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PDES PHYSICAL FILE EXCHANGE TESTING IN THE PDES TESTBED VALIDATION SYSTEM

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**U.S. DEPARTMENT OF COMMERCE
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February 8, 1990

PDES Physical File Exchange Testing in the PDES Validation System

1.0 Introduction

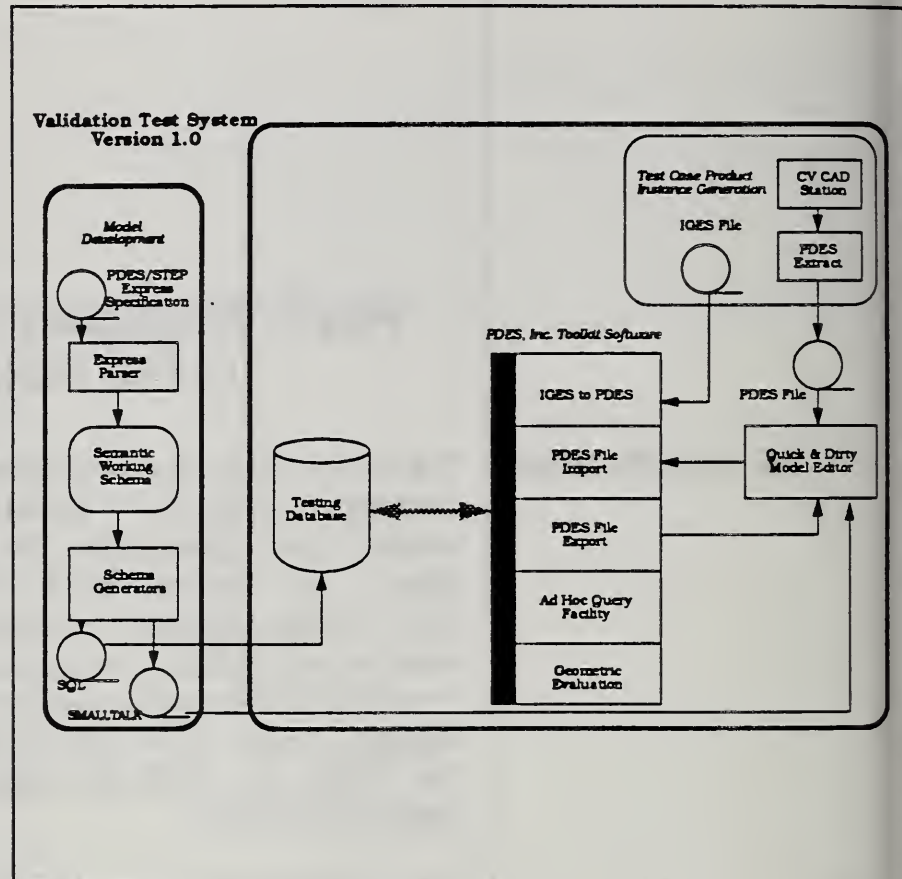
The Product Data Exchange Specification (PDES) [Smith88] is an emerging standard that is intended to address the problems of data exchange and representation for a variety of manufacturing enterprises. The National PDES Testbed is a facility established at NIST for the purposes of validating, testing, developing software tools for, and refining the proposed standard [Furlani89]. Some of this effort is being performed in conjunction with industrial partners through research agreements and memorandums of understanding. The PDES, Inc. [SCRA89] industrial consortium is a key NIST partner in this effort.

The PDES, Inc. Technical Products Implementation (TPI) team and the Testbed staff have developed initial, prototype software systems that are being used to perform validation testing of the specification. The set of software systems involved are known collectively as the Validation Test System Version 1.0 (see Figure 1). Since there are several software modules involved, it was imperative that the ability for these software modules to exchange test data be verified. The object of this report is to discuss the results of an investigation into the PDES data exchange capability of three of the primary software components.

2.0 Software Tested

The Testbed staff wished to show that a PDES physical file could be output from the Computervision CAD system, passed through the Quick & Dirty Model Editor (QDES) [Clark90], and finally passed through the TPI-developed PDES Inc. Toolkit System (PITS) software [Cheever89]. Aside from ensuring that a file could be passed through the systems, we also wanted to learn what side effects, if any, the software systems would have on the content or structure of the physical file. Figure 1 shows the configuration of the Validation Testing Architecture and the relationships between the software under test.

Figure 1: Validation Testing Architecture



3.0 Test Results

The goal of passing a physical file that originated from the CAD system all the way through to the PITS software has been achieved. Completing this activity took approximately three months overall, during which time numerous bugs were fixed in all of the software components involved. The problems that were encountered included some which might be considered trivial in nature but were sufficiently serious to prevent successful file exchange; examples of these problems included incorrect comment delimiters and improper structuring of the HEADER section of the file. The most serious problem that arose in the testing was the inability of the PITS software to recognize topological entities (the data extracted from the CAD system includes entities from the Topology topological model). This problem was eventually resolved by creating a Topology model in Express [Schenck89] based on the original Tokyo IPIM version, that could be parsed by the PITS software¹.

There are indeed a few side-effects caused by the software on the physical file. When a file passes through QDES any comments that were present in the input file are lost when the physical file is output from QDES. Passing a file through QDES also has the effect of "un-embedding" embedded data in the input file; i.e., embedded data entities (which are only present in files extracted from the CAD system) are assigned their own entity ID and a reference to this ID is created in the originating entity. This is beneficial because the PITS software does not accept embedded entities, on the other hand it makes it difficult to keep track of a particular data entity by its ID because the data entities are assigned new IDs upon input to QDES. Passing a file through the PITS software also changes the entity IDs, so once again, tracking data by its initial entity ID is not possible.

1. The author thanks Len Slovinsky of PDES, Inc. and Steve Clark of NIST for their cooperation, guidance, and timely bug fixes.

Table I summarizes the physical file exchange capabilities that have been tested.

Table 1: Exchange Capability Summary

		TO		
		CV CAD	QDES	PITS
FROM	CV CAD	●	× ¹	●
	QDES	●	×	× ²
	PITS	●	× ³	×

Notes

• indicates exchange not possible

X indicates exchange possible with the following qualifications:

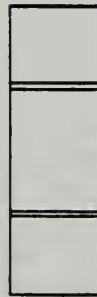
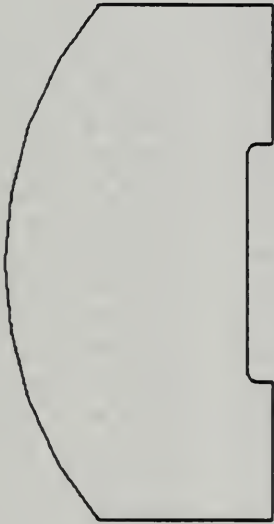
1. Output of CAD system is intermediate file which must be passed through a program to obtain the desired PDES physical file.
2. Must only use Geometry1A option in PITS if the data originated from CV CAD.
3. Exchange file produced by PITS must be passed through filter program before it will be accepted by QDES.

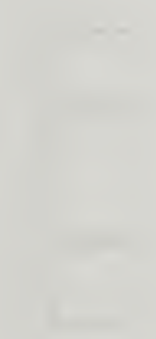
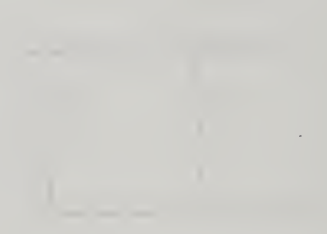
An example of the test data resulting from each of the systems is given in the appendices.

4.0 References

- [Cheever89] Cheever, R., "PITS User Guide", PDES, Inc. Internal Document, August 1989.
- [Clark90] Clark, S., "QDES Users' Guide", National Institute of Standards and Technology, Gaithersburg, MD, February 1990 Draft.
- [Furlani89] Furlani, C., "The National PDES Testbed - An Overview", Presented at UPCAEDM '89, July 23-26, 1989, Laramie, WY.
- [Schenck89] Schenck, D., ed., "Information Modeling Language Express: Language Reference Manual", ISO TC184/SC4/WG1 Document N362, May 1989.
- [SCRA89] South Carolina Research Authority, "PDES, Inc. Program Technical Development Plan", Charleston, SC, August 3, 1989.
- [Smith88b] Smith, B., and Rinaudot, G., eds., "Product Data Exchange Specification", NISTIR 88-4004, National Institute of Standards and Technology, Gaithersburg, MD, December 1988.

APPENDIX A: Drawing of Example Part





APPENDIX B: Physical File Derived From CV CAD System

```
STEP;  
HEADER;  
FILE_IDENTIFICATION(  
  'SPACER',  
  '19891027.101138',  
  ('Tina Lee & Sandy Ressler, (301)-975-3550 or 3549'),  
  ('National Bureau of Standards, Factory Automation Systems Division'),  
  'STEP VERSION 1.0',  
  'AMRF Part Model to Step File Translator, Version 1.0',  
  'AMRF PART MODEL');  
FILE_DESCRIPTION('THIS FILE IS TRANSLATED FROM AN AMRF PART MODEL  
FILE');  
IMP_LEVEL('1.0');  
ENDSEC;
```

```
DATA;  
@1 = CARTESIAN_POINT( , 0.000000, 0.000000, 0.000000);  
@2 = CARTESIAN_POINT( , -1.813000, -1.375000, 0.000000);  
@3 = CARTESIAN_POINT( , -1.813000, 1.375000, 0.000000);  
@4 = CARTESIAN_POINT( , -2.500000, -3.250000, 2.000000);  
@5 = CARTESIAN_POINT( , -0.969000, -1.500000, 2.000000);  
@6 = CARTESIAN_POINT( , -1.813000, -1.375000, 2.000000);  
@7 = CARTESIAN_POINT( , -1.938000, -1.375000, 2.000000);  
@8 = CARTESIAN_POINT( , 0.000000, 0.000000, 2.000000);  
@9 = CARTESIAN_POINT( , -5.000000, 0.000000, 2.000000);  
@10 = CARTESIAN_POINT( , -3.799672, 3.250000, 2.000000);  
@11 = CARTESIAN_POINT( , -1.625000, 1.625000, 2.000000);  
@12 = CARTESIAN_POINT( , -0.812500, 3.250000, 2.000000);  
@13 = CARTESIAN_POINT( , -0.812500, 1.500000, 2.000000);  
@14 = CARTESIAN_POINT( , -1.938000, -0.750000, 2.000000);  
@15 = CARTESIAN_POINT( , -1.813000, 1.375000, 2.000000);  
@16 = CARTESIAN_POINT( , -1.813000, 1.500000, 2.000000);  
@17 = CARTESIAN_POINT( , -2.500000, -3.250000, 0.000000);  
@18 = CARTESIAN_POINT( , -0.969000, -1.500000, 0.000000);  
@19 = CARTESIAN_POINT( , -1.813000, -1.500000, 0.000000);  
@20 = CARTESIAN_POINT( , -5.000000, 0.000000, 0.000000);  
@21 = CARTESIAN_POINT( , -3.799672, -3.250000, 0.000000);  
@22 = CARTESIAN_POINT( , -1.625000, 1.625000, 0.000000);  
@23 = CARTESIAN_POINT( , -0.812500, 3.250000, 0.000000);  
@24 = CARTESIAN_POINT( , -0.812500, 1.500000, 0.000000);  
@25 = CARTESIAN_POINT( , -1.938000, -0.750000, 0.000000);  
@26 = CARTESIAN_POINT( , -1.938000, 1.375000, 0.000000);  
@27 = CARTESIAN_POINT( , -3.799671, -3.250000, 0.000000);  
@28 = CARTESIAN_POINT( , -3.799671, 3.250000, 1.000000);  
@29 = CARTESIAN_POINT( , -1.625000, -3.250000, 1.000000);  
@30 = CARTESIAN_POINT( , -1.625000, -1.500000, 1.000000);  
@31 = CARTESIAN_POINT( , -1.625000, 3.250000, 2.000000);  
@32 = CARTESIAN_POINT( , -1.625000, 1.500000, 2.000000);  
@33 = CARTESIAN_POINT( , -1.813000, 1.500000, 1.000000);
```

```

@34 = CARTESIAN_POINT( , -1.938000, -1.375000, 0.000000);
@35 = CARTESIAN_POINT( , -3.799671, -3.250000, 2.000000);
@36 = CARTESIAN_POINT( , -1.624985, -3.250000, 2.000000);
@37 = CARTESIAN_POINT( , -1.624985, -1.500000, 2.000000);
@38 = CARTESIAN_POINT( , -1.813000, -1.500000, 2.000000);
@39 = CARTESIAN_POINT( , -1.625000, 3.250015, 2.000000);
@40 = CARTESIAN_POINT( , -1.938000, 1.375000, 2.000000);
@41 = CARTESIAN_POINT( , -1.624985, -3.250000, 0.000000);
@42 = CARTESIAN_POINT( , -1.624985, -1.500000, 0.000000);
@43 = CARTESIAN_POINT( , -3.799672, 3.250000, 0.000000);
@44 = CARTESIAN_POINT( , -1.625000, 3.250015, 0.000000);
@45 = CARTESIAN_POINT( , -1.625000, 1.500000, 0.000000);
@46 = CARTESIAN_POINT( , -1.813000, 1.500000, 0.000000);
@47 = DIRECTION( , 0.000000, 0.000000, 1.000000);
@48 = DIRECTION( , 0.000000, 0.000000, -1.000000);
@49 = DIRECTION( , 1.000000, 0.000000, 0.000000);
@50 = DIRECTION( , 0.000000, 1.000000, 0.000000);
@51 = DIRECTION( , 0.000000, -1.000000, 0.000000);
@52 = DIRECTION( , -1.000000, 0.000000, 0.000000);
@53 = LINE( , #4, #49);
@54 = LINE( , #5, #49);
@55 = CIRCLE( , 0.125000, AXIS2_PLACEMENT( , #6, #47,
DIRECTION( , -1.000000, 0.000000, 0.000000)));
@56 = CIRCLE( , 5.000000, AXIS2_PLACEMENT( , #8, #47,
DIRECTION( , -1.000000, 0.000000, 0.000000)));
@57 = CIRCLE( , 5.000001, AXIS2_PLACEMENT( , #8, #47,
DIRECTION( , -0.759934, 0.650000, 0.000000)));
@58 = LINE( , #11, #50);
@59 = LINE( , #11, #50);
@60 = LINE( , #12, #52);
@61 = LINE( , #13, #52);
@62 = LINE( , #14, #51);
@63 = CIRCLE( , 0.125000, AXIS2_PLACEMENT( , #15, #47,
DIRECTION( , 0.000000, 1.000000, 0.000000)));
@64 = LINE( , #17, #52);
@65 = LINE( , #18, #52);
@66 = CIRCLE( , 0.125000, AXIS2_PLACEMENT( , #2, #48,
DIRECTION( , 0.000000, -1.000000, 0.000000)));
@67 = CIRCLE( , 5.000000, AXIS2_PLACEMENT( , #1, #48,
DIRECTION( , -1.000000, 0.000000, 0.000000)));
@68 = CIRCLE( , 5.000001, AXIS2_PLACEMENT( , #1, #48,
DIRECTION( , -0.759934, -0.650000, 0.000000)));
@69 = LINE( , #22, #51);
@70 = LINE( , #22, #51);
@71 = LINE( , #23, #49);
@72 = LINE( , #24, #49);
@73 = LINE( , #25, #50);
@74 = CIRCLE( , 0.125000, AXIS2_PLACEMENT( , #3, #48,
DIRECTION( , -1.000000, 0.000000, 0.000000)));
@75 = LINE( , #27, #47);
@76 = LINE( , #28, #47);
@77 = LINE( , #29, #48);

```



```

@78 = LINE( , #30, #48);
@79 = LINE( , #31, #47);
@80 = LINE( , #32, #47);
@81 = LINE( , #33, #47);
@82 = LINE( , #34, #47);
@83 = LINE( , #26, #47);
@84 = LINE( , #19, #47);
@85 = PLANE( , AXIS2_PLACEMENT( ,
    CARTESIAN_POINT( , 0.000000, 0.000000, 2.000000), #47, ));
@86 = PLANE( , AXIS2_PLACEMENT( ,
    CARTESIAN_POINT( , 0.000000, 0.000000, -0.000000), #48, ));
@87 = CYLINDRICAL_SURFACE( , 5.000000, AXIS2_PLACEMENT( , #1, #47, ));
@88 = PLANE( , AXIS2_PLACEMENT( ,
    CARTESIAN_POINT( , -1.625000, -0.000000, -0.000000), #49, ));
@89 = PLANE( , AXIS2_PLACEMENT( ,
    CARTESIAN_POINT( , 0.000000, 3.250000, 0.000000), #50, ));
@90 = PLANE( , AXIS2_PLACEMENT( ,
    CARTESIAN_POINT( , 0.000000, -3.250000, 0.000000), #51, ));
@91 = PLANE( , AXIS2_PLACEMENT( ,
    CARTESIAN_POINT( , -0.000000, 1.500000, -0.000000), #51, ));
@92 = PLANE( , AXIS2_PLACEMENT( ,
    CARTESIAN_POINT( , -1.938000, -0.000000, -0.000000), #49, ));
@93 = PLANE( , AXIS2_PLACEMENT( ,
    CARTESIAN_POINT( , -0.000000, -1.500000, -0.000000), #50, ));
@94 = CYLINDRICAL_SURFACE( , 0.125000, AXIS2_PLACEMENT( , #2, #47, ));
@95 = CYLINDRICAL_SURFACE( , 0.125000, AXIS2_PLACEMENT( , #3, #47, ));
@96 = VERTEX( #35);
@97 = VERTEX( #36);
@98 = VERTEX( #37);
@99 = VERTEX( #38);
@100 = VERTEX( #7);
@101 = VERTEX( #9);
@102 = VERTEX( #10);
@103 = VERTEX( #32);
@104 = VERTEX( #39);
@105 = VERTEX( #16);
@106 = VERTEX( #40);
@107 = VERTEX( #41);
@108 = VERTEX( #27);
@109 = VERTEX( #19);
@110 = VERTEX( #42);
@111 = VERTEX( #34);
@112 = VERTEX( #20);
@113 = VERTEX( #43);
@114 = VERTEX( #44);
@115 = VERTEX( #45);
@116 = VERTEX( #46);
@117 = VERTEX( #26);
@118 = EDGE( #96, #97, CURVE_LOGICAL_STRUCTURE(#53, .T.));
@119 = EDGE( #97, #98, CURVE_LOGICAL_STRUCTURE(#58, .T.));
@120 = EDGE( #103, #104, CURVE_LOGICAL_STRUCTURE(#59, .T.));
@121 = EDGE( #104, #102, CURVE_LOGICAL_STRUCTURE(#60, .T.));

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@122 = EDGE( #102, #101, CURVE_LOGICAL_STRUCTURE(#57, .T.));
@123 = EDGE( #101, #96, CURVE_LOGICAL_STRUCTURE(#56, .T.));
@124 = EDGE( #107, #108, CURVE_LOGICAL_STRUCTURE(#64, .T.));
@125 = EDGE( #108, #112, CURVE_LOGICAL_STRUCTURE(#68, .T.));
@126 = EDGE( #112, #113, CURVE_LOGICAL_STRUCTURE(#67, .T.));
@127 = EDGE( #113, #114, CURVE_LOGICAL_STRUCTURE(#71, .T.));
@128 = EDGE( #114, #115, CURVE_LOGICAL_STRUCTURE(#69, .T.));
@129 = EDGE( #110, #107, CURVE_LOGICAL_STRUCTURE(#70, .T.));
@130 = EDGE( #108, #96, CURVE_LOGICAL_STRUCTURE(#75, .T.));
@131 = EDGE( #114, #104, CURVE_LOGICAL_STRUCTURE(#79, .T.));
@132 = EDGE( #97, #107, CURVE_LOGICAL_STRUCTURE(#77, .T.));
@133 = EDGE( #113, #102, CURVE_LOGICAL_STRUCTURE(#76, .T.));
@134 = EDGE( #116, #115, CURVE_LOGICAL_STRUCTURE(#72, .T.));
@135 = EDGE( #115, #103, CURVE_LOGICAL_STRUCTURE(#80, .T.));
@136 = EDGE( #103, #105, CURVE_LOGICAL_STRUCTURE(#61, .T.));
@137 = EDGE( #111, #117, CURVE_LOGICAL_STRUCTURE(#73, .T.));
@138 = EDGE( #117, #106, CURVE_LOGICAL_STRUCTURE(#83, .T.));
@139 = EDGE( #106, #100, CURVE_LOGICAL_STRUCTURE(#62, .T.));
@140 = EDGE( #110, #109, CURVE_LOGICAL_STRUCTURE(#65, .T.));
@141 = EDGE( #109, #99, CURVE_LOGICAL_STRUCTURE(#84, .T.));
@142 = EDGE( #99, #98, CURVE_LOGICAL_STRUCTURE(#54, .T.));
@143 = EDGE( #98, #110, CURVE_LOGICAL_STRUCTURE(#78, .T.));
@144 = EDGE( #109, #111, CURVE_LOGICAL_STRUCTURE(#66, .T.));
@145 = EDGE( #111, #100, CURVE_LOGICAL_STRUCTURE(#82, .T.));
@146 = EDGE( #100, #99, CURVE_LOGICAL_STRUCTURE(#55, .T.));
@147 = EDGE( #117, #116, CURVE_LOGICAL_STRUCTURE(#74, .T.));
@148 = EDGE( #116, #105, CURVE_LOGICAL_STRUCTURE(#81, .T.));
@149 = EDGE( #105, #106, CURVE_LOGICAL_STRUCTURE(#63, .T.));
@150 = EDGE_LOOP( (
    EDGE_LOGICAL_STRUCTURE(#118, .T.),
    EDGE_LOGICAL_STRUCTURE(#119, .T.),
    EDGE_LOGICAL_STRUCTURE(#142, .F.),
    EDGE_LOGICAL_STRUCTURE(#146, .F.),
    EDGE_LOGICAL_STRUCTURE(#139, .F.),
    EDGE_LOGICAL_STRUCTURE(#149, .F.),
    EDGE_LOGICAL_STRUCTURE(#136, .F.),
    EDGE_LOGICAL_STRUCTURE(#120, .T.),
    EDGE_LOGICAL_STRUCTURE(#121, .T.),
    EDGE_LOGICAL_STRUCTURE(#122, .T.),
    EDGE_LOGICAL_STRUCTURE(#123, .T.) );
@151 = EDGE_LOOP( (
    EDGE_LOGICAL_STRUCTURE(#124, .T.),
    EDGE_LOGICAL_STRUCTURE(#125, .T.),
    EDGE_LOGICAL_STRUCTURE(#126, .T.),
    EDGE_LOGICAL_STRUCTURE(#127, .T.),
    EDGE_LOGICAL_STRUCTURE(#128, .T.),
    EDGE_LOGICAL_STRUCTURE(#134, .F.),
    EDGE_LOGICAL_STRUCTURE(#147, .F.),
    EDGE_LOGICAL_STRUCTURE(#137, .F.),
    EDGE_LOGICAL_STRUCTURE(#144, .F.),
    EDGE_LOGICAL_STRUCTURE(#140, .F.),
    EDGE_LOGICAL_STRUCTURE(#129, .T.) );

```



```

@152 = EDGE_LOOP( (
EDGE_LOGICAL_STRUCTURE(#126, F.),
EDGE_LOGICAL_STRUCTURE(#125, F.),
EDGE_LOGICAL_STRUCTURE(#130, .T.),
EDGE_LOGICAL_STRUCTURE(#123, F.),
EDGE_LOGICAL_STRUCTURE(#122, F.),
EDGE_LOGICAL_STRUCTURE(#133, F.) ));
@153 = EDGE_LOOP( (
EDGE_LOGICAL_STRUCTURE(#128, F.),
EDGE_LOGICAL_STRUCTURE(#131, .T.),
EDGE_LOGICAL_STRUCTURE(#120, F.),
EDGE_LOGICAL_STRUCTURE(#135, F.) ));
@154 = EDGE_LOOP( (
EDGE_LOGICAL_STRUCTURE(#129, F.),
EDGE_LOGICAL_STRUCTURE(#143, F.),
EDGE_LOGICAL_STRUCTURE(#119, F.),
EDGE_LOGICAL_STRUCTURE(#132, .T.) ));
@155 = EDGE_LOOP( (
EDGE_LOGICAL_STRUCTURE(#127, F.),
EDGE_LOGICAL_STRUCTURE(#133, .T.),
EDGE_LOGICAL_STRUCTURE(#121, F.),
EDGE_LOGICAL_STRUCTURE(#131, F.) ));
@156 = EDGE_LOOP( (
EDGE_LOGICAL_STRUCTURE(#124, F.),
EDGE_LOGICAL_STRUCTURE(#132, F.),
EDGE_LOGICAL_STRUCTURE(#118, F.),
EDGE_LOGICAL_STRUCTURE(#130, F.) ));
@157 = EDGE_LOOP( (
EDGE_LOGICAL_STRUCTURE(#134, .T.),
EDGE_LOGICAL_STRUCTURE(#135, .T.),
EDGE_LOGICAL_STRUCTURE(#136, .T.),
EDGE_LOGICAL_STRUCTURE(#148, F.) ));
@158 = EDGE_LOOP( (
EDGE_LOGICAL_STRUCTURE(#137, .T.),
EDGE_LOGICAL_STRUCTURE(#138, .T.),
EDGE_LOGICAL_STRUCTURE(#139, .T.),
EDGE_LOGICAL_STRUCTURE(#145, F.) ));
@159 = EDGE_LOOP( (
EDGE_LOGICAL_STRUCTURE(#140, .T.),
EDGE_LOGICAL_STRUCTURE(#141, .T.),
EDGE_LOGICAL_STRUCTURE(#142, .T.),
EDGE_LOGICAL_STRUCTURE(#143, .T.) ));
@160 = EDGE_LOOP( (
EDGE_LOGICAL_STRUCTURE(#144, .T.),
EDGE_LOGICAL_STRUCTURE(#145, .T.),
EDGE_LOGICAL_STRUCTURE(#146, .T.),
EDGE_LOGICAL_STRUCTURE(#141, F.) ));
@161 = EDGE_LOOP( (
EDGE_LOGICAL_STRUCTURE(#147, .T.),
EDGE_LOGICAL_STRUCTURE(#148, .T.),
EDGE_LOGICAL_STRUCTURE(#149, .T.),
EDGE_LOGICAL_STRUCTURE(#138, F.) ));

```

```

@162 = FACE( , (
  LOOP_LOGICAL_STRUCTURE(#150, .T.) ),
  SURFACE_LOGICAL_STRUCTURE(#85, .T.));
@163 = FACE( , (
  LOOP_LOGICAL_STRUCTURE(#151, .T.) ),
  SURFACE_LOGICAL_STRUCTURE(#86, .T.));
@164 = FACE( , (
  LOOP_LOGICAL_STRUCTURE(#152, .T.) ),
  SURFACE_LOGICAL_STRUCTURE(#87, .F.));
@165 = FACE( , (
  LOOP_LOGICAL_STRUCTURE(#153, .T.) ),
  SURFACE_LOGICAL_STRUCTURE(#88, .T.));
@166 = FACE( , (
  LOOP_LOGICAL_STRUCTURE(#155, .T.) ),
  SURFACE_LOGICAL_STRUCTURE(#89, .T.));
@167 = FACE( , (
  LOOP_LOGICAL_STRUCTURE(#156, .T.) ),
  SURFACE_LOGICAL_STRUCTURE(#90, .T.));
@168 = FACE( , (
  LOOP_LOGICAL_STRUCTURE(#157, .T.) ),
  SURFACE_LOGICAL_STRUCTURE(#91, .T.));
@169 = FACE( , (
  LOOP_LOGICAL_STRUCTURE(#158, .T.) ),
  SURFACE_LOGICAL_STRUCTURE(#92, .T.));
@170 = FACE( , (
  LOOP_LOGICAL_STRUCTURE(#159, .T.) ),
  SURFACE_LOGICAL_STRUCTURE(#93, .T.));
@171 = FACE( , (
  LOOP_LOGICAL_STRUCTURE(#160, .T.) ),
  SURFACE_LOGICAL_STRUCTURE(#94, .T.));
@172 = FACE( , (
  LOOP_LOGICAL_STRUCTURE(#161, .T.) ),
  SURFACE_LOGICAL_STRUCTURE(#95, .T.));
@173 = FACE( , (
  LOOP_LOGICAL_STRUCTURE(#154, .T.) ),
  SURFACE_LOGICAL_STRUCTURE(#88, .T.));
@174 = CLOSED_SHELL( (
  FACE_LOGICAL_STRUCTURE(#162, .T.),
  FACE_LOGICAL_STRUCTURE(#163, .T.),
  FACE_LOGICAL_STRUCTURE(#164, .T.),
  FACE_LOGICAL_STRUCTURE(#165, .T.),
  FACE_LOGICAL_STRUCTURE(#166, .T.),
  FACE_LOGICAL_STRUCTURE(#167, .T.),
  FACE_LOGICAL_STRUCTURE(#168, .T.),
  FACE_LOGICAL_STRUCTURE(#169, .T.),
  FACE_LOGICAL_STRUCTURE(#170, .T.),
  FACE_LOGICAL_STRUCTURE(#171, .T.),
  FACE_LOGICAL_STRUCTURE(#172, .T.),
  FACE_LOGICAL_STRUCTURE(#173, .T.) ));
ENDSEC;

```

ENDSTEP;

APPENDIX C: Physical File Output From QDES

```
STEP;
HEADER;
FILE_IDENTIFICATION(
''
'(12 January 1990 1:11:43 pm)',
('Steve Clark'),
('(National Institute of Standards and Technology)'),
'STEP VERSION1.0',
'QDES Smalltalk Editor',
'');
FILE_DESCRIPTION('THIS FILE HAS BEEN MODIFIED BY THE QDES EDITOR');
IMP_LEVEL('1.0');
ENDSEC;
DATA;
@1 = CARTESIAN_POINT(, 0.0, 0.0, 2.0);
@2 = DIRECTION(, 0.0, 0.0, -1.0);
@3 = CARTESIAN_POINT(, -1.813, 1.5, 0.0);
@4 = DIRECTION(, -1.0, 0.0, 0.0);
@5 = CARTESIAN_POINT(, -1.813, -1.5, 2.0);
@6 = DIRECTION(, -1.0, 0.0, 0.0);
@7 = CARTESIAN_POINT(, 0.0, 0.0, 0.0);
@8 = CARTESIAN_POINT(, -1.813, 1.375, 0.0);
@9 = CARTESIAN_POINT(, -1.62498, -1.5, 2.0);
@10 = DIRECTION(, 0.0, 0.0, 1.0);
@11 = CARTESIAN_POINT(, -1.625, -1.5, 1.0);
@12 = AXIS2_PLACEMENT(, #7, #2, #6);
@13 = AXIS2_PLACEMENT(, #8, #2, #4);
@14 = DIRECTION(, -0.759934, -0.65, 0.0);
@15 = CIRCLE(, 5.0, #12);
@16 = VERTEX(#5);
@17 = CARTESIAN_POINT(, -1.938, -1.375, 2.0);
@18 = DIRECTION(, -1.0, 0.0, 0.0);
@19 = AXIS2_PLACEMENT(, #1, #10, #18);
@20 = LINE(, #11, #2);
@21 = DIRECTION(, 1.0, 0.0, 0.0);
@22 = CARTESIAN_POINT(, -0.969, -1.5, 2.0);
@23 = CARTESIAN_POINT(, -1.938, 1.375, 2.0);
@24 = VERTEX(#9);
@25 = CIRCLE(, 0.125, #13);
@26 = LINE(, #22, #21);
@27 = CURVE_LOGICAL_STRUCTURE(#26, .T.);
@28 = AXIS2_PLACEMENT(, #7, #2, #14);
@29 = DIRECTION(, 0.0, -1.0, 0.0);
@30 = CARTESIAN_POINT(, -1.625, 1.5, 2.0);
@31 = CARTESIAN_POINT(, -1.813, -1.5, 0.0);
@32 = CARTESIAN_POINT(, -1.813, -1.375, 0.0);
@33 = VERTEX(#23);
@34 = CARTESIAN_POINT(, -1.938, -0.75, 2.0);
```

```

@35 = CARTESIAN_POINT(, -5.0, 0.0, 2.0);
@36 = CARTESIAN_POINT(, -1.938, 1.375, 0.0);
@37 = CARTESIAN_POINT(, -1.938, -0.75, 0.0);
@38 = DIRECTION(, 0.0, -1.0, 0.0);
@39 = EDGE(#16, #24, #27);
@40 = CARTESIAN_POINT(, -3.79967, -3.25, 2.0);
@41 = CIRCLE(, 5.0, #19);
@42 = CARTESIAN_POINT(, -3.79967, 3.25, 0.0);
@43 = CURVE_LOGICAL_STRUCTURE(#15, .T.);
@44 = AXIS2_PLACEMENT(, #32, #2, #29);
@45 = CARTESIAN_POINT(, -1.813, 1.375, 2.0);
@46 = CURVE_LOGICAL_STRUCTURE(#20, .T.);
@47 = CURVE_LOGICAL_STRUCTURE(#41, .T.);
@48 = CURVE_LOGICAL_STRUCTURE(#25, .T.);
@49 = CARTESIAN_POINT(, -1.938, -1.375, 0.0);
@50 = DIRECTION(, -1.0, 0.0, 0.0);
@51 = VERTEX(#31);
@52 = CIRCLE(, 0.125, #44);
@53 = EDGE_LOGICAL_STRUCTURE(#39, .T.);
@54 = VERTEX(#35);
@55 = VERTEX(#3);
@56 = CARTESIAN_POINT(, -2.5, -3.25, 0.0);
@57 = CARTESIAN_POINT(, -1.62498, -1.5, 0.0);
@58 = LINE(, #34, #38);
@59 = LINE(, #31, #10);
@60 = LINE(, #56, #50);
@61 = DIRECTION(, 0.0, 1.0, 0.0);
@62 = CARTESIAN_POINT(, -0.969, -1.5, 0.0);
@63 = DIRECTION(, -1.0, 0.0, 0.0);
@64 = CARTESIAN_POINT(, -1.625, -3.25, 1.0);
@65 = VERTEX(#30);
@66 = CARTESIAN_POINT(, -1.813, -1.375, 2.0);
@67 = CARTESIAN_POINT(, -1.625, 3.25002, 2.0);
@68 = VERTEX(#36);
@69 = VERTEX(#57);
@70 = VERTEX(#17);
@71 = CARTESIAN_POINT(, -3.79967, 3.25, 1.0);
@72 = CARTESIAN_POINT(, -2.5, -3.25, 2.0);
@73 = CURVE_LOGICAL_STRUCTURE(#58, .T.);
@74 = DIRECTION(, -0.759934, 0.65, 0.0);
@75 = VERTEX(#40);
@76 = CARTESIAN_POINT(, -5.0, 0.0, 0.0);
@77 = CARTESIAN_POINT(, -3.79967, -3.25, 0.0);
@78 = CARTESIAN_POINT(, -1.625, 3.25, 2.0);
@79 = VERTEX(#42);
@80 = EDGE(#68, #55, #48);
@81 = CARTESIAN_POINT(, -1.62498, -3.25, 0.0);
@82 = LINE(, #62, #50);
@83 = AXIS2_PLACEMENT(, #1, #10, #74);
@84 = LINE(, #78, #10);
@85 = CARTESIAN_POINT(, -1.625, 1.625, 0.0);

```


@86 = CARTESIAN_POINT(, -0.8125, 3.25, 0.0);
@87 = CARTESIAN_POINT(, -0.8125, 1.5, 0.0);
@88 = EDGE(#33, #70, #73);
@89 = CURVE_LOGICAL_STRUCTURE(#52, .T.);
@90 = CARTESIAN_POINT(, -0.8125, 1.5, 2.0);
@91 = EDGE(#54, #75, #47);
@92 = DIRECTION(, 0.0, 1.0, 0.0);
@93 = VERTEX(#49);
@94 = LINE(, #85, #38);
@95 = CARTESIAN_POINT(, -3.79967, 3.25, 2.0);
@96 = EDGE_LOGICAL_STRUCTURE(#91, .F.);
@97 = LINE(, #64, #2);
@98 = LINE(, #86, #21);
@99 = LINE(, #87, #21);
@100 = VERTEX(#81);
@101 = LINE(, #37, #61);
@102 = AXIS2_PLACEMENT(, #45, #10, #92);
@103 = LINE(, #71, #10);
@104 = CARTESIAN_POINT(, -1.813, 1.5, 1.0);
@105 = CIRCLE(, 5.0, #28);
@106 = VERTEX(#76);
@107 = CURVE_LOGICAL_STRUCTURE(#60, .T.);
@108 = CARTESIAN_POINT(, -1.625, 1.625, 2.0);
@109 = CARTESIAN_POINT(, -1.625, 3.25002, 0.0);
@110 = CARTESIAN_POINT(, -1.625, 1.5, 0.0);
@111 = LINE(, #77, #10);
@112 = EDGE(#24, #69, #46);
@113 = EDGE(#51, #93, #89);
@114 = AXIS2_PLACEMENT(, #66, #10, #63);
@115 = CURVE_LOGICAL_STRUCTURE(#98, .T.);
@116 = CURVE_LOGICAL_STRUCTURE(#84, .T.);
@117 = EDGE(#106, #79, #43);
@118 = CURVE_LOGICAL_STRUCTURE(#94, .T.);
@119 = CURVE_LOGICAL_STRUCTURE(#82, .T.);
@120 = LINE(, #72, #21);
@121 = CARTESIAN_POINT(, -1.62498, -3.25, 2.0);
@122 = CURVE_LOGICAL_STRUCTURE(#103, .T.);
@123 = CURVE_LOGICAL_STRUCTURE(#99, .T.);
@124 = VERTEX(#109);
@125 = EDGE_LOGICAL_STRUCTURE(#80, .F.);
@126 = CARTESIAN_POINT(, -0.8125, 3.25, 2.0);
@127 = VERTEX(#77);
@128 = CURVE_LOGICAL_STRUCTURE(#105, .T.);
@129 = CIRCLE(, 5.0, #83);
@130 = CURVE_LOGICAL_STRUCTURE(#59, .T.);
@131 = EDGE(#69, #51, #119);
@132 = EDGE_LOGICAL_STRUCTURE(#112, .T.);
@133 = LINE(, #108, #61);
@134 = CARTESIAN_POINT(, -1.625, 0.0, 0.0);
@135 = EDGE(#100, #127, #107);
@136 = LINE(, #90, #50);

```

@137 = VERTEX(#95);
@138 = CURVE_LOGICAL_STRUCTURE(#101, .T.);
@139 = LINE(, #49, #10);
@140 = VERTEX(#110);
@141 = EDGE_LOGICAL_STRUCTURE(#131, .T.);
@142 = CURVE_LOGICAL_STRUCTURE(#129, .T.);
@143 = VERTEX(#67);
@144 = CURVE_LOGICAL_STRUCTURE(#97, .T.);
@145 = EDGE(#51, #16, #130);
@146 = EDGE_LOGICAL_STRUCTURE(#145, .T.);
@147 = EDGE(#79, #124, #115);
@148 = LINE(, #85, #38);
@149 = CARTESIAN_POINT(, -1.813, 1.5, 2.0);
@150 = EDGE_LOGICAL_STRUCTURE(#117, .F.);
@151 = VERTEX(#149);
@152 = LINE(, #104, #10);
@153 = CURVE_LOGICAL_STRUCTURE(#136, .T.);
@154 = EDGE(#124, #140, #118);
@155 = CURVE_LOGICAL_STRUCTURE(#139, .T.);
@156 = CIRCLE(, 0.125, #114);
@157 = CURVE_LOGICAL_STRUCTURE(#111, .T.);
@158 = EDGE(#127, #106, #128);
@159 = EDGE(#65, #151, #153);
@160 = EDGE(#124, #143, #116);
@161 = CURVE_LOGICAL_STRUCTURE(#148, .T.);
@162 = CURVE_LOGICAL_STRUCTURE(#120, .T.);
@163 = EDGE(#137, #54, #142);
@164 = VERTEX(#121);
@165 = CURVE_LOGICAL_STRUCTURE(#156, .T.);
@166 = EDGE_LOGICAL_STRUCTURE(#147, .T.);
@167 = CARTESIAN_POINT(, 0.0, 0.0, 0.0);
@168 = EDGE(#93, #68, #138);
@169 = EDGE(#79, #137, #122);
@170 = EDGE_LOGICAL_STRUCTURE(#135, .T.);
@171 = LINE(, #30, #10);
@172 = CARTESIAN_POINT(, 0.0, 0.0, 2.0);
@173 = EDGE(#55, #140, #123);
@174 = EDGE(#75, #164, #162);
@175 = CARTESIAN_POINT(, 0.0, 3.25, 0.0);
@176 = LINE(, #36, #10);
@177 = CURVE_LOGICAL_STRUCTURE(#176, .T.);
@178 = AXIS2_PLACEMENT(, #134, #21, );
@179 = CURVE_LOGICAL_STRUCTURE(#133, .T.);
@180 = EDGE_LOGICAL_STRUCTURE(#154, .T.);
@181 = CARTESIAN_POINT(, 0.0, -3.25, 0.0);
@182 = EDGE_LOGICAL_STRUCTURE(#88, .T.);
@183 = EDGE(#93, #70, #155);
@184 = EDGE_LOGICAL_STRUCTURE(#168, .T.);
@185 = EDGE_LOGICAL_STRUCTURE(#168, .F.);
@186 = EDGE(#68, #33, #177);
@187 = CIRCLE(, 0.125, #102);

```



```

@188 = AXIS2_PLACEMENT(, #8, #10, );
@189 = EDGE_LOGICAL_STRUCTURE(#158, .T.);
@190 = EDGE_LOOP((#141, #146, #53, #132));
@191 = EDGE_LOGICAL_STRUCTURE(#173, .F.);
@192 = CURVE_LOGICAL_STRUCTURE(#171, .T.);
@193 = EDGE_LOGICAL_STRUCTURE(#183, .F.);
@194 = EDGE_LOGICAL_STRUCTURE(#169, .F.);
@195 = EDGE(#65, #143, #179);
@196 = EDGE_LOGICAL_STRUCTURE(#145, .F.);
@197 = EDGE_LOGICAL_STRUCTURE(#113, .F.);
@198 = EDGE(#164, #100, #144);
@199 = EDGE(#140, #65, #192);
@200 = EDGE_LOGICAL_STRUCTURE(#186, .T.);
@201 = CURVE_LOGICAL_STRUCTURE(#187, .T.);
@202 = EDGE_LOGICAL_STRUCTURE(#163, .F.);
@203 = EDGE(#127, #75, #157);
@204 = EDGE(#70, #16, #165);
@205 = CURVE_LOGICAL_STRUCTURE(#152, .T.);
@206 = AXIS2_PLACEMENT(, #32, #10, );
@207 = CARTESIAN_POINT(, 0.0, -1.5, 0.0);
@208 = EDGE_LOGICAL_STRUCTURE(#131, .F.);
@209 = EDGE_LOGICAL_STRUCTURE(#203, .T.);
@210 = EDGE_LOGICAL_STRUCTURE(#158, .F.);
@211 = EDGE(#69, #100, #161);
@212 = AXIS2_PLACEMENT(, #167, #2, );
@213 = EDGE_LOGICAL_STRUCTURE(#117, .T.);
@214 = EDGE_LOGICAL_STRUCTURE(#211, .T.);
@215 = AXIS2_PLACEMENT(, #172, #10, );
@216 = EDGE_LOGICAL_STRUCTURE(#159, .F.);
@217 = LINE(, #108, #61);
@218 = AXIS2_PLACEMENT(, #207, #61, );
@219 = EDGE_LOOP((#170, #189, #213, #166, #180, #191, #125, #185,
#197, #208, #214));
@220 = CURVE_LOGICAL_STRUCTURE(#217, .T.);
@221 = LINE(, #126, #50);
@222 = CURVE_LOGICAL_STRUCTURE(#221, .T.);
@223 = EDGE_LOGICAL_STRUCTURE(#174, .T.);
@224 = EDGE_LOGICAL_STRUCTURE(#203, .F.);
@225 = PLANE(, #218);
@226 = PLANE(, #178);
@227 = CYLINDRICAL_SURFACE(, 0.125, #188);
@228 = EDGE_LOGICAL_STRUCTURE(#204, .T.);
@229 = AXIS2_PLACEMENT(, #175, #61, );
@230 = EDGE_LOGICAL_STRUCTURE(#198, .F.);
@231 = EDGE_LOGICAL_STRUCTURE(#183, .T.);
@232 = EDGE_LOGICAL_STRUCTURE(#113, .T.);
@233 = EDGE_LOGICAL_STRUCTURE(#135, .F.);
@234 = CARTESIAN_POINT(, 0.0, 1.5, 0.0);
@235 = EDGE_LOOP((#184, #200, #182, #193));
@236 = EDGE(#164, #24, #220);
@237 = EDGE_LOOP((#232, #231, #228, #196));

```

```

@238 = EDGE_LOOP((#150, #210, #209, #96, #202, #194));
@239 = CYLINDRICAL_SURFACE(, 0.125, #206);
@240 = EDGE_LOGICAL_STRUCTURE(#199, .F.);
@241 = AXIS2_PLACEMENT(, #181, #38, );
@242 = EDGE(#143, #137, #222);
@243 = LOOP_LOGICAL_STRUCTURE(#190, .T.);
@244 = EDGE(#55, #151, #205);
@245 = EDGE(#151, #33, #201);
@246 = LOOP_LOGICAL_STRUCTURE(#219, .T.);
@247 = PLANE(, #215);
@248 = PLANE(, #212);
@249 = EDGE_LOGICAL_STRUCTURE(#195, .F.);
@250 = LOOP_LOGICAL_STRUCTURE(#237, .T.);
@251 = EDGE_LOGICAL_STRUCTURE(#173, .T.);
@252 = EDGE_LOGICAL_STRUCTURE(#91, .T.);
@253 = EDGE_LOGICAL_STRUCTURE(#174, .F.);
@254 = EDGE_LOGICAL_STRUCTURE(#160, .T.);
@255 = EDGE_LOGICAL_STRUCTURE(#236, .T.);
@256 = SURFACE_LOGICAL_STRUCTURE(#225, .T.);
@257 = EDGE_LOGICAL_STRUCTURE(#147, .F.);
@258 = SURFACE_LOGICAL_STRUCTURE(#226, .T.);
@259 = EDGE_LOOP((#233, #230, #253, #224));
@260 = SURFACE_LOGICAL_STRUCTURE(#239, .T.);
@261 = EDGE_LOGICAL_STRUCTURE(#242, .T.);
@262 = EDGE_LOGICAL_STRUCTURE(#154, .F.);
@263 = EDGE_LOGICAL_STRUCTURE(#159, .T.);
@264 = EDGE_LOGICAL_STRUCTURE(#204, .F.);
@265 = EDGE_LOGICAL_STRUCTURE(#245, .T.);
@266 = EDGE_LOGICAL_STRUCTURE(#245, .F.);
@267 = EDGE_LOGICAL_STRUCTURE(#242, .F.);
@268 = LOOP_LOGICAL_STRUCTURE(#259, .T.);
@269 = EDGE_LOGICAL_STRUCTURE(#199, .T.);
@270 = EDGE_LOOP((#262, #254, #249, #240));
@271 = FACE(, (#250), #260);
@272 = EDGE_LOGICAL_STRUCTURE(#244, .T.);
@273 = PLANE(, #229);
@274 = EDGE_LOGICAL_STRUCTURE(#211, .F.);
@275 = AXIS2_PLACEMENT(, #7, #10, );
@276 = LOOP_LOGICAL_STRUCTURE(#270, .T.);
@277 = EDGE_LOGICAL_STRUCTURE(#244, .F.);
@278 = SURFACE_LOGICAL_STRUCTURE(#227, .T.);
@279 = CYLINDRICAL_SURFACE(, 5.0, #275);
@280 = EDGE_LOGICAL_STRUCTURE(#80, .T.);
@281 = EDGE_LOGICAL_STRUCTURE(#198, .T.);
@282 = EDGE_LOGICAL_STRUCTURE(#186, .F.);
@283 = SURFACE_LOGICAL_STRUCTURE(#248, .T.);
@284 = EDGE_LOGICAL_STRUCTURE(#163, .T.);
@285 = AXIS2_PLACEMENT(, #234, #38, );
@286 = EDGE_LOGICAL_STRUCTURE(#39, .F.);
@287 = PLANE(, #241);
@288 = PLANE(, #285);

```



```

@289 = EDGE_LOOP((#251, #269, #263, #277));
@290 = FACE(, (#243), #256);
@291 = FACE(, (#246), #283);
@292 = EDGE_LOGICAL_STRUCTURE(#169, .T.);
@293 = EDGE_LOOP((#280, #272, #265, #282));
@294 = SURFACE_LOGICAL_STRUCTURE(#279, .F.);
@295 = EDGE_LOGICAL_STRUCTURE(#195, .T.);
@296 = CARTESIAN_POINT(, -1.938, 0.0, 0.0);
@297 = EDGE_LOGICAL_STRUCTURE(#88, .F.);
@298 = SURFACE_LOGICAL_STRUCTURE(#247, .T.);
@299 = SURFACE_LOGICAL_STRUCTURE(#287, .T.);
@300 = EDGE_LOGICAL_STRUCTURE(#160, .F.);
@301 = AXIS2_PLACEMENT(, #296, #21, );
@302 = EDGE_LOOP((#223, #255, #286, #264, #297, #266, #216, #295,
#261, #284, #252));
@303 = EDGE_LOGICAL_STRUCTURE(#236, .F.);
@304 = LOOP_LOGICAL_STRUCTURE(#302, .T.);
@305 = PLANE(, #301);
@306 = FACE(, (#268), #299);
@307 = FACE_LOGICAL_STRUCTURE(#290, .T.);
@308 = FACE(, (#276), #258);
@309 = LOOP_LOGICAL_STRUCTURE(#238, .T.);
@310 = EDGE_LOOP((#257, #292, #267, #300));
@311 = LOOP_LOGICAL_STRUCTURE(#289, .T.);
@312 = EDGE_LOGICAL_STRUCTURE(#112, .F.);
@313 = FACE(, (#304), #298);
@314 = LOOP_LOGICAL_STRUCTURE(#235, .T.);
@315 = LOOP_LOGICAL_STRUCTURE(#310, .T.);
@316 = EDGE_LOOP((#274, #312, #303, #281));
@317 = SURFACE_LOGICAL_STRUCTURE(#273, .T.);
@318 = LOOP_LOGICAL_STRUCTURE(#293, .T.);
@319 = FACE(, (#318), #278);
@320 = FACE(, (#309), #294);
@321 = SURFACE_LOGICAL_STRUCTURE(#288, .T.);
@322 = SURFACE_LOGICAL_STRUCTURE(#305, .T.);
@323 = FACE_LOGICAL_STRUCTURE(#271, .T.);
@324 = FACE_LOGICAL_STRUCTURE(#308, .T.);
@325 = FACE_LOGICAL_STRUCTURE(#306, .T.);
@326 = FACE(, (#315), #317);
@327 = FACE_LOGICAL_STRUCTURE(#320, .T.);
@328 = FACE_LOGICAL_STRUCTURE(#319, .T.);
@329 = FACE(, (#311), #321);
@330 = FACE_LOGICAL_STRUCTURE(#291, .T.);
@331 = FACE(, (#314), #322);
@332 = FACE_LOGICAL_STRUCTURE(#313, .T.);
@333 = LOOP_LOGICAL_STRUCTURE(#316, .T.);
@334 = SURFACE_LOGICAL_STRUCTURE(#226, .T.);
@335 = FACE(, (#333), #334);
@336 = FACE_LOGICAL_STRUCTURE(#331, .T.);
@337 = FACE_LOGICAL_STRUCTURE(#335, .T.);
@338 = FACE_LOGICAL_STRUCTURE(#326, .T.);

```

```
@339 = FACE_LOGICAL_STRUCTURE(#329, .T.);  
@340 = CLOSED_SHELL((#328, #325, #327, #323, #330, #307, #324, #338,  
#332, #336, #337, #339));  
@341 = CARTESIAN_POINT(, -3.79967, -3.25, 0.0);  
ENDSEC;  
ENDSTEP;
```

APPENDIX D: Physical File From PITS

```
STEP;  
HEADER;  
FILE_IDENTIFICATION('                                ','1990 01 16 13 56'  
20,('                                '),(''  
'),'1','1','PDES');  
FILE_DESCRIPTION('THIS FILE ORIGINATED FROM PITS AND HAS BEEN FED BACK  
THROUGH.');
```

IMP_LEVEL('USER DEFINED ENTITIES ONLY');

```
ENDSEC;  
DATA;  
@1=CARTESIAN_POINT(0.,0.,2.);  
@2=CARTESIAN_POINT(-1.813,1.5,0.);  
@3=CARTESIAN_POINT(-1.813,-1.5,2.);  
@4=CARTESIAN_POINT(0.,0.,0.);  
@5=CARTESIAN_POINT(-1.813,1.375,0.);  
@6=CARTESIAN_POINT(-1.62498,-1.5,2.);  
@7=CARTESIAN_POINT(-1.625,-1.5,1.);  
@8=CARTESIAN_POINT(-1.938,-1.375,2.);  
@9=CARTESIAN_POINT(-0.969,-1.5,2.);  
@10=CARTESIAN_POINT(-1.938,1.375,2.);  
@11=CARTESIAN_POINT(-1.625,1.5,2.);  
@12=CARTESIAN_POINT(-1.813,-1.5,0.);  
@13=CARTESIAN_POINT(-1.813,-1.375,0.);  
@14=CARTESIAN_POINT(-1.938,-0.75,2.);  
@15=CARTESIAN_POINT(-5.,0.,2.);  
@16=CARTESIAN_POINT(-1.938,1.375,0.);  
@17=CARTESIAN_POINT(-1.938,-0.75,0.);  
@18=CARTESIAN_POINT(-3.79967,-3.25,2.);  
@19=CARTESIAN_POINT(-3.79967,3.25,0.);  
@20=CARTESIAN_POINT(-1.813,1.375,2.);  
@21=CARTESIAN_POINT(-1.938,-1.375,0.);  
@22=CARTESIAN_POINT(-2.5,-3.25,0.);  
@23=CARTESIAN_POINT(-1.62498,-1.5,0.);  
@24=CARTESIAN_POINT(-0.969,-1.5,0.);  
@25=CARTESIAN_POINT(-1.625,-3.25,1.);  
@26=CARTESIAN_POINT(-1.813,-1.375,2.);  
@27=CARTESIAN_POINT(-1.625,3.25002,2.);  
@28=CARTESIAN_POINT(-3.79967,3.25,1.);  
@29=CARTESIAN_POINT(-2.5,-3.25,2.);  
@30=CARTESIAN_POINT(-5.,0.,0.);  
@31=CARTESIAN_POINT(-3.79967,-3.25,0.);  
@32=CARTESIAN_POINT(-1.625,3.25,2.);  
@33=CARTESIAN_POINT(-1.62498,-3.25,0.);  
@34=CARTESIAN_POINT(-1.625,1.625,0.);  
@35=CARTESIAN_POINT(-0.8125,3.25,0.);  
@36=CARTESIAN_POINT(-0.8125,1.5,0.);  
@37=CARTESIAN_POINT(-0.8125,1.5,2.);  
@38=CARTESIAN_POINT(-3.79967,3.25,2.);  
@39=CARTESIAN_POINT(-1.813,1.5,1.);
```


@40=CARTESIAN_POINT(-1.625,1.625,2.);
@41=CARTESIAN_POINT(-1.625,3.25002,0.);
@42=CARTESIAN_POINT(-1.625,1.5,0.);
@43=CARTESIAN_POINT(-1.62498,-3.25,2.);
@44=CARTESIAN_POINT(-0.8125,3.25,2.);
@45=CARTESIAN_POINT(-1.625,0,0.);
@46=CARTESIAN_POINT(-1.813,1.5,2.);
@47=CARTESIAN_POINT(0,0,0.);
@48=CARTESIAN_POINT(0,0,2.);
@49=CARTESIAN_POINT(0,3.25,0.);
@50=CARTESIAN_POINT(0,-3.25,0.);
@51=CARTESIAN_POINT(0,-1.5,0.);
@52=CARTESIAN_POINT(0,1.5,0.);
@53=CARTESIAN_POINT(-1.938,0,0.);
@54=CARTESIAN_POINT(-3.79967,-3.25,0.);
@55=DIRECTION(0,0,-1.);
@56=DIRECTION(-1,0,0.);
@57=DIRECTION(-1,0,0.);
@58=DIRECTION(0,0,1.);
@59=DIRECTION(-0.759934,-0.65,0.);
@60=DIRECTION(-1,0,0.);
@61=DIRECTION(1,0,0.);
@62=DIRECTION(0,-1,0.);
@63=DIRECTION(0,-1,0.);
@64=DIRECTION(-1,0,0.);
@65=DIRECTION(0,1,0.);
@66=DIRECTION(-1,0,0.);
@67=DIRECTION(-0.759934,0.65,0.);
@68=DIRECTION(0,1,0.);
@69=AXIS2_PLACEMENT(#4,#55,#57);
@70=AXIS2_PLACEMENT(#5,#55,#56);
@71=AXIS2_PLACEMENT(#1,#58,#60);
@72=AXIS2_PLACEMENT(#4,#55,#59);
@73=AXIS2_PLACEMENT(#13,#55,#62);
@74=AXIS2_PLACEMENT(#1,#58,#67);
@75=AXIS2_PLACEMENT(#20,#58,#68);
@76=AXIS2_PLACEMENT(#26,#58,#66);
@77=AXIS2_PLACEMENT(#45,#61,);
@78=AXIS2_PLACEMENT(#5,#58,);
@79=AXIS2_PLACEMENT(#13,#58,);
@80=AXIS2_PLACEMENT(#47,#55,);
@81=AXIS2_PLACEMENT(#48,#58,);
@82=AXIS2_PLACEMENT(#51,#65,);
@83=AXIS2_PLACEMENT(#49,#65,);
@84=AXIS2_PLACEMENT(#50,#63,);
@85=AXIS2_PLACEMENT(#4,#58,);
@86=AXIS2_PLACEMENT(#52,#63,);
@87=AXIS2_PLACEMENT(#53,#61,);
@88=LINE(#7,#55);
@89=LINE(#9,#61);
@90=LINE(#14,#63);
@91=LINE(#12,#58);

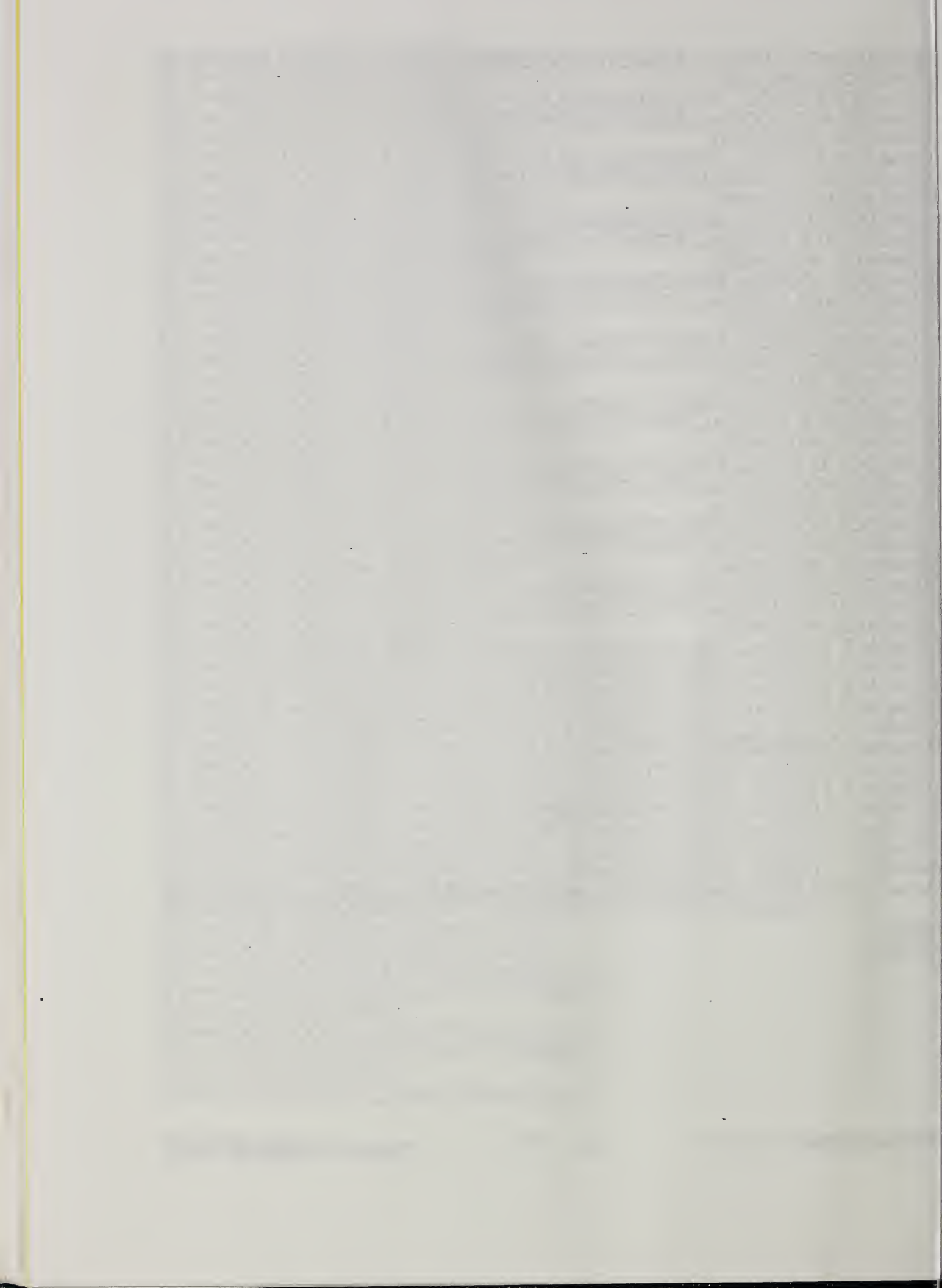
@92=LINE(#22,#64);
@93=LINE(#24,#64);
@94=LINE(#32,#58);
@95=LINE(#34,#63);
@96=LINE(#25,#55);
@97=LINE(#35,#61);
@98=LINE(#36,#61);
@99=LINE(#17,#65);
@100=LINE(#28,#58);
@101=LINE(#31,#58);
@102=LINE(#29,#61);
@103=LINE(#40,#65);
@104=LINE(#37,#64);
@105=LINE(#21,#58);
@106=LINE(#34,#63);
@107=LINE(#39,#58);
@108=LINE(#11,#58);
@109=LINE(#16,#58);
@110=LINE(#40,#65);
@111=LINE(#44,#64);
@112=CIRCLE(5.,#69);
@113=CIRCLE(0.125,#70);
@114=CIRCLE(5.,#71);
@115=CIRCLE(0.125,#73);
@116=CIRCLE(5.,#72);
@117=CIRCLE(5.,#74);
@118=CIRCLE(0.125,#76);
@119=CIRCLE(0.125,#75);
@120=PLANE(#82);
@121=PLANE(#77);
@122=PLANE(#81);
@123=PLANE(#80);
@124=PLANE(#83);
@125=PLANE(#84);
@126=PLANE(#86);
@127=PLANE(#87);
@128=CYLINDRICAL_SURFACE(0.125,#78);
@129=CYLINDRICAL_SURFACE(0.125,#79);
@130=CYLINDRICAL_SURFACE(5.,#85);
@131=VERTEX(#3);
@132=VERTEX(#6);
@133=VERTEX(#10);
@134=VERTEX(#12);
@135=VERTEX(#15);
@136=VERTEX(#2);
@137=VERTEX(#11);
@138=VERTEX(#16);
@139=VERTEX(#23);
@140=VERTEX(#8);
@141=VERTEX(#18);
@142=VERTEX(#19);
@143=VERTEX(#21);

@144=VERTEX(#33);
@145=VERTEX(#30);
@146=VERTEX(#41);
@147=VERTEX(#31);
@148=VERTEX(#38);
@149=VERTEX(#42);
@150=VERTEX(#27);
@151=VERTEX(#46);
@152=VERTEX(#43);
@153=CURVE_LOGICAL_STRUCTURE(#89,.T.);
@154=EDGE(#131,#132,#153);
@155=CURVE_LOGICAL_STRUCTURE(#113,.T.);
@156=EDGE(#138,#136,#155);
@157=CURVE_LOGICAL_STRUCTURE(#90,.T.);
@158=EDGE(#133,#140,#157);
@159=CURVE_LOGICAL_STRUCTURE(#114,.T.);
@160=EDGE(#135,#141,#159);
@161=CURVE_LOGICAL_STRUCTURE(#88,.T.);
@162=EDGE(#132,#139,#161);
@163=CURVE_LOGICAL_STRUCTURE(#115,.T.);
@164=EDGE(#134,#143,#163);
@165=CURVE_LOGICAL_STRUCTURE(#112,.T.);
@166=EDGE(#145,#142,#165);
@167=CURVE_LOGICAL_STRUCTURE(#93,.T.);
@168=EDGE(#139,#134,#167);
@169=CURVE_LOGICAL_STRUCTURE(#92,.T.);
@170=EDGE(#144,#147,#169);
@171=CURVE_LOGICAL_STRUCTURE(#91,.T.);
@172=EDGE(#134,#131,#171);
@173=CURVE_LOGICAL_STRUCTURE(#97,.T.);
@174=EDGE(#142,#146,#173);
@175=CURVE_LOGICAL_STRUCTURE(#95,.T.);
@176=EDGE(#146,#149,#175);
@177=CURVE_LOGICAL_STRUCTURE(#116,.T.);
@178=EDGE(#147,#145,#177);
@179=CURVE_LOGICAL_STRUCTURE(#104,.T.);
@180=EDGE(#137,#151,#179);
@181=CURVE_LOGICAL_STRUCTURE(#94,.T.);
@182=EDGE(#146,#150,#181);
@183=CURVE_LOGICAL_STRUCTURE(#117,.T.);
@184=EDGE(#148,#135,#183);
@185=CURVE_LOGICAL_STRUCTURE(#99,.T.);
@186=EDGE(#143,#138,#185);
@187=CURVE_LOGICAL_STRUCTURE(#100,.T.);
@188=EDGE(#142,#148,#187);
@189=CURVE_LOGICAL_STRUCTURE(#98,.T.);
@190=EDGE(#136,#149,#189);
@191=CURVE_LOGICAL_STRUCTURE(#102,.T.);
@192=EDGE(#141,#152,#191);
@193=CURVE_LOGICAL_STRUCTURE(#105,.T.);
@194=EDGE(#143,#140,#193);
@195=CURVE_LOGICAL_STRUCTURE(#109,.T.);

@196=EDGE(#138,#133,#195);
@197=CURVE_LOGICAL_STRUCTURE(#103,.T.);
@198=EDGE(#137,#150,#197);
@199=CURVE_LOGICAL_STRUCTURE(#96,.T.);
@200=EDGE(#152,#144,#199);
@201=CURVE_LOGICAL_STRUCTURE(#108,.T.);
@202=EDGE(#149,#137,#201);
@203=CURVE_LOGICAL_STRUCTURE(#101,.T.);
@204=EDGE(#147,#141,#203);
@205=CURVE_LOGICAL_STRUCTURE(#118,.T.);
@206=EDGE(#140,#131,#205);
@207=CURVE_LOGICAL_STRUCTURE(#106,.T.);
@208=EDGE(#139,#144,#207);
@209=CURVE_LOGICAL_STRUCTURE(#110,.T.);
@210=EDGE(#152,#132,#209);
@211=CURVE_LOGICAL_STRUCTURE(#111,.T.);
@212=EDGE(#150,#148,#211);
@213=CURVE_LOGICAL_STRUCTURE(#107,.T.);
@214=EDGE(#136,#151,#213);
@215=CURVE_LOGICAL_STRUCTURE(#119,.T.);
@216=EDGE(#151,#133,#215);
@217=EDGE_LOGICAL_STRUCTURE(#154,.T.);
@218=EDGE_LOGICAL_STRUCTURE(#160,.F.);
@219=EDGE_LOGICAL_STRUCTURE(#156,.F.);
@220=EDGE_LOGICAL_STRUCTURE(#162,.T.);
@221=EDGE_LOGICAL_STRUCTURE(#168,.T.);
@222=EDGE_LOGICAL_STRUCTURE(#172,.T.);
@223=EDGE_LOGICAL_STRUCTURE(#166,.F.);
@224=EDGE_LOGICAL_STRUCTURE(#174,.T.);
@225=EDGE_LOGICAL_STRUCTURE(#170,.T.);
@226=EDGE_LOGICAL_STRUCTURE(#176,.T.);
@227=EDGE_LOGICAL_STRUCTURE(#158,.T.);
@228=EDGE_LOGICAL_STRUCTURE(#186,.T.);
@229=EDGE_LOGICAL_STRUCTURE(#186,.F.);
@230=EDGE_LOGICAL_STRUCTURE(#178,.T.);
@231=EDGE_LOGICAL_STRUCTURE(#190,.F.);
@232=EDGE_LOGICAL_STRUCTURE(#194,.F.);
@233=EDGE_LOGICAL_STRUCTURE(#188,.F.);
@234=EDGE_LOGICAL_STRUCTURE(#172,.F.);
@235=EDGE_LOGICAL_STRUCTURE(#164,.F.);
@236=EDGE_LOGICAL_STRUCTURE(#196,.T.);
@237=EDGE_LOGICAL_STRUCTURE(#184,.F.);
@238=EDGE_LOGICAL_STRUCTURE(#168,.F.);
@239=EDGE_LOGICAL_STRUCTURE(#204,.T.);
@240=EDGE_LOGICAL_STRUCTURE(#178,.F.);
@241=EDGE_LOGICAL_STRUCTURE(#166,.T.);
@242=EDGE_LOGICAL_STRUCTURE(#208,.T.);
@243=EDGE_LOGICAL_STRUCTURE(#180,.F.);
@244=EDGE_LOGICAL_STRUCTURE(#192,.T.);
@245=EDGE_LOGICAL_STRUCTURE(#204,.F.);
@246=EDGE_LOGICAL_STRUCTURE(#206,.T.);
@247=EDGE_LOGICAL_STRUCTURE(#200,.F.);

@248=EDGE_LOGICAL_STRUCTURE(#194,.T.);
@249=EDGE_LOGICAL_STRUCTURE(#164,.T.);
@250=EDGE_LOGICAL_STRUCTURE(#170,F.);
@251=EDGE_LOGICAL_STRUCTURE(#202,F.);
@252=EDGE_LOGICAL_STRUCTURE(#198,F.);
@253=EDGE_LOGICAL_STRUCTURE(#190,.T.);
@254=EDGE_LOGICAL_STRUCTURE(#160,.T.);
@255=EDGE_LOGICAL_STRUCTURE(#192,F.);
@256=EDGE_LOGICAL_STRUCTURE(#182,.T.);
@257=EDGE_LOGICAL_STRUCTURE(#210,.T.);
@258=EDGE_LOGICAL_STRUCTURE(#174,F.);
@259=EDGE_LOGICAL_STRUCTURE(#212,.T.);
@260=EDGE_LOGICAL_STRUCTURE(#176,F.);
@261=EDGE_LOGICAL_STRUCTURE(#180,.T.);
@262=EDGE_LOGICAL_STRUCTURE(#206,F.);
@263=EDGE_LOGICAL_STRUCTURE(#216,.T.);
@264=EDGE_LOGICAL_STRUCTURE(#216,F.);
@265=EDGE_LOGICAL_STRUCTURE(#212,F.);
@266=EDGE_LOGICAL_STRUCTURE(#202,.T.);
@267=EDGE_LOGICAL_STRUCTURE(#214,.T.);
@268=EDGE_LOGICAL_STRUCTURE(#208,F.);
@269=EDGE_LOGICAL_STRUCTURE(#214,F.);
@270=EDGE_LOGICAL_STRUCTURE(#156,.T.);
@271=EDGE_LOGICAL_STRUCTURE(#200,.T.);
@272=EDGE_LOGICAL_STRUCTURE(#196,F.);
@273=EDGE_LOGICAL_STRUCTURE(#184,.T.);
@274=EDGE_LOGICAL_STRUCTURE(#154,F.);
@275=EDGE_LOGICAL_STRUCTURE(#188,.T.);
@276=EDGE_LOGICAL_STRUCTURE(#198,.T.);
@277=EDGE_LOGICAL_STRUCTURE(#158,F.);
@278=EDGE_LOGICAL_STRUCTURE(#182,F.);
@279=EDGE_LOGICAL_STRUCTURE(#210,F.);
@280=EDGE_LOGICAL_STRUCTURE(#162,F.);
@281=EDGE_LOOP((#221,#222,#217,#220));
@282=EDGE_LOOP((#225,#230,#241,#224,#226,#231,#219,#229,#235,#238,#242));
@283=EDGE_LOOP((#228,#236,#227,#232));
@284=EDGE_LOOP((#249,#248,#246,#234));
@285=EDGE_LOOP((#223,#240,#239,#218,#237,#233));
@286=EDGE_LOOP((#250,#247,#255,#245));
@287=EDGE_LOOP((#260,#256,#252,#251));
@288=EDGE_LOOP((#253,#266,#261,#269));
@289=EDGE_LOOP((#270,#267,#263,#272));
@290=EDGE_LOOP((#244,#257,#274,#262,#277,#264,#243,#276,#259,#273,#254));
@291=EDGE_LOOP((#258,#275,#265,#278));
@292=EDGE_LOOP((#268,#280,#279,#271));
@293=LOOP_LOGICAL_STRUCTURE(#284,.T.);
@294=SURFACE_LOGICAL_STRUCTURE(#129,.T.);
@295=FACE(,#293),#294);
@296=LOOP_LOGICAL_STRUCTURE(#281,.T.);
@297=SURFACE_LOGICAL_STRUCTURE(#120,.T.);
@298=FACE(,#296),#297);
@299=LOOP_LOGICAL_STRUCTURE(#282,.T.);

```
@300=SURFACE_LOGICAL_STRUCTURE(#123,.T.);
@301=FACE(,(#299),#300);
@302=LOOP_LOGICAL_STRUCTURE(#286,.T.);
@303=SURFACE_LOGICAL_STRUCTURE(#125,.T.);
@304=FACE(,(#302),#303);
@305=LOOP_LOGICAL_STRUCTURE(#287,.T.);
@306=SURFACE_LOGICAL_STRUCTURE(#121,.T.);
@307=FACE(,(#305),#306);
@308=LOOP_LOGICAL_STRUCTURE(#290,.T.);
@309=SURFACE_LOGICAL_STRUCTURE(#122,.T.);
@310=FACE(,(#308),#309);
@311=LOOP_LOGICAL_STRUCTURE(#289,.T.);
@312=SURFACE_LOGICAL_STRUCTURE(#128,.T.);
@313=FACE(,(#311),#312);
@314=LOOP_LOGICAL_STRUCTURE(#285,.T.);
@315=SURFACE_LOGICAL_STRUCTURE(#130,.F.);
@316=FACE(,(#314),#315);
@317=LOOP_LOGICAL_STRUCTURE(#291,.T.);
@318=SURFACE_LOGICAL_STRUCTURE(#124,.T.);
@319=FACE(,(#317),#318);
@320=LOOP_LOGICAL_STRUCTURE(#288,.T.);
@321=SURFACE_LOGICAL_STRUCTURE(#126,.T.);
@322=FACE(,(#320),#321);
@323=LOOP_LOGICAL_STRUCTURE(#283,.T.);
@324=SURFACE_LOGICAL_STRUCTURE(#127,.T.);
@325=FACE(,(#323),#324);
@326=LOOP_LOGICAL_STRUCTURE(#292,.T.);
@327=SURFACE_LOGICAL_STRUCTURE(#121,.T.);
@328=FACE(,(#326),#327);
@329=FACE_LOGICAL_STRUCTURE(#298,.T.);
@330=FACE_LOGICAL_STRUCTURE(#295,.T.);
@331=FACE_LOGICAL_STRUCTURE(#307,.T.);
@332=FACE_LOGICAL_STRUCTURE(#304,.T.);
@333=FACE_LOGICAL_STRUCTURE(#316,.T.);
@334=FACE_LOGICAL_STRUCTURE(#313,.T.);
@335=FACE_LOGICAL_STRUCTURE(#301,.T.);
@336=FACE_LOGICAL_STRUCTURE(#310,.T.);
@337=FACE_LOGICAL_STRUCTURE(#325,.T.);
@338=FACE_LOGICAL_STRUCTURE(#328,.T.);
@339=FACE_LOGICAL_STRUCTURE(#319,.T.);
@340=FACE_LOGICAL_STRUCTURE(#322,.T.);
@341=CLOSED_SHELL((#334,#332,#333,#330,#335,#329,#331,#339,#336,#337,#338,#340
));
ENDSEC;
ENDSTEP;
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4. TITLE AND SUBTITLE
 Physical File Testing in the PDES Testbed Validation System

5. AUTHOR(S)
 James E. Fowler

6. PERFORMING ORGANIZATION <i>(If joint or other than NBS, see instructions)</i> NATIONAL BUREAU OF STANDARDS U.S. DEPARTMENT OF COMMERCE GAITHERSBURG, MD 20899	7. Contract/Grant No. 8. Type of Report & Period Covered
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10. SUPPLEMENTARY NOTES

Document describes a computer program; SF-185, FIPS Software Summary, is attached.

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)*

This document describes the testing of PDES physical data file exchange between software systems within the validation testing architecture.

12. KEY WORDS *(Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)*

National PDES Testbed, PDES, Validation testing

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