April 12, 1994

Docket No. 52-003

APPLICANT: Westinghouse Electric Corporation

FACILITY: AP600

SUBJECT: SUMMARY OF MEETING TO DISCUSS MODULAR CONSTRUCTION

On April 7, 1994, representatives of the U.S. Nuclear Regulatory Commission and its contractors, and Westinghouse and its contractors, met at the Avondale Shipyard in Avondale, Louisiana, to discuss modular construction and its application to the AP600 design. Enclosure 1 is a list of attendees.

Westinghouse began the meeting with a presentation of the AP600 Modular Design Process. Next, Avondale discussed its experience with modular fabrication, including the shop fabrication process, and transportation considerations. Westinghouse concluded the formal presentation with a discussion of the AP600 design provisions to address fabrication and assembly issues, and plant site activities upon receipt of a module. Enclosure 2 contains the presentation material.

Following the formal presentation, the meeting attendees took a tour of the Avondale Shipyard, and observed the modular construction process for both structural and equipment modules.

original signed by: Thomas J. Kenyon
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Associate Directorate for Advanced Reactor
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Enclosures:
As stated

cc w/enclosures:
See next page

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WDean, EDO	GBagchi, 7H15		

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NAME	PShea	KShembarger:sg	TKenyon	RArchitzel	
DATE	04/11/94	04/11/94	04/11/94	04/12/94	

OFFICIAL RECORD COPY DOCUMENT NAME: AVONDALE.KMS

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Westinghouse Electric Corporation

Docket No. 52-003

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WESTINGHOUSE AP600
MODULAR CONSTRUCTION MEETING
MEETING ATTENDEES
APRIL 7, 1994

Name	Organization
J. Castello	Westinghouse
P. Mandava	Westinghouse
D. Lingren	Westinghouse
A. Dufrene	Avondale Industries
T. Verret	Avondale Industries
B. Sigsworth	Avondale Industries
R. Meric, Jr.	Avondale Industries
T. Doussan	Avondale Industries
K. Shembarger	NRC/NRR
D. Terao	NRC/NRR
T. Cheng	NRC/NRR
A. Howe	NRC/NRR
J. Nakoski	NRC/NRR
H. Graves	NRC/RES
R. Morante	BNL (NRC consultant)
J. Braverman	BNL (NRC consultant)

Enclosure 1

Modular Construction

Presentation to the Nuclear Regulatory Commission

April 7, 1994

Westinghouse Electric Corporation

Avondale Industries, Inc.

Enclosure 2

Modular Construction
Agenda

Introduction	D. A. Lindgren
AP600 Modular Design Process Design Responsibility Process flow Design Criteria	J. E. Castello
Avondale experience with modular fabrication Equipment modules Structural modules Experience with concrete filled steel modules	T. Verret
Shop fabrication process Preparation of modular construction plans. Typical module fabrication process	R. Dufrene
Procedure development Welding - process, procedure, PWHT, inspections, etc. Fabrication tolerances Use of mockups and prototypes Handling and lifting Protective coatings	T. Verret
Transportation considerations Modes of transportation Transportation loads Typical transportation problems Requirements for special shipping fixtures, jigs, or orientation Protection during shipping	T. Verret
AP600 design provisions to address fabrication and assembly issues Access for inspection and maintenance Constructability Fit up tolerances Industry standards	J. E. Castello
Plant site activities Receipt inspection Storage, handling, protection Additional preparation activities Erection tolerances and variances Welding procedures and inspections	J. E. Castello
Lunch	
Tour	T. Verret
Questions and discussion	All

Introduction

- Objective

  Provide the NRC with examples of modular fabrication and an explanation of the AP600 process for design of modules

- What we will see

  Examples of current Avondale capabilities and practices for design and fabrication of modules

- What we will not see

  Detailed Examples of fabrication of safety-related modules

  Design or analysis for the AP600 structural modules ASME "N" or "NPT" stamp fabrication

  Requirements for placement of concrete

AP600 Design Team

Westinghouse Electric Corporation

- Responsible for the overall design and design certification of the AP600 nuclear power plant.
- NSSS Design, Criteria, General arrangement overall configuration, project management

Bechtel

- Responsible for the design and analysis of structural modules.
- Nuclear island buildings and system

Avondale Industries

- Responsible for modularzation and development of modules for the AP600

Southern Company Services (SCS)

- Responsible for the design of turbine building and systems

Burns and Roe

- Annex, diesel generator, and solid waste buildings and system.

MK-Ferguson Company

- Responsible for the AP600 Construction Plan, constructability, schedule and cost estimate

AP600 MODULAR DESIGN PROCESS

- MODULE DEFINITION
- WHY MODULES
- DESIGN RESPONSIBILITY
- DESIGN PROCESS
- DESIGN CRITERIA

AP600 MODULAR DESIGN PROCESS

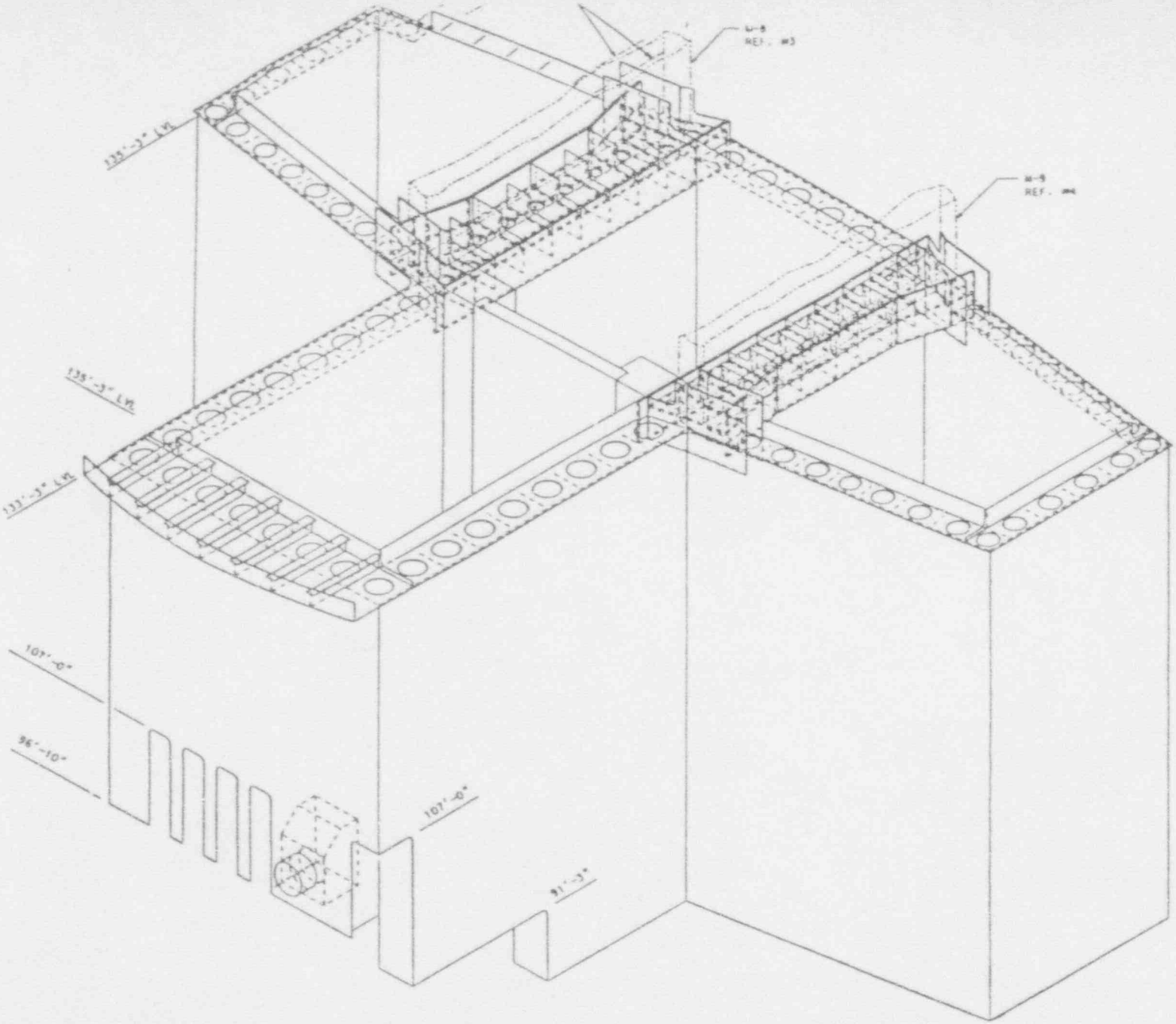
MODULE

- AN ASSEMBLY OF COMPONENTS AND STRUCTURE FABRICATED AT AN OFF SITE PLANT INTO A SELF SUPPORTING UNIT SUITABLE FOR RAIL SHIPMENT

AP600 MODULES

- STRUCTURAL

- EQUIPMENT
  - MECHANICAL
  - PIPING
  - ELECTRICAL


W-8
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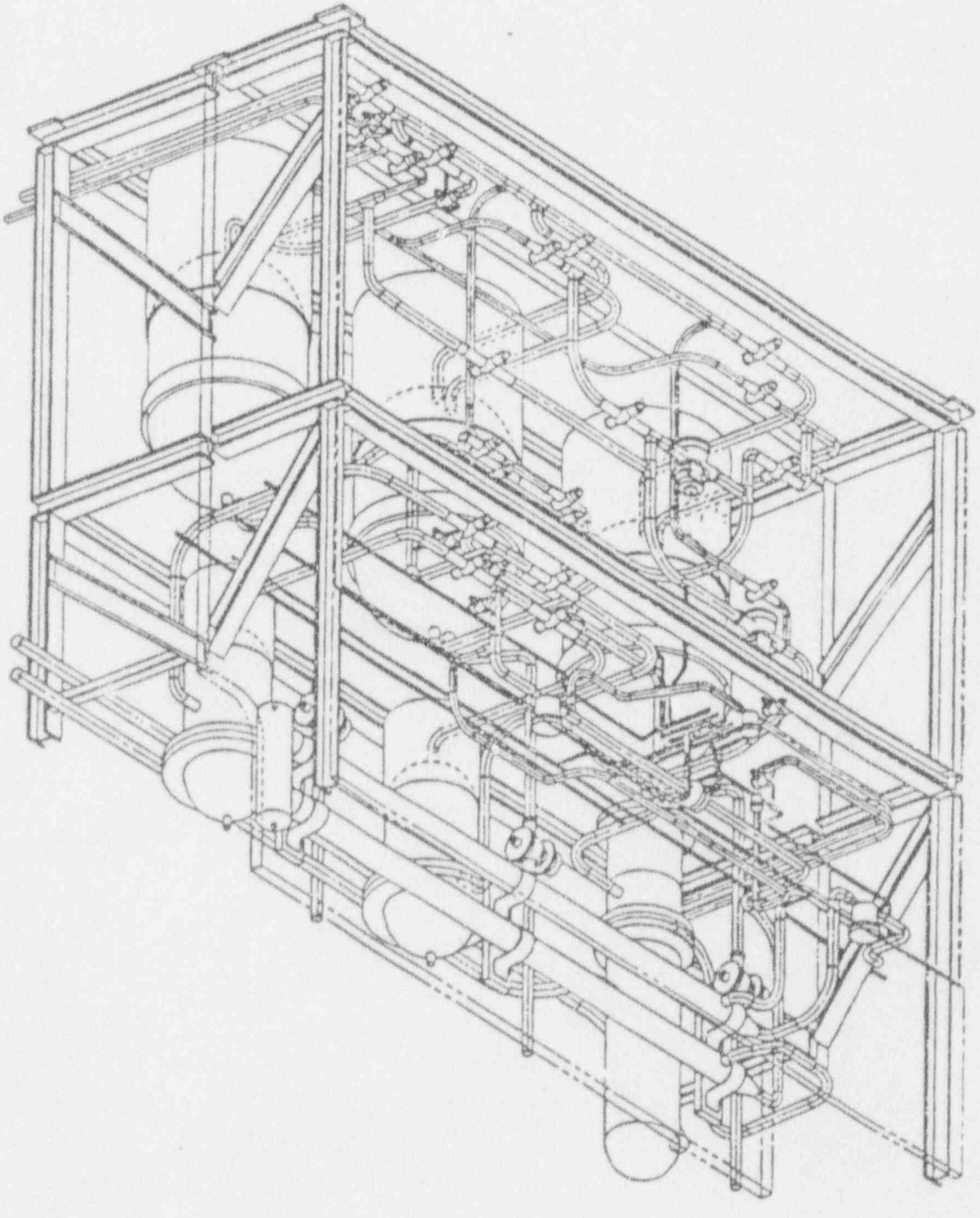
133'-3" LVL
101'-0"
96'-10"
101'-0"
91'-3"



AP600 MODULAR DESIGN PROCESS

WHY MODULES?

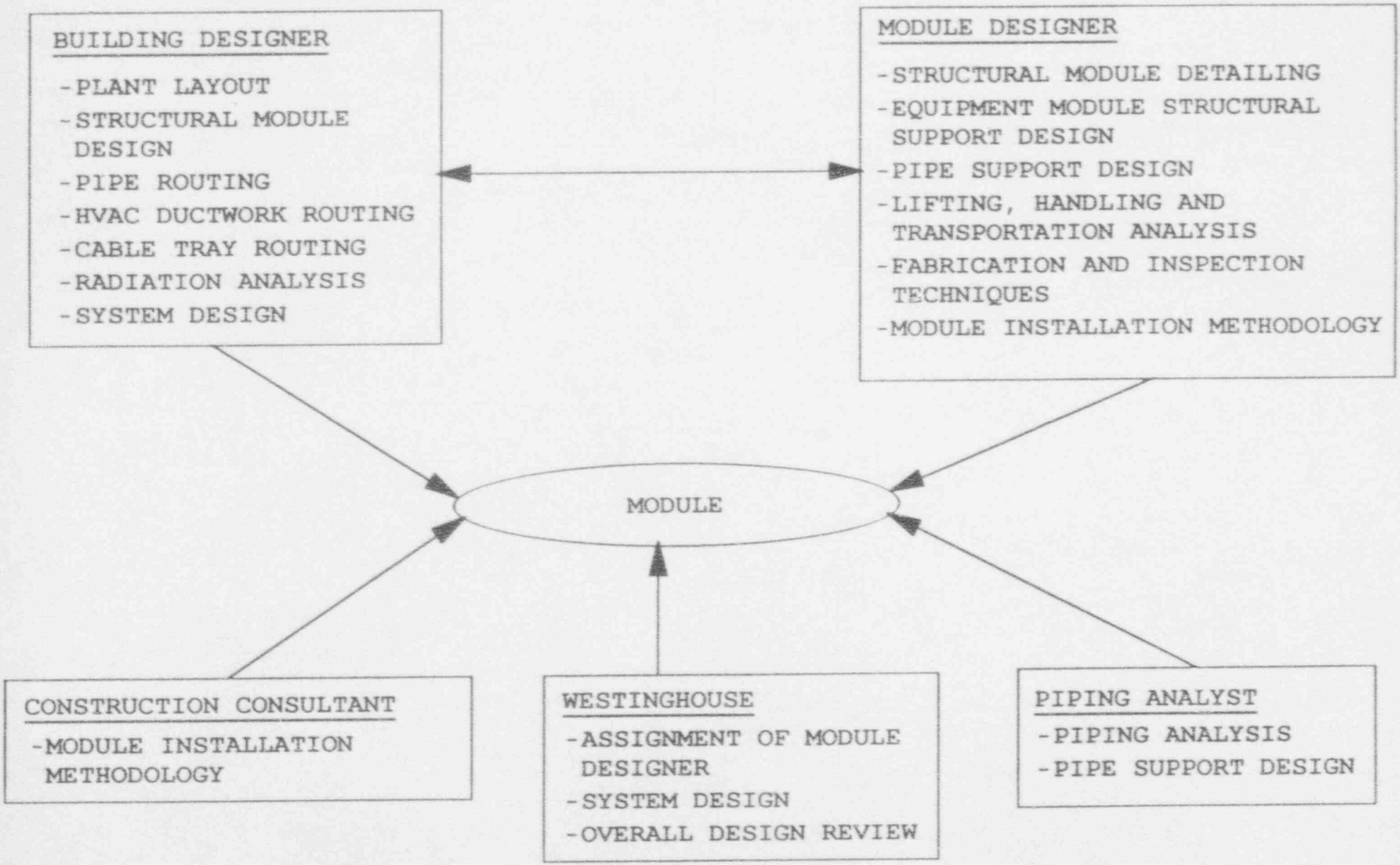
- FABRICATION PERFORMED IN A CONTROLLED ENVIRONMENT WITH A STABLE, WELL TRAINED AND SUPERVISED WORKFORCE

  - HIGHER QUALITY
  - BETTER COST AND SCHEDULE CONTROL
  - TESTING AND INSPECTION PRIOR TO SHIPMENT
  - EFFICIENT MATERIAL HANDLING

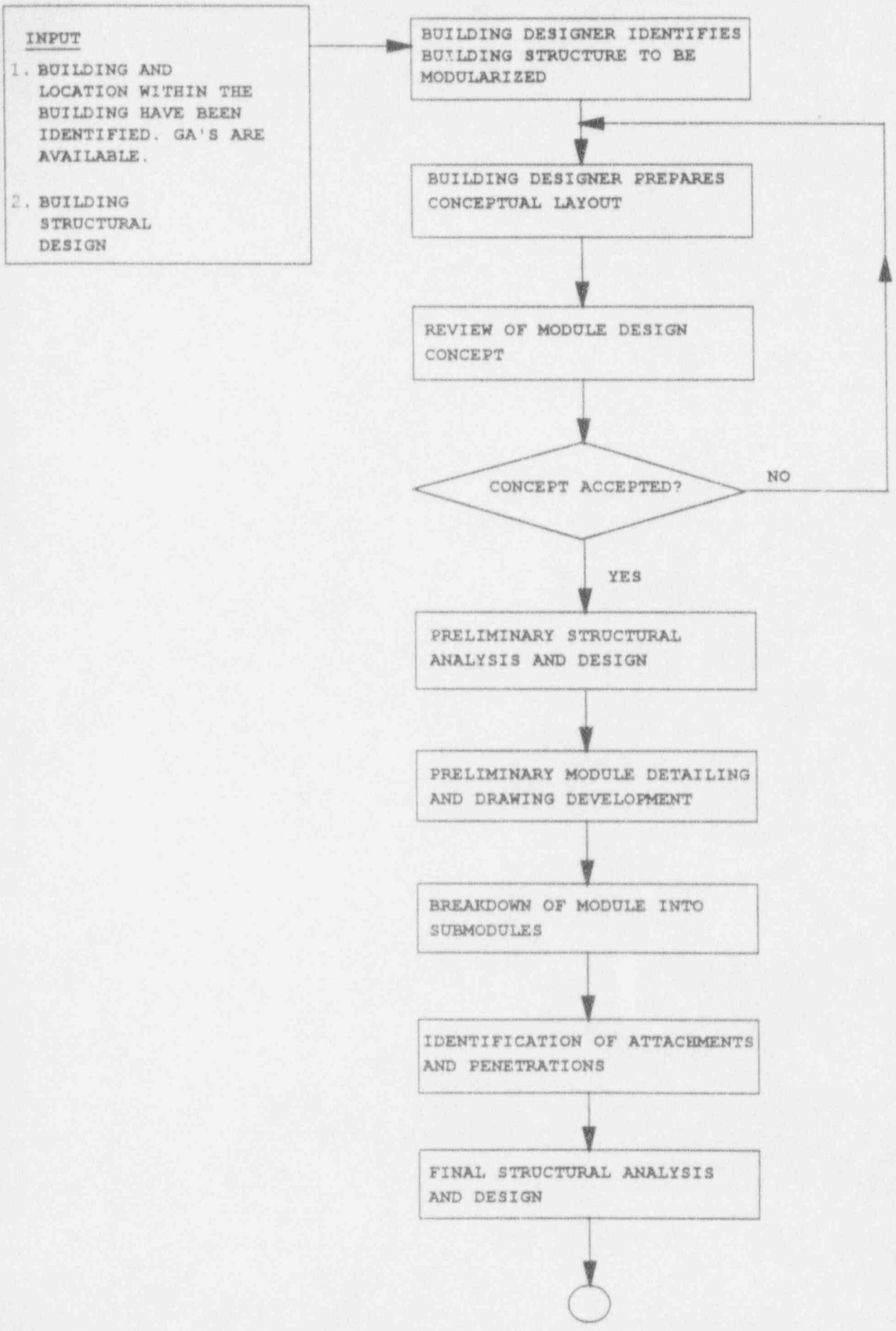
- REQUIRES COMPLETE PLANNING AND ENGINEERING PRIOR TO CONSTRUCTION

- FABRICATION WORK IS PERFORMED EARLY IN THE SCHEDULE WHEN THERE IS TIME TO CORRECT PROBLEMS

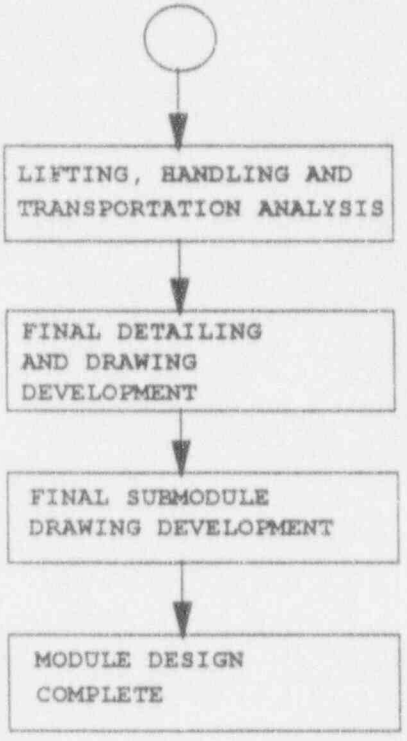
AP600 MODULE DESIGN RESPONSIBILITY



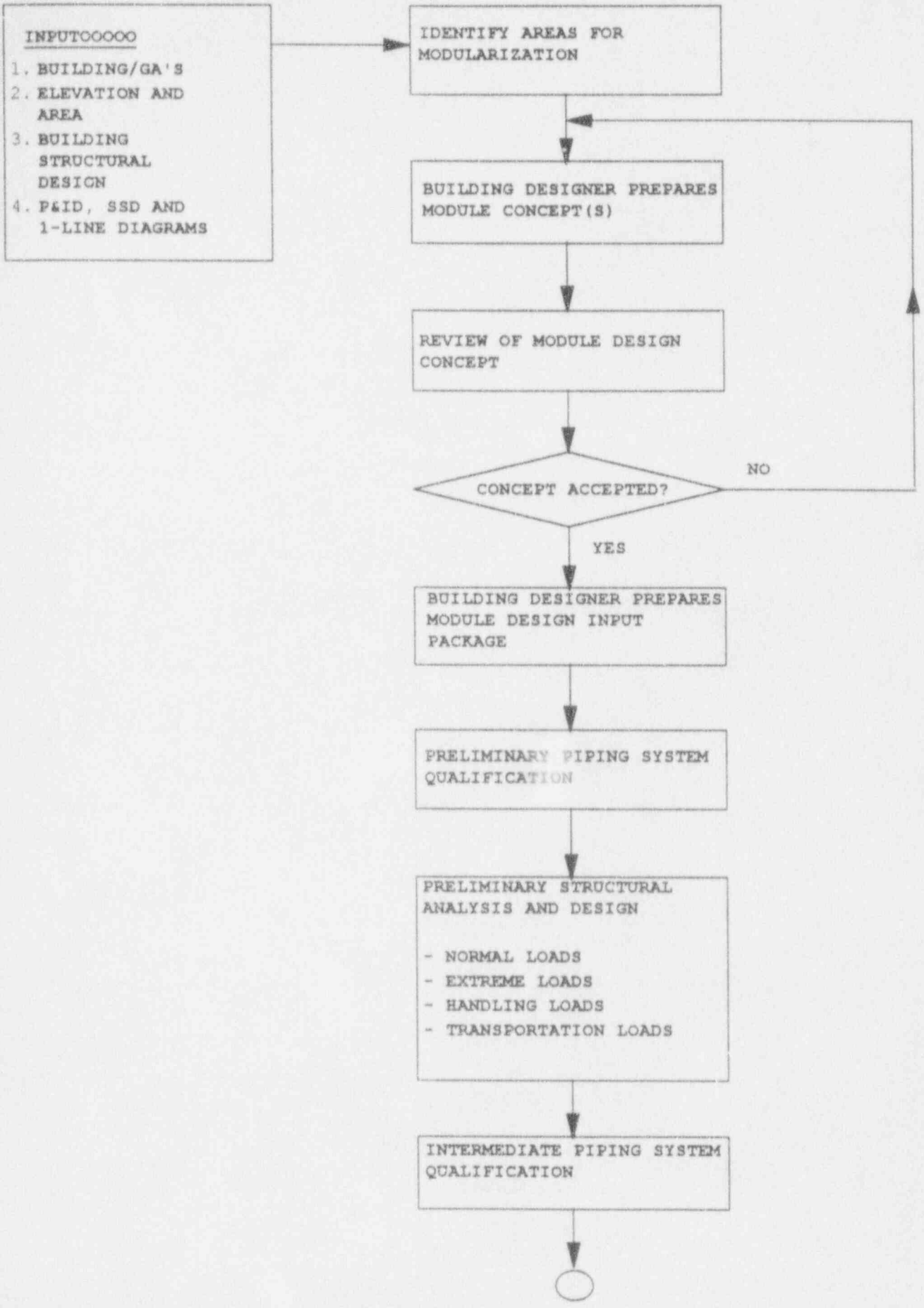
AP600 DESIGN PROCESS FOR STRUCTURAL MODULES



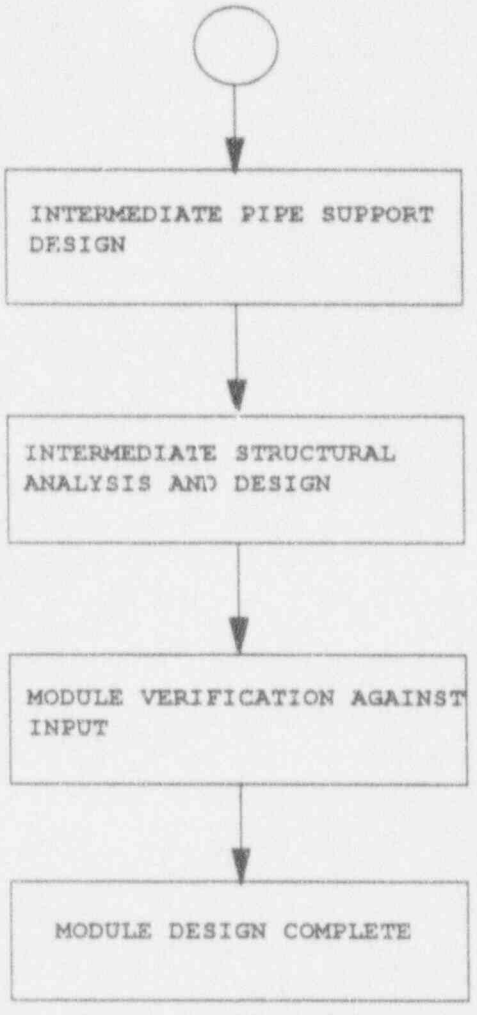
AP600 DESIGN PROCESS FOR STRUCTURAL MODULES



AP600 DESIGN PROCESS FOR EQUIPMENT MODULES



AP600 DESIGN PROCESS FOR EQUIPMENT MODULES



AP600 MODULAR DESIGN PROCESS

DESIGN CRITERIA

- DESIGN CRITERIA ARE THE SAME AS IF STICK BUILT EXCEPT FOR ADDITIONAL LIFTING, HANDLING AND TRANSPORTATION ANALYSES

- ADDITIONAL PROJECT SPECIFIC CRITERIA EXISTS TO MEET CONSTRUCTABILITY REQUIREMENTS

  EXAMPLES:
  - HOLES IN DIAPHRAGMS TO ALLOW CONCRETE TO FLOW
  - MINIMUM SPACING BETWEEN STIFFENERS
  - LIMITED NUMBER OF STRUCTURAL STEEL AND PIPE SIZES

AP600 MODULAR DESIGN PROCESS

STRUCTURAL MODULE DESIGN CRITERIA

TYPE	SAFETY RELATED	NON-SAFETY RELATED
FORM	AISC-N690, ACI SP-4	AISC-ASD 9TH, ACI SP-4
WALL	AISC-N690, ACI-349, ACI SP-4	AISC-ASD 9TH, ACI SP-4
FLOOR	AISC-N690	AISC-ASD 9TH
FINNED FLOOR	ACI-349	N/A
STEEL FRAMING	AISC-N690	AISC-ASD 9TH

AP600 MODULAR DESIGN PROCESS

EQUIPMENT MODULE DESIGN CRITERIA

ITEM	SAFETY RELATED	NON-SAFETY RELATED
SUPPLEMENTAL STEEL	AISC-N690	AISC-ASD 9TH
PIPE	ASME-III SEISMIC II/I ASME/ANSI B31.1	ASME/ANSI B31.1
PIPE SUPPORTS	ASME-III NF SEISMIC II/I AISC-ASD 9TH	AISC-ASD 9TH

AP600 DESIGN PROVISIONS TO ADDRESS FABRICATION AND ASSEMBLY ISSUES

- ACCESS FOR INSPECTION AND MAINTENANCE
- CONSTRUCTABILITY
- FIT UP TOLERANCE
- INDUSTRY STANDARDS

AP600 DESIGN PROVISIONS TO ADDRESS FABRICATION AND ASSEMBLY ISSUES

ACCESS FOR INSPECTION AND MAINTENANCE

- ACCESSIBILITY AND MAINTENANCE STUDY
- 3-D COMPUTER MODEL
- OFF SITE FABRICATION ALLOWS INSPECTION ON ALL SIDES
- STRUCTURAL MODULES BUILT FROM SUBMODULES
- SIZE IS LIMITED BY RAIL SHIPMENT ENVELOPE

AP600 DESIGN PROVISIONS TO ADDRESS FABRICATION AND ASSEMBLY ISSUES

CONSTRUCTABILITY

- CONSTRUCTABILITY REVIEW AND PLAN

- STRUCTURAL WALL MODULE PROVISIONS
  - MINIMUM SPACING REQUIREMENTS FOR MAIN PLATES, DIAPHRAGMS AND STIFFENERS
  - HOLES IN DIAPHRAGM PLATES FOR CONCRETE TO FLOW THROUGH
  - VERTICAL LEG UP ON STIFFENERS

AP600 DESIGN PROVISIONS TO ADDRESS FABRICATION AND ASSEMBLY ISSUES

FIT UP TOLERANCE

STRUCTURAL MODULES

- HORIZONTAL AND VERTICAL DATUM LINES
- SUB-MODULES CUT-TO-FIT TO EXACT SIZE INCLUDING SHRINKAGE ALLOWANCE
- ERECTION STOCK OF 1 INCH ON CORNER SUB-MODULES

EQUIPMENT MODULES

- MODULE PIPING TO FIELD PIPING ACCOMPLISHED VIA A MAKE-UP PIECE
- MULTIPLE MODULES TEMPORARILY JOINED IN FABRICATION SHOP

AP600 DESIGN PROVISIONS TO ADDRESS FABRICATION AND ASSEMBLY ISSUES

INDUSTRY STANDARDS

- DESIGN REQUIREMENTS ARE THE SAME AS IF STICK BUILT

ITEM	SAFETY RELATED	NON-SAFETY RELATED
STRUCTURAL STEEL	AISC-N690 Q1.23	AISC-ASD 9TH SECTION 5, CH. M
PIPING AND COMPONENTS	ASME III	ASME/ANSI B31.1
PIPE SUPPORTS	ASME III	AISC-ASD 9TH SECTION 5, CH. M

PLANT SITE ACTIVITIES

- RECEIPT INSPECTION
- STORAGE HANDLING AND PROTECTION
- ADDITIONAL PREPARATION ACTIVITIES
- ERECTION TOLERANCES AND VARIANCES
- WELDING PROCEDURES AND INSPECTIONS

PLANT SITE ACTIVITIES

RECEIPT INSPECTION

- PER ASME NQA-2, PART 2.2 SECTION 5, 1989 EDITION

STORAGE, HANDLING AND PROTECTION

- PER ASME NQA-2, PART 2.2 1989 EDITION

ADDITIONAL PREPARATION ACTIVITIES

- ON SITE FABRICATION FACILITY FOR ASSEMBLING SUB-MODULES

PLANT SITE ACTIVITIES

ERECTION TOLERANCES AND VARIANCES

- REQUIREMENTS ARE THE SAME AS IF STICK BUILT WITH SOME ADDITIONAL SPECIFIC REQUIREMENTS FOR STRUCTURAL MODULES

WELDING PROCEDURES AND INSPECTIONS

- REQUIREMENTS ARE THE SAME AS IF STICK BUILT
  - AWS D1.1
  - ASME III

- SITE WELDS - SAME CRITERIA

AP600 MODULAR DESIGN PROCESS

SUMMARY

- FABRICATION UNDER CONTROLLED ENVIRONMENT
- DESIGN CRITERIA ARE THE SAME AS STICK BUILT WITH ADDITIONAL LIFTING, HANDLING AND SHIPPING ANALYSES
- OFF SITE FABRICATION ALLOWS BETTER TESTING AND INSPECTION
- PLANT SITE ACTIVITIES ARE THE SAME AS STICK BUILT

AVONDALE EXPERIENCE WITH MODULAR CONSTRUCTION

- MAIN YARD 268 ACRES
- WESTWEGO YARD 18 ACRES
- SERVICE FOUNDRY 77 ACRES
- GULFPORT GRP YARD 121 ACRES
- GULFPORT LCAC YARD 25 ACRES
- ENGINEERING DEPT. APPROXIMATELY 350 PEOPLE
  - NAVAL ARCHITECTURE
  - STRUCTURAL DESIGN
  - MACHINERY DESIGN
  - PIPING
  - HVAC
  - ELECTRICAL
  - ELECTRONICS

AVONDALE EXPERIENCE WITH MODULAR CONSTRUCTION

- STARTED MODULAR CONSTRUCTION 1982
- MODULAR CONSTRUCTION APPLIED TO MILITARY, COMMERCIAL AND INDUSTRIAL PROJECTS
- BENEFITS
  - SCHEDULE REDUCTION
  - COST REDUCTION
  - IMPROVES QUALITY
  - IMPROVES SAFETY
  - IMPROVES STANDARDIZATION
- TYPICAL SHIP HAS 200 MODULES.
- AP600 HAS 282 MODULES IDENTIFIED.

AVONDALE EXPERIENCE WITH MODULAR CONSTRUCTION

- EQUIPMENT MODULES
  - PACKAGE UNIT SHOP 32,743 SQUARE FEET
  - PIPE FABRICATION SHOP 54,500 SQUARE FEET
  - MACHINE SHOP 51,300 SQUARE FEET
  - ELECTRICAL/ELECTRONIC 13,800 SQUARE FEET
- STRUCTURAL MODULES
  - FABRICATION CAPABILITY 175,000 TONS OF STEEL PER YEAR
  - PLATE SHOP 178,000 SQUARE FEET
  - TEE BEAM SHOP 27,000 SQUARE FEET
  - BLACKSMITH SHOP 4,800 SQUARE FEET
  - SHEETMETAL SHOP 55,450 SQUARE FEET
- CONCRETE FILLED MODULES
  - HYDROELECTRIC PLANT 192 MEGAWATT
  - DELIVERED (6) MONTHS AHEAD OF SCHEDULE
  - SUCCESSFUL PROJECT PRODUCING 103% OF RATED CAPACITY
  - AVONDALE DEVELOPED DETAIL MODULAR DESIGN DRAWINGS SIMILAR TO AP600 STRUCTURAL MODULES

SHOP FABRICATION PROCESS

- PREPARATION OF MODULAR CONSTRUCTION PLANS
  - PREPARED BY PRODUCTION PLANNING DEPT.
  - UNIT ERECTION SCHEDULE
  - PALLET CODING
- MODULE FABRICATION PROCESS
  - PLATE SHOP TO UNIT ERECTION AREA
  - PREOUTFITTING OF MODULES
  - UNIT ERECTION TO LAUNCH SITE

SHOP FABRICATION PROCESS

- PROCEDURE DEVELOPMENT
  - DEVELOPED BY INDIVIDUAL DEPARTMENTS
    - ENGINEERING
    - WELDING
    - PRODUCTION CRAFTS
    - QUALITY CONTROL
    - MATERIAL CONTROL
- WELDING
  - PROCESS
  - PROCEDURES DEVELOPED BY WELDING DEPT.
  - POST WELD HEAT TREATMENT
  - INSPECTION

- FABRICATION TOLERANCES
  - AS SPECIFIED ON CONTRACT
  - CAN MEET CONSTRUCTION TOLERANCE SPECIFIED FOR AP600 CONTRACT
- USE OF MOCKUPS AND PROTOTYPES
  - MODEL SHOP
- HANDLING AND LIFTING
  - HANDLING AND LIFTING DRAWINGS AND PROCEDURES DEVELOPED BY ENGINEERING DEPT.
  - HEAVY TRANSPORTERS USED TO TRANSPORT MODULES TO FABRICATION AREAS
  - CRANE CAPACITY

    600 TON FLOATING CRANE

    250 TON OUTFITTING CRANE

    200 TON OUTFITTING CRANE

    (3) 130 TON BUILDING WAYS CRANE

    (29) 50 TON CRANES
- PROTECTIVE COATINGS
  - 52,890 SQUARE FOOT ENVIRONMENTALLY CONTROLLED PAINT & BLAST BLDG.
  - STEEL BLASTED TO REMOVE MILL SCALE AND COATED WITH PRECONSTRUCTION PRIMER
  - MODULES BLASTED AND PAINTED AFTER ASSEMBLY PRIOR TO ERECTION
  - COATING AS SPECIFIED IN CONTRACT

TRANSPORTATION CONSIDERATIONS

- MODES OF TRANSPORTATION
  - RAIL 12 FT HIGH X 12 FT WIDE X 80 FT LONG - 80 TONS
  - TRUCK 13 1/2 FT HIGH X 8 1/2 FT WIDE X 48 FT LONG - 20 TONS
  - WATER 41 FT HIGH X 90 FT WIDE X 200 FT LONG - 1000 TONS
- TRANSPORTATION LOADS
  - 4.0 G (4 times the acceleration due to gravity) Longitudinal acceleration forces to calculate shipping loads in longitudinal direction, along shipping axis, both directions
  - 1.0 G Lateral acceleration forces to calculate shipping loads in lateral direction, perpendicular to shipping axis, both directions
  - 1.5 G Vertical acceleration forces to calculate shipping loads in vertical direction
  - The allowable stress for structural steel members shall be increased by one third for the purpose of checking stresses produced by shipping loads. Allowable Stress is that specified in the AISC Manual of Steel Construction ASD, Ninth Edition.
- TYPICAL TRANSPORTATION PROBLEMS
  - CLEARANCES FOR BRIDGES, ROADWAY OBSTRUCTIONS, ETC.
- REQUIREMENTS FOR SPECIAL HANDLING, FIXTURES, JIGS, ORIENTATION
  - EQUIPMENT REGISTER
  - ASSOCIATION OF AMERICAN RAILROADS GENERAL RULES GOVERNING THE LOADING ON OPEN TOP CARS
  - ASME NQA-2, PART 2.2 1989 EDITION

- PROTECTION DURING SHIPPING
  - SHIPPING SUPPORTS AS NECESSARY
  - BLANK ENDS OF PIPE
  - PROVIDE COVERS AS NECESSARY