?REL_ID1 ?ENT1 ?ENT2 1 M )
     (DEGREE-OF ?REL_ID2 ?ENTX ?ENT2 1 M )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID1 ?REL_ID2 )
     (COULD_NOT_CONCLUDE (PREVENT_ALTERATION ?STAGE ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID2 ?REAS) )
     (FUNCTION-CALL *EXTRACT-CURR-REP* ?REL_ID1 ?ENTR ?REPRESENTATION1 ?ENTS ?LIST_OF_REPS )
     (FUNCTION-CALL EQUAL-TERMS ?REPRESENTATION1 ABSORBS )
     (FUNCTION-CALL *EXTRACT-CURR-REP* ?REL_ID2 ?ENTA ?REPRESENTATION2 ?ENTB ?LIST_OF_REPS )
     (FUNCTION-CALL NOT-EQUAL ?REPRESENTATION2 ABSORBS )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                          ?REL_ID1 ?ENT2 SYMBOL-POINTS-TO ?ENT1 INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
                          ?REL_ID1 ?ENT2 SYMBOL-POINTS-TO ?ENT1 INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                          ?REL_ID2 ?ENTX ABSORBS ?ENT2  INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
                          ?REL_ID2 ?ENTX ABSORBS ?ENT2 INEFFICIENT_REPRESENTATION) )

THEN (SWITCH_TWO_REPRESENTATIONS ?REL_ID1 ?REL_ID2 T ?CLUSTER_ID ?SKEL_ID_NUMBER ?LIST_OF_REPS)

     NO CERTAINTY FACTOR
```

```
 *** RULE SEL_REP_12 ***

IF   (DEGREE-OF ?REL_ID1 ?ENT1 ?ENT2 1 M )
     (DEGREE-OF ?REL_ID2 ?ENT2 ?ENT3 1 M )
     (FUNCTION-CALL *IS-ONE-OF* ?REL_IDX ( ?REL_ID1 ?REL_ID2 ) )
     (FUNCTION-CALL *IDENTIFY-OTHER-REL* ?REL_IDX ( ?REL_ID1 ?REL_ID2 ) ?OTHER-REL )
     (COULD_NOT_CONCLUDE (PREVENT_ALTERATION ?STAGE ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID1 ?REAS) )
     (COULD_NOT_CONCLUDE (PREVENT_ALTERATION ?STAGE ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID2 ?REAS) )
     (FUNCTION-CALL *EXTRACT-CURR-REP* ?REL_ID1 ?ENTR ?REPRESENTATION1 ?ENTS ?LIST_OF_REPS )
     (FUNCTION-CALL EQUAL-TERMS ?REPRESENTATION1 ABSORBS )
     (FUNCTION-CALL *EXTRACT-CURR-REP* ?REL_ID2 ?ENTA ?REPRESENTATION2 ?ENTB ?LIST_OF_REPS )
     (FUNCTION-CALL NOT-EQUAL ?REPRESENTATION2 ABSORBS )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                              ?REL_ID1 ?ENT2 SYMBOL-POINTS-TO ?ENT1 INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
                              ?REL_ID1 ?ENT2 SYMBOL-POINTS-TO ?ENT1 INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                              ?REL_ID2 ?ENT2 ABSORBS ?ENT3 INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
                              ?REL_ID2 ?ENT2 ABSORBS ?ENT3 INEFFICIENT_REPRESENTATION) )

THEN (SWITCH_TWO_REPRESENTATIONS ?REL_IDX ?OTHER-REL T ?CLUSTER_ID ?SKEL_ID_NUMBER ?LIST_OF_REPS)

     NO CERTAINTY FACTOR
```

```
 *** RULE SEL_REP_13 ***

IF   (DEGREE-OF ?REL_ID1 ?ENT1 ?ENT2 1 M )
     (DEGREE-OF ?REL_ID2 ?ENT2 ?ENT3 1 M )
     (FUNCTION-CALL *IS-ONE-OF* ?REL_IDX (?REL_ID1 ?REL_ID2) )
     (FUNCTION-CALL *IDENTIFY-OTHER-REL* ?REL_IDX (?REL_ID1 ?REL_ID2) ?OTHER-REL )
     (COULD_NOT_CONCLUDE (PREVENT_ALTERATION ?STAGE ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID1 ?REAS) )
     (COULD_NOT_CONCLUDE (PREVENT_ALTERATION ?STAGE ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID2 ?REAS) )
     (FUNCTION-CALL *EXTRACT-CURR-REP* ?REL_ID1 ?ENTR ?REPRESENTATION1 ?ENTS ?LIST_OF_REPS )
     (FUNCTION-CALL NOT-EQUAL ?REPRESENTATION1 ABSORBS )
     (FUNCTION-CALL *EXTRACT-CURR-REP* ?REL_ID2 ?ENTA ?REPRESENTATION2 ?ENTB ?LIST_OF_REPS )
     (FUNCTION-CALL EQUAL-TERMS ?REPRESENTATION2 ABSORBS )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                          ?REL_ID2 ?ENT3 SYMBOL-POINTS-TO ?ENT2 INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
                          ?REL_ID2 ?ENT3 SYMBOL-POINTS-TO ?ENT2 INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER
                          ?REL_ID1 ?ENT1 ABSORBS ?ENT2 INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
                          ?REL_ID1 ?ENT1 ABSORBS ?ENT2 INEFFICIENT_REPRESENTATION) )

THEN (SWITCH_TWO_REPRESENTATIONS ?REL_IDX ?OTHER-REL T ?CLUSTER_ID ?SKEL_ID_NUMBER ?LIST_OF_REPS)

     NO CERTAINTY FACTOR
```

```
------------------------------------------------------------
RULES FOR SECTION 7.7 --> THE SKELETON ANALYSIS RULE GROUP.
------------------------------------------------------------
```

A SKELETON SHOULD BE DISCARDED IF ITS COST GREATER THAN OR EQUAL TO 100,000 PROCESSING SECONDS, AND THE COST OF THE SKELETON GREATER THAN OR EQUAL TO 1.25 TIMES THE COST OF THE ITS PARENT SKELETON.

```
 *** RULE SKEL_ANAL_1 ***

IF   (SKELETON-HISTORY ?PAR_ID_NUMBER ?ANCESTOR_ID ?PARCOST ?CLUSTER_ID )
     (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PAR_ID_NUMBERSKEL ?SKEL-COST ?CLUSTER_ID )
     (FUNCTION-CALL *>=* ?SKEL-COST 100000.0 )
     (FUNCTION-CALL DIVIDE ?SKEL-COST ?PARCOST ?QT )
     (FUNCTION-CALL *>=* ?QT 1.25 )

THEN (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID EXCESSIVE-COST)

     NO CERTAINTY FACTOR
```

A SKELETON SHOULD BE DISCARDED IF ITS COST IS LESS THAN 100000 IN PROCESSING SECONDS, AND THE COST OF THE SKELETON GREATER THAN OR EQUAL TO 2.0 TIMES THE COST OF THE ITS PARENT SKELETON.

```
 *** RULE SKEL_ANAL_2 ***

IF   (SKELETON-HISTORY ?PAR_ID_NUMBERSKEL ?ANOTHER ?PARCOST ?CLUSTER_ID )
     (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PAR_ID_NUMBER ?SKEL-COST ?CLUSTER_ID )
     (FUNCTION-CALL *>* 100000.0 ?SKEL-COST )
     (FUNCTION-CALL DIVIDE ?SKEL-COST ?PARCOST ?QT )
     (FUNCTION-CALL *>=* ?QT 2.0 )

THEN (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID EXCESSIVE-COST)

     NO CERTAINTY FACTOR
```

A SKELETON HAVING A LOWER COST SUCCESSOR SHOULD BE DISCARDED IF ITS COST IS GREATER THAN OR EQUAL TO 100,000 PROCESSING SECONDS, AND THE COST OF THE SKELETON GREATER THAN OR EQUAL TO 1.25 TIMES THE COST OF THE SUCCESSOR.

```
 *** RULE SKEL_ANAL_3 ***

IF   (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PAR_ID_NUMBER ?SKEL-COST ?CLUSTER_ID )
     (SKELETON-HISTORY ?PAR_ID_NUMBER ?GP ?PARCOST ?CLUSTER_ID )
     (FUNCTION-CALL *>=* ?SKEL-COST 100000.0 )
     (FUNCTION-CALL DIVIDE ?PARCOST ?SKEL-COST ?QT )
     (FUNCTION-CALL *>=* ?QT 1.25 )

THEN (DISCARD-SKELETON ?PAR_ID_NUMBER ?CLUSTER_ID BETTER-CHILD-COST)

     NO CERTAINTY FACTOR
```

A SKELETON HAVING A LOWER COST SUCCESSOR SHOULD DISCARDED IF ITS COST IS LESS THAN 100000 PROCESSING SECONDS, AND THE COST OF THE SKELETON GREATER THAN OR EQUAL TO 2.0 TIMES THE COST OF THE SUCCESSOR.

```
 *** RULE SKEL_ANAL_4 ***

IF   (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PAR_ID_NUMBER ?SKEL-COST ?CLUSTER_ID )
     (SKELETON-HISTORY ?PAR_ID_NUMBER ?GP ?PARCOST ?CLUSTER_ID )
     (FUNCTION-CALL *>* 100000.0 ?SKEL-COST )
     (FUNCTION-CALL DIVIDE ?PARCOST ?SKEL-COST ?QT )
     (FUNCTION-CALL *>=* ?QT 2.0 )

THEN (DISCARD-SKELETON ?PAR_ID_NUMBER ?CLUSTER_ID BETTER-CHILD-COST)

     NO CERTAINTY FACTOR
```

THIS RULE DISCARDS A SKELETON BECAUSE OF EXCESSIVE COST IN A CLUSTER WHERE ENUMERATION HAS TAKEN PLACE.

```
 *** RULE SKEL_ANAL_5 ***

IF   (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PAR_ID_NUMBER ?SKEL-COST ?CLUSTER_ID )
     (LOWEST-COST-SKEL ?CLUSTER_ID ?LOWSKEL ?LOWCOST )
     (FUNCTION-CALL MULTIPLY-VALUES ?LOWCOST 4 ?COST_CUTOFF )
     (FUNCTION-CALL *>* ?SKEL-COST ?COST_CUTOFF )

THEN (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID ENUMERATED_HIGH_COST_SKELETON)

     NO CERTAINTY FACTOR
```

A SKELETON SHOULD DISCARDED IF IT CONTAINS A RELATIONSHIP REPRESENTATION WHICH IS PART OF A CANONICAL RECORD THAT HAS BEEN DETERMINED TO BE INEFFICIENT BY THE DESIGN STRUCTURE EVALUATION GROUP.

```
 *** RULE SKEL_ANAL_6 ***

IF   (REPRESENTATION_CONCLUSION ?CLUSTER_ID GLOBAL_TO_CLUSTER ?REL_ID ?ENT1
          ?REPRESENTATION ?ENT2 INEFFICIENT_REPRESENTATION )
     (CONCLUSION_FOR_SKELETON ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 ?SKEL_ID_NUMBER ?RECORD_ID_NUMBER
               ?RECORD_LEN INEFFICIENT_REPRESENTATION )

THEN (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID INTERNAL-BAD-REP)

     NO CERTAINTY FACTOR
```

THE NEXT SIX RULES CONCLUDE A SKELETON SHOULD DISCARDED IF IT CONTAINS A CANONICAL RECORD WHICH EXCEEDS A DEVICE LENGTH LIMIT. SUCH RECORDS ARE CONSIDERED INFEASIBLE. THE RULES ARE APPLIED DURING SKELETON GENERATION ONLY FOR DESIGN PROBLEMS WHERE DEVICE LENGTH LIMITATIONS HAVE BEEN SPECIFIED BY THE USER. THE FIRST FOUR RULES TEMPORARILY DISCARD SKELETONS WITH EXCESSIVELY LONG RECORDS, THAT IS WHILE SKELETON GENERATION IS IN PROGRESS. THE LAST TWO RULES MAKE PERMANENT DETERMINATIONS AND ARE INVOKED AFTER SKELETON GENERATION OR ENUMERATION IS COMPLETE.

THIS RULE CONCLUDES THAT A SKELETON IS INFEASIBLE BECAUSE IT HAS A CANONICAL RECORD EXCEEDING A DEVICE LENGTH LIMITATION. THE NEXT FIVE RULES USE THIS CONCLUSION TO DISCARD SKELETONS IN VARIOUS SITUATIONS.

```
 *** RULE SKEL_ANAL_7 ***

IF   (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PAR_ID_NUMBER ?SKEL_COST ?CLUSTER_ID )
     (FUNCTION-CALL *LARGE-RECORD* ?CLUSTER_ID ?SKEL_ID_NUMBER ?REC-VAR ?LENGTH )

THEN (SKELETON_INFORMATION ?CLUSTER_ID ?SKEL_ID_NUMBER INFEASIBLE RECORD-LENGTH ?LENGTH)

     NO CERTAINTY FACTOR
```

```
THIS RULE DISCARDS THE FIRST SKELETON GENERATED IF IT HAS INFEASIBLE RECORDS
AND SUBSEQUENT SKELETONS HAVE BEEN GENERATED WHICH DO NOT HAVE INFEASIBLE RECORDS.

 *** RULE SKEL_ANAL_8 ***

IF   (USER-MESSAGE ALL-CG *ENF-TRACK-LIMITS* )
     (SKELETON-HISTORY ?SKEL_ID_NUMBER 1 ?SKEL_COST ?CLUSTER_ID )
     (SKELETON_INFORMATION ?CLUSTER_ID 1 INFEASIBLE RECORD-LENGTH ?LENGTH )
     (FUNCTION-CALL *WITHIN-TRACK-LENGTH-RECORDS* ?CLUSTER_ID ?ANOTHER-SKEL )

THEN (DISCARD-SKELETON 1 ?CLUSTER_ID RECORD-LENGTH)

     NO CERTAINTY FACTOR



THE NEXT TWO RULES APPLY TO SKELETONS GENERATED AFTER THE FIRST SKELETON. THE RULES CONCLUDE
THAT A SKELETON SHOULD BE TEMPORARILY DISCARDED BECAUSE IT CONTAINS AN INFEASIBLE RECORD WITH
A LENGTH EXCEEDING A DEVICE LENGTH LIMIT, AND THE RECORDS OF THE PARENT SKELETON ARE WITHIN LIMITS.

 *** RULE SKEL_ANAL_9 ***

IF   (USER-MESSAGE ALL-CG *ENF-TRACK-LIMITS* )
     (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PAR_ID_NUMBERENT_SKEL ?SKEL_COST ?CLUSTER_ID )
     (FUNCTION-CALL NOT-EQUAL ?SKEL_ID_NUMBER 1 )
     (SKELETON_INFORMATION ?CLUSTER_ID ?SKEL_ID_NUMBER INFEASIBLE RECORD-LENGTH ?LENGTH )
     (FUNCTION-CALL *WITHIN-TRACK-LENGTH-RECORDS* ?CLUSTER_ID ?PAR_ID_NUMBERENT_SKEL )

THEN (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID RECORD-LENGTH)

     NO CERTAINTY FACTOR



 *** RULE SKEL_ANAL_10 ***

IF   (USER-MESSAGE ALL-CG *ENF-TRACK-LIMITS* )
     (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PAR_ID_NUMBERENT_SKEL ?SKEL_COST ?CLUSTER_ID )
     (FUNCTION-CALL NOT-EQUAL ?SKEL_ID_NUMBER 1 )
     (SKELETON_INFORMATION ?CLUSTER_ID ?SKEL_ID_NUMBER INFEASIBLE RECORD-LENGTH ?LENGTH1 )
     (SKELETON_INFORMATION ?CLUSTER_ID ?PAR_ID_NUMBERENT_SKEL INFEASIBLE RECORD-LENGTH ?LENGTH2 )
     (FUNCTION-CALL *>* ?LENGTH1 ?LENGTH2 )

THEN (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID RECORD-LENGTH)

     NO CERTAINTY FACTOR
```

```
THIS RULE PERMANENTLY DISCARDS A SKELETON FROM SELECTION FOR FINE-TUNING BECAUSE OF
EXCESSIVE RECORD LENGTH AFTER THE RECORD PHASE OF SKELETON GENERATION IS COMPLETE.

 *** RULE SKEL_ANAL_11 ***

IF   (USER-MESSAGE ALL-CG *ENF-TRACK-LIMITS* )
     (MESSAGE ?CLUSTER_ID END-OF-RECORD-PHASE )
     (SKELETON_INFORMATION ?CLUSTER_ID ?SKEL_ID_NUMBER INFEASIBLE RECORD-LENGTH ?LENGTH )

THEN (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID INFEASIBLE_RECORD_STRUCTURE)

     NO CERTAINTY FACTOR



THIS RULE PERMANENTLY DISCARDS A SKELETON FROM SELECTION FOR FINE-TUNING BECAUSE OF EXCESSIVE RECORD
LENGTH IN A CLUSTER. IT IS APPLIED AFTER SKELETON ENUMERATION HAS TAKEN PLACE.

 *** RULE SKEL_ANAL_12 ***

IF   (USER-MESSAGE ALL-CG *ENF-TRACK-LIMITS* )
     (CG-DECISION ?CLUSTER_ID ?CLUSTER_SET_ID ?WHICH ENUMERATE_SKELETONS )
     (MESSAGE ?CLUSTER_ID END-OF-RECORD-PHASE )
     (SKELETON_INFORMATION ?CLUSTER_ID ?SKEL_ID_NUMBER INFEASIBLE RECORD-LENGTH ?LENGTH )

THEN (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID INFEASIBLE_RECORD_STRUCTURE)

     NO CERTAINTY FACTOR
```

```
THIS IS A RULE FOR IDENTIFYING A SKELETON AS HAVING A POSSIBLE LOCAL MINIMUM. THE RELATIONSHIP
?REL_TO_BE_CHANGED MUST HAVE ITS REPRESENTATION CHANGED TO ABSORPTION TO AVOID THE LOCAL MINIMUM.

 *** RULE SKEL_ANAL_13 ***

IF   (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PAR_ID_NUMBER ?SKEL_COST ?CLUSTER_ID )
     (SKELETON-HISTORY ?CHILD_SKEL_ID_OF ?SKEL_ID_NUMBER ?CHILD_COST ?CLUSTER_ID )
     (FUNCTION-CALL *>* ?SKEL_COST ?CHILD_COST )
     (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?CHILD_SKEL_ID_OF ?REL_ID ?ENT1 ABSORBS
               ?ABSORBED_ENTITY ?RESULT )
     (FUNCTION-CALL *IS-ONE-OF* ?RESULT (GOOD-REP BETTER) )
     (DEGREE-OF ?REL_TO_BE_CHANGED ?ENT2 ?ABSORBED_ENTITY 1 M )
     (FUNCTION-CALL NOT-EQUAL ?REL_ID ?REL_TO_BE_CHANGED )
     (RELATIONSHIP_CHARACTERIZATION ?REL_TO_BE_CHANGED ALTERNATE-ABSORPTION CHARACTERIZATION )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
                              ?REL_TO_BE_CHANGED ?ENT2 ABSORBS ?ABSORBED_ENTITY
                              INEFFICIENT_REPRESENTATION) )

THEN (SKELETON_INFORMATION ?CLUSTER_ID ?SKEL_ID_NUMBER LOCAL-MINIMUM-BRANCH
          ?REL_ID ?REL_TO_BE_CHANGED)

     NO CERTAINTY FACTOR



THE NEXT TWO RULES DISCARD SKELETONS BECAUSE THEY CONTAIN A CYCLE OF ABSORPTION.  THE EXISTENCE OF
THESE CONDITIONS IS DETERMINED ALGORITHMICALLY AND THE "MESSAGE" FACT EXPRESSIONS ARE THEN ADDED TO
THE DATABASE.

 *** RULE SKEL_ANAL_14 ***

IF   (MESSAGE ?CLUSTER_ID ?SKEL_ID_NUMBER ABSORPTION_CYCLE )

THEN (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID ABSORPTION_CYCLE)

     NO CERTAINTY FACTOR
```

```
THIS RULE IS THE SAME AS ABOVE EXCEPT IT PERTAINS TO A SKELETON CONTAINING AN ENTITY ABSORBED
ALONG TWO DIFFERENT RELATIONSHIPS.

 *** RULE SKEL_ANAL_15 ***

IF   (MESSAGE ?CLUSTER_ID ?SKEL_ID_NUMBER DOUBLE_ABSORB_RELATIONSHIP )

THEN (DISCARD-SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID DOUBLE_ABSORB_RELATIONSHIP)

     NO CERTAINTY FACTOR



THIS RULE CONCLUDES THAT A TEMPORARY INTERSECTION CLUSTER HAS A SIGNIFICANTLY LOWER COST.
THE RULE STATES THAT IF THE PHASE IS RECORD OR RESTRICTED RECORD, THE CLUSTER IS A TEMPORARY
INTERSECTION CLUSTER, A SKELETON WITH A COST 10% LOWER HAS BEEN GENERATED, THEN CONCLUDE THIS
IS A TEMPORARY INTERSECTION CLUSTER IN WHICH A SIGNIFICANTLY LOWER COST SKELETON HAS BEEN FOUND.
THE RELATIONSHIP WHICH WAS VARIED TO PRODUCE TO LOWER COST IS INSTANTIATED TO ?REL_ID.
SEE SECTION 7.3.

 *** RULE SKEL_ANAL_16 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (RECORD RESTRICTED-RECORD) )
     (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (CLUSTER ?CLUSTER_ID ?CLUSTER-SET )
     (FUNCTION-CALL EQUAL-TERMS ?CLUSTER-SET TEMPORARY_INTERSECTION_CLUSTER )
     (SKELETON-HISTORY ?SKEL_ID_NUMBER ?PAR_ID_NUMBER ?SKELCOST ?CLUSTER_ID )
     (SKELETON-HISTORY ?PAR_ID_NUMBER ?PAR_ID_NUMBER2 ?PAR_SKEL_COST ?CLUSTER_ID )
     (FUNCTION-CALL DIVIDE ?SKELCOST ?PAR_SKEL_COST ?PERCENT )
     (FUNCTION-CALL *<=* ?PERCENT 0.9 )
     (SELECT_FOR_ALTERATION ?REL_ID ?CLUSTER_ID ?SKEL_ID_NUMBER ?CRITICALITY )

THEN (LOW_COST_SKELETON_IN_INTERSECTION_CLUSTER ?CLUSTER_ID ?SKEL_ID_NUMBER ?REL_ID)

     NO CERTAINTY FACTOR
```

```
-----------------------------------------------------------------------
RULES FOR SECTION 7.8 --> THE DESIGN STRUCTURE EVALUATION RULE GROUP.
-----------------------------------------------------------------------

THIS RULE DETERMINES THAT ABSORPTION ALONG RELATIONSHIP ?REL_ID IS GLOBALLY INEFFICIENT FOR ALL
SKELETONS IN CLUSTER ?CLUSTER_ID IF THE PHASE IS RECORDS, ABSORPTION ALONG ?REL_ID WAS FOUND TO
BE BAD IN TWO RECORDS WITH LENGTHS WHICH VARY BY MORE THAN 15% OF EACH OTHER, THE ENTITY BEING
ABSORBED HAS A LARGE AMOUNT OF LARGE SUBSET RETRIEVAL ON IT.

 *** RULE REPRESENTATION_CONCLUSION_1 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID ?PHASE )
     (FUNCTION-CALL *IS-ONE-OF* ?PHASE (RECORD RESTRICTED-RECORD) )
     (CONCLUSION_FOR_SKELETON ?REL_ID ?ENT1 ABSORBS ?ENT2 ?SKEL_ID_NUMBER1
               ?RECORD_ID_NUMBER1 ?RECORD_LEN1 INEFFICIENT_REPRESENTATION )
     (CONCLUSION_FOR_SKELETON ?REL_ID ?ENT1 ABSORBS ?ENT2 ?SKEL_ID_NUMBER2
               ?RECORD_ID_NUMBER2 ?RECORD_LEN2 INEFFICIENT_REPRESENTATION )
     (ACTIVITY_CHARACTERIZATION_FOR ?ENT2 RETRIEVAL LARGE-SUBSET SIGNIFICANT )
     (FUNCTION-CALL NOT-EQUAL ?SKEL_ID_NUMBER1 ?SKEL_ID_NUMBER2 )
     (FUNCTION-CALL NOT-EQUAL ?RECORD_ID_NUMBER1 ?RECORD_ID_NUMBER2 )
     (FUNCTION-CALL *>=* ?RECORD_LEN1 ?RECORD_LEN2 )
     (FUNCTION-CALL DIVIDE ?RECORD_LEN2 ?RECORD_LEN1 ?Q )
     (FUNCTION-CALL *>=* 0.85 ?Q )

THEN (DESIGN_STRUCTURE_ANALYSIS ?CLUSTER_ID GLOBAL_TO_CLUSTER ?REL_ID ?ENT1 ABSORBS ?ENT2
          INEFFICIENT_REPRESENTATION)

     NO CERTAINTY FACTOR
```

A REPRESENTATION FOR RELATIONSHIP ?REL_ID IS GLOBALLY INEFFICIENT FOR ALL SKELETONS IN CLUSTER ?CLUSTER_ID IF THE PHASE IS RELATIONSHIPS, AND THE REPRESENTATION WAS FOUND TO BE BAD IN TWO RECORDS WITH LENGTHS VARY BY MORE THAN 15% OF EACH OTHER.

```
 *** RULE REPRESENTATION_CONCLUSION_2 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID RELATIONSHIP-PHASE )
     (CONCLUSION_FOR_SKELETON ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 ?SKEL_ID_NUMBER1
          ?RECORD_ID_NUMBER1 ?RECORD_LEN1 INEFFICIENT_REPRESENTATION )
     (CONCLUSION_FOR_SKELETON ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 ?SKEL_ID_NUMBER2
          ?RECORD_ID_NUMBER2 ?RECORD_LEN2 INEFFICIENT_REPRESENTATION )
     (FUNCTION-CALL NOT-EQUAL ?SKEL_ID_NUMBER1 ?SKEL_ID_NUMBER2 )
     (FUNCTION-CALL NOT-EQUAL ?RECORD_ID_NUMBER1 ?RECORD_ID_NUMBER2 )
     (FUNCTION-CALL *>=* ?RECORD_LEN1 ?RECORD_LEN2 )
     (DEVICE_LENGTH ?WHAT ?TRACK_LEN )
     (FUNCTION-CALL *>=* ?TRACK_LEN ?RECORD_LEN2 )
     (FUNCTION-CALL DIVIDE ?RECORD_LEN2 ?RECORD_LEN1 ?Q )
     (FUNCTION-CALL *>=* 0.85 ?Q )

THEN (DESIGN_STRUCTURE_ANALYSIS ?CLUSTER_ID GLOBAL_TO_CLUSTER
          ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2  INEFFICIENT_REPRESENTATION)

     NO CERTAINTY FACTOR
```

THIS IS A SIMILAR RULE WHICH APPLIES TO TWO RECORDS LONGER THAN A TRACK HAVING LENGTHS WITHIN 40% OF EACH OTHER. USER SPECIFIED DEVICE LENGTH RESTRICTIONS NEED NOT BE IN FORCE.

```
 *** RULE REPRESENTATION_CONCLUSION_3 ***

IF   (CONCLUDE_PHASE ?CLUSTER_ID RELATIONSHIP-PHASE )
     (CONCLUSION_FOR_SKELETON ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 ?SKEL_ID_NUMBER1
          ?RECORD_ID_NUMBER1 ?RECORD_LEN1 INEFFICIENT_REPRESENTATION )
     (CONCLUSION_FOR_SKELETON ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 ?SKEL_ID_NUMBER2
          ?RECORD_ID_NUMBER2 ?RECORD_LEN2 INEFFICIENT_REPRESENTATION )
     (FUNCTION-CALL NOT-EQUAL ?SKEL_ID_NUMBER1 ?SKEL_ID_NUMBER2 )
     (FUNCTION-CALL NOT-EQUAL ?RECORD_ID_NUMBER1 ?RECORD_ID_NUMBER2 )
     (FUNCTION-CALL *>=* ?RECORD_LEN1 ?RECORD_LEN2 )
     (DEVICE_LENGTH ?WHAT ?TRACK_LEN )
     (FUNCTION-CALL *>=* ?RECORD_LEN2 ?TRACK_LEN )
     (FUNCTION-CALL DIVIDE ?RECORD_LEN2 ?RECORD_LEN1 ?Q )
     (FUNCTION-CALL *>=* 0.6 ?Q )

THEN (DESIGN_STRUCTURE_ANALYSIS ?CLUSTER_ID GLOBAL_TO_CLUSTER
          ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 INEFFICIENT_REPRESENTATION)

     NO CERTAINTY FACTOR
```

```
THIS RULE DETERMINES THAT A SYMBOLIC POINTER FOR A RELATIONSHIP IS GLOBALLY EFFICIENT FOR ALL SKELETONS
IN A CLUSTER IF THE POINTER WAS PREVIOUSLY FOUND TO BE GOOD FOR IN A SKELETON OF THE SAME CLUSTER, AND
THE POINTER IS IN THE SAME DIRECTION AS A SIGNIFICANT AMOUNT OF NONFORWARDING CONTEXT ACTIVITY. THIS
RULE EFFECTIVELY CONFIRMS THE EXISTENCE OF A GOOD SOLUTION FOR A RELATIONSHIP WITH NONFORWARDING
CONTEXT ACTIVITY.

 *** RULE REPRESENTATION_CONCLUSION_4 ***

IF   (CONCLUSION_FOR_SKELETON ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT2 ?SKEL_ID_NUMBER1
          ?CR_NAME ?RECORD_LEN EFFICIENT_REPRESENTATION )
     (ACTIVITY_CHARACTERIZATION_FOR ?REL_ID ?ENT1 ?ENT2 NON_FORWARDING_CONTEXT_ACTIVITY ?ANY-SIZE
          SIGNIFICANT )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )

THEN (DESIGN_STRUCTURE_ANALYSIS ?CLUSTER_ID GLOBAL_TO_CLUSTER
          ?REL_ID ?ENT1 SYMBOL-POINTS-TO ?ENT2 EFFICIENT_REPRESENTATION)

     NO CERTAINTY FACTOR



THIS RULE CONCLUDES A RELATIONSHIP REPRESENTATION IS EFFICIENT FOR SKELETON ?SKEL_ID_NUMBER IF THIS
REPRESENTATION HAS NOT PREVIOUSLY BEEN FOUND TO BE INEFFICIENT IN ?SKEL_ID_NUMBER AND HAS NOT BEEN
FOUND TO BE GLOBALLY INEFFICIENT IN THE CLUSTER.

 *** RULE REPRESENTATION_CONCLUSION_5 ***

IF   (CURRENT_SKELETON ?SKEL_ID_NUMBER ?CLUSTER_ID )
     (RELATIONSHIP_IN_CLUSTER ?REL_ID ?CLUSTER_ID )
     (SKELETON ?CLUSTER_ID ?SKEL_ID_NUMBER ?SKEL-COST ?LIST_OF_REPS ?COST )
     (FUNCTION-CALL *EXTRACT-CURR-REP* ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 ?LIST_OF_REPS )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
                          ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 INEFFICIENT_REPRESENTATION) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ?SKEL_ID_NUMBER
                          ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 HIGHER_COST) )
     (COULD_NOT_CONCLUDE (REPRESENTATION_CONCLUSION ?CLUSTER_ID ALL_SKELETONS
                          ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2 INEFFICIENT_REPRESENTATION) )

THEN (EFFICIENT_REPRESENTATION_FOUND ?CLUSTER_ID ?SKEL_ID_NUMBER
          ?REL_ID ?ENT1 ?REPRESENTATION ?ENT2)

     NO CERTAINTY FACTOR
```

GLOSSARY

CLUSTER-ROOT-ENTITY - an independent entity having one or more dependent entities.

COMPUTE_CRITICALITY - compute criticality of relationship alteration.

DEPENDENT-ENTITY-HAS-LG-SUB-ACTIVITY-WITH-SELECTION - a dependent entity is the focus of large subset activity with selection criteria.

FREQ-INDEPENDENT-TO-INTERSECTION - total retrieval frequency from independent to dependent entity with no forwarding contexts.

FREQ-INTERSECTION-TO-INDEPENDENT - total retrieval frequency from dependent to independent entity with no forwarding contexts.

GET_LEAST_COST_VIABLE_SKELETON - the lowest cost, e.g. most efficient skeleton generated within a cluster.

INTERSECTION-NO-ATTRIBUTES - an intersection entity with no attributes.

TOTAL_DIRECT_ACTIVITY - total direct activity, e.g. initial context activity on a specific entity.

TOTAL_RELATIONSHIP_ACTIVITY - total all activity using a relationship, e.g. subsequent context activity.

ACTION-ON - determination of control module decision during selective skeleton generation.

ACTIVITY-CUTOFF-FOR-BREAKS - boundary between high and low activity for establishing break relationships.

ACTIVITY-CUTOFF-POINT-FOR-ENTITY - boundary between high and low retrieval activity for record.

ADJACENT_CLUSTERS - identifies two clusters as being adjacent, e.g. they have a connecting relationship between them.

ALL-ITEMS-FORM-IDENTIFIER-FOR - all attributes for the entity are part of primary identifier.

ASSOCIATE-INTERSECT-ENTITY-WITH-REL - intersection entity most strongly associated with independent entity along relationship.

BOND_RELATIONSHIP - indicates a conclusion prohibiting selection of this relationship as a breakpoint.

BREAK - indicates a relationship has been selected as a breakpoint.

CANON-RECORD-ANALYSIS - analysis predicate for canonical record.

CANON-RECORD-DETERMINATION - conclusion about record as part of solution.

CARDINALITY - indicates entity cardinality, e.g. number of instances of an entity.

CLUSTER-ACTION - determination of control module design action on cluster.

CLUSTER_CHARACTERIZATION - cluster characterization: cluster name, set name, characterization.

CLUSTER_PRIORITY - a measure of priority of an individual cluster for processing.

COMPLETELY_RECOMBINE - indicates complete recombination action.

CONCLUDED-BECAUSE-OF-FACTS--> - the preceding fact was concluded by the following list of facts.

CONCLUDE_PHASE - relationship generation phase - record or relationship, or combined.

CONCLUSION_FOR_SKELETON - indicates determination of efficiency or inefficiency of a relationship representation relevant to all skeletons in a cluster.

CONFLICTING-RETRIEVAL-CONTEXTS - indicates a relationship is involved in conflicting retrieval contexts.

COULD-NOT-CONCLUDE - the following fact could not be concluded.

CURRENT_SKELETON - identifies the skeleton selected to be worked on.

DBMS_REASONABLE_REPRESENTATION - translation of reasonable representation into form consistent with target database management system.

DEGREE-OF - indicates relationship degree, or relationship cardinality.

DEPENDS-ON - the first entity depends on the second.

DESCRIPTOR-COMPONENT - identifies an attribute as being part of the descriptor.

DEVICE_LENGTH - maximum allowable record based on physical device restriction.

DIRECT_ACTIVITY_ON_ENTITY - indicates total of direct activity on an entity according to subset size.

DISCARD-SKELETON - determination the skeleton will no longer be worked on and reason.

DIVIDE_CLUSTER - indicates a cluster will undergo division.

DIVIDE_COMPLETE - indicates a cluster has been subdivided with all 'child' clusters having completed processing.

DO_NOT_USE_REPRESENTATION_FOR - indicates there is a reason for not using a representation for a particular relationship.

EFFICIENT_REPRESENTATION - identifies an efficient relationship representation within the context of a particular canonical record.

ELIMINATE_REPRESENTATION - eliminate this relationship representation during relationship restriction.

ENTITY_LENGTH_80_20_SEGMENTATION - the total length of the entity and the length of the primary segment based on 80/20 rule.

ENTITY_LENGTH_FOR_ATTRIBUTES - the total length of the entity based on attributes alone.

ENUMERATED_HIGH_COST_SKELETON - identification of a skeleton which can be discarded during skeleton enumeration because of high cost.

EQUAL-TERMS - the following terms are equal.

FOLLOW-UP-DECISION - follow up determination of design action on a cluster.

FRAGMENT-PROHIBITS - indicates a relationship should not be used as breakpoint to prevent excessive fragmentation of cluster.

FUNCTION-CALL - call to function which returns value: function name and arguments.

GENERATED_CANONICAL_RECORDS - indicates canonical records have been generated for a cluster.

GLOBAL_TO_CLUSTER - indicates determination of efficiency or inefficiency of a relationship representation relevant to all skeletons in a cluster.

HEAVY-DESCRIPTOR-ACTIVITY - existence of heavy nonforwarding context.

IMPORTANCE-FACTOR - numeric factor indicating importance of cluster based on internal problems.

INEFFICIENT_REPRESENTATION - identifies an inefficient relationship representation within the context of a particular canonical record.

INITIAL-CONTEXT-RECORD - record is initial context for retrieval: record name, identifier, frequency.

INITIAL-DECISION - initial determination of design action to take on a cluster.

INITIAL_REASONABLE_REPRESENTATION - indicates this is initial reasonable representation chosen at the beginning of processing.

INVOKE_BREAKPOINT_GROUP - control module decision for use of a breakpoint selection rule group.

IN_DIVIDE_PROCESS - indicates a cluster has been subdivided and 'child' clusters are undergoing design actions.

LEAF_ENTITY - an entity which corresponds to a leaf node in the LDS, e.g. has only one relationship.

LOW_FORWARDING_% - characterization of low forwarding percentage for a relationship.

MEMBER-ENTITY - identifies an entity as a member of a cluster.

MINIMUM_CUTOFF_FOR - boundary between high and low retrieval activity for relationship.

NON_FORWARDING_CONTEXT_ACTIVITY - the descriptor is used as projection criteria, e.g. existence of nonforwarding context.

NON_FORWARDING_CONTEXT_ACTIVITY - indicates existence of nonforwarding context activity.

NUMBER-OF-ENTITIES-IN-CLUSTER - number of entities in a cluster.

NUMBER-SKELETONS-GENERATED - number of skeletons generated for the cluster.

NUMBER_OF_POTENTIAL_SKELETONS_FOR - number of skeletons in the cluster.

PARTIAL_ID_RELATIONSHIP - indicates a relationship is part of an entity identifier.

PREVENTS-WORK-ON-SET - reason not to work on descendent cluster set.

PREVENT_ALTERATION - indicates there is a reason to prevent alteration of a relationship.

PROPOSED-BREAK - indicates a relationship has been proposed as a breakpoint.

PROPOSE_REPRESENTATION_FOR - proposed representation for relationship.

QUALIFYING_FOR_ALTERATION - indicates a relationship recommended for alteration has no conclusions recommending preventing alteration.

RECOMMEND_FOR_ALTERATION - indicates a relationship is recommended for alteration of its representation.

RECORD_SIZE_LARGE - the record produced by absorption along this relationship would be very small.

RECORD_SIZE_SMALL_&_LEAF_ENTITY - the record produced by absorbing the leaf entity would be very small.

RELATIONSHIP_ACTIVITY - indicates total of activity forwarded along a relationship according to subset size.

RELATIONSHIP_CHARACTERIZATION - identification of relationship as problem area or relationship of interest.

RELATIONSHIP_IN_CLUSTER - relationship belonging to a particular cluster.

REL_ACTIVITY_FORWARDED_TO_ENTITY - total activity on entity along relationships.

REPRESENTATION_CONCLUSION - a representation which was varied to and the resulting conclusion.

RESTRICT-REPRESENTATIONS - decision to apply rules to restrict representations.

SELECT-SPECIAL-REPS - decision to apply rules to select specialized representations.

SELECTED-REP - relationship representation is considered for processing in a particular cluster.

SELECT_FOR_ALTERATION - identifies a single relationship as selected for alteration.

SIGNIFICANT_WORKLOAD_COMPLEXITY - characterizes relationship as having significant workload complexity.

SKELETON-HISTORY - contains parent skeleton, cost, and name of a cluster.

TOTAL-ACTIVITY-ON-RELATIONSHIP - total activity on relationship.

TOTAL-ENTITY-DELETION-FREQUENCY - frequency of entity deletion.

TOTAL-ENTITY-INSERTION-FREQUENCY - frequency of entity insertion.

TOTAL_ALTERATION_CRITICALITY - indicates total alteration criticality for a relationship recommended for alteration.

TOTAL_DIRECT_ACTIVITY_ON_ENTITIES_IN - total retrieval frequency for relationship entities weighted by retrieval size.

TRIVIAL_SIZE_MANY_ENTITY - the record produced by absorption along this relationship would be very small.

TWO-PRIMARY-IDENTIFYING-RELATIONSHIPS - entity has more than one relationship which is part of the primary identifier.

TYPE-OF-ENTITY - one of four major entity types.

VERY-HEAVY-DESCRIPTOR-ACTIVITY - existence of very heavy nonforwarding context.

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11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

A knowledge-based system for physical database design has been developed at the National Computer Systems Laboratory. This system was previously described in NIST Special Publication 500-151. This is a follow-up report to that publication which describes the knowledge base for this system in detail. The description includes a complete explanation of each component of the knowledge base together with the actual rules used by the system.

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certainty factor; entity-relationship model; inference engine; knowledge-based system; logical data structure; physical database design.

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