

PREVENTATIVE MAINTENANCE TRENDS  
IN  
THE  
ELECTRIC UTILITY INDUSTRY

BY: D. L. GOODLING, WESTINGHOUSE ELECTRIC CORP.

FOR: FIRST BIENNIAL SYMPOSIUM & EXHIBITION ON  
MOVABLE BRIDGE DESIGN AND TECHNOLOGY  
ASME/DOT

NOVEMBER 5, 1985, TALLAHASSEE, FLORIDA

THE PURPOSE OF MY PRESENTATION IS TO DISCUSS THE ADVANCED  
MAINTENANCE PRACTICES BEING APPLIED IN THE FIELD OF ELECTRIC  
UTILITY POWER PLANT MAINTENANCE.

WE LEARN A GREAT DEAL FROM OUR CUSTOMERS AS WE GAIN A  
GREATER AWARENESS OF THEIR NEW APPROACHES, PRIORITIES AND  
CONCERNS.

SOME OF THE CONCEPTS DISCUSSED MAY BE LIMITED IN VALUE FOR  
YOUR APPLICATION.

ALL PROGRAMS, INCLUDING A PREVENTATIVE MAINTENANCE PROGRAM  
MUST BE COST EFFECTIVE.

IN THE ELECTRIC UTILITY INDUSTRY THE COST OF A PREVENTATIVE  
MAINTENANCE PROGRAM IS DIRECTLY RELATED TO THE COST OF RE-  
PLACEMENT POWER.

WHEN AN ELECTRIC GENERATING UNIT IS OUT OF SERVICE, BECAUSE  
OF A FORCED OUTAGE (EQUIPMENT FAILURE) OR A SCHEDULED

OUTAGE, THE REPLACEMENT POWER COSTS CAN BE SIGNIFICANT.

FOR EXAMPLE, REPLACEMENT POWER COSTS FOR AN 800 TO 1200 MW NUCLEAR UNIT CAN EXCEED \$1,000,000 PER DAY.

FOR A 600 MW COAL FIRED UNIT IT COULD BE \$500,000 PER DAY.

REPLACEMENT POWER COST FOR THE CITY OF TALLAHASSEE'S 250 MW OIL/GAS FIRED UNIT IS \$170,000 PER DAY.

IN KEEPING WITH THE KISS THEORY (KEEP IT SHORT AND SIMPLE), MANAGED MAINTENANCE CAN BE DESCRIBED IN ONE SENTENCE....A SYSTEMATIC APPROACH TO DEFINING AND MEETING THE MAINTENANCE NEEDS OF A POWER PLANT.

LET'S STOP HERE FOR A MOMENT AND CONSIDER WHAT IS THE ROLE OF MNAGEMENT SINCE OUR SERVICE TITLE SUGGESTS AN EMPHASIS ON EFFECTIVE MANAGEMENT MAINTENANCE ACTIVITIES.

THE WELL-KNOWN EDUCATOR, CONSULTANT, AN AUTHOR ON  
MANAGEMENT, PETER DRUCKER, DEFINES MANAGEMENT IN THE CONTEXT  
OF THREE AREAS; DISCIPLINE, TASKS, AND PEOPLE.

FOR THOSE OF YOU WHO HAVEN'T READ MR. DRUCKER'S BOOKS, HE  
CLEARLY STATES HIS VIEW OF MANAGEMENT'S ROLE--TO MAKE  
KNOWLEDGE MORE PRODUCTIVE.

LET'S LOOK AT HOW THIS RELATES TO A UTILITY AND WESTINGHOUSE  
AS A SERVICE SUPPLIED. IT'S SIMPLE--AMONG THE WIDE RANGE OF  
MAINTENANCE FUNCTIONS CONDUCTED BY THE UTILITY STATION'S  
STAFF, THESE THREE FUNCTIONS SIGNIFICANTLY CONTRIBUTE AND  
SUPPORT THE EFFECTIVE PERFORMANCE OF MAINTENANCE AND ODDLY  
ENOUGH, ADDRESS DRUCKER'S MANAGEMENT AREAS.

MANAGEMENT AREAS; DISCIPLINE - PREVENTIVE MAINTENANCE  
PLANNING

TASKS - MAINTENANCE INFORMATION SYSTEMS

PEOPLE - MAINTENANCE CONTRACTOR SERVICES

WESTINGHOUSE HAS DESIGNED ITS SERVICES AROUND THE FOLLOWING KEY ELEMENTS--A CLOSER WORKING RELATIONSHIP BETWEEN THE UTILITY AND WESTINGHOUSE THAN FOUND THROUGH TRADITIONAL SERVICE SUPPLIER RELATIONSHIPS (EVEN TO THE EXTENT OF JOINT CONDUCT OF SCOPES OF WORK).

EMPHASIZING THE IMPORTANCE OF AN INTEGRATED AND ENGINEERED SERVICE RESPONSE TO ASSIST THE UTILITY'S EFFORTS TO IMPROVE AVAILABILITY.

EXCELLENT IN QUALITY AND PRODUCTIVITY DURING THE CONDUCT OF WORK IS A PREREQUISITE FOR A COST EFFECTIVE APPROACH TO THE CONDUCT OF MAINTENANCE.

MANAGED MAINTENANCE POSSESSES THESE IMPORTANT CHARACTERISTICS--

AS WE ESTABLISH A CLOSER WORKING RELATIONSHIP WITH

UTILITIES, WE HEIGHTEN OUR SENSITIVITY TO THE ASPECTS OF MODULARITY, FLEXIBILITY, AND COOPERATION.

THIS IS NOT INTENDED TO PROVIDE A QUICK FIX OR REPAIR SERVICE ONLY. RATHER, WE ARE INTERESTED IN IDENTIFYING AND REMOVING THE ROOT CAUSE FOR FAILURES.

WESTINGHOUSE IS PERMANENTLY COMMITTED TO THE UTILITY INDUSTRY, ITS SUCCESS AND GROWTH. WE HAVE MADE SIGNIFICANT INVESTMENTS IN SERVICE FACILITIES, TOOLING, AND SYSTEMS. MANAGED MAINTENANCE IS CONSIDERED BY WESTINGHOUSE AS ONE OF THE MOST SIGNIFICANT SUPPORT SERVICES AVAILABLE TO THIS INDUSTRY. WE HOPE BEFORE THE END OF THIS PRESENTATION YOU WILL BETTER UNDERSTAND WHY WE MAKE SUCH A BOLD STATEMENT.

#### INTRODUCTION - OVERVIEW

DESCRIBE THE FOUR BULLETS AND INTRODUCE THE NEXT SECTION CURRENT MAINTENANCE PRACTICES AND TRENDS.

WESTINGHOUSE ENERGY SYSTEM SERVICE DIVISIONS (ESSD)  
COMMISSIONED AN EXTENSIVE STUDY OF UTILITY POWER PLANT  
MAINTENANCE PRACTICES AND TRENDS. ONE INTERESTING RESULT OF  
THE STUDY HAS THE EVOLUTIONARY NATURE IN THE DEVELOPMENT OF  
MAINTENANCE PRACTICES.

UTILITIES IN GENERAL DEVELOP THESE CAPABILITIES AT DIFFERENT  
RATES AND TO VARYING DEGREES.

SOME UTILITIES WILL STRESS DIAGNOSTICS AND ANALYSIS OR WHAT  
I WOULD REFER TO AS PREDICTIVE MAINTENANCE, WHILE OTHERS  
WILL EMPHASIZE PRODUCTIVITY ENHANCEMENT.

ADDITIONALLY, SOME UTILITIES MAY DECIDE TO DEVELOP THE MORE  
ADVANCED TECHNIQUES TO COVER A RELATIVELY SMALL NUMBER OF  
PLANT COMPONENTS WHILE OTHERS WILL EXPAND COMPONENT COVERAGE  
UTILIZING THE MORE BASIC CONCEPTS BEFORE ADDING MORE  
ADVANCED MAINTENANCE CAPABILITIES, SUCH AS DIAGNOSTICS AND  
ANALYSIS.

FOR ALL UTILITIES, HOWEVER, PREVENTIVE MAINTENANCE IS THE FIRST STEP TOWARD ADVANCED PRACTICES AND COMPUTERIZATION, IS A NECESSARY FOUNDATION FOR EXPANDED COMPONENT COVERAGE OR ADVANCED PREDICTIVE MAINTENANCE CAPABILITIES. PREVENTIVE MAINTENANCE IS ALSO A KEY TO LOWER OPERATING COSTS AND A MEANS TO EXTEND THE LIFE OF CAPITAL EQUIPMENT.

AS A RESULT OF THE BENEFITS DERIVED FROM A PM PROGRAM, THE MAJORITY OF UTILITIES CONTACTED IN THE STUDY EXPECTED TO EXPAND THEIR PM EFFORTS WITHIN THE NEXT FIVE YEARS.

AS THIS GRAPH INDICATES, CURRENT PRACTICES OF UTILITIES IS THAT APPROXIMATELY 40% OF THE MAINTENANCE PERFORMED IS CONSIDERED PREVENTIVE WHEREAS 60% IS CORRECTIVE. IN THE FUTURE, UTILITIES EXPECT TO CONCENTRATE MORE ON PREVENTIVE RATHER THAN CORRECTIVE MAINTENANCE AS SHOWN BY THE SHIFT IN THE CURVE - APPROXIMATELY 70% PM AND 30% CORRECTIVE.



## EVOLUTION

IN ADDITION TO EXPANSION OF PREVENTIVE MAINTENANCE BY THE INDUSTRY IN GENERAL, THERE IS ALSO A TREND TOWARDS MORE ADVANCED PRACTICES DUE TO:

- INNOVATIVE METHODS
- A MORE PROGRESSIVE ENVIRONEMTN
- EXTERNAL INFLUENCES PUC, NRC, ETC.
- GENERAL ECONOMIC BENEFITS, FOR EXAMPLE

COST OF REPLACEMENT POWER

COST OF CORRECTIVE MAINTENANCE

NEARLY ALL UTILITIES TODAY PERFORM SOME TYPE OF PREVENTIVE MAINTENANCE AND MANY HAVE COMPUTERIZED INFORMATION SYSTEMS IN ONE FORM OR ANOTHER. ADDITIONALLY, THOSE UTILITIES THAT DO HAVE COMPUTERIZED SYSTEMS ARE CONTINUALLY UPGRADING SYSTEM CAPABILITIES.

AN EFFECTIVE PM PROGRAM PAYS DIVIDENDS IN DIRECT MEASURABLE ECONOMIC TERMS BY REDUCED COST OF REPAIR AND MINIMIZING EQUIPMENT DOWNTIME. A LESS MEASURABLE - BUT REAL BENEFITS, ALSO RESULTS FROM IMPROVED SAFETY.

MAINTENANCE COST CAN BE PLACED INTO TWO BASIC CATEGORIES:

(1) PREVENTIVE# MAINTENANCE OR (2) BREAKDOWN REPAIRS.

MONIES SPENT FOR PM WILL BE REFLECTED IN LESS CAPITAL REQUIRED FOR BREAKDOWN REPAIRS. AN EFECTIVE PM PROGRAM HOLDS THE SUM OF THESE TWO EXPENDITURES TO A MINIMUM.

AS THE INTERVAL OF TIME BETWEEN PM INSPECTIONS INCREASE, COST OF PM WILL DIMINISH AND COST OF EQUIPMENT REPAIRS AND/OR REPLACEMENT WILL INCREASE. THE LOWEST TOTAL ANNUAL

EXPENSE WILL BE REALIZED BY MAINTAINING AN INSPECTION FREQUENCY THAT WILL KEEP THE SUM OF REPAIR/REPLACEMENT AND PM COSTS TO A MINIMUM AS INDICATED.

FROM THE STANDPOINT OF SAFETY, REDUCED PERSONAL INJURIES AND PROPERTY LOSS CLAIMS CAN HELP KEEP INSURANCE PREMIUMS AT FAVORABLE RATES.

STATISTICS COMPILED BY A MAJOR INSURER (FACTORY MUTUAL) FOR LOSSES ASSOCIATED WITH ELECTRICAL EQUIPMENT FAILURES, SUCH AS GENERATORS, MOTORS, TRANSFORMERS, ETC., IN 1967 AND 1968 INDICATED THAT FOR THIS PERIOD APPROXIMATELY ONE-HALF OF THE LOSSES ASSOCIATED WITH THESE FAILURES MIGHT HAVE BEEN PREVENTED BY AN EFFECTIVE PM PROGRAM.

ANOTHER EXTREMELY IMPORTANT ASPECT TO THE INDUSTRY TODAY IS PLANT AVAILABILITY AND THE REDUCTION IN QUANTITY AND DURATION OF FORCED OUTAGES TOGETHER WITH THE REDUCTION OF THE DURATION OF PLANNED OUTAGES.

FORCED OUTAGES IN GENERAL FOLLOW AN EVOLUTIONARY PATTERN OR LEARNING CURVE. AS A UTILITY GAINS EXPERIENCE WITH NEW PLANT OPERATION, BOTH THE QUALITY AND DURATION OF FORCED OUTAGES ARE REDUCED. IN ADDITION TO THE NORMAL LEARNING CURVE, AN EFFECTIVE PM PROGRAM CAN REDUCE THESE OUTAGES FURTHER BY ACCELERATING THE LEARNING PROCESS.

THE ACCELERATED LEARNING CURVE IS ACHIEVED BY PLANNING FOR

- ON-LINE MAINTENANCE ACTIVITIES
  
- MAINTENANCE DURING FORCED OUTAGES
  
- MAINTENANCE DURING SCHEDULED OUTAGES

AN ARTICLE IN THE AUGUST, 1980 ISSUE OF POWER ENGINEERING MAGAZINE DESCRIBING A COMPUTER ASSISTED PM PROGRAM INSTITUTED BY DAYTON POWER AND LIGHT AT THEIR TAIT STATION, INDICATED THAT WITH THE APPLICATION OF MODERN MANAGEMENT METHODS, ASSISTED BY COMPUTER TECHNOLOGY, BENEFICIAL

PROGRESS CAN BE MADE IN IMPROVED EQUIPMENT RELIABILITY AND AVAILABILITY.

OUR MANAGED MAINTENANCE SERVICES ARE DESIGNED TO DEVELOP KNOWLEDGE MUCH EARLIER BY COUPLING THE EXPERIENCE OF UTILITIES AND WESTINGHOUSE -- THUS ACCELERATING THE LEARNING PROCESS AND IMPROVING AVAILABILITY AND OUTAGE PLANNING.

AT THIS POINT, I WOULD LIKE TO GO THROUGH THE DETAILED ELEMENTS OF OUR MANAGED MAINTENANCE SERVICES PROGRAM. AS SHOWN HERE AND MENTIONED EARLIER; THE PROGRAM IS BOTH MODULAR AND FLEXIBLE.

WHAT WE REFER TO AS PHASE I OF THE MANAGED MAINTENANCE SERVICES IS THE PROGRAM SPECIFICATION WHICH BASICALLY DEALS WITH THE DETAILED COMPONENT AND SYSTEM DATA.

BASIC DEFINITION: COMPILE AND ANALYZE INFORMATION NECESSARY TO PROPERLY MAINTAIN SYSTEM AND EQUIPMENT WITHIN A POWER PLANT. IT IS A PROCESS OF COLLECTING, REVIEWING, APPLYING

JUDGEMENT EXPERIENCE AND KNOWLEDGE TO EQUIPMENT DATA AND RECOMMENDING THE PROPER MAINTENANCE PROCEDURES TO IMPROVE MAINTENANCE QUALITY, COST AND PRODUCTIVITY.

THE PRINCIPLE CHARACTERISTICS OF THE MAINTENANCE PROGRAM SPECIFICATION STAGE ARE:

- IT IS A TOTAL PLANT MAINTENANCE PROGRAM. IT CAN BE APPLIED TO EVERY COMPONENT, PIECE OF EQUIPMENT, OR SYSTEM WITHIN A PLANT. THE PROGRAM IS NOT RESTRICTED TO THE TURBINE-GENERATOR, BUT INCLUDES BOILER AND ALL BALANCE OF PLANT EQUIPMENT IF DESIRED BY THE UTILITY.
- EQUIPMENT SPECIFIC MAINTENANCE REQUIREMENTS. THE PROGRAM THOROUGHLY IDENTIFIES THE PROPER MAINTENANCE FOR EACH PIECE OF EQUIPMENT BY ITS COMPONENTS AND ALSO, HOW IT AFFECTS THE MAINTENANCE AND OPERATION OF THE SYSTEM OF WHICH IT IS A PART.
- RESOURCE PLANNING CAPABILITY FOR ROUTINE MAINTENANCE--THE

PROGRAM IDENTIFIES THE NECESSARY RESOURCES TO PERFORM MAINTENANCE SUCH AS MANPOWER, SKILLS, TOOLS, PROCEDURES, MATERIALS.

- SCHEDULING OF EQUIPMENT MAINTENANCE AND TESTING -- THE PRODUCTIVITY AND EFFICIENCY OF MAINTENANCE CAN BE ENHANCED WITH PROPER SCHEDULING AND ALLOCATION OF RESOURCES, EQUIPMENT MAINTENANCE AND TESTING. THERE IS A CRITICAL AREA FOR COST AND EQUIPMENT MANAGEMENT WHICH LIES BETWEEN EXCESSIVE PREVENTIVE MAINTENANCE AND INADEQUATE PREVENTIVE/CORRECTIVE MAINTENANCE.

THERE ARE MULTIPLE SOURCES OF MAINTENANCE RECOMMENDATIONS FOR EVERY PIECE OF EQUIPMENT AT THE PLANT. DECIDING WHICH OR WHAT COMBINATION OF RECOMMENDATIONS AND PROCEDURES WILL BE ADOPTED CAN BE A DIFFICULT, TEDIOUS, CONFUSING, AND OFTEN INEFFICIENT TASK. WESTINGHOUSE INCORPORATES VIRTUALLY EVERY INFLUENCE ON MAINTENANCE RECOMMENDATIONS INTO THE MAINTENANCE PROGRAM SPECIFICATION INCLUDING: CODES AND STANDARDS (ASME, IEEE) HISTORY, RECORDS, EQUIPMENT MANUALS,

PROCESS SPECIFICATIONS, AND PLANT STAFF EXPERIENCE.  
WESTINGHOUSE ALSO CONSIDERS ANY EXTERNAL INFLUENCES WHICH  
MAY EFFECT PLANT MAINTENANCE, OPERATIONAL AND MANAGEMENT  
PRACTICES SUCH AS PUCS, NERC, EPA, FERC, ETC.

THE VALUE ADDED TO THE MAINTENANCE PROGRAM SPECIFICATION  
OFFERED BY WESTINGHOUSE IS THE ENGINEERING JUDGEMENT WHICH  
ACCOMPANIES OUR EFFORT. WESTINGHOUSE'S EXPERIENCE,  
KNOWLEDGE AND COMMITMENT TO THE UTILITY INDUSTRY IS A  
VALUABLE ASSET AND CANNOT BE IGNORED.

THE INITIAL STEP IS TO SELECT THE EQUIPMENT AND SYSTEMS  
WHICH ARE TO BE INCLUDED IN THE PREVENTIVE MAINTENANCE  
PROGRAM. THIS IS DONE BY BOTH THE UTILITY AND WESTINGHOUSE  
AND IS BASED ON THREE PRINCIPLE AREAS: PLANT/SYSTEM  
OPERABILITY, PLANT/SYSTEM AVAILABILITY AND COST (COST OF  
MANAGEMENT AND COST OF REPAIR).



THE POWER PLANT IS DIVIDED INTO SEVERAL DISTINCT AREAS TO HELP ASSIST THE SELECTION PROCESS AND DIFFERENTIATE EQUIPMENT AND SYSTEMS.

THE NEXT STEP IS TO IDENTIFY AND LIST THE DESCRIPTIVE DATA FOR EACH PIECE OF EQUIPMENT. THIS WILL ASSIST IN THE COMPI- LATION, ORGANIZATION, MANIPULATION AND REFERENCING OF ALL THE EQUIPMENT AND SYSTEMS IN THE PLANT FOR ITEMS SUCH AS . . . .

EQUIPMENT IDENTIFICATION AND REQUIREMENTS WORK SHEET. AS A RESULT OF SELECTING EQUIPMENT AND IDENTIFYING DESCRIPTIVE DATA, A WORK SHEET IS DEVELOPED WHICH ALSO CONTAINS THE MAINTENANCE REQUIREMENTS RECOMMENDED AS A RESULT OF THE PROGRAM SPECIFICATION.

SECTION 1 LISTS EQUIPMENT NAME AND IDENTIFICATION, SECTION 2 LISTS ADDITIONAL EQUIPMENT MANUFACTURER DATA, SECTION 3 IS A REMARKS SECTION WHICH IS EXTREMELY IMPORTANT FOR FUTURE MAINTENANCE OR INHERENT OPERATION/MAINTENANCE TENDENCIES,

AND SECTION 4 LISTS THE MAINTENANCE REQUIREMENTS AND FREQUENCY FOR THE SPECIFIC PIECE OF EQUIPMENT (4.16 KV SWITCHGEAR).

THE PROCESS BY WHICH MAINTENANCE, TEST AND INSPECTION REQUIREMENTS ARE IDENTIFIED CONSISTS OF A REVIEW, SELECTION AND CONSOLIDATION OF THE MANY AND VARIED REQUIREMENTS CONTAINED IN ENGINEERING SPECIFICATIONS, CODES AND STANDARDS, HISTORY, VENDOR SPECIFICATIONS/EQUIPMENT MANUALS, WARRANTY REQUIREMENTS AND PLANT EXPERIENCE.

WESTINGHOUSE EMPLOYS THE VALUE ADDED EXPERTISE AND JUDGEMENT WHICH OPTIMIZES THE NECESSARY REQUIREMENTS TO BE RECOMMENDED.

AFTER THE MAINTENANCE REQUIREMENTS ARE ESTABLISHED AND AGREED TO, AN ACTIVITY WORK SHEET IS DEVELOPED. THE PURPOSE OF THE SHEET IS FOURFOLD:

LISTS EQUIPMENT NAME AND IDENTIFICATION, LISTS THE SPECIFIC

MAINTENANCE ACTIVITY AND BASIS, LISTS THE NECESSARY MANHOURS AND SKILLS AND ALSO EQUIPMENT STATUS, LISTS THE MATERIALS, SPECIAL TOOLS, PROCEDURES, REMARKS, AND NETWORK STATUS. THE NETWORK STATUS IDENTIFIES PRE- AND POST-MAINTENANCE ACTIVITIES, AS WELL AS INTERFACES.

IT IS IMPORTANT AT THIS TIME TO RE-EMPHASIZE THE VALUE ADDED OF WESTINGHOUSE ENGINEERING JUDGEMENT: FROM OUR EXPANDED KNOWLEDGE BASE OF PLANT DESIGN EXPERIENCE, OPERATING PLANT FEEDBACK, AND RELIABILITY ENGINEERING TECHNIQUES, WE ENHANCE MAINTENANCE MANAGEMENT TECHNIQUES AND PRACTICES AND ARE ABLE TO DIFFERENTIATE OUR SERVICES FROM THOSE AVAILABLE FROM OTHER VENDORS.

DURING THE PROGRAM SPECIFICATION STAGE, WE DEVELOP WHAT ARE CALLED NETWORKS FOR OUTAGE PLANNING PREPARATION. NETWORKS ARE A COMBINATION OF WORK ACTIVITIES WHICH ARE COORDINATED INTO OUTAGE PLANS. SEVERAL OF THE BENEFITS ARE:.....

THE SYSTEM ON THE CHART IS A PORTION OF A NETWORK FOR A COAL FEEDER WHICH INCLUDES THE FEEDER ITSELF, A FAN COIL PUMP, AND A FEEDER DRIVE. IT ALSO SHOWS PARALLEL ACTIVITIES AND CRITICAL PATH. NETWORKS CAN BE SIMPLE OR SOPHISTICATED DEPENDING ON THE EQUIPMENT, SYSTEM, MAINTENANCE REQUIREMENTS AND NEEDS OF THE PARTICULAR WORK ACTIVITY OR OUTAGE.

THE DELIVERABLES. THE SYSTEM WORKBOOKS ARE THE MANUAL COMPILATION OF PHASE I ACTIVITIES READY TO BE LOADED INTO THE ELECTRONIC DATA BASE AND TO A REFERENCE LIBRARY FOR STORAGE. THE WORKBOOKS SHOULD HAVE RESTRICTED USE FOR EDITING AND ADDITIONS TO THE MAINTENANCE RECOMMENDATIONS AND PROCEDURES.

SHOWN HERE IS ATYPICAL SET OF SYSTEM WORKBOOKS THAT CONTAIN THE DETAILED INFORMATION THAT IS MAINTAINED IN THE REFERENCE LIBRARY. EACH VOLUME CONTAINS DATA ON A PARTICULAR SYSTEM WITHIN THE CUSTOMER'S PLANT.

## MAINTENANCE INFORMATION SYSTEM

AS PREVIOUSLY MENTIONED DURING THE "REVIEW OF CURRENT MAINTENANCE PRACTICES," COMPUTERIZATION IS A NECESSARY FOUNDATION THAT UTILITIES BUILD UPON TO PROGRESS TOWARD MORE ADVANCED TECHNIQUES.

THE WESTINGHOUSE MANAGED MAINTENANCE COMPUTER PROGRAM (MMCP) PROVIDES AN ADVANCED MANAGEMENT TOOL FOR THE CONTROL OF PLANT PREVENTATIVE AND CORRECTIVE MAINTENANCE. THE COMPUTER PROGRAM HAS THE CAPABILITY TO PERFORM MAINTENANCE DATA STORAGE, MAINTENANCE PLANNING AND WORK ORDER GENERATION, HISTORICAL TREND ANALYSIS AND OUTAGE SUPPORT.

IT WAS DEVELOPED JOINTLY BY WESTINGHOUSE AND A UTILITY, WHOSE INPUT WAS COMBINED WITH WESTINGHOUSE DATA PROCESSING AND MAINTENANCE ENGINEERING EXPERTISE.

THERE ARE MANY REASONS TO COMPUTERIZE A MAINTENANCE SYSTEM AND PROBABLY THE TWO MOST SIGNIFICANT REASONS FOR

COMPUTERIZATION IS THAT PM REQUIRES A SYSTEMATIC APPROACH  
AND IT CENTRALIZES RECORDS.

THE OBJECTIVES OF THE PROGRAM ARE BASICALLY TO:

- STORE AND MANIPULATE INFORMATION.
  
- PROVIDE AN INTERACTIVE PROGRAM FOR UTILITY  
MAINTENANCE STAFF.

THE BASIC FUNCTIONS OF THE WESTINGHOUSE SOFTWARE PACKAGE ARE  
AS SHOWN:

- STORE PM DATA - THE SYSTEM USES THE DATA BASE METHOD FOR  
STORING INFORMATION WHICH IS A METHOD BY  
WHICH DATA IS GROUPED BY TYPE AND STORED  
IN SUCH A MANNER THAT THE SAME PIECE OF  
DATA IS NEVER STORED IN MORE THAN ONE  
PLACE. THIS CAN ACCOMMODATE RANDOM ACCESS  
WHICH MAKES IT POSSIBLE FOR THE SYSTEM TO

BE INTERACTIVE.

- SCHEDULE CORRECTIVE MAINTENANCE - IN ADDITION TO SCHE-  
DULING CORRECTIVE MAINTENACE, THE PROGRAM  
CAN INCLUDE ROUTINE P.M. ACTIVITIES IN THE  
MAJOR C.M. ACTIVITY.
  
- INTERACTIVE PLANNING/SCHEDULING - PERMITS THE USER TO TALK  
DIRECTLY TO THE MACHINE AND GET AN IM-  
MEDIATE RESPONSE WHICH ALLOWS THE USER  
TO KNOW IMMEDIATELY IF HE INPUTS AN  
INCORRECT PIECE OF DATA AND PERMITS HIM  
TO SEE EXISTING DATA WITHOUT HAVING TO  
WAIT. THE ALTERNATIVE IS THE BATCH MODE  
WHERE A USER SUBMITS A REQUEST FOR IN-  
FORMATION, THEN RETURNS LATER FOR THE  
ANSWER.

- ISSUE WORK ORDERS - THE SYSTEM CAN PRINT WORK ORDERS IN EITHER THE BATCH OR SELECT MODE. IN THE BATCH MODE, THE PLANNER CAN HAVE THE SYSTEM PRINT A WORK ORDER FOR EACH ITEM IN THE FILE THAT HE HAS SELECTED. IN THE SELECT MODE, THE PLANNER SELECTS SOME OF THE ITEMS IN THE FILE AND IGNORES THE OTHERS. HE CAN THEN PRINT ONLY THE WORK SEGMENTS THAT HE SELECTED AND LEAVE THE REST IN THE FILE. HE CAN ALSO GROUP WORK SEGMENTS TOGETHER INTO A SINGLE WORK ORDER.

- STORE MAINTENANCE HISTORY - THE SYSTEM MAINTAINS STATISTICS ON THE PERFORMANCE OF MAINTENANCE TASKS. NUMBER OF OCCURRENCES, AVERAGE MANHOURS, AND AVERAGE DURATIONS ARE CONSTANTLY MAINTAINED.



- TRACK MAINTENANCE BACKLOG - THE SYSTEM HAS THE CAPABILITY TO VIEW NOT ONLY WORK IN THE SHORT TERM BUT ALSO IT HAS THE ABILITY TO DO LONG-TERM TRENDING. THE SYSTEM WILL STORE AND DISPLAY HISTORICAL WORKLOADS AND COMPARE TO CURRENT VALUES TO ACCESS ANY LONG TERM TRENDS.
  
- RESOURCE PLANNING - SYSTEM MAINTAINS A RUNNING ACCOUNT OF THE MAN POWER RESOURCES NECESSARY TO PERFORM THE WORK BEING PLANNED AND COMPARE TO THE MANPOWER AVAILABLE.
  
- CAPABLE OF ANALYSIS - THE SYSTEM HAS A PROGRAM THAT WILL PERIODICALLY CHECK DATA BASE AND IDENTIFY WHERE AREAS EXIST IN WHICH PREVENTIVE MAINTENANCE SHOULD BE PERFORMED BUT CURRENTLY IS NOT.

- MINICOMPUTER COMPATIBLE - SYSTEM IS DESIGNED TO RUN ON A  
MINI COMPUTER WHICH MAKES IT POSSIBLE TO  
HAVE A MACHINE ON SITE DEDICATED TO  
MAINTENANCE AND MAKES IT POSSIBLE TO TAKE  
ADVANTAGE OF USER-FRIENDLY FEATURES WHICH  
ARE MORE READILY AVAILABLE ON A MINI  
COMPUTER.

THE MMCP CONSISTS OF TEN BASIS SUBSYSTEMS WHICH ARE DIVIDED  
IN LOGICAL GROUPS THAT PERMIT THE USER TO IMPLEMENT  
MAINTENANCE IN A LOGICAL AND TIMELY MANNER WHICH IS  
CONSISTENT WITH THE STATE OF THE USER'S MAINTENANCE PROGRAM.  
IT IS NOT INTENDED TO DICTATE MAINTENANCE, ONLY TO ASSIST  
THE USER BY IDENTIFYING REQUIRED TASKS. FUNCTIONS OF THESE  
MODULES ARE:

1. SYSTEM CONTROL

PROGRAMS IN THIS MODULE PROVIDE FOR DEFINING AND

MAINTAINING THE VARIOUS PARAMETERS WHICH ARE USED TO CONTROL MMCP FUNCTIONS, AS WELL AS VALIDATING VARIOUS USER DEFINED DATA FIELDS. THIS MODULE ALSO ALLOWS THE USER TO DEFINE THE LEVELS OF USER ACCESS TO THE SYSTEM.

2. PM DATA MAINTENANCE

PROGRAMS IN THIS MODULE PROVIDE FOR DEFINING AND MAINTAINING THE PREVENTIVE MAINTENANCE TASKS WHICH WILL FORM THE BASIS FOR THE USER MAINTENANCE PROGRAM. THE KEY DATA MAINTAINED IS THAT RELATED TO THE PLANT EQUIPMENT AND ACTIVITIES WHICH ARE DEFINED FOR THE EQUIPMENT. REPORTING IS PROVIDED IN BOTH SCREEN DISPLAY AND PRINTED FORMATS. THIS MODULE PROVIDES THE ABILITY TO COLLECT PM DATA AND RECORD IT IN THE COMPUTER. IF NECESSARY, THIS MODULE TOGETHER WITH THE SYSTEM CONTROL SUBSYSTEM, COULD PROVIDE A USER WITH A MANUALLY ORIENTED MAINTENANCE PROGRAM USING THE DATA TO HANDWRITE WORK ORDERS FOR THE PLANT. HOWEVER, THE REAL STRENGTH OF THE SYSTEM IS TO BE ABLE TO USE THIS DATA TO

USE THIS DATA TO AUTOMATICALLY FEED THE WORK ORDER  
FUNCTION.

3. PM DATA ANALYSIS

IT'S ONE THING TO DEFINE A PM PROGRAM FOR A PLANT. IT'S  
ANOTHER THING TO IMPLEMENT IT. THE PROGRAMS IN THIS  
MODULE PROVIDE FOR REVIEWING AND PROJECTING THE WORK  
LOAD WHICH THE PM DATA REPRESENTS. IN ADDITION SPECI-  
FIC PROGRAMS ARE DESIGNED TO AID THE USER IN REVIEWING  
THE DATA ON THE PM FILE AND BE SURE THAT IMPORTANT  
CONTROL FIELDS, ETC., AREN'T LEFT BLANK. THE GRAPHIC,  
AS WELL AS PRINTED ANALYSES GENERATED BY THESE PROGRAMS  
PROVIDE ONE OF THE STRONGEST TOOLS AVAILABLE IN THE  
MARKET TO AID THE CUSTOMER IN DEFINING A PM PROGRAM  
WHICH IS PRACTICAL AND CAN BE IMPLEMENTED WITH THE  
AVAILABLE RESOURCES.

4. PM SCHEDULING SUPPORT AND GROUPING

NECESSARY FOR A TOOL WHICH CAN IDENTIFY PM ACTIVITIES WHICH ARE DUE, HAS THE ABILITY TO ASSURE THAT ANY RELATED WORK WHICH IS NEAR DUE CAN BE INCLUDED WITH THE WORK PRESENTLY DUE. THE PROGRAMS IN THIS MODULE ARE DESIGNED TO PROVIDE THAT FUNCTION. NOT ONLY CAN WORK TO RELATED EQUIPMENT BE SCHEDULED TOGETHER, BUT ALSO WORK ON VARIOUS EQUIPMENT CAN BE RELATED TO PRODUCE WORK ORDERS WHICH SEQUENCES OTHERWISE UNRELATED WORK. THIS MODULE ALSO PROVIDES THE ABILITY TO IDENTIFY OUT-AGE SCHEDULES FOR USE IN OTHER PROCESSES, SUCH AS LOAD LEVELING AND MAINTENANCE FORECASTING.

5. SCHEDULING

PROGRAMS IN THIS MODULE SUPPORT THE OVERALL PLANNING AND SCHEDULING FUNCTION FOR WORK ORDERS. PREDEFINED PM TASKS CAN BE AUTOMATICALLY OR MANUALLY INTRODUCED TO THE MAINTENANCE CANDIDATE FILE. IN ADDITION, USERS CAN

DEFINE AND INTRODUCE CORRECTIVE TYPE MAINTENANCE CANDIDATES TO THE FILE. THESE CANDIDATES ARE APPLIED TO THE RESOURCES AVILABLE (ALSO DEFINED IN THIS MODULE) ALLOWING PLANNERS TO REVIEW AND ADJUST WORK TO FIT THE AVAILABLE RESOURCES AND PLANT CONDITIONS. THIS IS DONE WITH A NUMBER OF ONLINE SCREENS DEPENDING ON THE PLANNING FUNCTION BEING PERFORMED (I.E., RESOURCE ANALYSIS, WORK ORDER SELECTION, ETC.). WORK ORDERS FOR SELECTED CANDIDATES CAN BE GENERATED AUTOMATICALLY OR MANUALLY. THE USER HAS THE ABILITY TO POST AND TRACK THE WORK ORDERS THROUGH THE MAINTENANCE OPERATION.

INCLUDED IN THIS MODULE IS THE ABILITY TO PRINT STANDARD TASK LISTS FOR FREQUENT TASKS, SUCH AS MONITORING AND RECORDING TEMPERATURES, PRESSURES, ETC.

6. BACKLOG ANALYSIS

PROGRAMS IN THIS MODULE PROVIDE VARIOUS VIEW OF THE

BACKLOG BASED ON USER DEFINED CRITERIA. MMCP CONSIDERS ALL WORK NOT YET COMPLETED AS BACKLOG, INCLUDING ITEMS SCHEDULED AHEAD. AVAILABLE INTERFACES ALLOW FOR HOOKS TO USER MATERIAL SYSTEMS. THIS SUBSYSTEM PROVIDES FOR THE MANUAL UPDATING OF MATERIAL ALLOCATION DATA. A KEY FEATURE OF THIS SYSTEM IS THE PROVISION FOR 'WILD CARD' SELECT CRITERIA WHICH ALLOWS FOR ENTRY OF PARTIAL SELECTION DATA FOR RETRIEVAL (I.E., ALL TAGS STARTING WITH VALMO @.....)

THIS SUBSYSTEM SUPPORTS THE PLANNING EFFORTS WHICH ARE PERFORMED IN THE SCHEDULING SUBSYSTEM.

7. LOAD LEVELING

THE CREATION OF MAINTENANCE CANDIDATES CAN CREATE SPIKES IN WORK LOAD WHEN MAINTENANCE WHICH OCCURS EVERY YEAR, THREE YEARS, ETC. ALSO ITEMS DUE ON A GIVEN DATE BUT REQUIRING AN OUTAGE CONDITION MAY REQUIRE A DUE DATE CHANGE. THIS MODULE CONSIDERS THE OUTAGE SCHEDULES AND

AVAILABLE RESOURCES AND WILL SHIFT OR LEVEL WORK TO FIT THE CONDITIONS.

8. MAINTENANCE FORECASTING

PROGRAMS IN THIS MODULE PROVIDE USERS WITH THE ABILITY TO PROJECT FUTURE RESOURCE REQUIREMENTS BASED ON CURRENT BACKLOG, AS WELL AS PM WHICH WILL BE INTRODUCED INTO THE BACKLOG FOR MONTHS OR YEARS AHEAD. GRAPHIC DISPLAYS AND LISTINGS PROVIDE MEANINGFUL TOOLS TO EVALUATE AND ANALYZE FUTURE WORK FOR BUDGEING OR SCHEDULING FUNCTIONS. A FEATURE OF THIS SYSTEM IS TO GENERATE DATA WHICH CAN BE FED TO A CPM TOOL FOR THE DEVELOPMENT OF REFERENCE PLAN OUTAGES.

9. HISTORY ANALYSIS

PROGRAMS IN THIS MODULE PROVIDE FOR THE CLOSING OF WORK ORDERS INTO A HISTORY DATA BASE. THE DATE IN THE HISTORY FILE CAN BE MAINTAINED IF REQUIRED. THE REAL



STRENGTH OF THIS MODULE IS IN THE VARIOUS HISTORY DISPLAYS AND ANALYSIS WHICH ALLOW THE USER TO MEASURE THEIR MAINTENANCE EFFORTS. THE ANALYSIS CAN AID IN FINDING EXCESSIVE OR INADEQUATE PM DEFINITIONS, AS WELL AS IDENTIFYING MISSING PM (EXCESSIVE CORRECTIVE WORK WHICH MAY BE REDUCED BY A DEFINED PM PLAN).

#### 10. NETWORK PLANNING SUPPORT

PROGRAMS IN THIS MODULE PROVIDE THE USER WITH THE ABILITY TO ESTABLISH CRITERIA WITH PM DATA THAT PROVIDES TASK RELATIONSHIPS WHICH CAN BE FED INTO A CPM TOOL.

HERE IS A TYPICAL SCREEN OF A P.M. ACTIVITY WHICH SHOWS THE INFORMATION AVAILABLE SUCH AS UNIT, SYSTEM AND UTILITIES CODE THAT WE REFERRED TO AS SPIN (STANDARD PLANT IDENTIFICATION NUMBER), WHICH GROUPS SIMILAR PIECES OF EQUIPMENT TOGETHER.

WE WOULD RECOMMEND YOU USE THIS CODE TO DESCRIBE WHAT THE

COMPONENT IS AND NOT WHERE IT IS. ADDITIONALLY, YOU CAN SEE THE OTHER TYPE OF INFORMATION SUCH AS: AREA RESPONSIBLE, PRIORITY ACTIVITY TIME, ETC.

ANOTHER TYPE OF ACTIVITY SCREEN IS FOR A NON-RECURRING ACTIVITY, SUCH AS CORECTIVE MAINTENANCE. THIS IS VERY SIMILAR TO THE PREVIOUS SCREEN THAT YOU HAD SEEN WHICH, IN GENERAL, CONTAINS QUITE A BIT OF INFORMATION, BUT THIS HELPS TO AVOID JUMPING AROUND FROM SCREEN TO SCREEN. THE ACTIVITY SCREENS CONTAIN THREE BASIC SECTIONS AS YOU CAN SEE.

SECTION 1 - EQUIPMENT IDENTIFICATION DATA

SECTION 2 - ADMINISTRATIVE TYPE DATA, INCLUDING DUE DATE FOR C.M. (THIS ALLOWS FOR COORDINATION WITH P.M. ACTIVITIES).

SECTION 3 - WHAT WE REFER TO AS A "CYCLING SUBSECTION" WHICH IS NOT LIMITED TO A PARTICULAR DATA FIELD I.E., IF REQUIRED, ONE MAY ENTER MANY LINES OF INFORMATION.

CYCLING FIELDS OF SECTION 3: ALL CYCLING FIELDS ALSO HAVE THEIR OWN SCREENS TO ALLOW YOU TO VIEW ALL ENTRIES OF A PARTICULAR FIELD AT ONE TIME.

MPWR: NUMBER OF MEN REQUIRED PLUS DURATION NOT TOTAL MANHOURS BECAUSE YOU NEED TO DESCRIBE HOW BIG THE CREW MUST BE.

RESOURCE POOL: AVOIDS POSSIBLE DOUBLING UP WORK ON ONE GROUP OF WORKERS. HELPS DEFINE A SPECIFIC GROUP OF PEOPLE YOU WANT THOSE WORKERS TO COME FROM.

INCLUDED P.M. ACTIVITIES: SOME MAJOR ACTIVITIES (E.G., PUMP REBUILD) INCLUDE, BY DEFINITION, MANY STANDARD P.M. TASKS (E.G., LUBRICATION, BEARING REPLACEMENT, ETC.) SO THIS FIELD ALLOWS YOU TO:

- 1) VIEW ALL OTHER PM ACTIVITIES FOR THAT ITEM AND THEN:
  
- 2) DECIDE IF SOME OF THOSE OTHER ACTIVITIES ARE INDEED INCL. IN THE MAJOR ACTIVITY. IF SO, A "Y" IS PUT IN SELECT FIELD FOR EACH ACTIVITY WHICH IS INCLUDED, THEREBY READJUSTING THE PERIOD FOR THAT INCL. ACTIVITY TO THE RECOGNITION THAT IT WILL NOT BE PERFORMED AS ORIGINALLY SCHEDULED, BUT DURING THE PUMP REBUILD INSTEAD.

WE CAN SEE THE INFORMATION FLOW AND CLOSED LOOP FEEDBACK NATURE OF THE MMCP TOGETHER WITH THE ABILITY TO ACCOMMODATE LONG RANGE PLANNING--OUTAGE PLANNING--AND THE NORMAL DAY TO DAY INDIVIDUAL WORK PLANNING FUNCTIONS INCLUDING UNSCHEDULED WORK. AN IMPORTANT CONCEPT IN THIS PROCEDURE IS THAT PEOPLE

ARE CONTROLLING THE MAINTENANCE AND NOT THE MACHINE.

BY FOLLOWING THIS FLOW CHART, ONE MAY RELATE TO THE INFORMATION FLOW AND DOCUMENTATION AVAILABLE WITH MMCP. INPUTS WHICH HAVE BEEN GENERATED DURING THE MAINTENANCE SPECIFICATION PHASE ARE UTILIZED TO GENERATE NOT ONLY WORKING DOCUMENTS, SUCH AS WORK REQUEST, BUT ALSO REFERENCE REPORTS SUCH AS ENGINEERING DATA REPORTS, MANPOWER REQUIREMENTS, AVAILABILITY REPORTS, ETC.

IN ORDER TO VERIFY THE MAINTENANCE PLAN EVEN DURING THE DEVELOPMENT OF THE PLAN. A P.M. SIMULATOR PROGRAM HAS BEEN INCORPORATED INTO THE SYSTEM TO SIMULATE A MAINTENANCE ORGANIZATION TRYING TO EXECUTE THE PLAN AS SPECIFIED.

THE ACCUMULATING FEATURES OF THIS SIMULATION PROGRAM ALLOWS THE MAINTENANCE ENGINEERS TO MINOTOR THE PROGRESS OF THE PLAN AS IT IS BEING DEVELOPED WHICH RESULTS IN A PROGRESS REPORTING SYSTEM WHICH GIVES THE EXACT STATUS OF THE EFFORT.

HOW DOES ONE GO ABOUT SELECTING WORK. SHOWN HERE IS A TYPICAL "WORK ORDER SELECTION" CANDIDATE SCREEN OUTPUT. MANY PAGES OF CANDIDATES ARE POSSIBLE, ALL GROUPED IN THE FOLLOWING SEQUENCE:

1. BY WORK ORDER GROUP (RELATED ACTIVITIES AS DEFINED BY YOU, I.E., LUBRICATION.
2. BY COMPONENT GROUP (RELATED EQUIPMENT IDENTIFICATION TAG NUMBER) SUCH AS A PUMP AND HEAT EXCHANGER RELATED TO A PARTICULAR VALVE.
3. BY INDIVIDUAL EQUIPMENT TAG NUMBER IDENTIFICATION, I.E., VALVES.

ONCE THE WORK HAS BEEN SELECTED, THE PLANNER CAN THEN ISSUE WORK ORDERS FOR THE FUNCTIONS TO BE PERFORMED. HERE WE SEE A WORK ORDER FOR A MOTOR CONTROL LOOP OF A PARTICULAR TYPE. THE WORK ORDER INCLUDES AMONG OTHER ITEMS, UNIT STATUS—SPECIAL INSTRUCTIONS—COMPLETION INFORMATION MANPOWER—

COMPONENT INFORMATION.

THE ANALYSIS FEATURES OF THE MMCP ARE AS SHOWN AND INCLUDE:

- DATA VERIFICATION - IN ADDITION TO CHECKING DATA BASE FOR AREAS THAT PM SHOULD BE PERFORMED BUT IS NOT, THE SYSTEM HAS PROGRAMS TO SEE IF THE ESTIMATED ACTIVITY DURATION AGREE WITH THE ACTUAL EXPERIENCE.

- MANPOWER LOAD LEVELING - DUE TO THE NATURE IN WHICH PM DATA WOULD BE SPECIFIED, THERE ARE NORMALLY SPIKES AT THE END OF COMMONLY SPECIFIED PERIODS, SUCH AS ONE YEAR OR FIFTH OUTAGE.

AFTER A NUMBER OF YEARS, THESE SPIKES WOULD TEND TO WORK THEMSELVES OUT SINCE SCHEDULING IS BASED ON HISTORY AND FREQUENCY. IN THE BEGINNING, HOWEVER, THE PROGRAM WOULD BE ABLE TO SMOOTH OUT MANPOWER REQUIREMENTS TO HELP THE MAINTENANCE DEPARTMENT PERFORM WORK IN A MORE ORDERLY FASHION.

- HISTORY ANALYSIS - AS PREVIOUSLY MENTIONED, THE PROGRAM WILL MAINTAIN STATISTICS ON TASKS AND CHECK THE DATA BASE FOR ACCURACY. IT SHOULD BE NOTED THAT THE HISTORICAL ANALYSIS PROGRAMS DO NOT AUTOMATICALLY CHANGE ANY OF THE VARIABLES IN THE DATA BASE, THEY MERELY PROVIDE INFORMATION TO ENGINEERS THAT THEY CAN USE TO DETERMINE WHETHER OR NOT THE DATA SHOULD BE MODIFIED. THIS IS AN IMPORTANT CONCEPT IN PEOPLE ARE CONTROLLING THE MAINTENANCE NOT THE MACHINE.

- MULTIPLE SORTING OPTIONS - THE PROGRAM IS CAPABLE OF A NUMBER OF SORTING OPTIONS. TYPICALLY, IT WILL SORT ON NOT ONLY ALL SKILLS, BUT ALSO ON SPECIFIC SKILLS REQUIRED. ALSO, IT IS ABLE TO SORT ON PRIORITY ITEMS AND WORK REQUIRED, FOR AN EXAMPLE WITH THE UNIT AT POWER OR WHEN THE UNIT IS DOWN FOR MAINTENANCE.

#### MANHOURS BAR CHART SCREEN

- BAR GRAPH OUTPUT - FOR AN EXAMPLE, A BAR GRAPH OUTPUT OF MANHOURS REQUIRED FOR A PERIOD OF TIME, I.E. MONTHS,



YEARS, ETC.

A UNIQUE FEATURE OF THE PROGRAM IS THAT IT IS COMPRISED TO THREE DISTINCT MODULES WITH THE CAPABILITY TO ADD FUTURE MODULES, SUCH AS DIAGNOSTICS AND ANALYSIS. THE THREE MODULES ARE DATA STORAGE ANALYSIS AND VERIFICATION - PLANNING AND WORK ORDER GENERATION - HISTORY TREND ANALYSIS AND OUTAGE SUPPORT.

THE BASIC IDEA BEHIND THIS APPROACH IS TO ALLOW A CUSTOMER THE FLEXIBILITY TO BEGIN WITH A BASIC MODULE AND ADD TO IT IN THE FUTURE.

IF DESIRED, THE PROGRAM CAN BE EXPANDED TO LINK INTO OTHERS IN-HOUSE COMPUTER SYSTEMS THROUGH EXTERNAL COMMUNICATIONS LINKS. THIS FEATURE ENABLES THE CLIENT TO ADD THE CAPABILITY FOR THE MMCP TO TALK DIRECTLY TO OTHER PROGRAMS IF DESIRED.

IN SUMMARY, THE MMCP PACKAGE HAS THE KEY ATTRIBUTES OF AN  
IDEAL AND DYNAMIC SYSTEM.