US Army Corps
of Engineers
Waterways Experiment
Station

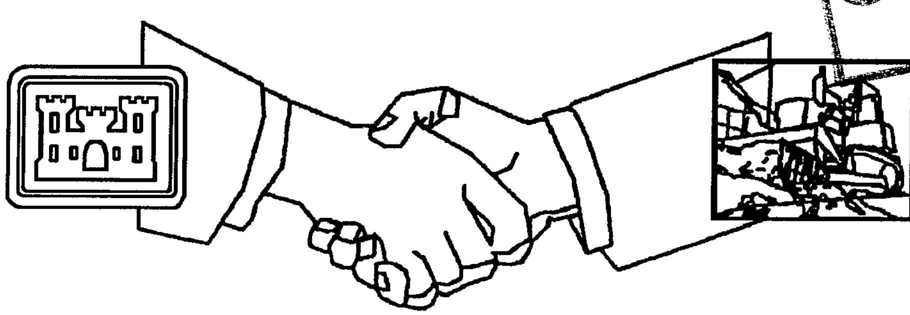
Final Report
CPAR-ITL-94-1
December 1994

CONSTRUCTION PRODUCTIVITY ADVANCEMENT RESEARCH (CPAR) PROGRAM

Interference Checking of Construction Design

by

Arthur Bennett, Ken Cook, Gregory A. Covington,
Laurel T. Gorman, Albert N. Williamson



**A Corps/Industry Partnership to Advance
Construction Productivity and Reduce Costs**

Construction Productivity Advancement
Research (CPAR) Program

Technical Report
CPAR-ITL-94-1
December 1994

Interference Checking of Construction Design

by Arthur Bennett

U.S. Army Engineer District, Walla Walla
Bldg. 602, City County Airport
Walla Walla, WA 99362-9265

Ken Cook, Gregory A. Covington, Laurel T. Gorman, Albert N. Williamson

U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

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Final report

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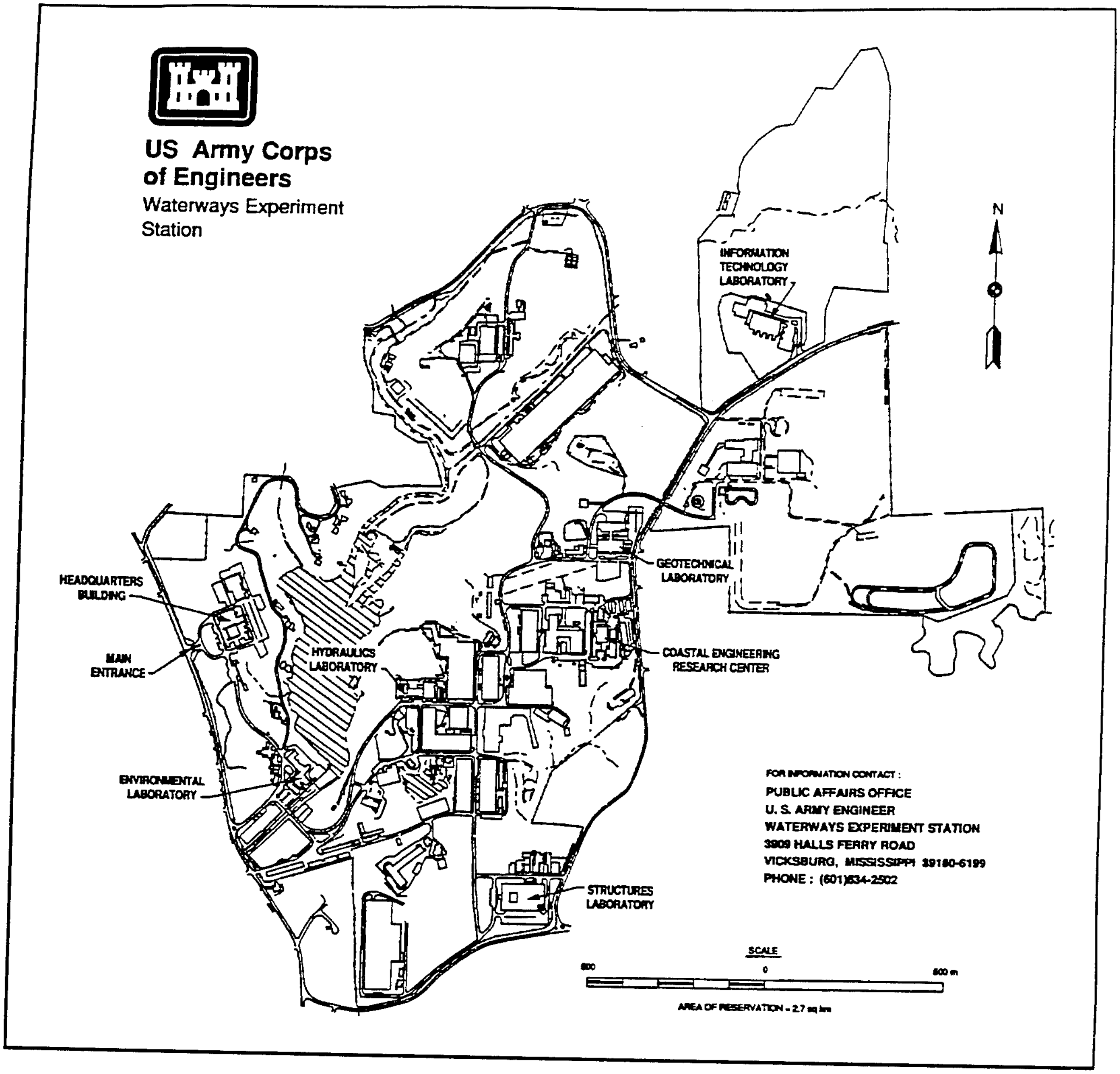
Washington, DC 20314-1000



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Contents

Preface

The Construction Productivity Advancement Research (CPAR) program was authorized by Section 7 of the Water Resources Development Act of 1988. This Act authorized the Secretary of the Army to utilize the U.S. Army Corps of Engineers (Corps) laboratories and research centers to undertake collaborative research and development with the U.S. construction industry. This legislation, along with the Stevenson-Wydler Technology Innovation Act of 1980, as amended, is the basis for the cost-shared research, development, and demonstration CPAR program.

The project discussed herein, CPAR Project No. 901-930, stems from the Intergraph Corporation proposal No. 6-8903-21023, dated 23 May 1990, entitled "Cooperative Research and Development Agreement for Interdisciplinary Interference Checking Software." The CPAR project was conducted jointly by the Tri-Service CADD/GIS Technology Center, Information Technology Laboratory (ITL), U.S. Army Engineer Waterways Experiment Station (WES), and the CPAR Partner, Intergraph Corporation, Huntsville, Alabama. The Tri-Service CADD/GIS Technology Center was chartered in 1992 to foster the use of computer-aided design and drafting (CADD) and geographical information system (GIS) technologies for life-cycle facilities management within the Army, Navy, and Air Force. The Center operates under the direction of Dr. N. Radhakrishnan, Director, ITL, and Mr. Carl S. Stephens, Chief, Tri-Service CADD/GIS Technology Center. The Center functions under the direction of the Executive Steering Group, composed of Messrs. Richard Armstrong and Paul Barber, U.S. Army; Dr. Get Moy, Office of the Secretary of Defense (OSD); Dr. Robert Wolff, U.S. Air Force; and Mr. Harry Zimmerman, U.S. Navy. Dr. Wolff serves as chairman of the group. The Executive Steering Group's goals and objectives for the Center are guided through the efforts of the Executive Working Group chaired by Mr. Hugh Adams, U.S. Army. The group is composed of Messrs. Deke Smith and Jim Carberry, U.S. Navy; Maj David Biecheuval, Lt Col Kaminskas, and Mr. Don Ritenour, U.S. Air Force; Messrs. Adams, M. K. Miles, and Dr. Radhakrishnan, U.S. Army; and Mr. Tom Rutherford, OSD.

The U.S. Army Engineer District, Walla Walla, detailed Mr. Arthur Bennett to the Center for the purpose of testing and evaluating the interference checker and assisting in the preparation of this report. The report was prepared by Mr. Bennett and Messrs. Ken Cook, Gregory A. Covington, and Albert N. Williamson, and Ms. Laurel T. Gorman, Tri-Service CADD/GIS Technology Center, ITL, WES. Intergraph Corporation, as the CPAR partner, developed and interference checker and participated in the evaluation of the application software. Ms. Alice Dilbeck and Mr. Jim Barr, staff members of Intergraph Corporation, reviewed this CPAR report, and their written comments were incorporated.

At the time of publication of this report, Dr. Robert W. Whalin was Director of WES. COL Bruce K. Howard, EN, was the Commander.

1 Introduction

Background

Spatial conflicts between building materials and equipment (i.e., multiple objects trying to occupy the same space) are often not discovered until a project is well into construction. Correcting these conflicts requires in-the-field modifications that can be expensive and time-consuming. Historically, designers and engineers have relied entirely on manual methods to identify possible spatial conflicts during the design of a project. Unfortunately, due to inadequate coordination among disciplines, conflicts continue to occur. For instance, working independently, a mechanical and electrical engineer may unknowingly locate heating, ventilation, and air conditioning (HVAC) ductwork and electrical conduit lines in the same location. Such common, and costly occurrences, illustrate the need for an interference-checking application that identifies conflicts early in the design when corrections can be made quickly and economically. Acknowledging these benefits, the Tri-Service CADD/GIS Technology Center, through its network of DoD designers and engineers, defined the requirements for a software application package capable of recognizing and reporting spatial conflicts based on three-dimensional (3-D) computer-aided design and drafting (CADD) models/construction drawings. The identification of this need and the recognition of its value to the construction industry led to the development of Intergraph's Model Interference Checker (MIC) and Interactive Interference Checker (IntIfc) under the Construction Productivity Research (CPAR) Program.

Purpose

This CPAR project was initiated to develop an automated method for diagnosing spatial conflicts during the design of a building by interrogating 3-D CADD drawings. Since designers typically use multiple hardware/software platforms to develop designs, the ideal automated package would accept spatial information, in various formats, from each design discipline involved in the design process (Figure 1). The locations of conflict would be displayed graphically and a descriptive list of all

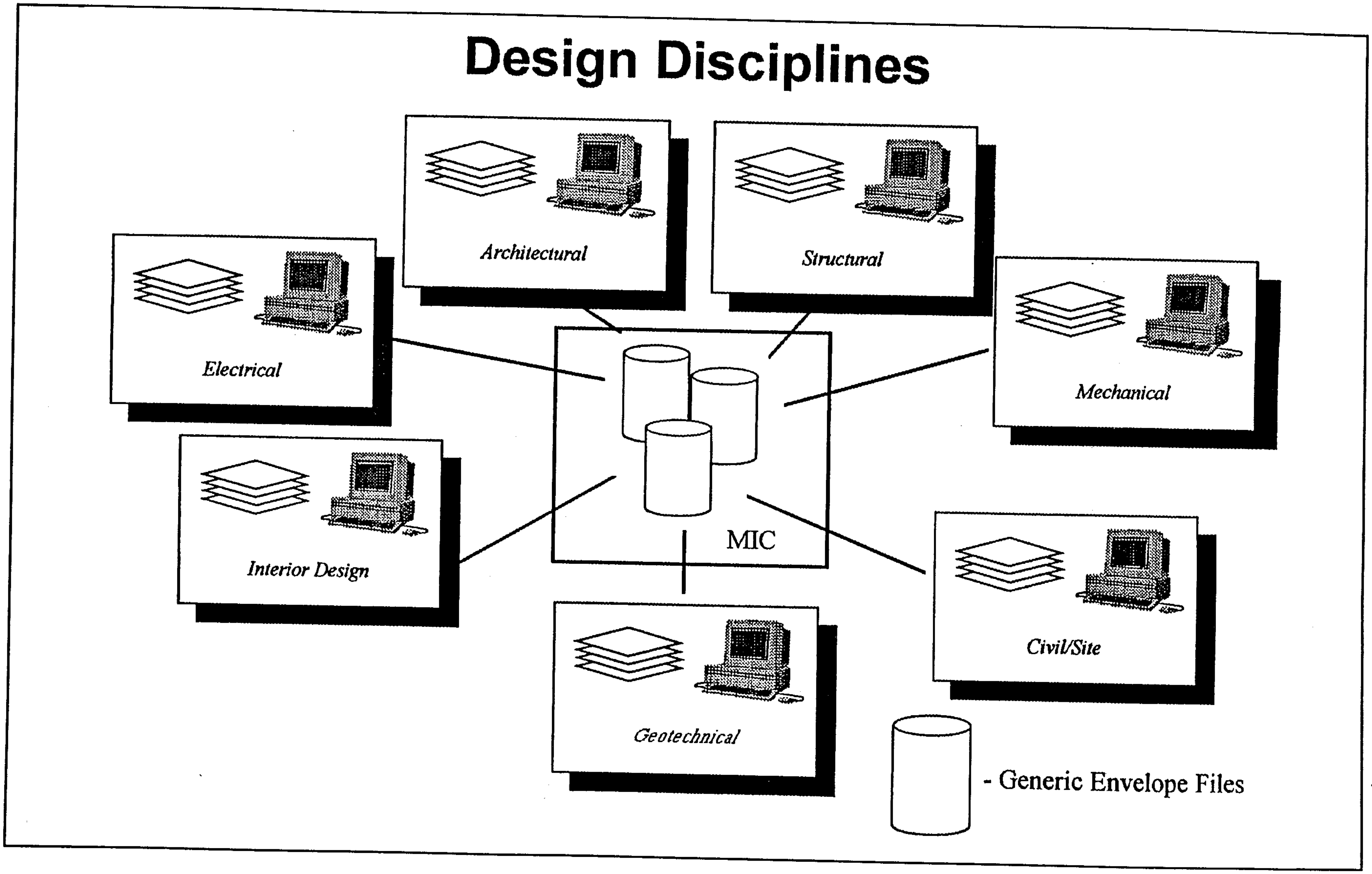

Figure 1. Model Interference Checker (MIC) envelope files

interferences would be formulated to facilitate conflict remediation among the designers.

Scope

The scope of this CPAR project was to develop automated interference-checking software that accepts interdisciplinary design data in multiple formats and both identifies and documents potential spatial conflicts.

2 Software Development, Functional Description, and Operation

Software Development

The reliability of an interference-checking software application is dependent on the precise location of every item/component in a 3-D project model (drawing). Since various individuals with diverse expertise (including draftsmen, technicians, engineers, interior designers, and architects) contribute to the project model, a multiuser checking system is needed to detect spatial conflicts as each individual integrates their portion of the design into the project model. To this end, a computer software solution was pursued that methodically scrutinizes 3-D design models/construction drawings and identifies spatial conflicts. Appendix A defines the various design disciplines and their contributions to the completed project design model.

The underlying CADD software application used to generate the design models (drawings) discussed in this report was Intergraph Corporation's MicroStation version 4.0. MicroStation generates the 3-D CADD drawings necessary to support software applications, such as MIC and IntIfc, that require "intelligent graphics." Intelligent graphics are drawing elements such as lines, circles, and arcs that have nongraphic database information associated with them. With intelligent graphics, a simple shape such as a cylinder can be more accurately defined as a high pressure liquid gas tank or a shielded electrical conduit. Without 3-D models and intelligent graphics, advanced applications such as MIC cannot accurately identify interference or conflicts in CADD drawings.

Ideally, project models are portrayed in 3-D CADD drawings that, when combined, provide a holistic view of the project suitable for interference checking. Individual models are typically categorized by the design discipline responsible for its development (i.e., architectural, structural, mechanical, electrical). The design disciplines and associated 3-D drawing models chosen to demonstrate and evaluate the capabilities of MIC and IntIfc were:

a. Architectural - floor plans and sections.

b. Mechanical - duct work and pipe layout.

c. Structural - structural shapes and fittings.

Functional Description

The Model Interface Checker (MIC) was designed to provide designers with the tools necessary to analyze project models for interferences. Through MIC, a designer can interrogate a design model and obtain a detailed report of all interferences or spatial conflicts. MIC provides interference-checking and detection capabilities using input data from any Intergraph or MicroStation application that produces a 3-D model or combination of models. The models may originate from a variety of Intergraph application software packages, including Micas-Plus, ModelDraft, Project Architect, Project Engineer-HVAC, and Project Engineer-Pipe.

MIC detects three basic categories of interference: hard, soft, and construction. A hard interference is one that exists between actual physical objects. A soft interference exists between nonphysical space envelopes, i.e., pipe insulation and maintenance passageways. A construction interference exists when there is conflict between a user-defined distance and the actual distance separating two components in the design model; i.e. the user specifies a clearance requirement around a piece of equipment. If the model contains an object within the clearance space of that equipment, a construction interference will be reported. For example, if piping components are required to be at least 1 in. from all other structural components and an object is closer than 1 in., a conflict will be detected and reported.

Interferences are reported in ASCII or tabular form in order of precedence (according to hard, soft, and construction) in the following order: hard/hard, hard/soft, hard/construction, soft/soft, soft/construction, construction/construction.

Operating Environment

Model Interface Checker (MIC)

NOTE: To operate successfully, MIC requires that a project database be created (typically Informix or Oracle) prior to any application analysis. Once created, MIC manages all database connections internally. Informix and Oracle database creation and management are addressed in the MIC user manual but are not addressed herein.

MIC provides a front-end shell (user interface) that allows user access to the primary functional areas. These areas are:

a. *Project Administrator.* Project Administrator is used to create projects which in turn create the associated database schema necessary for MIC to access and manage database connections.

b. *Project Environment Manager.* Project Environment Manager provides the user with predefined forms and menus used to manage models (drawings) information within individual projects. As with Project Administrator, Project Environment is primary a "house keeping" function within the MIC application.

c. *Interference Management.* Interference Management provides the interference commands that build and verify envelope files and performs the actual interference checking. Running interference checking within Interference Management is a three-step process.

- *Step 1: Create envelope files.* To complete an interference check on a project model, MIC generates an **envelope file** for each drawing file in a project model. (All envelope files have a .env file name extension. For example, for a 3-D CADD drawing file named bceqp01.dgn, MIC creates an associated envelope file named bceqp01.env.) Each envelope file defines the volume and clearances of the objects or components in the associated drawing files. It is these envelope files that MIC evaluates to identify interferences and conflicts.

- *Step 2: Compare envelope files for spatial conflicts.* The user may identify particular drawing or portions of drawing to check for interferences. The user may also select the types of interference (hard/hard, hard/soft, hard/construction, etc). Once the particular files are chosen, and the type of interference is selected, the MIC application automatically evaluates the 3-D model drawing data and identifies the areas of conflict.

- *Step 3: Report conflicts.* MIC provides two types of spatial conflict reports. Graphical conflicts are shown as highlighted areas of the model drawings. Text reports are provided in ASCII or tabular form. See Appendixes B through D for examples.

Drawing elements detectable with MIC are confined to specific subtypes, including (numbers in parentheses indicate the Intergraph element type):

a. Surfaces (18)
subtype 0 = surface of projection
subtype 8 = surface of revolution

b. Solids (19)
subtype 0 = volume of projection

c. Cones (23)
subtype 0 = general (nonspecific) cone

d. Cells with nested primitives

Although MIC can operate with any of the Intergraph 3-D modeling applications, it is assumed that most users will use MIC in conjunction with the architectural and engineering applications that use relational databases such as Informix and Oracle. For the scope of this CPAR project, 3-D models (drawings) were developed within Project Architect, Project Engineer-HVAC, and Project Engineer-Pipe applications. Appendix E provides a general description of these applications.

Interactive Interference Checker (IntIfC)

The IntIfc software was provided as a supplement to the MIC product and was evaluated as a part of the CPAR project. IntIfc is a basic MicroStation Development Language (MDL) application which provides the capability to detect interfering elements or vectors in 3-D MicroStation design files. Unlike MIC, IntIfc does not require a database or database schema. IntIfc automatically generates interference envelopes for components in the master design file and the attached reference model. However, it does not detect interferences between reference files. IntIfc is executable only through the Intergraph CLIX[1] environment via MicroStation 4.0 software or later versions.

Operation of the IntIfc product is initiated in a master design file through a key-in command line or through use of MDL applications available in a user pull-down menu.

1 Intergraph's UNIX operating system.

After analysis of the model, a text file displays the total number of interferences detected during the interference checking process. Interferences are also displayed graphically in response to the system prompts—First, Next, Previous, or Last. In the displays, each interference appears on the monitor as highlighted line-work. A zoom-in/out capability is provided for detailed study of the selected view on the computer monitor.

As with MIC, the only MicroStation elements detectable under IntIfc are specific subtypes of solids (19), surfaces (18), cones (23), or cells with nested primitives. Interference checking is allowed between master design files and an attached reference files. The software does not permit interference checking between attached reference files. A report file (Figure 2) is generated but is not saved unless this option had been specifically selected.

```
Number of Clashes found = 27
Clash number 1
      Item A: Generic
            Discipline : Unknown
            Model : /usr/newpipe/design/igds01.dgn
      Item B: Generic
            Discipline : Unknown
            Model : /usr/newpipe/design/igds01.dgn

Clash number 2
      Item A: Generic
            Discipline : Unknown
            Model : /usr/newpipe/design/igds01.dgn
      Item B: Generic
            Discipline : Unknown
            Model : /usr/newpipe/design/igds01.dgn

Clash number 3
      Item A: Generic
            Discipline : Unknown
            Model : /usr/newpipe/design/igds01.dgn
      Item B: Generic
            Discipline : Unknown
            Model : /usr/newpipe/design/rway01.dgn

Clash number 4
      Item A: Generic
            Discipline : Unknown
            Model : /usr/newpipe/design/igds01.dgn
      Item B: Generic
            Discipline : Unknown
            Model : /usr/newpipe/design/rway01.dgn

Clash number 5
      Item A: Generic
            Discipline : Unknown
            Model : /usr/newpipe/design/igds01.dgn
      Item B: Generic
            Discipline : Unknown
            Model : /usr/newpipe/design/rway01.dgn
```

Figure 2. Typical interactive interference checker report

3 Evaluation Procedures

MIC

The evaluation procedure was structured to assess ease of application setup, execution, and use, and to determine if the product would function in accordance with all software prompts and documentation. The data sets, MIC execution procedure, and work-flow plan discussed in the following paragraphs were used in the evaluation process.

Preliminary evaluation

A preliminary product evaluation was accomplished using data sets provided by Intergraph Corporation. These data sets included piping, mechanical equipment, and structural steel components with both hard and soft areas for interference detection. This evaluation was primarily used to familiarize the reviewers with the MIC application and its operation. Results from this evaluation are not included in this report.

Final evaluation

Final evaluation was performed using data from a project completed by the U.S. Army Engineer District, Japan (JED), Pacific Ocean Division; included in the design were a swimming pool, gymnasium, spectator seating area, and other fitness facilities.

For the evaluation, Intergraph applications were used to produce architectural (P-Arch), mechanical (PE-Pipe and PE-HVAC), and structural (P-Arch) designs for the facility. Although the original designs received from JED were devoid of interferences, the files were modified at predetermined locations so that interferences would occur between the P-Arch, PE-Pipe, and PE-HVAC files. Application software and design files were loaded and a project created in accordance with instructions provided in the MIC user's guide.[1]

Intlfc

For the Intlfc evaluation, the identical data from the MIC evaluation were used. Intlfc was initiated and detection of interfering elements occurred that was consistent with the previous MIC evaluation with the exceptions as described in Chapter 4. Because Intlfc does not perform interference checking between reference files, interferences between reference files were not identified.

1 Intergraph Corporation. (1993). "Model interference checker user's guide," Huntsville, AL.

4 Evaluation Results

MIC

Data were evaluated using MIC version 04.03.01. An Intergraph representative was available throughout this evaluation. In the course of the evaluation, serious software deficiencies were discovered that prompted Intergraph, via the Intergraph representative, to request a new version of MIC without these deficiencies.

The data were again evaluated with the new version of MIC, version 04.03.02. The change from version 04.03.01 to version 04.03.02 corrected the software dependency problems among P-Arch, PE-HVAC, and PE-Pipe. These compatibility problems emphasized the need for care in ascertaining the compatibility of various software packages required for MIC operation.

Appendixes B, C, and D present typical interference reports generated by MIC as part of the evaluation. Appendix B gives an overall synopsis of all interferences detected. Interferences occurring within the envelope files bceqp01.env, bcpipe01.env, and sarea38p.env are listed, followed by interferences occurring between pairs of envelope files (bceqp01.env and sarea38p.env, etc.). Appendix C lists specific locations where interferences were detected. Interferences are organized by order of precedence beginning with hard/hard interferences. As with Appendix B, Appendix C lists interference locations internal to the envelope files first, followed by interferences between pairs of envelope files. Appendix D presents a set of graphic representations showing each of the interferences detected in order of precedence beginning with hard/hard for internal interferences within an envelope file, followed by interferences detected between pairs of envelope files.

Intlfc

Intlfc successfully detected interferences. However, several problems were experienced and are enumerated in Appendix F.

5 Conclusions and Recommendations

Conclusions

Software dependency problems

Evaluation of the data sets highlighted the impact of software dependency problems. Using MIC version 04.03.01, serious software incompatibilities were discovered that ultimately resulted in failure of MIC to perform for the product evaluation. At the urging of the Intergraph representative, a newer version of MIC, version 04.03.02, was obtained that ultimately became functional following correction of several software dependency problems.

Software installation

Software installation was undoubtedly exacerbated by the software dependency problems. However, the services of a System Manager or Database Manager greatly facilitated the software loading and installation process.

MIC performance

MIC was a very comprehensive application covering all element conflict types that had been installed in the data sets examined. Reporting was very detailed and informative, with the exception of the coordinate list for each interfering model, which proved to be of little value. Plots were, in general, easy to read, describing all interferences in detail.

Form screens

A number of problems involving the complexity of the form screens resulted in a significant amount of time being required to interpret the meaning and intent of the forms before information could be input to the system. Specific problems that were encountered using the form screens are described in Appendix G.

Recommendations

The MIC product that was developed and evaluated in connection with this CPAR project was still in a developmental stage and, as such, had not benefitted from beta testing and feedback from field use. As a result, many of the problems with software dependencies, form screen sequences and nomenclature, and the organization and clarity of the user's guide that were encountered would not normally be experienced. The form screen problems were not considered to be serious, but they were problems that users of the MIC product should be aware of and be prepared to deal with when installing and using MIC.

The results of this evaluation showed that use of the MIC product, when it has reached maturity, can be expected to be beneficial to the construction industry and to the tri-service community of CADD/GIS users. Initial installation and setup problems notwithstanding, the MIC product successfully performed the tasks of detecting and reporting interferences. MIC's greatest benefit will probably be seen in large processing plant design and not standard commercial/government building design. Because of its setup complexity and requirements for extremely accurate 3-D models, MIC will be less productive in standard building design. Some design disciplines, particularly mechanical and electrical, still design using two-dimensional drawings only. For MIC to function at its true potential, these disciplines will be forced to design completely in 3-D.

Commercialization/Technology Transfer

Intergraph Corporation

The CPAR partner has introduced the MIC product to the construction industry and is promoting and marketing the product, its post-sale support, and implementation guidance and support through their regular marketing channels. The MIC product, identified as Interference Checker (SE**213), is available to the tri-service community under Facilities CAD-2 Contract Number N66032-93-D-0021.

Tri-Service CADD/GIS Technology Center

The resources of the Tri-Service CADD/GIS Technology Center, WES, are being used to inform the CADD/GIS user community in the Army, Navy, Air Force, and Corps of Engineers of the availability of the MIC product, as follows:

a. The October 1993 issue of the *CADD/GIS Bulletin*[1] introduced MIC in an article entitled "Interdisciplinary Interference Checker Evaluated."

b. Planning is under way for workshops to train personnel on the procedures for installing and using the MIC software for interference checking. A course guide, developed by Intergraph,[2] is being used as guidance for the preparation and presentation of workshop training. The workshops, which will be held in the training facilities of the Information Technology Laboratory, Waterways Experiment Station, will consist of both lectures and hands-on experience in procedures for installing and using the MIC product and development of the files required for proper MIC operation.

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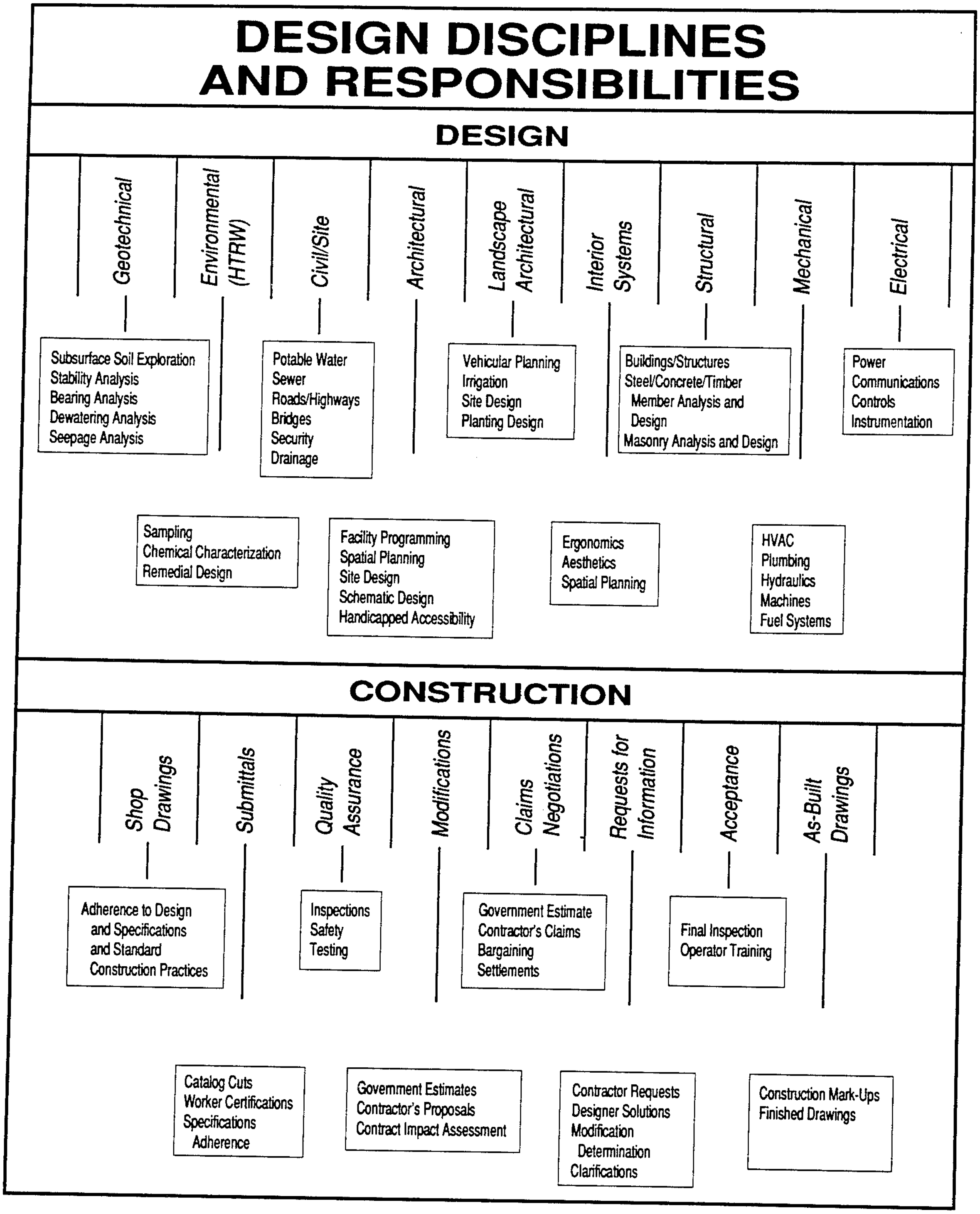
[1] A. Williamson. (1993). "Interdisciplinary interference checker," *CADD/GIS Bulletin*, Vol 93-2, Tri-Service CADD/GIS Technology Center, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

[2] Intergraph Corporation. (1993). "Model interference checker user's guide," Huntsville, AL.

Appendix A
Design Disciplines in the Project Design Model


DESIGN DISCIPLINES AND RESPONSIBILITIES
DESIGN
Geotechnical
Environmental (HTRW)
Civil/Site
Architectural
Landscape Architectural
Interior Systems
Structural
Mechanical
Electrical
Subsurface Soil Exploration
Stability Analysis
Bearing Analysis
Dewatering Analysis
Seepage Analysis
Potable Water
Sewer
Roads/Highways
Bridges
Security
Drainage
Vehicular Planning
Irrigation
Site Design
Planting Design
Buildings/Structures
Steel/Concrete/Timber
Member Analysis and Design
Masonry Analysis and Design
Power
Communications
Controls
Instrumentation
Sampling
Chemical Characterization
Remedial Design
Facility Programming
Spatial Planning
Site Design
Schematic Design
Handicapped Accessibility
Ergonomics
Aesthetics
Spatial Planning
HVAC
Plumbing
Hydraulics
Machines
Fuel Systems
CONSTRUCTION
Shop Drawings
Submittals
Quality Assurance
Modifications
Claims Negotiations
Requests for Information
Acceptance
As-Built Drawings
Adherence to Design and Specifications and Standard Construction Practices
Inspections
Safety
Testing
Government Estimate
Contractor's Claims
Bargaining
Settlements
Final Inspection
Operator Training
Catalog Cuts
Worker Certifications
Specifications Adherence
Government Estimates
Contractor's Proposals
Contract Impact Assessment
Contractor Requests
Designer Solutions
Modification Determination
Clarifications
Construction Mark-Ups
Finished Drawings

Appendix B
Synopsis of Clashes

```
                    PDS Interference Synopsis

bceqp01.env
Number of clashes = 0

bcpipe01.env
Number of clashes = 7

sarea38p.env
Number of clashes = 0

bceqp01.env
sarea38p.env
Number of clashes = 7

bceqp01.env
bcpipe01.env
Number of clashes = 7

bcpipe01.env
sarea38p.env
Number of clashes = 5
```

Appendix C
Locations of Clashes

PDS Interference Report

Date: 22-Jul-93 Time: 16:27:53

Model 'A' Design File Name: bcpipe01

Entire Design Volume Included In Report

PDS Interference Clashes
Hard/Hard Clashes

No	Item Name	Table	Row	X Coord	Y Coord	Z Coord
1	GAT 101-6"-1C0031-P-6 "	3	33554553	E 1319' 1 13/32" Pla	N 344' 10 1/16" Plan	El 16' 8 19/32" Plan
1	PIPE 101-6"-1C0031-P-6 "	5	33554495	E 1319' 1 13/32" Pla	N 347' 1 1/16" Plant	El 14' 9 15/32" Plan

PDS Interference Clashes
Hard/Soft Clashes

No	Item Name	Table	Row	X Coord	Y Coord	Z Coord
2	E45LR 101-6"-1C0031-P-6 "	3	33554548	E 1319' 1 13/32" Pla	N 356' 8 13/16" Plan	El 14' 0 15/32" Plan
2	PIPE 101-6"-1C0031-P-6 "	5	33554494	E 1319' 1 13/32" Pla	N 356' 5 1/16" Plant	El 14' 0 15/32" Plan
3	PIPE 101-6"-1C0031-P-6 "	5	33554491	E 1319' 1 13/32" Pla	N 356' 11 15/32" Pla	El 14' 3 1/8" Plant
3	E45LR 101-6"-1C0031-P-6 "	3	33554549	E 1319' 1 13/32" Pla	N 361' 4 17/32" Plan	El 18' 8 3/16" Plant
4	PIPE 101-6"-1C0031-P-6 "	5	33554492	E 1319' 1 13/32" Pla	N 361' 4 17/32" Plan	El 18' 11 15/16" Pla
4	E90LR 202-6"-1C0031-N-0 "	3	33554558	E 1319' 8 29/32" Pla	N 361' 4 17/32" Plan	El 23' 11 15/16" Pla
5	PIPE 101-6"-1C0031-P-6 "	5	33554492	E 1319' 1 13/32" Pla	N 361' 4 17/32" Plan	El 18' 11 15/16" Pla
5	PIPE 202-6"-1C0031-N-0 "	5	33554500	E 1319' 8 29/32" Pla	N 361' 4 17/32" Plan	El 24' 8 15/16" Plan

PDS Interference Clashes
Soft/Soft Clashes

No	Item Name	Table	Row	X Coord	Y Coord	Z Coord
6	E45LR 101-6"-1C0031-P-6 "	3	33554548	E 1319' 1 13/32" Pla	N 356' 8 13/16" Plan	El 14' 0 15/32" Plan
6	PIPE 101-6"-1C0031-P-6 "	5	33554491	E 1319' 1 13/32" Pla	N 356' 11 15/32" Pla	El 14' 3 1/8" Plant

7	E45LR 101-6"-1C0031-P-6 "	3	33554549	E 1319' 1 13/32" PlaN 361' 4 17/32" PlanEl 18' 8 3/16" Plant
7	PIPE 101-6"-1C0031-P-6 "	5	33554492	E 1319' 1 13/32" PlaN 361' 4 17/32" PlanEl 18' 11 15/16" Pla

PDS Interference Report

Date: 22-Jul-93 Time: 16:28:32

Model 'A' Design File Name: bceqp01

Entire Design Volume Included In Report

Model 'B' Design File Name: sarea38p

Entire Design Volume Included In Report

PDS Interference Clashes
Hard/Hard Clashes

No	Item Name	Table	Row	X Coord	Y Coord	Z Coord
15	TANK1	21	3	E 1317' 7 13/32" PlaN	355' 6 1/16" PlantEl	16' 2 15/32" Plan
15	Volume : V5	34	5	E 1322' 11 13/32" PlN	351' 10 1/16" PlanEl	14' 2 15/32" Plan
16	TANK1	21	3	E 1325' 1 13/32" PlaN	357' 6 1/16" PlantEl	10' 2 15/32" Plan
16	Volume : V10	34	10	E 1320' 7 13/32" PlaN	349' 6 1/16" PlantEl	12' 2 15/32" Plan
17	TANK1	21	3	E 1317' 7 13/32" PlaN	355' 6 1/16" PlantEl	16' 2 15/32" Plan
17	Column : C16	34	16	E 1323' 5 31/32" PlaN	352' 11 1/8" PlantEl	14' 4 7/32" Plant
18	TANK1	21	3	E 1317' 7 13/32" PlaN	355' 6 1/16" PlantEl	16' 2 15/32" Plan
18	Brace : BR30	34	30	E 1323' 7 31/32" PlaN	352' 6 3/32" PlantEl	14' 4 7/32" Plant
19	TANK1	21	3	E 1317' 7 13/32" PlaN	355' 6 1/16" PlantEl	16' 2 15/32" Plan
19	Brace : BR34	34	34	E 1323' 7 31/32" PlaN	352' 6 3/32" PlantEl	14' 4 7/32" Plant
20	TANK2	21	4	E 1315' 1 15/32" PlaN	366' 11 29/32" PlaEl	23' 4 15/32" Plan
20	Beam : B28	34	28	E 1310' 11 15/32" PlN	352' 6 3/32" PlantEl	25' 4 7/32" Plant

PDS Interference Clashes
Hard/Soft Clashes

No	Item Name	Table	Row	X Coord	Y Coord	Z Coord
21	TANK3	21	5	E 1319' 1 13/32" PlaN	349' 6 1/16" PlantEl	10' 2 15/32" Plan
21	Volume : V10	34	10	E 1320' 7 13/32" PlaN	349' 6 1/16" PlantEl	12' 2 15/32" Plan

PDS Interference Report

Date: 22-Jul-93 Time: 16:29:14

Model 'A' Design File Name: bceqp01

Entire Design Volume Included In Report

Model 'B' Design File Name: bcpipe01

Entire Design Volume Included In Report

PDS Interference Clashes
Hard/Hard Clashes

No	Item Name	Table	Row	X Coord	Y Coord	Z Coord
8	TANK1	21	3	E 1317' 7 13/32" Pla	N 355' 6 1/16" Plant	El 16' 2 15/32" Plan
8	PIPE 101-6"-1C0031-P-6 "	5	33554491	E 1319' 1 13/32" Pla	N 356' 11 15/32" Pla	El 14' 3 1/8" Plant
9	TANK3	21	5	E 1319' 1 13/32" Pla	N 349' 6 1/16" Plant	El 10' 2 15/32" Plan
9	PIPE 101-6"-1C0031-P-6 "	5	33554494	E 1319' 1 13/32" Pla	N 356' 5 1/16" Plant	El 14' 0 15/32" Plan
10	TANK3	21	5	E 1319' 1 13/32" Pla	N 349' 6 1/16" Plant	El 10' 2 15/32" Plan
10	PIPE 101-6"-1C0031-P-6 "	5	33554497	E 1319' 1 13/32" Pla	N 345' 7 1/16" Plant	El 10' 2 15/32" Plan

PDS Interference Clashes
Hard/Soft Clashes

No	Item Name	Table	Row	X Coord	Y Coord	Z Coord
11	TANK1	21	3	E 1319' 1 13/32" Pla	N 357' 6 1/16" Plant	El 10' 2 15/32" Plan
11	E45LR 101-6"-1C0031-P-6 "	3	33554548	E 1319' 1 13/32" Pla	N 356' 8 13/16" Plan	El 14' 0 15/32" Plan
12	TANK1	21	3	E 1319' 1 13/32" Pla	N 357' 6 1/16" Plant	El 10' 2 15/32" Plan
12	PIPE 101-6"-1C0031-P-6 "	5	33554494	E 1319' 1 13/32" Pla	N 356' 5 1/16" Plant	El 14' 0 15/32" Plan
13	TANK3	21	5	E 1319' 1 13/32" Pla	N 349' 6 1/16" Plant	El 10' 2 15/32" Plan
13	E90LR 101-6"-1C0031-P-6 "	3	33554554	E 1319' 1 13/32" Pla	N 347' 1 1/16" Plant	El 14' 0 15/32" Plan

PDS Interference Clashes
Soft/Soft Clashes

No	Item Name	Table	Row	X Coord	Y Coord	Z Coord

14	TANK3	21	5	E 1319' 1 13/32" PlaN 349' 6 1/16" PlantEl 10' 2 15/32" Plan
14	PIPE 101-6"-1C0031-P-6 "	5	33554495	E 1319' 1 13/32" PlaN 347' 1 1/16" PlantEl 14' 9 15/32" Plan

PDS Interference Report

Date: 22-Jul-93 Time: 16:29:52

Model 'A' Design File Name: bcpipe01

Entire Design Volume Included In Report

Model 'B' Design File Name: sarea38p

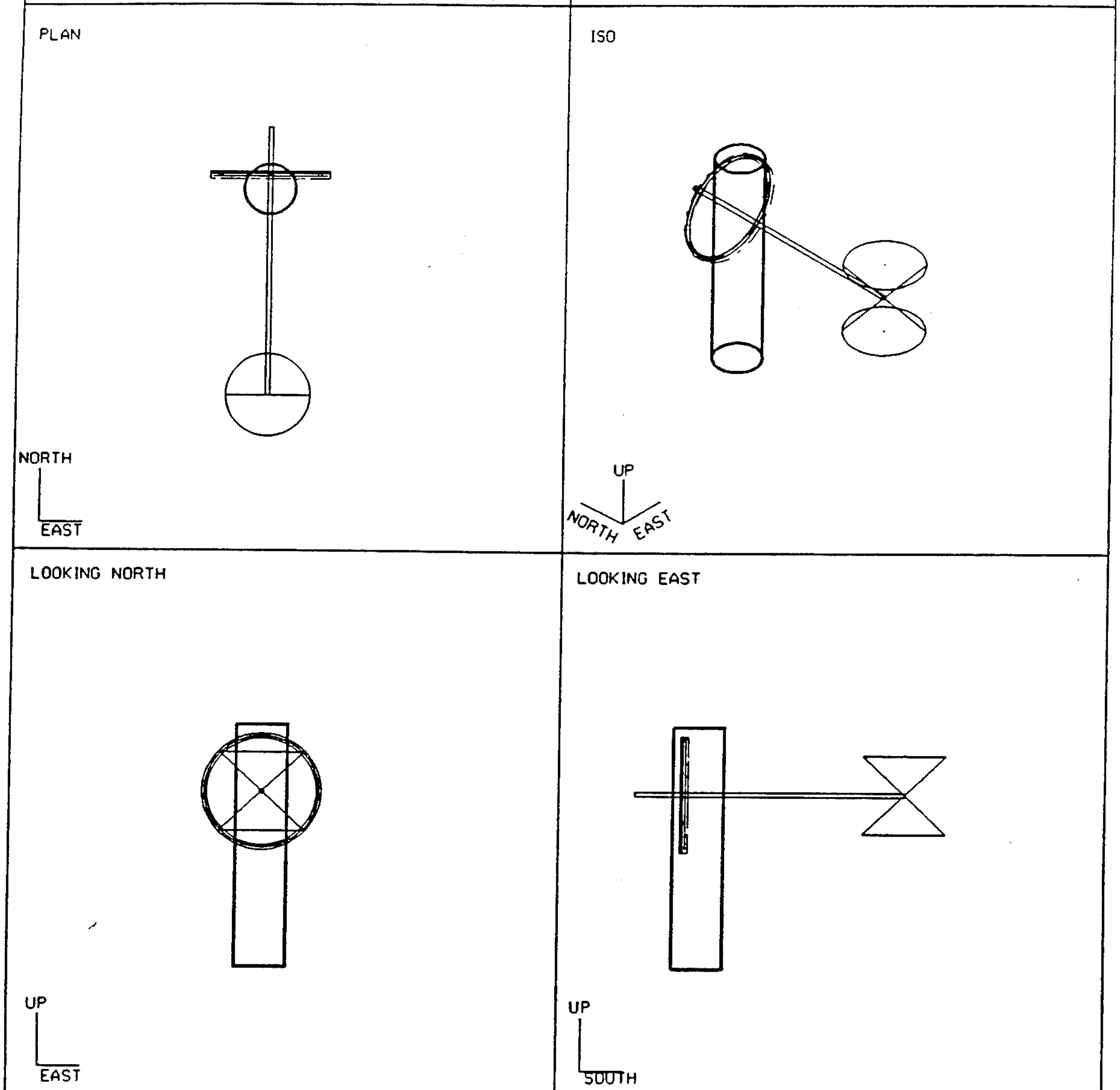
Entire Design Volume Included In Report

PDS Interference Clashes
Hard/Hard Clashes

No	Item Name	Table	Row	X Coord	Y Coord	Z Coord
22	PIPE 101-6"-1C0031-P-6 "	5	33554492	E 1319' 1 13/32" Pla	N 361' 4 17/32" Plan	El 18' 11 15/16" Pla
22	Brace : BR37	34	37	E 1310' 7 31/32" Pla	N 352' 6 3/32" Plant	El 25' 4 7/32" Plant
23	PIPE 202-6"-1C0031-N-0 "	5	33554498	E 1323' 4 15/32" Pla	N 341' 4 17/32" Plan	El 23' 11 15/16" Pla
23	Column : C16	34	16	E 1323' 5 31/32" Pla	N 352' 11 1/8" Plant	El 14' 4 7/32" Plant
24	PIPE 202-6"-1C0031-N-0 "	5	33554498	E 1323' 4 15/32" Pla	N 341' 4 17/32" Plan	El 23' 11 15/16" Pla
24	Beam : B25	34	25	E 1310' 7 31/32" Pla	N 352' 2 9/16" Plant	El 25' 4 7/32" Plant
25	GAT 202-6"-1C0031-N-0 "	3	33554559	E 1323' 4 15/32" Pla	N 357' 4 17/32" Plan	El 23' 11 15/16" Pla
25	Beam : B27	34	27	E 1323' 4 15/32" Pla	N 380' 0 3/32" Plant	El 25' 4 7/32" Plant
26	FWN 202-6"-1C0031-N-0 "	3	33554561	E 1323' 4 15/32" Pla	N 356' 9 13/32" Plan	El 23' 11 15/16" Pla
26	Beam : B27	34	27	E 1323' 4 15/32" Pla	N 380' 0 3/32" Plant	El 25' 4 7/32" Plant

Appendix D
Graphic Display of Clashes

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :



CLASH : 1	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS HARD

MODEL A : BCPIPE01 ITEM A : GAT 101-6"-1C0031-P-6 "	MODEL B : BCPIPE01 ITEM B : PIPE 101-6"-1C0031-P-6 "
E 1318'1 29/32" PLANT N 343'10 9/16" PLANT EL14'9 15/32" PLANT	E 1320'0 29/32" PLANT N 347'10 3/8" PLANT EL17'5 15/32" PLANT

PROJECT : PDS1	AREA :	THU JUL22 16:27:47 1993

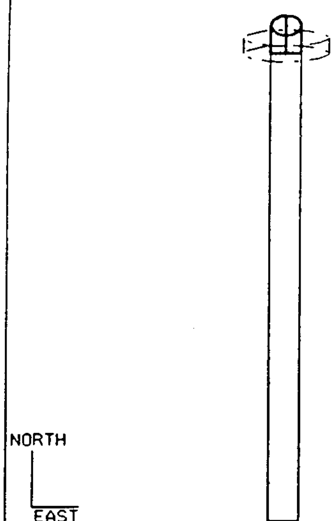
ACTION :

OWNER :

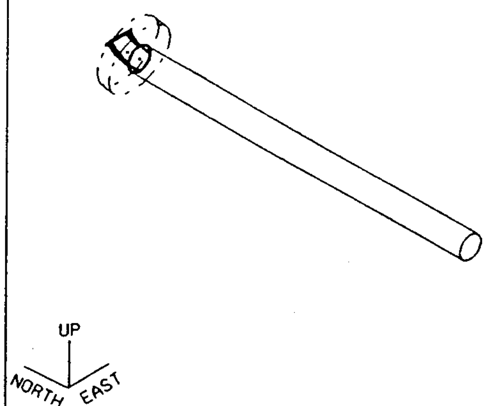
RETURN FOR APPROVAL :

TRANSFER TO :

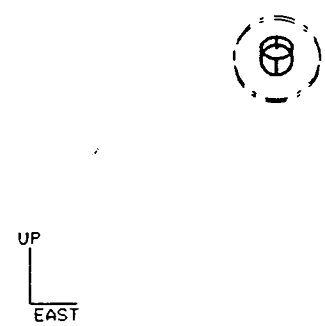
PLAN



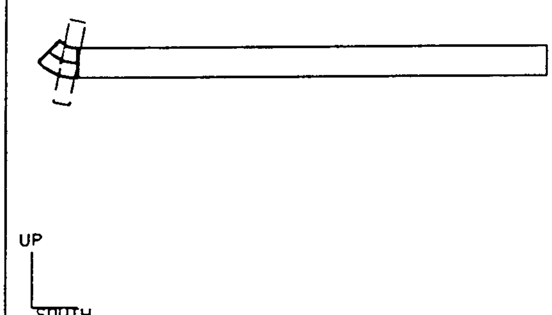
ISO



LOOKING NORTH



LOOKING EAST



CLASH : 2

STATUS : UNAPPROVED

CLASH TYPE : HARD VERSUS SOFT

MODEL A : BCPIPE01
ITEM A : E45LR
101-6"-1C0031-P-6 "

MODEL B : BCPIPE01
ITEM B : PIPE
101-6"-1C0031-P-6 "

E 1318'4 3/32" PLANT
N 347'10 1/16" PLANT
El 13'3 5/32" PLANT

E 1319'10 23/32" PLANT
N 357'6 1/32" PLANT
El 14'10 23/32" PLANT

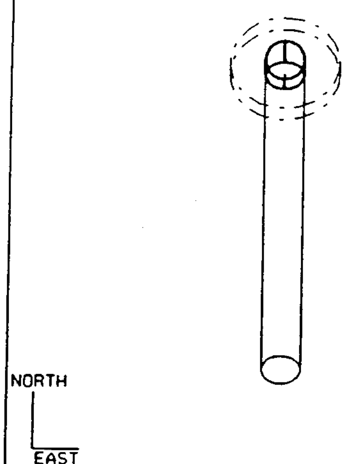
PROJECT : PDS1

AREA :

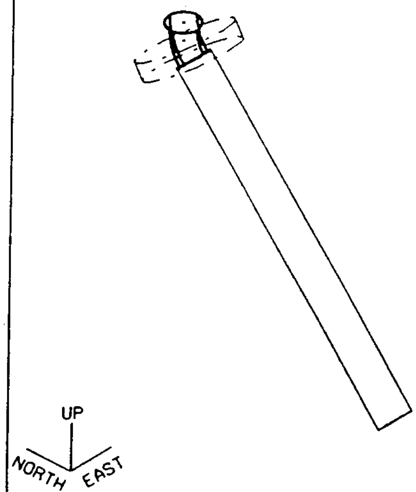
THU JUL22 16:27:54 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

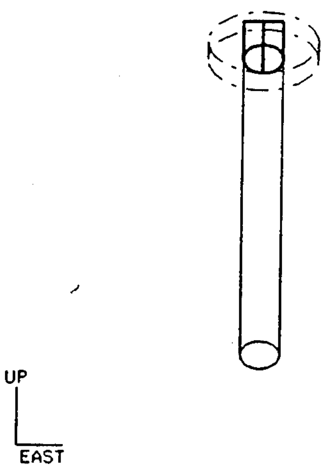
PLAN



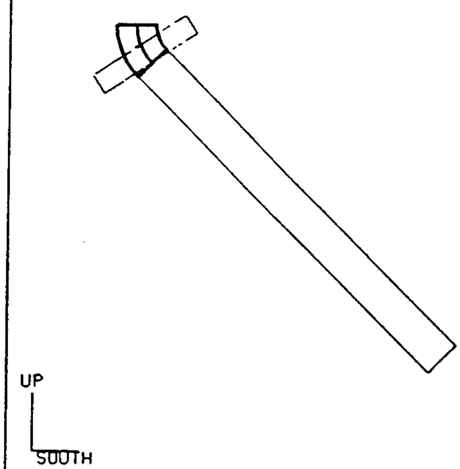
ISO



LOOKING NORTH



LOOKING EAST



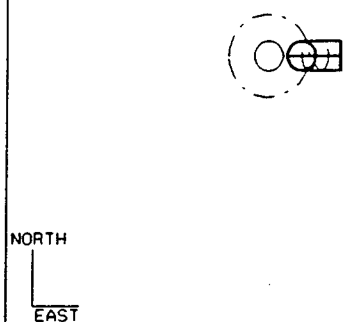
CLASH : 3	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS SOFT

MODEL A : BCPIPE01 ITEM A : PIPE 101-6"-1C0031-P-6 "	MODEL B : BCPIPE01 ITEM B : E45LR 101-6"-1C0031-P-6 "
E 1318'4 3/32" PLANT N 356'4 7/8" PLANT El 13'8 17/32" PLANT	E 1319'10 23/32" PLANT N 362'1 27/32" PLANT El 19'1 3/4" PLANT

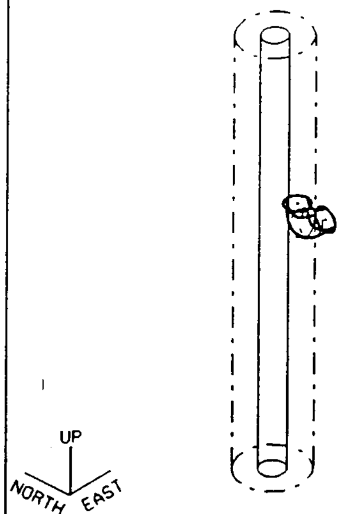
PROJECT : PDS1	AREA :	THU JUL22 16:27:59 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

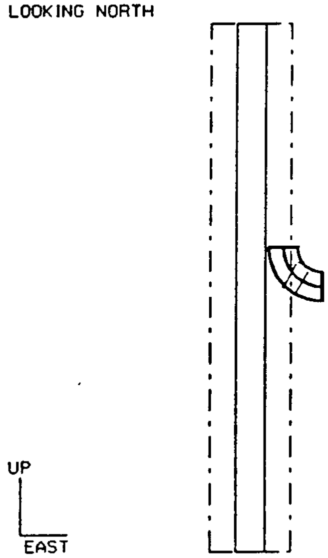
PLAN



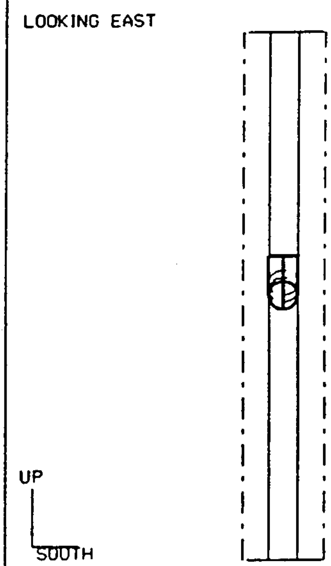
ISO



LOOKING NORTH



LOOKING EAST

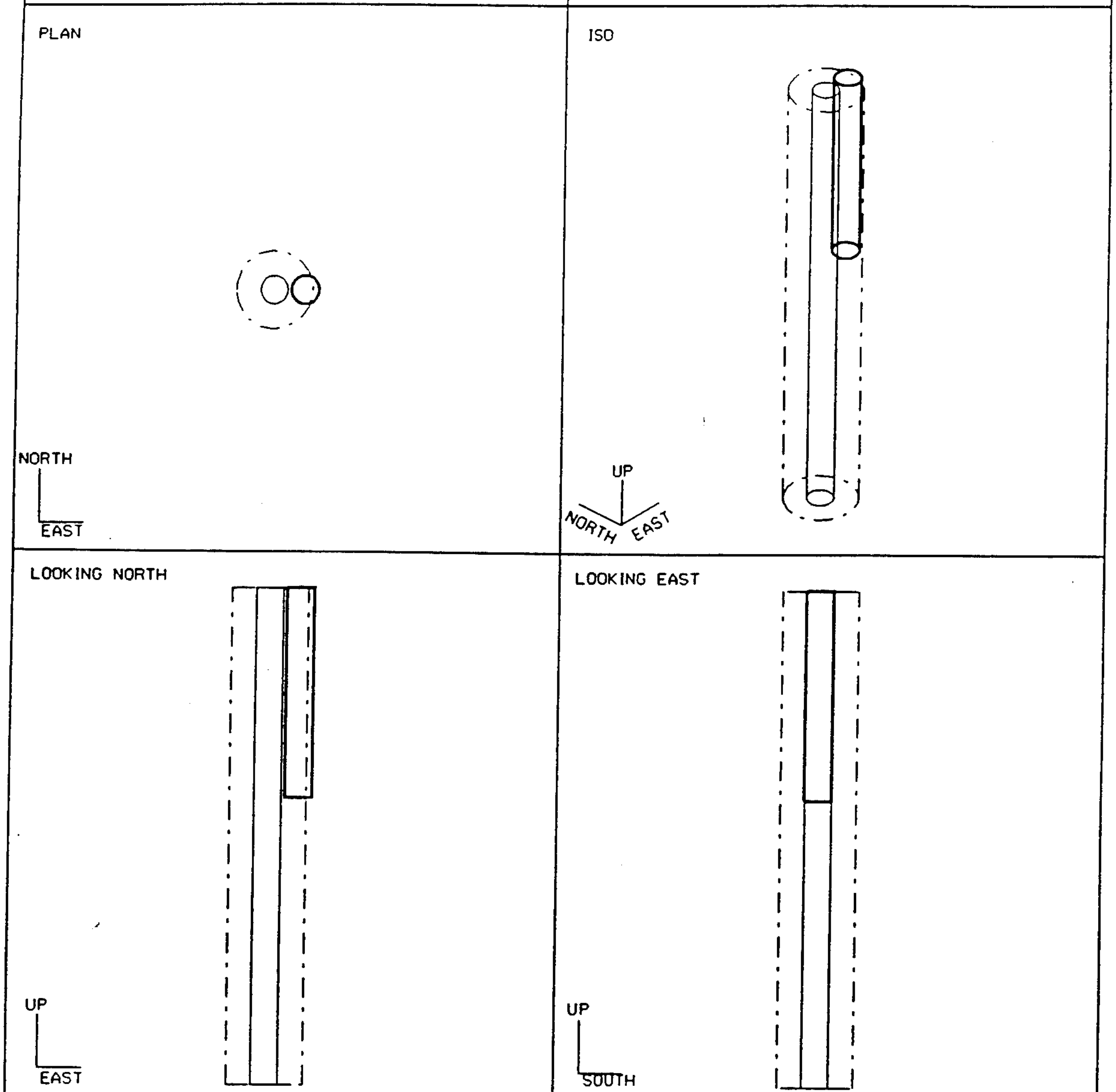


CLASH : 4	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS SOFT

MODEL A : BCPIPE01 ITEM A : PIPE 101-6"-1C0031-P-6 "	MODEL B : BCPIPE01 ITEM B : E90LR 202-6"-1C0031-N-0 "
E 1318' 4 3/32" PLANT N 360' 7 7/32" PLANT El 18' 11 15/16" PLANT	E 1320' 5 29/32" PLANT N 362' 1 27/32" PLANT El 28' 11 15/16" PLANT

PROJECT : PDS1	AREA :	THU JUL22 16:28:05 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :



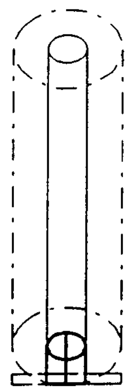
CLASH : 5	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS SOFT

MODEL A : BCPIPE01 ITEM A : PIPE 101-6"-1C0031-P-6 "	MODEL B : BCPIPE01 ITEM B : PIPE 202-6"-1C0031-N-0 "
E 1318'4 3/32" PLANT N 360'7 7/32" PLANT El 18'11 15/16" PLANT	E 1320'0 7/32" PLANT N 362'1 27/32" PLANT El 28'11 15/16" PLANT

PROJECT : PDS1	AREA :	THU JUL22 16:28:10 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

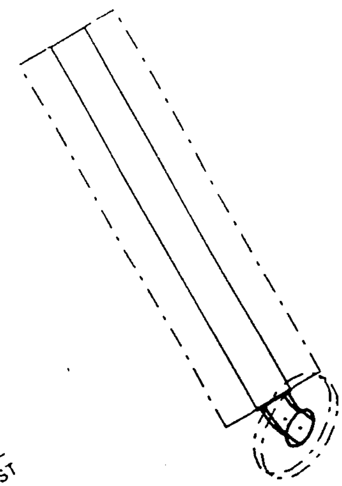
PLAN



NORTH

EAST

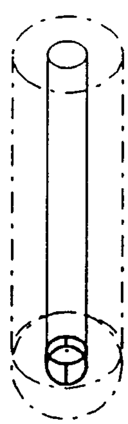
ISO



UP

NORTH EAST

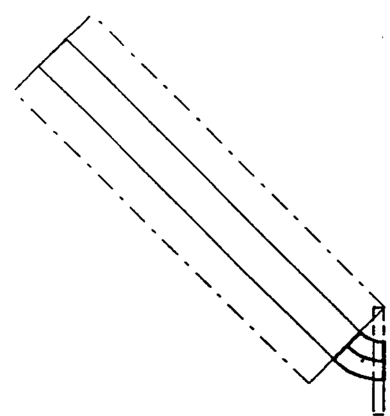
LOOKING NORTH



UP

EAST

LOOKING EAST



UP

SOUTH

CLASH : 6	STATUS : UNAPPROVED	CLASH TYPE : SOFT VERSUS SOFT

MODEL A : BCPIPE01 ITEM A : E45LR 101-6"-1C0031-P-6 "	MODEL B : BCPIPE01 ITEM B : PIPE 101-6"-1C0031-P-6 "
E 1318' 4 3/32" PLANT N 356' 3 1/4" PLANT El 13' 3 5/32" PLANT	E 1319' 10 23/32" PLANT N 361' 8 15/32" PLANT El 19' 0 1/8" PLANT

PROJECT : PDS1	AREA :	THU JUL22 16:28:15 1993

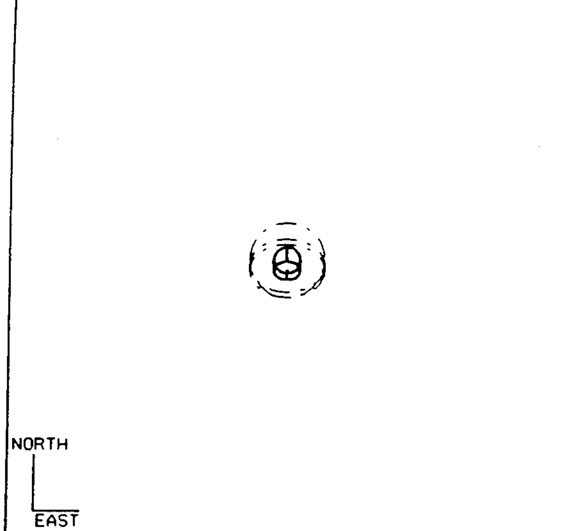
ACTION :

OWNER :

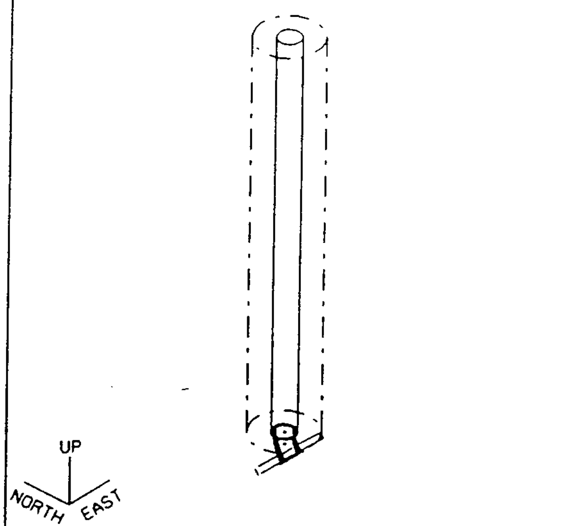
RETURN FOR APPROVAL :

TRANSFER TO :

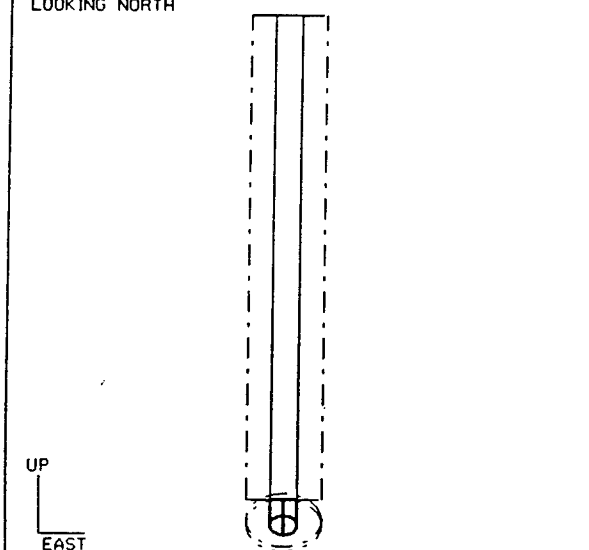
PLAN



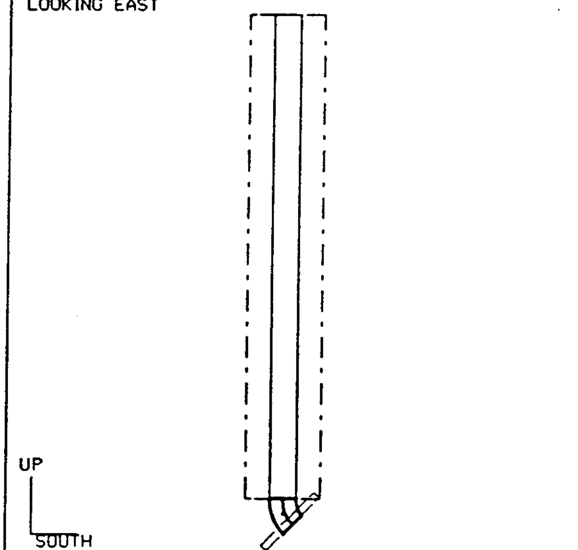
ISO



LOOKING NORTH



LOOKING EAST



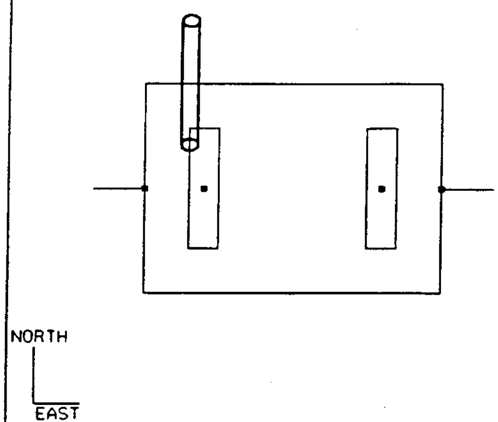
CLASH : 7	STATUS : UNAPPROVED	CLASH TYPE : SOFT VERSUS SOFT

MODEL A : BCPIPE01 ITEM A : E45LR 101-6"-1C0031-P-6 "	MODEL B : BCPIPE01 ITEM B : PIPE 101-6"-1C0031-P-6 "
E 1318' 4 3/32" PLANT N 360' 6 9/32" PLANT El 17' 10 31/32" PLANT	E 1319' 10 23/32" PLANT N 362' 1 27/32" PLANT El 28' 11 15/16" PLANT

PROJECT : PDS1 AREA : THU JUL22 16:28:21 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

PLAN



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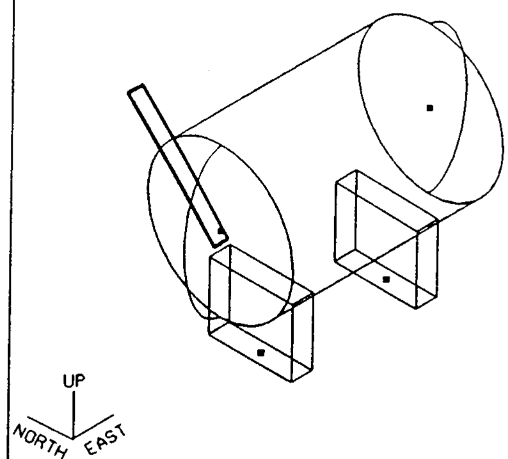
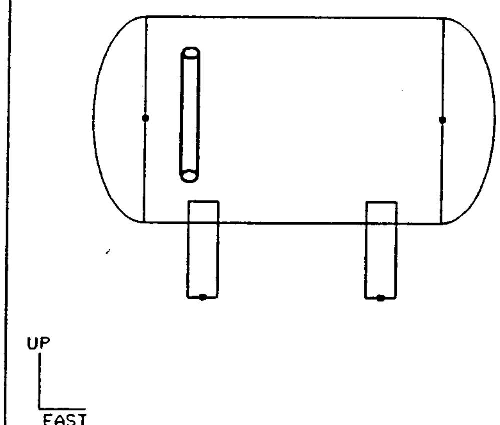
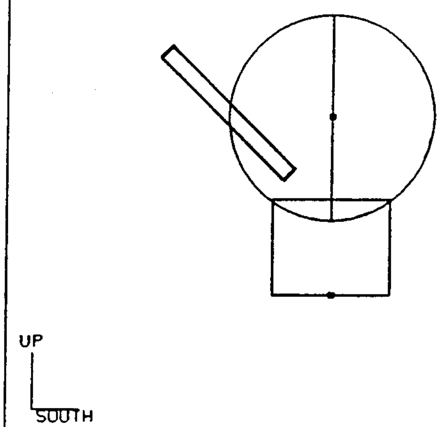


LOOKING NORTH



LOOKING EAST



CLASH : 8	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS HARD

MODEL A : BCEQPØ1 ITEM A : TANK1	MODEL B : BCPIPEØ1 ITEM B : PIPE 1Ø1-6"-1CØØ31-P-6 "
E 1315'1Ø 13/32" PLANT N 352'Ø 1/16" PLANT El 1Ø'2 15/32" PLANT	E 1329'4 13/32" PLANT N 361'8 15/32" PLANT El 19'8 15/32" PLANT

PROJECT : PDS1 AREA : THU JUL22 16:29:11 1993

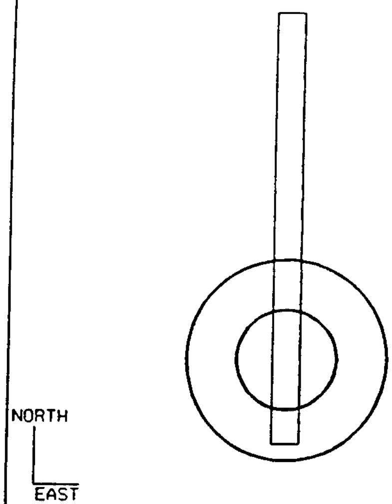
ACTION :

OWNER :

RETURN FOR APPROVAL :

TRANSFER TO :

PLAN



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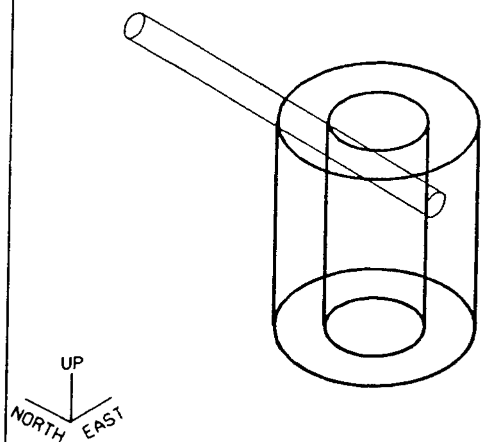
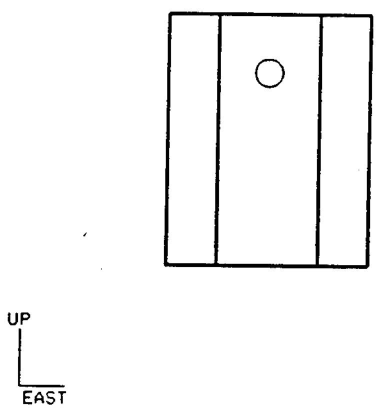
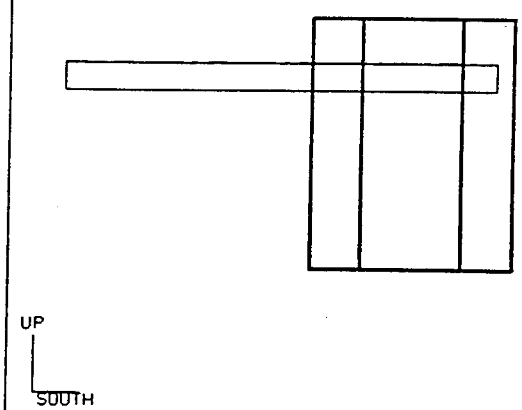


LOOKING NORTH



LOOKING EAST



CLASH : 9

STATUS : UNAPPROVED

CLASH TYPE : HARD VERSUS HARD

MODEL A : BCEOPØ1
ITEM A : TANK3

MODEL B : BCPIPEØ1
ITEM B : PIPE
1Ø1-6"-1CØØ31-P-6 "

E 1317' 1 13/32" PLANT
N 347' 6 1/16" PLANT
EL 1Ø' 2 15/32" PLANT

E 1321' 1 13/32" PLANT
N 356' 5 1/16" PLANT
EL 15' 2 15/32" PLANT

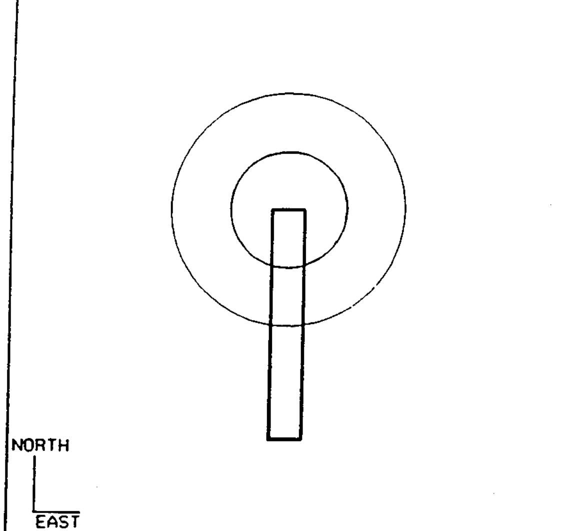
PROJECT : PDS1

AREA :

THU JUL22 16:29:16 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

PLAN



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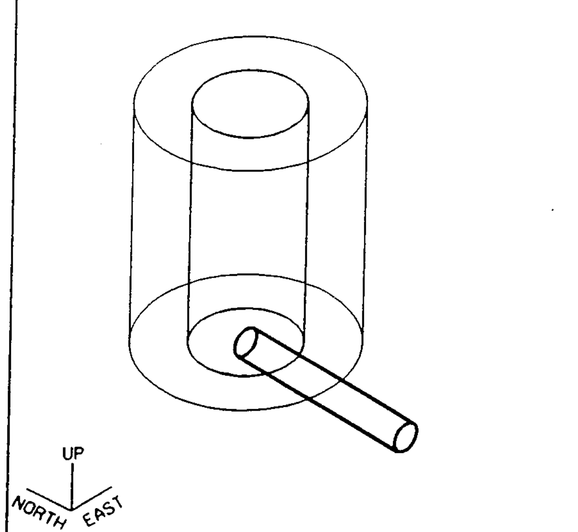
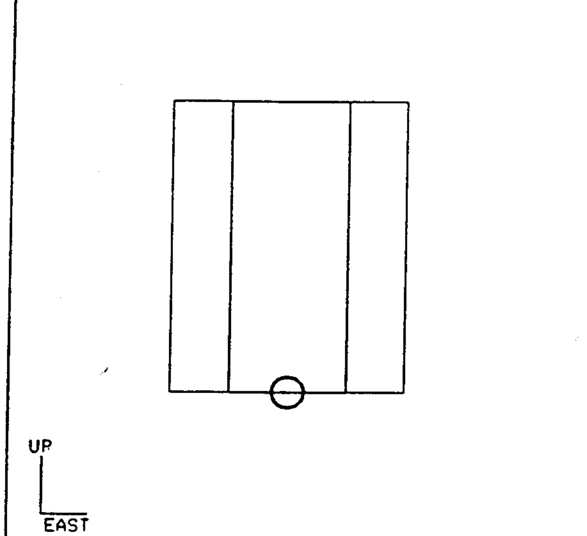
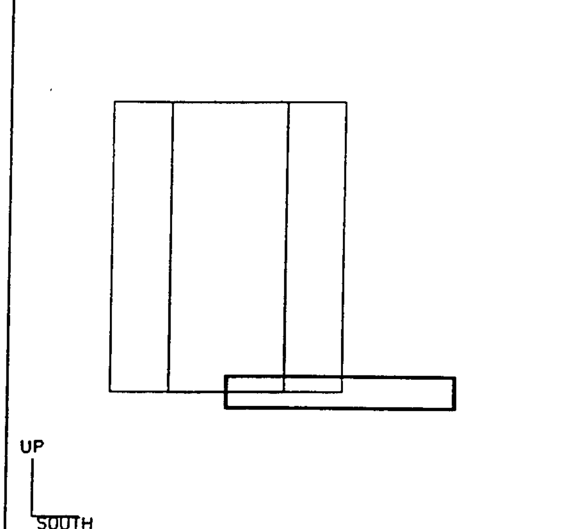


LOOKING NORTH



LOOKING EAST



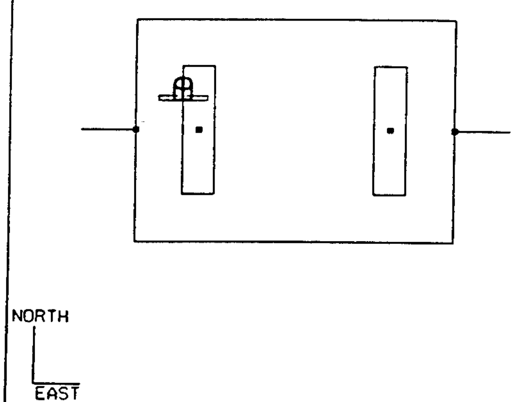
CLASH : 10	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS HARD

MODEL A : BCEOP01 ITEM A : TANK3	MODEL B : BCPIPE01 ITEM B : PIPE 101-6"-1C0031-P-6 "
E 1317'1 13/32" PLANT N 345'7 1/16" PLANT EL9'5 5/32" PLANT	E 1321'1 13/32" PLANT N 351'6 1/16" PLANT EL15'2 15/32" PLANT

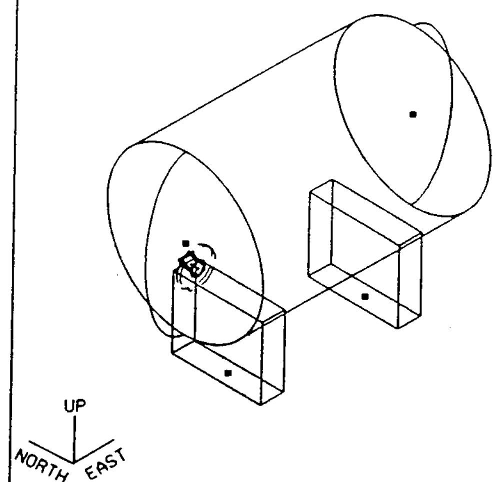
PROJECT : PDS1	AREA :	THU JUL22 16:29:21 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

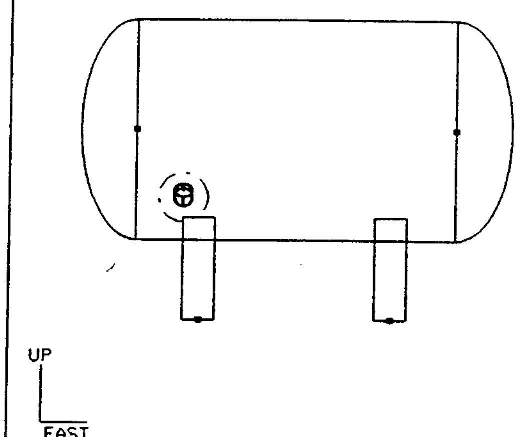
PLAN



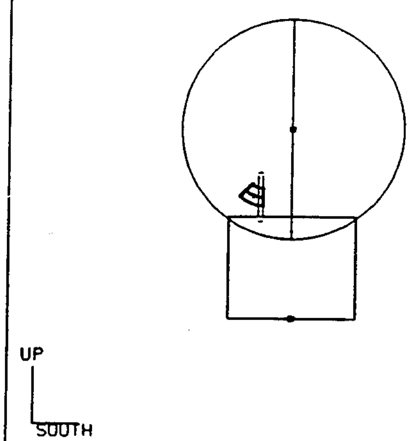
ISO



LOOKING NORTH



LOOKING EAST



CLASH : 11	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS SOFT

MODEL A : BCEQP01 ITEM A : TANK1	MODEL B : BCPIPE01 ITEM B : E45LR 101-6"-1C0031-P-6 "
E 1315'10 13/32" PLANT N 352'0 1/16" PLANT El10'2 15/32" PLANT	E 1329'4 13/32" PLANT N 359'0 1/16" PLANT El19'8 15/32" PLANT

PROJECT : PDS1	AREA :	THU JUL22 16:29:26 1993

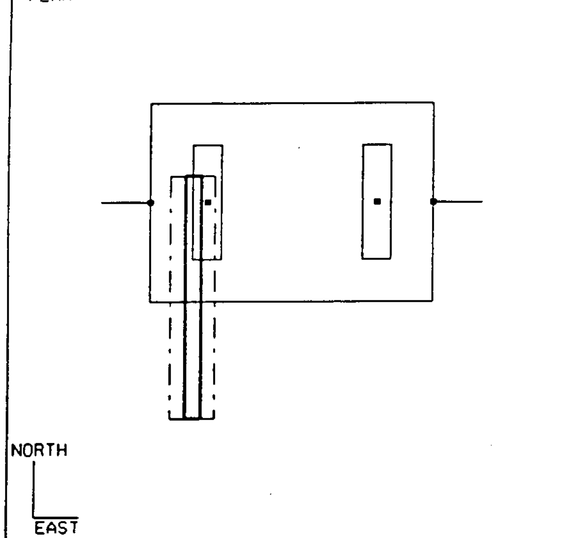
ACTION :

OWNER :

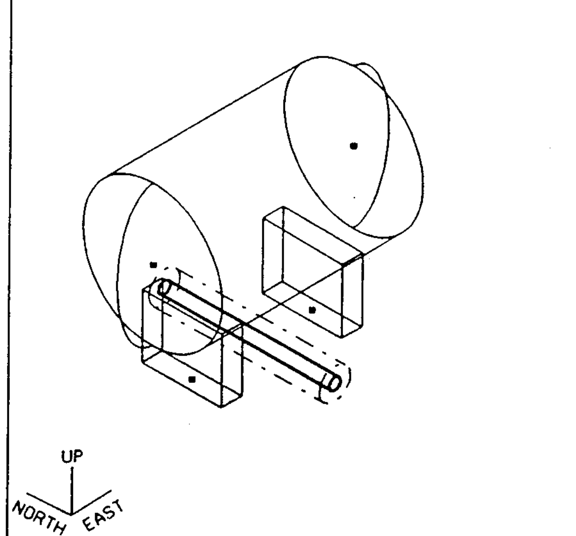
RETURN FOR APPROVAL :

TRANSFER TO :

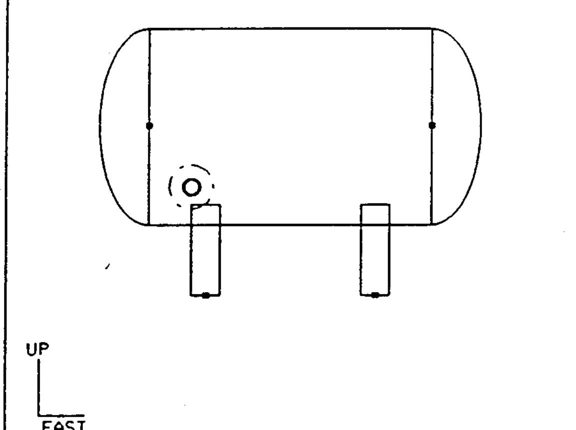
PLAN



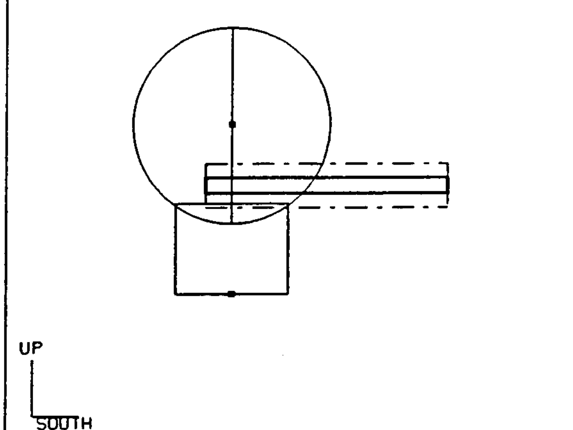
ISO



LOOKING NORTH



LOOKING EAST



CLASH : 12

STATUS : UNAPPROVED

CLASH TYPE : HARD VERSUS SOFT

MODEL A : BCEQP01
ITEM A : TANK1

MODEL B : BCPIPE01
ITEM B : PIPE
101-6"-1C0031-P-6 "

E 1315'10 13/32" PLANT
N 347'10 1/16" PLANT
EL10'2 15/32" PLANT

E 1329'4 13/32" PLANT
N 359'0 1/16" PLANT
EL19'8 15/32" PLANT

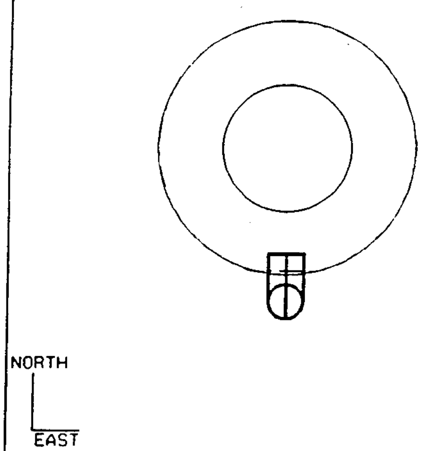
PROJECT : PDS1

AREA :

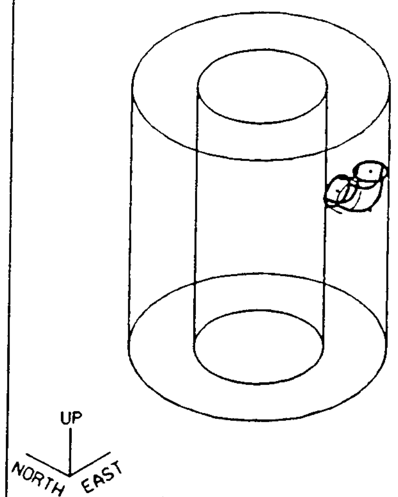
THU JUL22 16:29:32 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

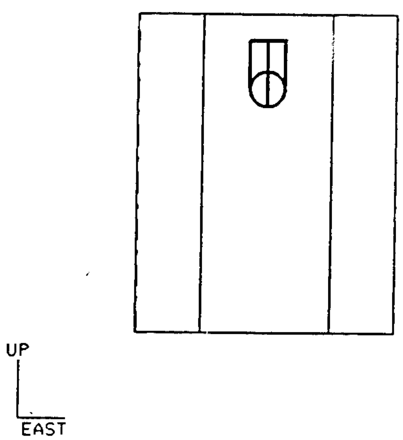
PLAN



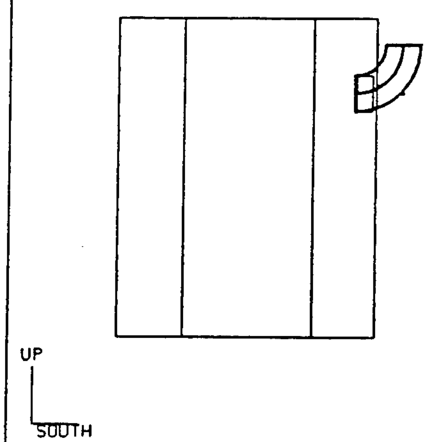
ISO



LOOKING NORTH



LOOKING EAST



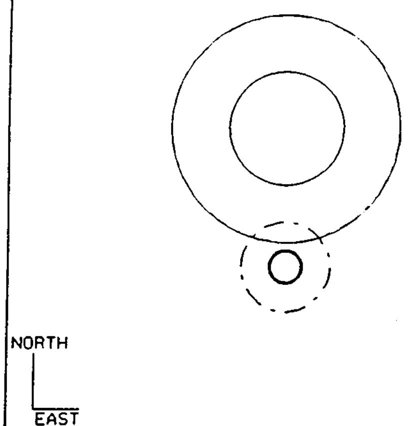
CLASH : 13	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS SOFT

MODEL A : BCEOPØ1 ITEM A : TANK3	MODEL B : BCPIPEØ1 ITEM B : E9ØLR 1Ø1-6"-1CØØ31-P-6 "
E 1317' 1 13/32" PLANT N 346' 3 3/4" PLANT EL1Ø' 2 15/32" PLANT	E 1321' 1 13/32" PLANT N 351' 6 1/16" PLANT EL15' 2 15/32" PLANT

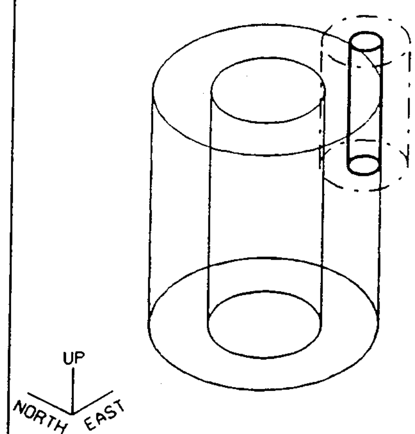
PROJECT : PDS1	AREA :	THU JUL22 16:29:37 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

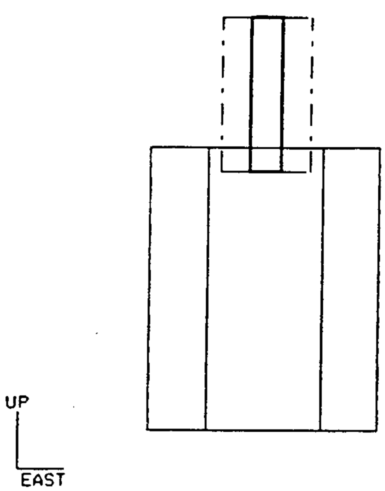
PLAN



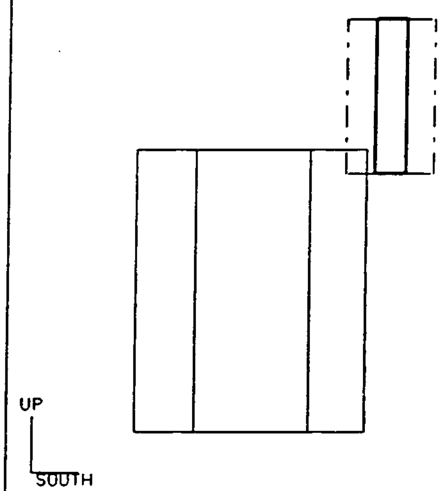
ISO



LOOKING NORTH



LOOKING EAST



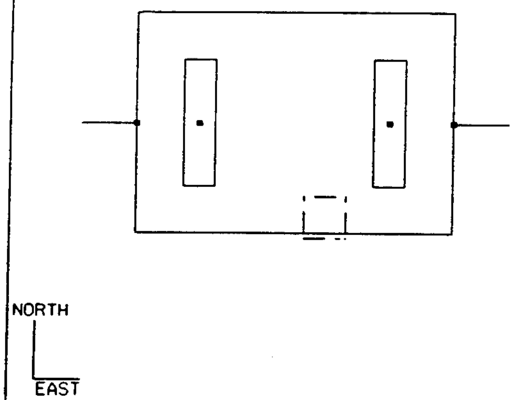
CLASH : 14	STATUS : UNAPPROVED	CLASH TYPE : SOFT VERSUS SOFT

MODEL A : BCEQPØ1 ITEM A : TANK3	MODEL B : BCPIPEØ1 ITEM B : PIPE 1Ø1-6"-1CØØ31-P-6 "
E 1317'1 13/32" PLANT N 346'3 3/4" PLANT EL1Ø'2 15/32" PLANT	E 1321'1 13/32" PLANT N 351'6 1/16" PLANT EL17'5 15/32" PLANT

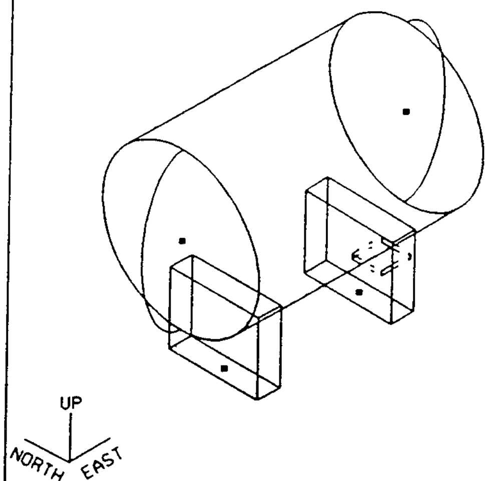
PROJECT : PDS1	AREA :	THU JUL22 16:29:43 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

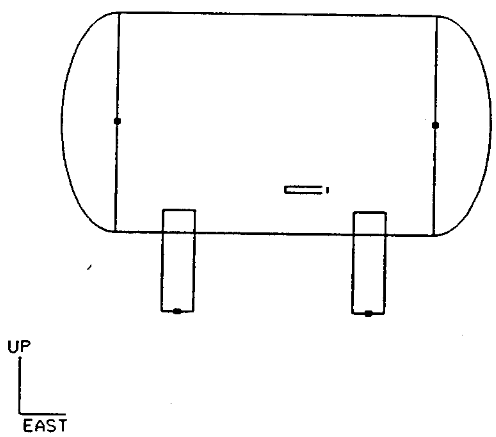
PLAN



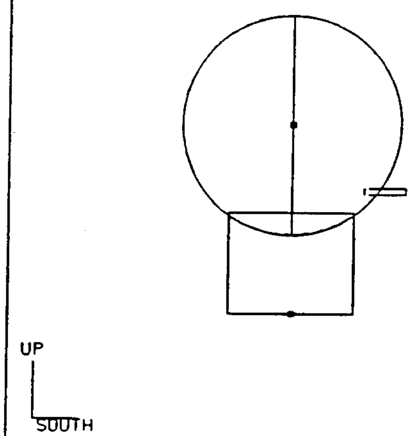
ISO



LOOKING NORTH



LOOKING EAST



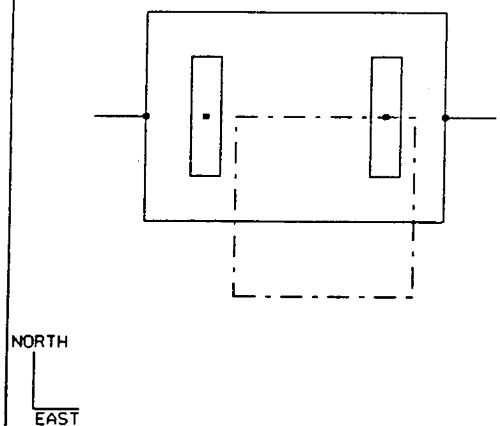
CLASH : 15	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS HARD

MODEL A : BCEQP01 ITEM A : TANK1	MODEL B : SAREA38P ITEM B : VOLUME : V5
E 1315' 10 13/32" PLANT N 351' 10 1/16" PLANT EL 10' 2 15/32" PLANT	E 1329' 4 13/32" PLANT N 359' 0 1/16" PLANT EL 19' 8 15/32" PLANT

PROJECT : PDS1	AREA :	THU JUL22 16:28:28 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

PLAN



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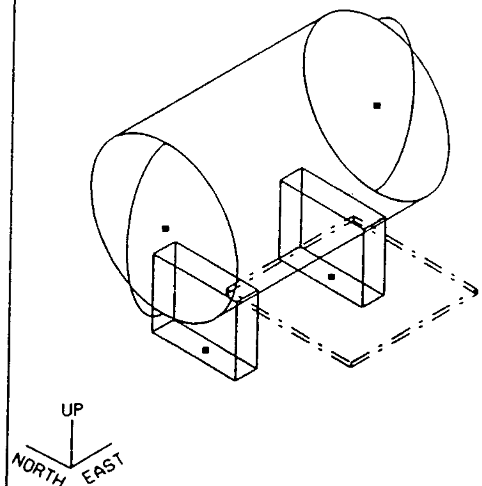
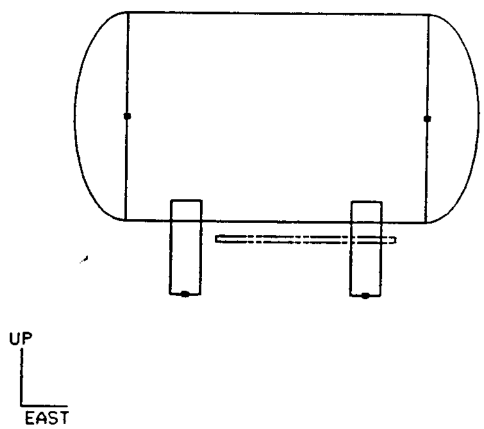
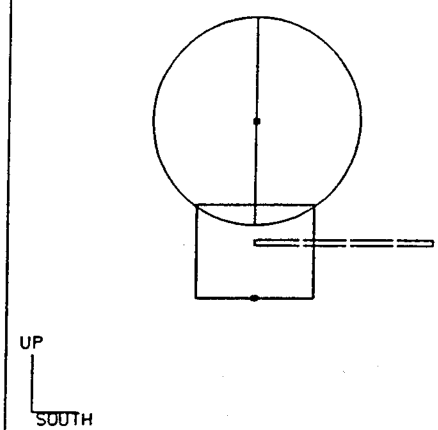


LOOKING NORTH



LOOKING EAST



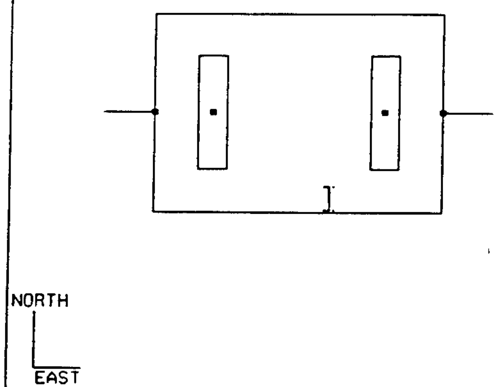
CLASH : 16	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS HARD

MODEL A : BCEQP01 ITEM A : TANK1	MODEL B : SAREA38P ITEM B : VOLUME : V10
E 1315' 10 13/32" PLANT N 349' 6 1/16" PLANT EL 10' 2 15/32" PLANT	E 1329' 4 13/32" PLANT N 359' 0 1/16" PLANT EL 19' 8 15/32" PLANT

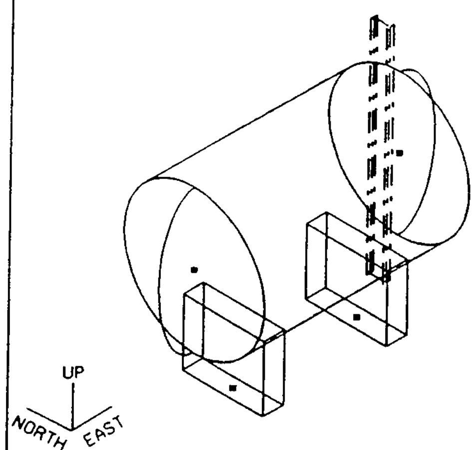
PROJECT : PDS1	AREA :	THU JUL22 16:28:34 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

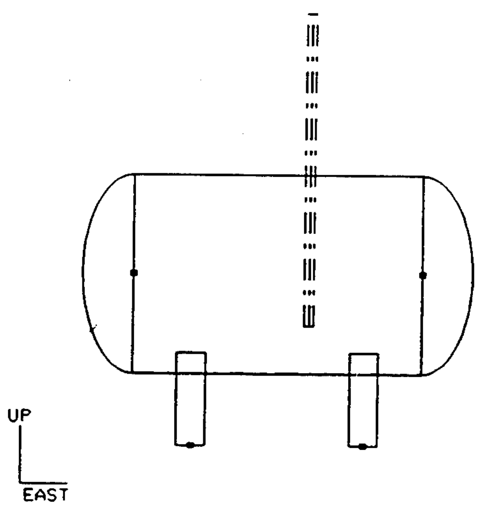
PLAN



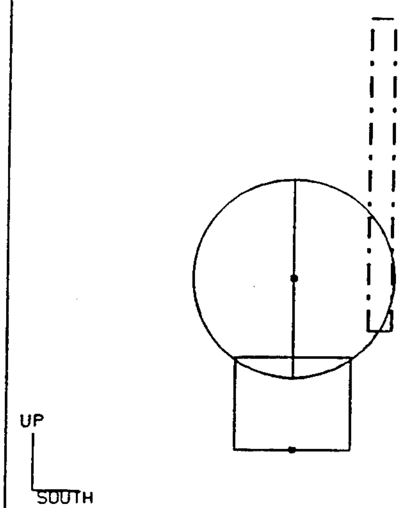
ISO



LOOKING NORTH



LOOKING EAST



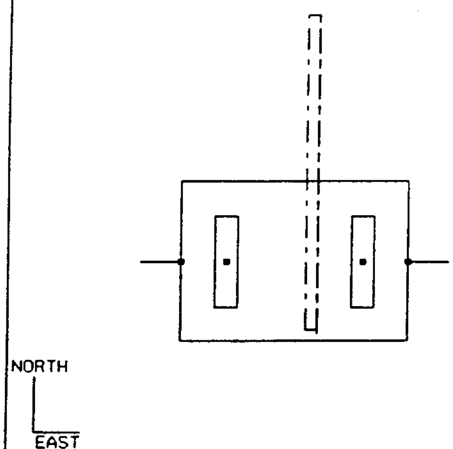
CLASH : 17	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS HARD

MODEL A : BCEQP01 ITEM A : TANK1	MODEL B : SAREA38P ITEM B : COLUMN : C16
E 1315' 10 13/32" PLANT N 352' 0 1/16" PLANT EL 10' 2 15/32" PLANT	E 1329' 4 13/32" PLANT N 359' 0 1/16" PLANT EL 25' 4 7/32" PLANT

PROJECT : PDS1	AREA :	THU JUL22 16:28:40 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

PLAN



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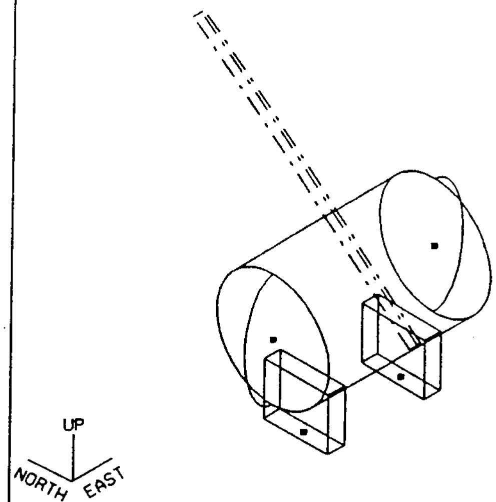
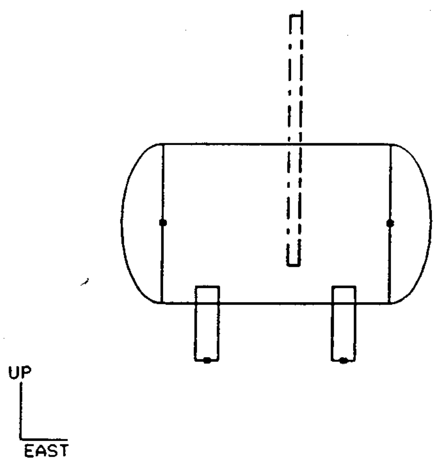
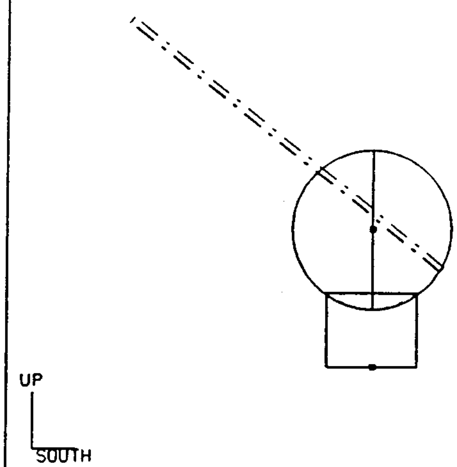


LOOKING NORTH



LOOKING EAST



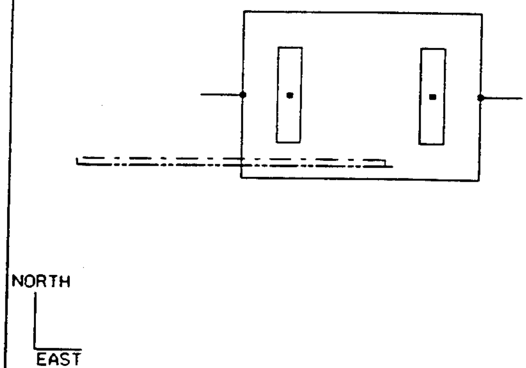
CLASH : 18	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS HARD

MODEL A : BCEOPØ1 ITEM A : TANK1	MODEL B : SAREA38P ITEM B : BRACE :BR3Ø
E 1315'1Ø 13/32" PLANT N 352'Ø 1/16" PLANT EL1Ø'2 15/32" PLANT	E 1329'4 13/32" PLANT N 366'3 3/32" PLANT EL25'6 15/16" PLANT

PROJECT : PDS1	AREA :	THU JUL22 16:28:46 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

PLAN



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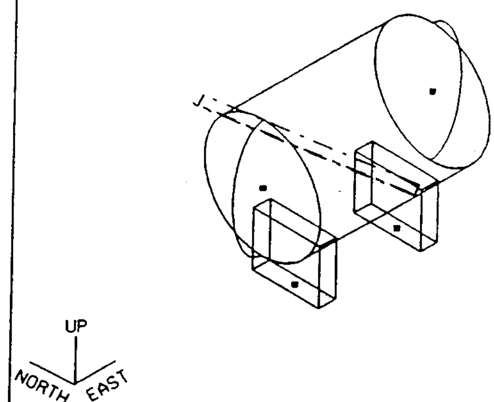
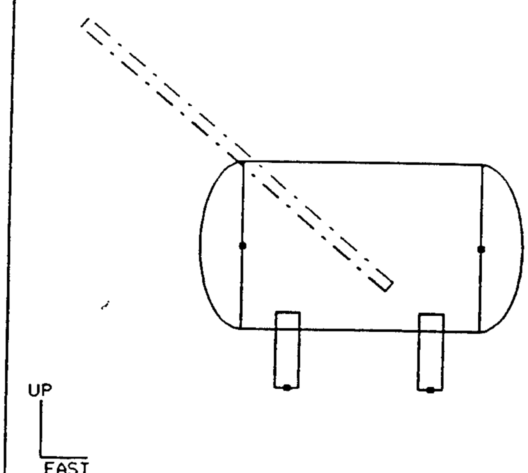
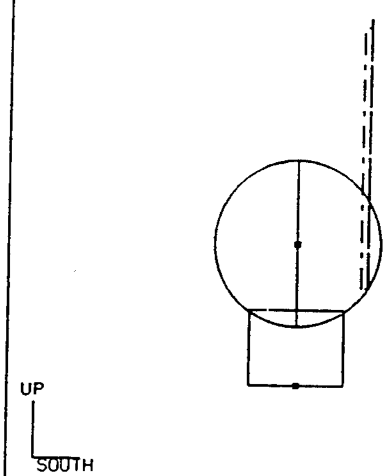


LOOKING NORTH



LOOKING EAST



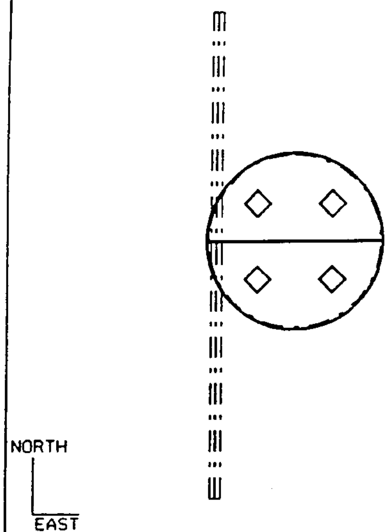
CLASH : 19	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS HARD

MODEL A : BCEOP01 ITEM A : TANK1	MODEL B : SAREA38P ITEM B : BRACE : BR34
E 1310'7 31/32" PLANT N 352'0 1/16" PLANT EL10'2 15/32" PLANT	E 1329'4 13/32" PLANT N 359'0 1/16" PLANT EL25'8 13/16" PLANT

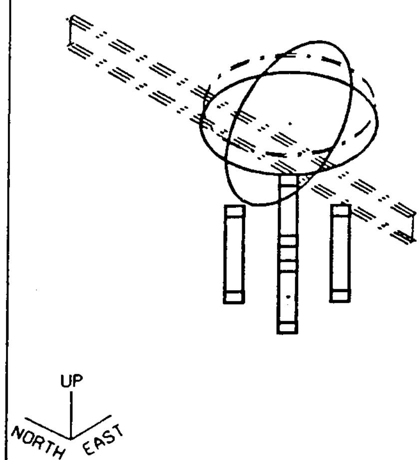
PROJECT : PDS1	AREA :	THU JUL22 16:28:52 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

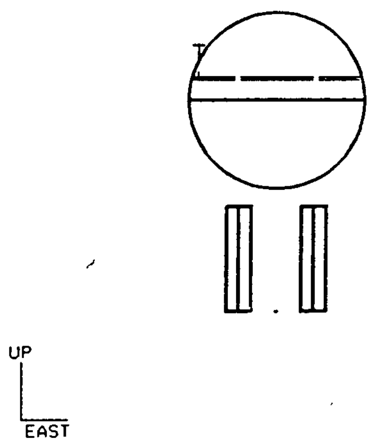
PLAN



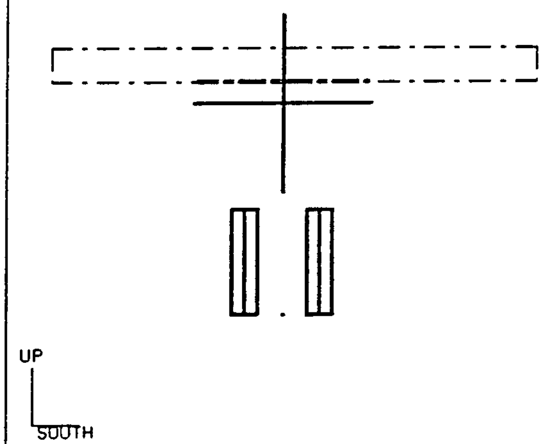
ISO



LOOKING NORTH



LOOKING EAST



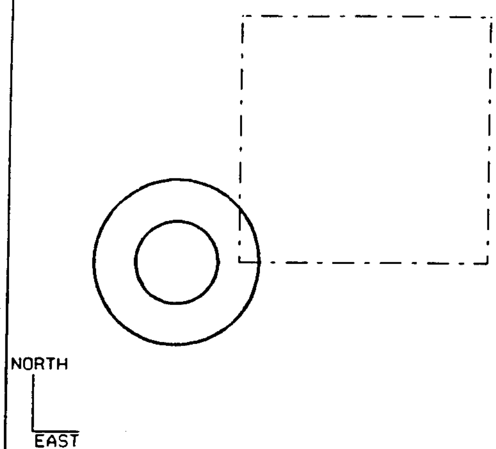
CLASH : 20	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS HARD

MODEL A : BCEQP01 ITEM A : TANK2	MODEL B : SAREA38P ITEM B : BEAM : B28
E 1310' 1 15/32" PLANT N 352' 6 3/32" PLANT EL 10' 2 15/32" PLANT	E 1320' 1 15/32" PLANT N 380' 0 3/32" PLANT EL 27' 2 15/32" PLANT

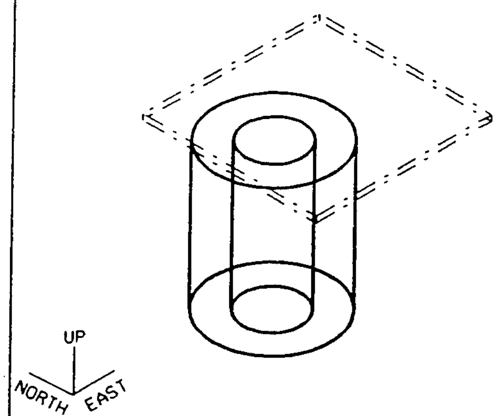
PROJECT : PDSI	AREA :	THU JUL22 16:28:59 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

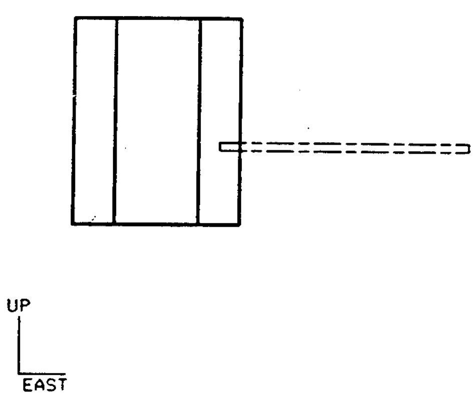
PLAN



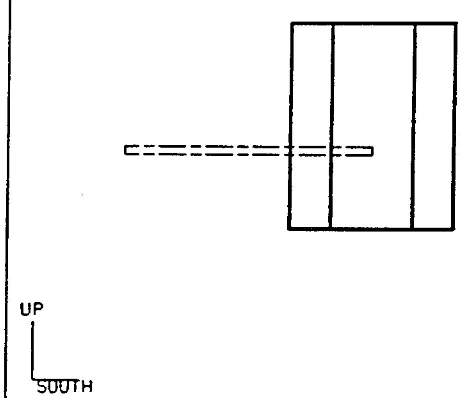
ISO



LOOKING NORTH



LOOKING EAST



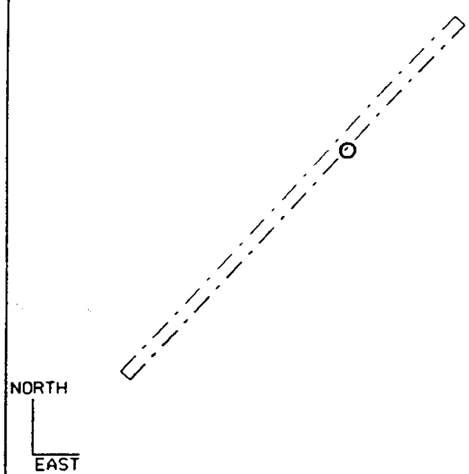
CLASH : 21	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS SOFT

MODEL A : BCEQP01 ITEM A : TANK3	MODEL B : SAREA38P ITEM B : VOLUME : V10
E 1317'1 13/32" PLANT N 347'6 1/16" PLANT EL 10'2 15/32" PLANT	E 1326'7 13/32" PLANT N 355'6 1/16" PLANT EL 15'2 15/32" PLANT

PROJECT : PDS1	AREA :	THU JUL22 16:29:04 1993

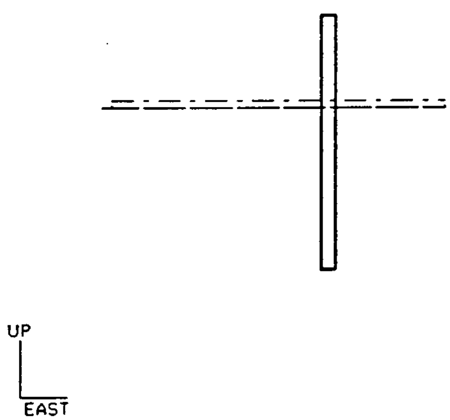
ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

PLAN

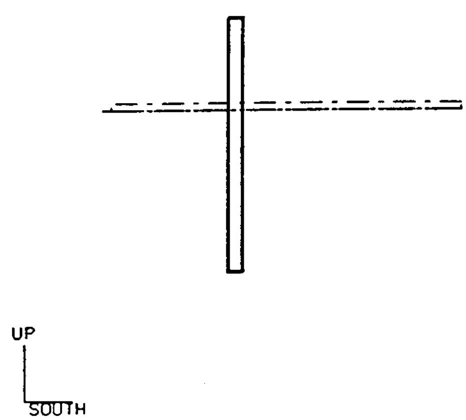


ISO

LOOKING NORTH



LOOKING EAST



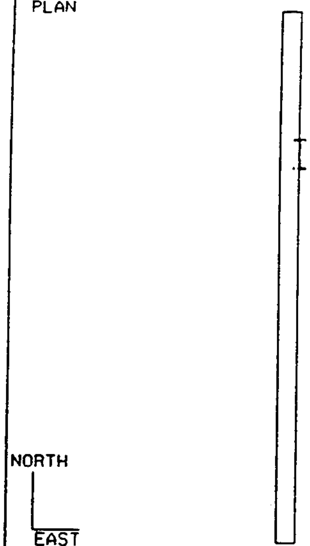
CLASH : 22	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS HARD

MODEL A : BCPIPE01 ITEM A : PIPE 101-6"-1C0031-P-6 "	MODEL B : SAREA38P ITEM B : BRACE : BR37
E 1310' 3 5/8" PLANT N 352' 6 3/32" PLANT EL 18' 11 15/16" PLANT	E 1323' 7 31/32" PLANT N 366' 7 3/16" PLANT EL 28' 11 15/16" PLANT

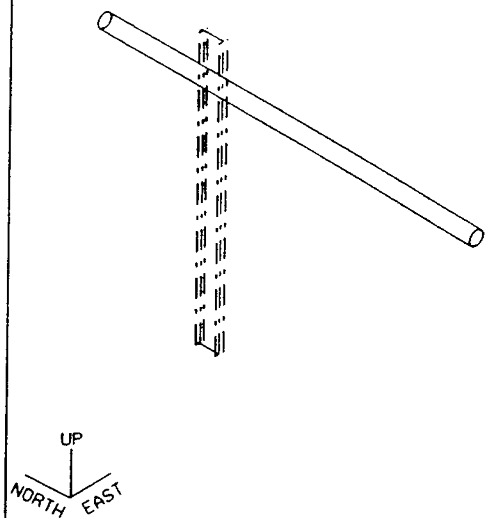
PROJECT : PDS1	AREA :	THU JUL22 16:29:48 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

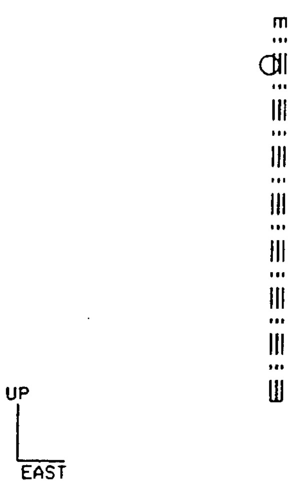
PLAN



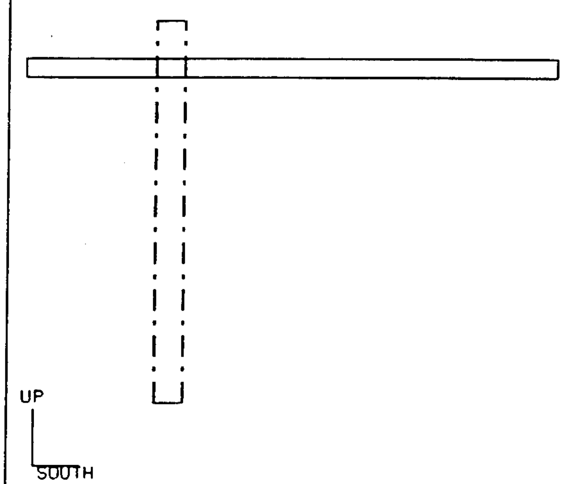
ISO



LOOKING NORTH



LOOKING EAST



CLASH : 23	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS HARD

MODEL A : BCPIPE01 ITEM A : PIPE 202-6"-1C0031-N-0 "	MODEL B : SAREA38P ITEM B : COLUMN : C16
E 1323' 1 5/32" PLANT N 341' 4 17/32" PLANT El 14' 4 7/32" PLANT	E 1323' 9 31/32" PLANT N 356' 7 21/32" PLANT El 25' 4 7/32" PLANT

PROJECT : PDS1	AREA :	THU JUL 22 16:29:54 1993

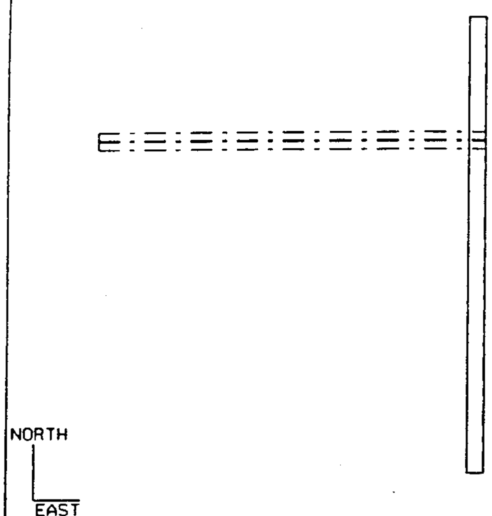
ACTION :

OWNER :

RETURN FOR APPROVAL :

TRANSFER TO :

PLAN



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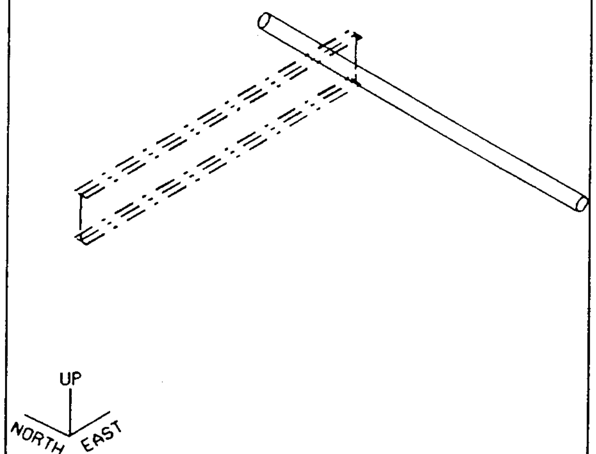
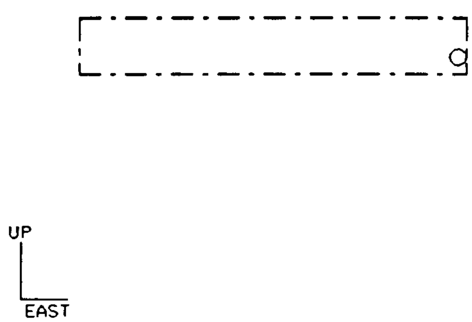
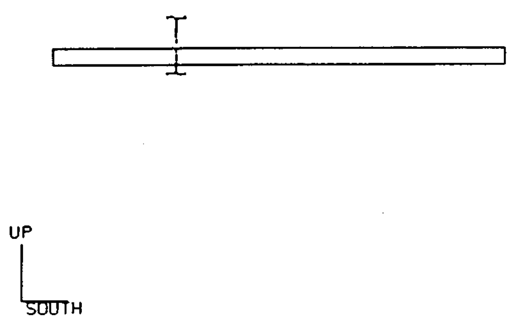


LOOKING NORTH



LOOKING EAST



CLASH : 24

STATUS : UNAPPROVED

CLASH TYPE : HARD VERSUS HARD

MODEL A : BCPIPE01
ITEM A : PIPE
202-6"-1C0031-N-0 "

MODEL B : SAREA38P
ITEM B : BEAM : B25

E 1310' 7 31/32" PLANT
N 341' 4 17/32" PLANT
EL23' 4 21/32" PLANT

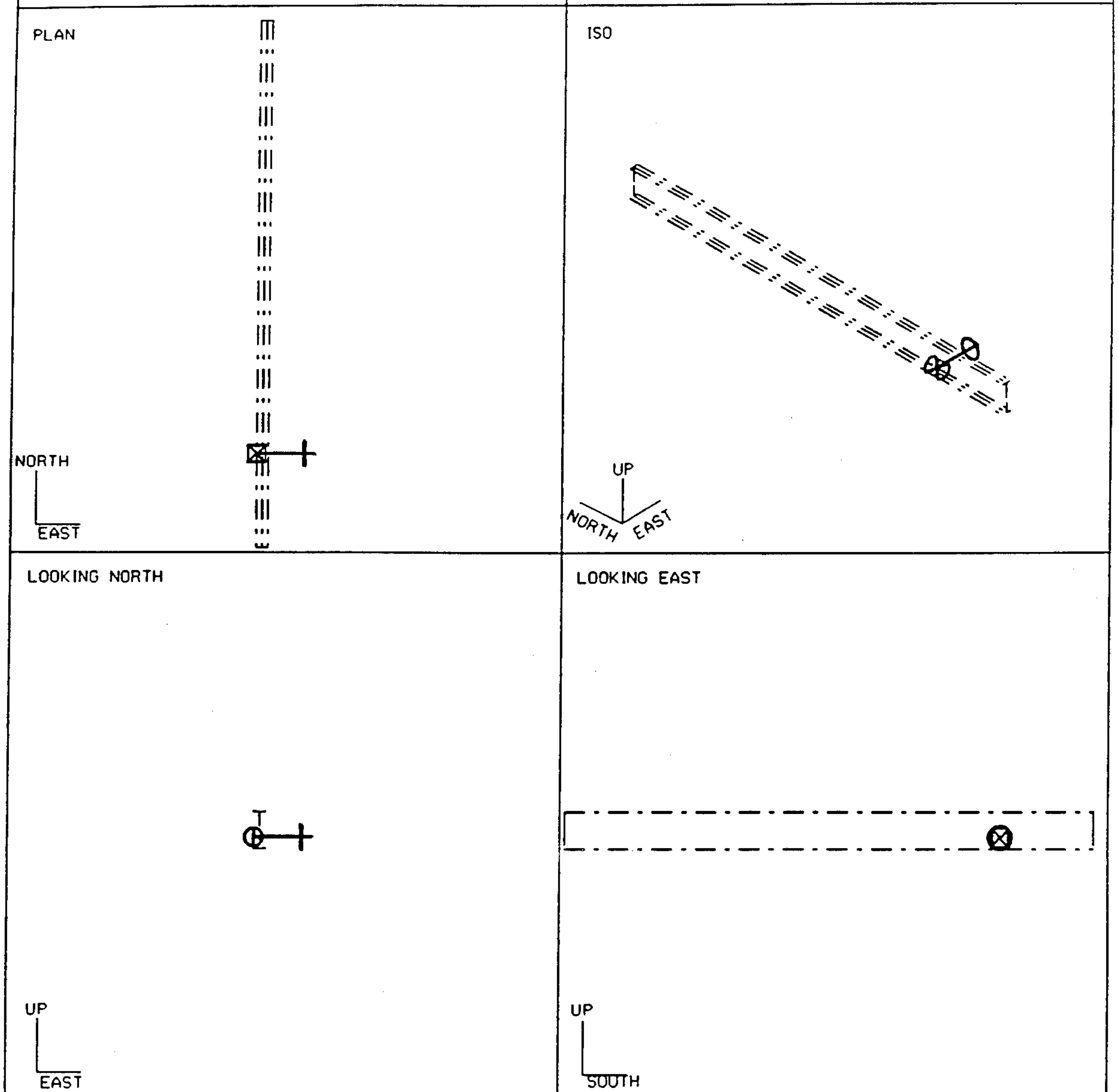
E 1323' 7 31/32" PLANT
N 356' 7 21/32" PLANT
EL25' 4 7/32" PLANT

PROJECT : PDS1

AREA :

THU JUL22 16:29:59 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :

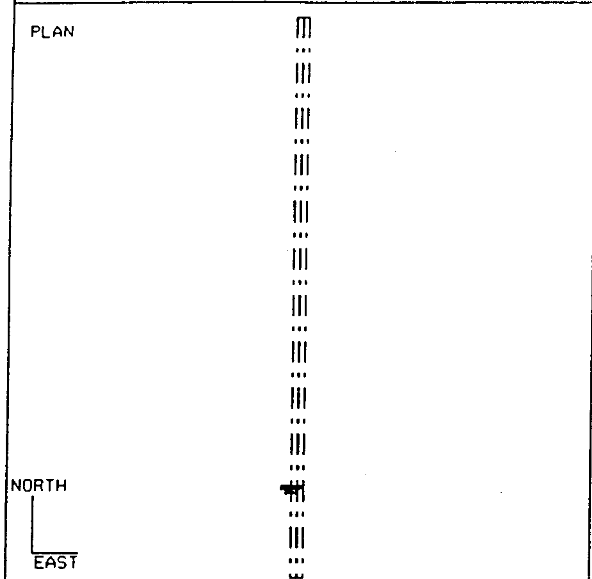


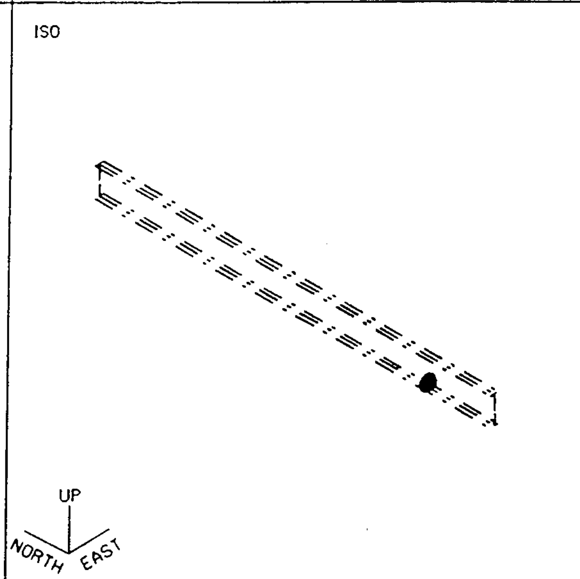
CLASH : 25	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS HARD

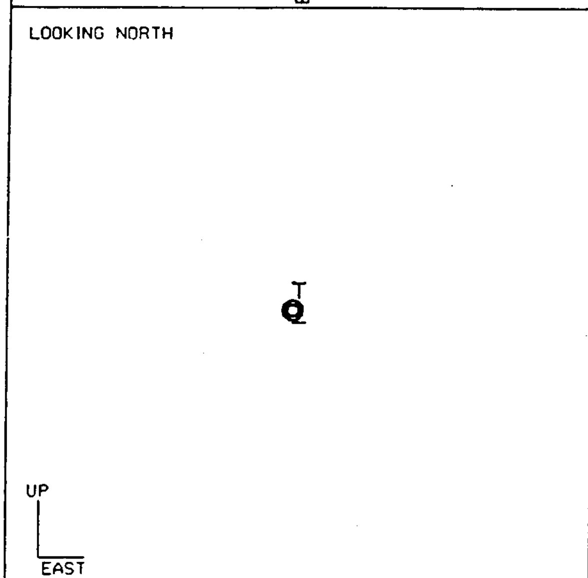
MODEL A : BCPIPE01 ITEM A : GAT 202-6"-1C0031-N-0 "	MODEL B : SAREA38P ITEM B : BEAM :B27
E 1322'10 31/32" PLANT N 352'6 3/32" PLANT EL23'4 3/16" PLANT	E 1326'3 27/32" PLANT N 380'0 3/32" PLANT EL25'4 7/32" PLANT

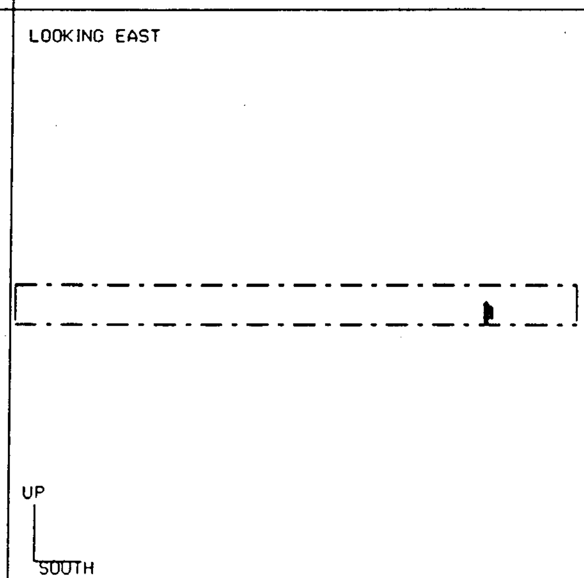
PROJECT : PDS1	AREA :	THU JUL22 16:30:06 1993

ACTION :	OWNER :
RETURN FOR APPROVAL :	TRANSFER TO :









CLASH : 26	STATUS : UNAPPROVED	CLASH TYPE : HARD VERSUS HARD

MODEL A : BCPIPE01 ITEM A : FWN 202-6"-1C0031-N-0 "	MODEL B : SAREA38P ITEM B : BEAM : B27
E 1322' 10 31/32" PLANT N 352' 6 3/32" PLANT El23' 4 21/32" PLANT	E 1323' 11 15/32" PLANT N 380' 0 3/32" PLANT El25' 4 7/32" PLANT

PROJECT : PDS1	AREA :	THU JUL22 16:30:11 1993

Appendix E
General Description of Application Software

Project Architect

Project Architect, also known as P-Arch, is a workstation-based architectural drafting and design product capable of creating 3-D models, 2-D floor plans, building sections, elevation drawings, reflected ceiling plans, and roof plans. P-Arch provides the capability for managing database (nongraphic) information such as room numbers, material quantities, and other project data using relational databases.

Nongraphic Information

Databases are used by P-Arch to associate nongraphic information with graphic elements in design files. P-Arch provides the interface for the maintenance and operation of project databases. A structured query language (SQL) interface is indigenous to P-Arch and most common relational databases used by Intergraph.

The SQL interface differences in relational database management systems (RDBMS's) provided by vendors are identified by a relational interface system (RIS) so that RIS can provide a generic networked access to all architectural databases. As a result, all architectural databases generated with RDBMS's and supported by RIS, including Informix Standard Engine and On-line, Oracle, and Ingres, are accessible.

An RIS schema, created by the user, defines the information in an RDBMS that is related to a particular project database. The RIS schema is utilized by P-Arch to identify a unique database/user combination in the commercial database system. As a result of the various interfaces provided with P-Arch, a user is not required to know the syntax of the RIS create schema statements to efficiently maintain databases through RIS.

Project Engineer-HVAC (PE-HVAC)

PE-HVAC provides the design engineer with the capability to lay out, size, and model HVAC ducts and fittings, select and place HVAC devices, label drawings, create reports from a design, modify existing HVAC drawings, add to existing drawings, and check for spatial interferences. When using this application, HVAC system designs are created by placing fittings and devices and laying out duct routes. Ducts may be defined by lines or arcs with a cross section at one end to provide a visualization of duct sizes, shapes, and justifications. An interactive duct-sizing calculator provides the capability to presize or resize ducts. The results are applied not only to the duct design but also to fittings that are incorporated into the design.

PE-HVAC product information is provided in the "Project Engineer HVAC (PE-HVAC) Reference Guide (DEA100350)."[1]

Project Engineer-Pipe (PE-Pipe)

The functionality of PE-Pipe is much the same as that of PE-HVAC, except that PE-Pipe is used for pipe layout and designs.

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1 Intergraph Corporation. (1993). "Project Engineer HVAC (PE-HVAC) Reference Guide — Volumes 1 and 2," Huntsville, AL.

Appendix F
Specific Problems Encountered in Intlfc

Problems encountered with IntIfc included:

a. When prompted with the Review/Display Interferences dialogue box, the workstation locked up any time a data point was entered. This problem was resolved by eliminating the Ustn-32 process at

/usr/ip32/mstation/umenu/bin/umenu

Once this was accomplished, use of IntIfc would continue without interruption.

b. In extremely complicated and congested design files, interferences were especially difficult to distinguish on the monitor screen. This was especially true when linework was defined as color white against white highlighted linework identifying interference locations.

c. IntIfc failed to detect interfering solid surfaces generated through use of the Derived Surfaces dialogue box, even though the interferences were clearly perceptible on the monitor screen.

d. The textual report produced by IntIfc was of little value other than identification of file names and directory paths of interfering elements.

Appendix G
Specific Problems Encountered in MIC

Problems

Problems encountered with MIC form screens included:

a. In a typical Intergraph project work flow, the Project Data Management form would normally be expected to follow the Interference Management form. However, these forms were reversed in their order in the MIC setup procedure.

b. The CREATE PROJECT form screen prompts for a directory. However, the specific directory requested is not clearly apparent. After several trial-and-error entries, the directory that should be entered at this point was the designation of the physical path to the project directory.

c. In the MicroStation environment, some of the standard MicroStation menus functioned only intermittently. In addition, the Top Bar Menu appeared distorted. The Top Bar distortion problem was caused by an improper seed file configuration from the seed file configuration information found on the back screen of a single monitor system.

d. The double click option for entry selection did not function on some form command screens.

User's Guide

The User's Guide, dated May 1993,[1] was the only guidance provided for using the MIC product. Comments on this document are enumerated below to assist any who may be using the MIC product before the User's Guide has been updated.

a. In the Preface, page ix of the User's Guide, under the heading "Document Purpose," the statement is made that the

"document is designed as a reference; it is organized around the structure of the product rather than presenting a typical work flow. Use this guide when you need to look up a specific Interference Checker/Manager function."

In view of this, care was required to NOT assume that the presentation of information was work-flow oriented.

b. In the Preface, page ix, under the heading "Document Prerequisites/ Audience," the statement is made that

"This document is intended for Project Managers who have a working knowledge of relational databases ..."

However, no instructional information on interface requirements for importing information from other application products or operating procedures was provided as expected.

c. In the Preface, page ix, under the heading "Related Documents/ Products," the reference to Interference Manager was not clear as to whether the reference was being made to the MIC product or to the Interference Manager form screen.

d. On page 1-2, the statement was made that "The Project Administrator controls the creation and modification of PDS 3D projects." However, the nomenclature, "PDS 3D projects," was never defined.

e. On pages 3-8 and 3-9, all references to coordinate system inputs are to the Plant Coordinate System. A pictorial example of a Plant Coordinate System monument is provided, but the applicability of this coordinate system to other applications, such as Project Architect, was never made clear. Intergraph later clarified this feature as not supported by MIC even though it is on the form.

[1] Intergraph Corporation. (1993). "Model interference checker user's guide," Huntsville, AL.

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Arthur Bennett, Ken Cook, Gregory A. Covington,
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13. ABSTRACT *(Maximum 200 words)*

A vital function of the Corps' mission is the design, construction, and maintenance of projects. These projects require complex drawings generated from computer-aided design and drafting (CADD) technology to support engineering construction and design tasks. To provide the basic tools necessary to analyze a design project and reduce construction problems associated with multidisciplinary drawings, a Construction Productivity Advancement Research (CPAR) project was initiated to specifically address spatial conflicts that occur with facility design drawings.

CPAR projects are based on ideas brought to the Corps by a prospective construction industry partner (or partners). All collaborative research and development projects under this program are aimed at improving domestic construction productivity and are required to be within the mission areas of the Corps. Participation in the program is open to any U.S. private firm, including corporations, partnerships, limited partnerships and industrial development organizations, public and private foundations, academic institutions, nonprofit organizations, units of state and local governments, and others who have an interest in and the capability to address CPAR objectives.

Under this CPAR project, software was developed to automate interference checking of CADD design drawings, including multidisciplinary engineering designs. The project stemmed from Intergraph Corporation proposal

(Continued)

14. SUBJECT TERMS

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CADD software package	Intra-disciplinary
CPAR	Model interference checker

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No. 6-8903-21023, dated 23 May 1990, entitled "Cooperative Research and Development Agreement for Interdisciplinary Interference Checking Software." This resulted in CPAR No. 901-930.

This report describes the design functionality of the software products, the approach taken to evaluate them, the results obtained, conclusions reached on the basis of the evaluation, and recommendations. The report also describes the usefulness and limitations of the software products. These factors are addressed with recommended actions to facilitate use of the product by the U.S. construction industry.