Department of Energy

Condition Assessment Survey (CAS) Program

Deficiency Standards & Inspections Methods Manual

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for
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INTRODUCTION

PROGRAM OVERVIEW

INTRODUCTION

WHAT IS CAS?

WHY CAS?

HOW IS CAS IMPLEMENTED?

INTRODUCTION

GENERAL

Welcome to the DOE Condition Assessment Survey (CAS) Program. In the next few pages you will be introduced to a new way of seeing familiar things. As an introduction to CAS, this Program Overview will explain how the various parts of CAS have been developed and integrated to meet the needs of DOE sites, Field Offices, and Headquarters. Our discussion will center around three broad topics:

- WHY CAS?

  This section will discuss issues DOE has faced in previous inspection approaches and explain the CAS goals of providing creative "standardized" solutions.

- WHAT IS CAS?

  Here, key elements of the CAS Program and how they relate to each other will be examined.

- HOW IS CAS IMPLEMENTED?

  Strategies for beginning to use CAS and the key roles facility managers and CAS inspectors play within the CAS process are detailed.

Again, welcome to the CAS Program. Your role in this program is essential to its overall success

INTRODUCTION

DOE NATIONWIDE INVENTORY:

- 10,000 BUILDINGS AND 15,000 STRUCTURES ON 52 SITES NATIONWIDE
- LACK OF DOE STANDARDS
- VARYING DEGREES OF INSPECTION
- INCONSISTENT RESULTS LEADING TO INEQUITIES AMONG SITES

INTRODUCTION

WHY CAS? - The State of DOE

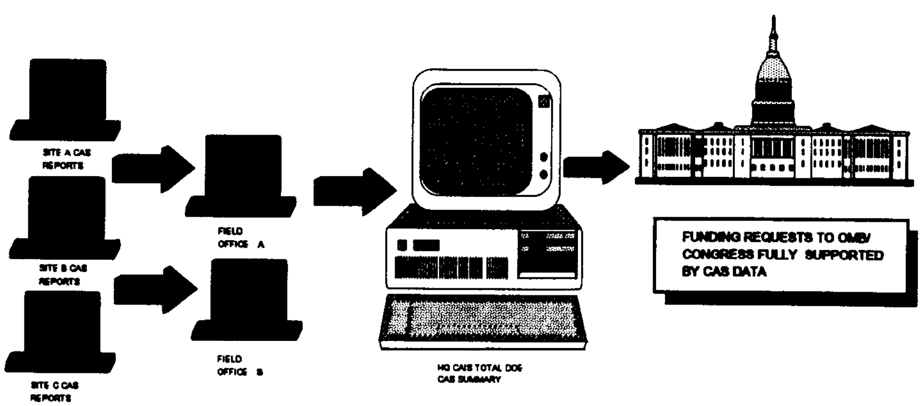
The use of standards, from simple weights and measures to complex computer language, has been a fundamental part of human development. Because of standards, we can be assured that a meter of length in one place is the same in another. This question of standards has become increasingly important for DOE. Over the past 50 years, DOE and predecessor agencies have been at the forefront of the nation's technical advances. This investment has left the department a vast array of facilities under its care. With 10,000 facilities and 15,000 miscellaneous structures comprising over 100,000,000 square feet at 52 sites across the country, the problem of design, construction, and maintenance of all DOE physical plants is acute. Add aging facilities, revised missions, and changing technology, and condition assessment becomes a vital tool to use to ensure facilities will continue to meet DOE's and the nation's program goals.

The current state of condition assessment across all DOE assets is mixed. While DOE regulations dictate facility assessments be made, no one methodology is mandated to conduct them. As a result, DOE surveys have varied from site to site, with some locations providing exhaustive in-depth analysis while others have used a more limited approach. Because of such different interpretations, it is difficult to judge the validity and comparability of data being provided. This, in turn, has led to funding requests that cannot be fully substantiated to Congress.

This lack of standards for use in the facility assessment process and the resultant inconsistencies in developing program budgets have convinced DOE that a standardized, clearly defined methodology for condition assessment is essential to support DOE's program missions.

INTRODUCTION

- ASSESS PHYSICAL CONDITION OF EXTENSIVE AND VARIED DOE FACILITY AN-D EQUIPMENT INVENTORY
- STANDARDIZE INSPECTION PROGRAM FOR ALL SITES
- IDENTIFY REPAIR/REPLACEMENT NEEDS TO FACILITATE KEY BUDGET DECISION MAKING
- DEVELOP SUPPORTABLE FUNDING REQUESTS BASED ON “UNIVERSAL” STANDARDS



INTRODUCTION

WHY CAS? - Four Key Requirements

In today's economic environment, it is essential that the DOE knows with confidence the condition of its vast asset inventory. To accomplish this, a method to review all DOE assets in a "standardized" approach is required. In designing guidelines for such a program, DOE established four key requirements:

Assess physical Condition of All Assets:

To be valid, all sites eventually must be included in the program. Universal participation will ensure that all DOE sites and installations will be using the same "score card."

Standardize Inspection Programs:

To remove the problem of inconsistent and misinterpreted facility inspection data, a "standard" evaluation method used by all DOE sites is required. Results from such a program will allow DOE to determine a "base condition" for all of its assets.

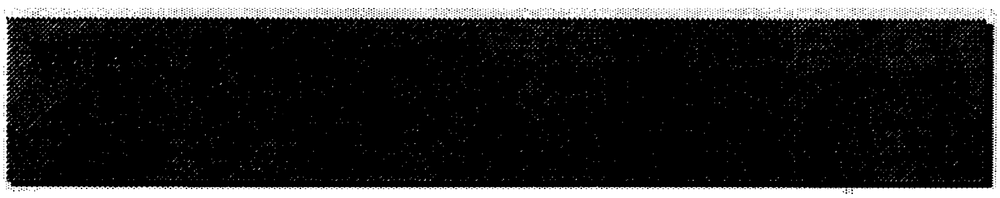
Identify Repair/Replacement Funding:

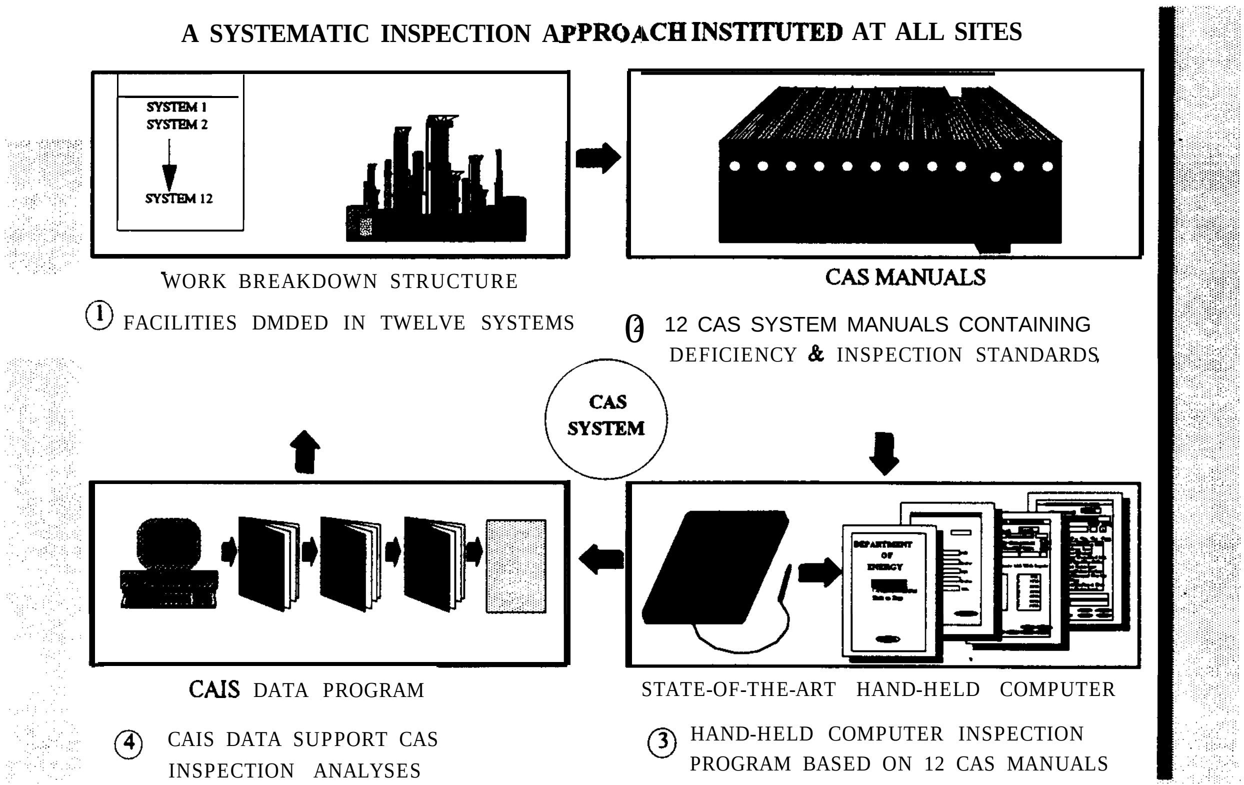
Using inspection data from all sites, a general picture across all DOE assets and programs can be used to direct limited resources to crucial areas. Standardized reports form "a level playing field" to ensure that all programs and missions will receive a fair analysis.

Develop Supportable Funding Requests:

In today's atmosphere of fiscal constraint, requests for funds from Congress require extensive Justification, backed up by reliable, consistent field data, if such programs are to be successfully supported.

INTRODUCTION





INTRODUCTION

WHAT IS CAS? - The Work Breakdown Structure (WBS)

The CAS system has been developed to answer the critical questions facing DOE. Using state-of-the-art hand-held computers and system software programs, the CAS process will establish a systemized, standard approach to facility and asset evaluations. This program will help DOE provide the necessary assets as it seeks to bring our nation's premier research and development agency into the year 2000 and beyond.

The condition assessment process involves evaluating separate building "systems" that comprise the entire facility. These systems traditionally fall under three broad professional disciplines: architectural (including structural), mechanical, and electrical. Specialty assessments (e.g. industrial hygiene, chemical engineering) are usually performed as adjuncts to these primary disciplines when required. The WBS employed under CAS is based on the 12 system assemblies that R.S. Means employs in its square foot cost analysis. Using this system as a foundation to define assemblies and components in the CAS Program will create a direct link to a broadly accepted industry-wide standard.

TABLE ONE

WORK BREAKDOWN STRUCTURE

SYSTEM (R.S. MEANS CAT.)	CONTROL NO.
FOUNDATIONS & FOOTINGS	0.01 SYSTEM
SUBSTRUCTURE	0.02 SYSTEM
SUPERSTRUCTURE	0.03 SYSTEM
EXTERIOR CLOSURE	0.04 SYSTEM
ROOFING	0.05 SYSTEM
INTERIOR FINISHES & CONSTRUCTION	0.06 SYSTEM
CONVEYING SYSTEMS	0.07 SYSTEM
MECHANICAL SYSTEMS	0.08 SYSTEM
ELECTRICAL SYSTEMS	0.09 SYSTEM
*PROD/LAB/OTHER EQUIPMENT	0.10 SYSTEM
SPECIALTY SYSTEMS	0.11 SYSTEM
SITEWORK	0.12 SYSTEM

CONSTRUCTION SPECIFICATIONS

DIVISION (MASTERFORMAT)	DESCRIPTION
01000	GENERAL REQUIREMENTS
02000	SITEWORK
03000	CONCRETE
04000	MASONRY
05000	METALS
06000	WOOD & PLASTICS
07000	THERMA L & MOISTURE PROTECTION
08000	DOORS & WINDOWS
09000	FINISHES
10000	SPECIALTIES
11000	EQUIPMENT
12000	FURNISHINGS
13000	SPECIAL CONSTRUCTION
14000	CONVEYING SYSTEMS
15000	MECHANICAL
16000	ELECTRICAL

The WBS of the CAS Program will be linked to the MASTERFORMAT system developed by the Construction Specifications Institute (CSI) and used as the basis for the DOE Design Guide (DOE 6430.1A). These CSI numbers will be referenced after each system assembly and component in the CAS Manuals as follows:

EXAMPLE: Roofing (CSI 07000)

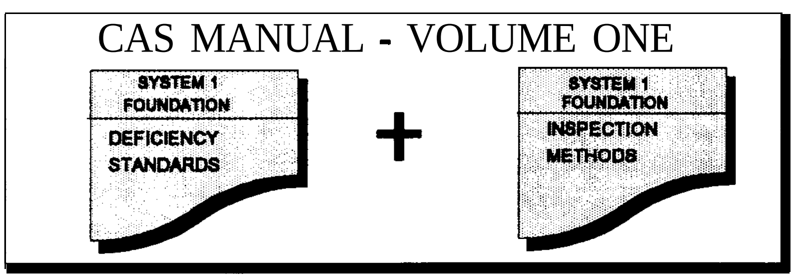
*NOTE: This section supersedes Means 0.10 category and includes FIS 700 Series Asset Codes.

INTRODUCTION

WHAT IS CAS?

DEFICIENCY STANDARDS & INSPECTION METHODS MANUAL

- DEVELOPED SEPARATELY FOR EACH SYSTEM
- DEFICIENCY STANDARDS CONTAIN NARRATIVE AND GRAPHICS FOR DESCRIBING DEFICIENCIES AFFECTING SYSTEM ASSEMBLIES
- INSPECTION METHODS CONTAIN PROCEDURES TO IDENTIFY TYPE, SEVERITY, AND PERCENT COVERAGE OF EACH COMPONENT OR SYSTEM DEFICIENCY ILLUSTRATED



INTRODUCTION

WHAT IS CAS? . DOE CAS Manual Format

Using these 12 systems as the basic organizing principal, the DOE CAS Manual will contain Deficiency Standards and Inspection Methods. It will be divided into 12 volumes corresponding to these established WBS systems. The internal organization of manuals is outlined below:

SECTION 1 • SYSTEM INFORMATION

1.1 Asset Determinant **Factor/CAS Repair Codes/CAS** Cost Factors - Discusses the Asset Determinant Factor (ADF), a decision matrix used to provide a graded approach to inspections commensurate with the use and relative importance of the asset inspected. Also addresses the CAS repair codes, and a general overview of cost estimating techniques.

1.2 Guide Sheet Tools **&** Materials Listing - Contains tools and materials groups used in conjunction with the inspection methods process for the system outlined in each volume.

1.3 Testing Methods - Contains the specific requirements for testing methods applicable to the systems

1.4 **Inspection Frequency** - Schedule of CAS inspection frequencies for systems/components.

1.5 Standard System Design **Life** Tables - Standard design life tables for the system assemblies/components.

1.6 System Work **Breakdown** Structure **(WBS)** - Complete listing of all assemblies/components

1.7 General System/Material Data - General material data relevant to system deficiency problems. (Optional, not included for all systems.)

SECTION 2 • DEFICIENCY STANDARDS

Each major assembly/component is defined by a brief narrative and accompanying graphic(s) that visually illustrate the general characteristics. Major deficiencies affecting this assembly/component are described, including probable failure points. A deficiency characteristics profile and graphic illustrations are provided with each deficiency defined.

SECTION 3 • INSPECTION **METHODS**

This section contains discussions of methods and procedures involved in inspecting each of the WBS systems. Each system contains an Inspection Method, including a narrative and a System/Component Inspection Guide Sheet Listing that provides a general overview for each defined major assembly/component type. This information will be developed for Standard and Non-Standard Inspections and testing methods that would be used in conjunction with Standard or Non-Standard Inspection Methods. Also included is a simulated example, “walking” the inspector through the data collection process.

SECTION 4 • REFERENCES

All major reference standards used and/or associated with the system are described, including government, industry, and DOE references.

APPENDICES

Appendix A Abbreviations - All abbreviated terms contained in the CAS manuals.

Appendix B Glossary - All technical terms directly related to the particular systems discussed will be defined in this subsection.

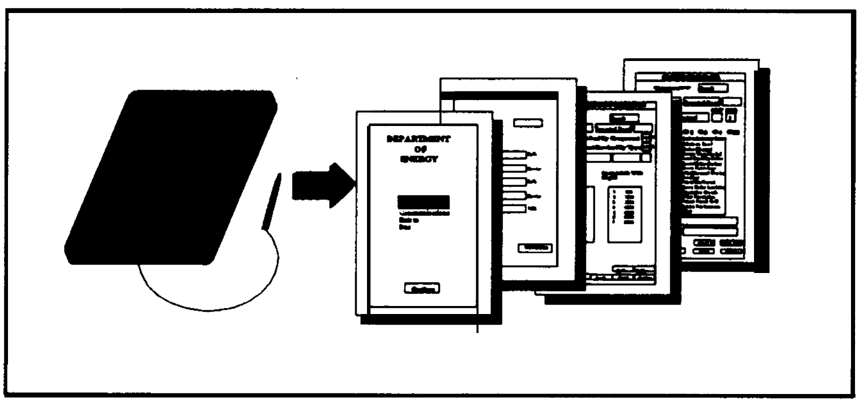
Appendix C Technical **Bulletins/Updates/Advisories** - This subsection contains technical information issued by the government and/or private industry that may affect specific data as developed in the particular volume. DOE guidelines may also be included in this subsection.

Appendix D **Revisions** Summary - All revisions listed in chronological sequence. The last revision listed will be the most current modification.

INTRODUCTION

STATE-OF-THE-ART TECHNOLOGY STREAMLINES FIELD CONDITION ASSESSMENT SURVEY PROCESS

- HAND-HELD COMPUTER "PROMPT-S" INSPECTOR WITH PRELOADED SOFTWARE SYSTEM "MENUS"
- INSPECT OR SELECTS DEFICIENCIES, SEVERITY, PERCENTAGE OF COVERAGE, LOCATION, ETC. FROM "MENU" SYSTEM



INTRODUCTION

WHAT IS CAS? - State-Of-The-Art Technology

At the outset of this introduction, we talked about a "new way" of seeing familiar things. The traditional methods of facility assessment inspection, using hard copy forms then entering data either by laptop or into a PC, have given way to a new, exciting technology: The Pen-Based Computer. This hardware, and the Condition Assessment Information System (CAIS) software developed to support it, form the heart of the DOE CAS data collection process. Using the CAS manuals as the basis to develop the inspection process, CAIS software will create pre-stocked survey "menus". These will be used to record defined deficiencies in terms of severity and coverage. With this user-friendly device, inspectors will simply use a pen-like device to record their observations directly on the prompted inspection screens developed for each system.

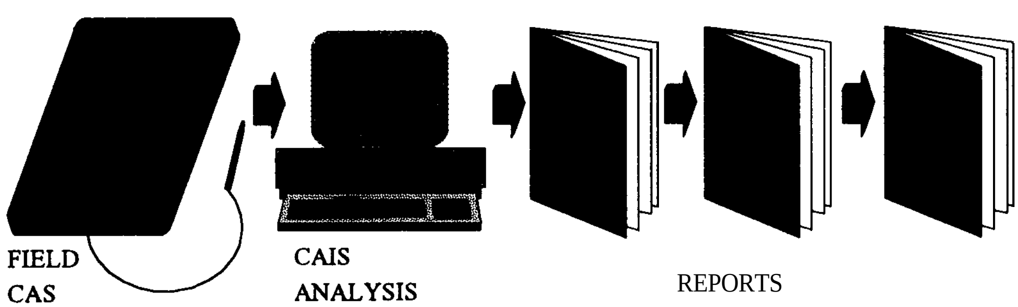
The advantages in using this technology for the DOE CAS Program are exceptional. The efficiency gained by using the hand-held computer technology to prompt the inventory and facility inspection process will be significant. This eliminates the manhour-intensive and error-prone process of converting manually developed data into an automated database. This technology system ensures that all pertinent data is collected, guiding the inspector through each step of the process. This method will significantly enhance the effectiveness of quality assurance/quality control of the DOE CAS Program, permitting editing as data is entered, eliminating illogical or erroneous choices.

In short, the CAS process will be conducted in a carefully structured, "standardized" manner to ensure that the quality of raw inspection data is consistent throughout all DOE installations.

INTRODUCTION

CAIS PROGRAM FOR HAND-HELD & PCs SUPPORT THE CAS PROGRAM

- INSPECTION DATA DOWNLOADED TO PC-BASED CAIS PROGRAM
- DATA ANALYZED, CATEGORIZED, AND SORTED
- REPORTS GENERALIZED, INCLUDING UNIVERSAL AND SUMMARY VERSIONS
- REPORTS WILL INCLUDE DEFICIENCY DESCRIPTIONS, COSTS TO REPAIR/REPLACE, AND SCHEDULE



INTRODUCTION

WHAT IS CAS? - The CAIS Connection

Asset condition information is uploaded directly to the PC and the CAIS program, eliminating the laborious hand input of data. If the hand-held is the "eyes and ears" of CAS, then the CAIS database is the "brain." In the program, raw data is sorted and analyzed to create CAS reports. Several key factors are determined during the process:

Deficiencies Affecting **Survey** Assets:

The inspector describes each deficiency noting its severity and coverage, i.e. how much of the component or assembly reflects the deficiency. The inspector also codes each component or assembly as to condition and the urgency and purpose of proposed repair or replacement actions.

Corrective Repairs:

Based on these recorded deficiencies, corrective actions and their associated repair codes are defined and processed by the CAIS database.

Project Costs:

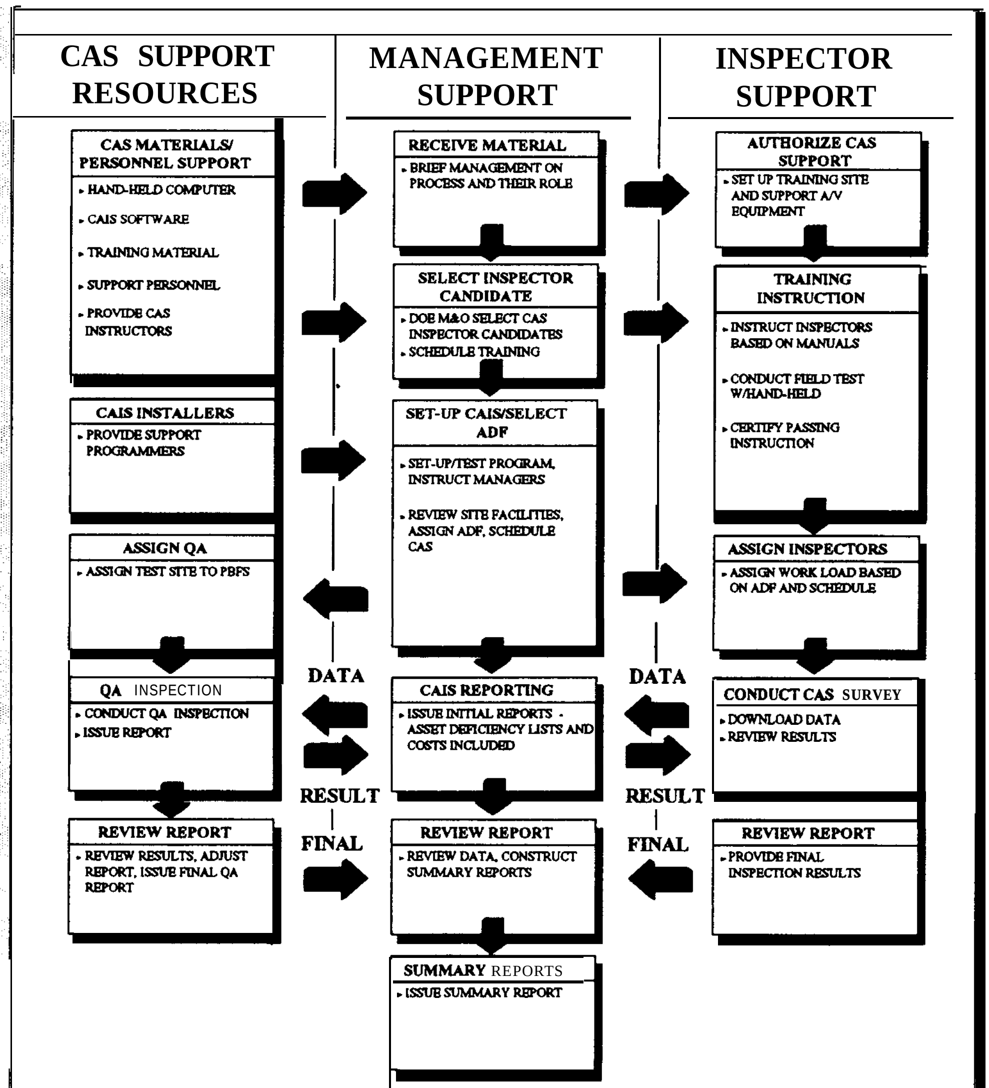
Costs to accomplish repairs and replacements are generated by the manipulation of field data in the CAIS program, which employs several methods including determining cost as a percentage of total replacement and/or direct entry of costs. (See Section 1, Subsection 1.1 for discussion of cost development.)

Asset Reports:

Preformatted reports and tables are generated by the CAIS System. Report types include "universal" reports listing all deficiencies and observations recorded by the Inspector, summary asset reports, and summary site reports. Data within the CAIS system can also be manipulated readily to create "custom" reports.

INTRODUCTION

HOW IS CAS IMPLEMENTED?



INTRODUCTION

HOW IS CAS IMPLEMENTED? - Support Roles

While CAS manuals, hardware and the CAIS database are the main building blocks of the CAS Program, CAS support personnel will form the standing framework. Your role in the implementation process is crucial if the CAS system is to succeed. In reviewing this process, three key support groups are highlighted.

CAS Contractor Support Personnel:

In conjunction with DOE managers and Site Management & Operations (M&O) contractors, CAS contractor support personnel will work closely with DOE in setting up and conducting the training program, installing CAIS, and validating CAS through a Quality Assurance (QA) program. This team of CAS trainers, CAIS programmers, and QA engineers and architects will form, along with DOE M&O personnel, the strong team required to support the CAS Program as it proceeds.

Manager Support:

No group is more important in implementing CAS than the DOE managers and M&O contractors. Their in-depth knowledge of the sites and their personnel will help guide and strengthen the entire CAS system.

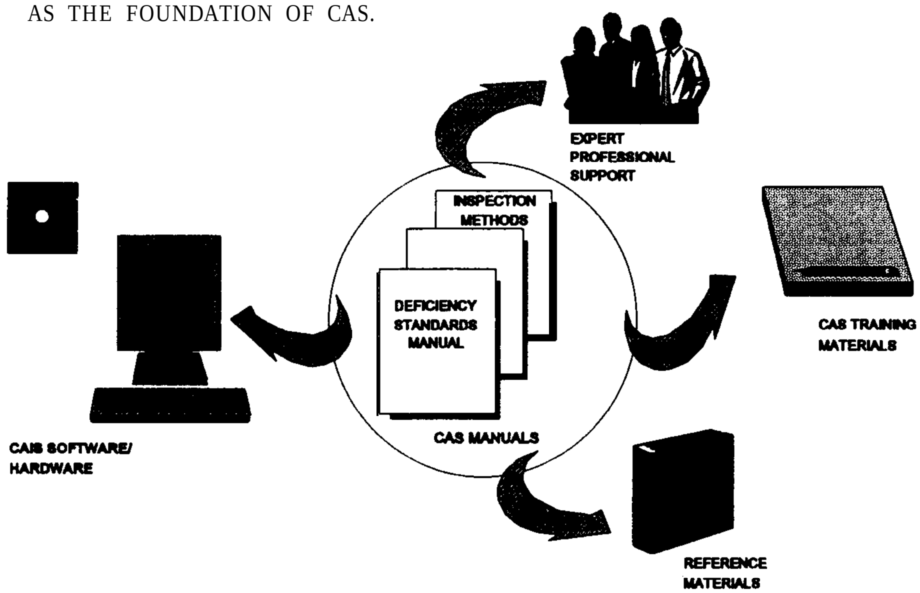
CAS Inspectors:

Without highly skilled, knowledgeable inspectors, the CAS Program will not succeed. The integrity of these inspectors and their expertise will ensure that the base data supporting the entire CAS process will be an accurate reflection of the condition of the DOE inventory of facilities and assets.

INTRODUCTION

CAS SUPPORT RESOURCES

- DEFICIENCY STANDARDS AND INSPECTION METHODS MANUALS SERVE AS THE FOUNDATION OF CAS.



INTRODUCTION

HOW IS CAS IMPLEMENTED? - CAS Support Resources

We have spoken generally of the CAS Process and those resources (manuals, hardware, CAIS software) required to implement the system. Additionally, the CAS contractor will supply all of the technical personnel to support, implement, and guide the CAS Program. Among those key professionals are:

CAS Tralning Instructors:

Professionals with a technical background and well-versed in training methods, will train CAS inspector candidates. Their mission will be to instruct and guide CAS inspector candidates through the entire process, supervise field exercises, and provide final testing. Their goal is that all candidates will be successful participants in the CAS Inspection process.

CAIS Programmers:

A key CAS Program element is the CAIS. Expert programmers will supervise the installation of the PC-based program and provide guidance and instruction for DOE M&O managers in using the system.

CAS/CAIS Hotline:

The Contractor will provide support resources in order to field questions from various site locations. Expert engineers, architects, and computer programmers will answer with written and/or verbal responses all inquiries originating from the field.

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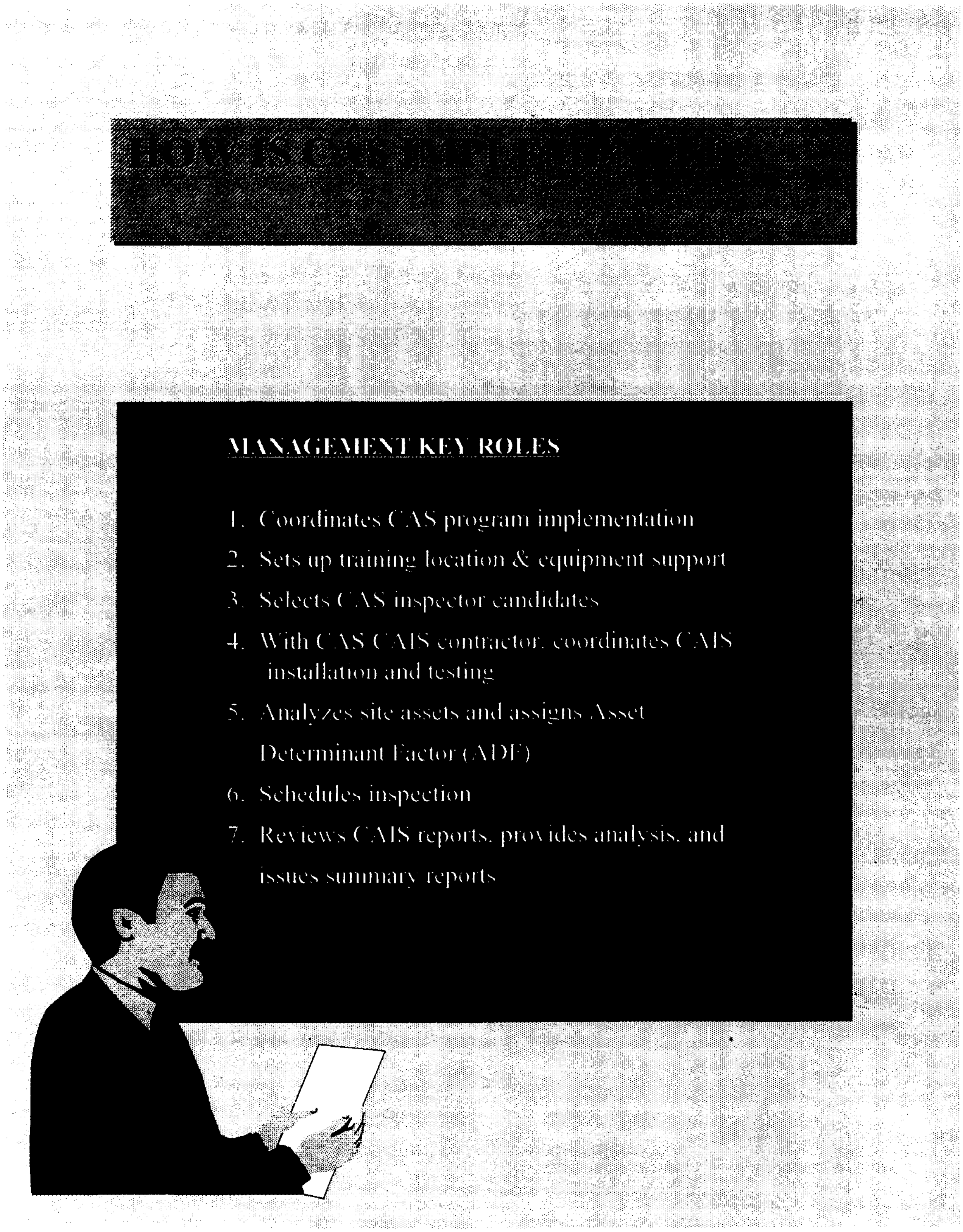


INTRODUCTION

HOW IS CAS IMPLEMENTED? • The Management Role

The critical role DOE M&O managers will play in the CAS process cannot be overstated. Their understanding and direct input will guide the construction of the CAS Program. Their chief responsibilities are:

Initial Implementation:

CAS start-up will include a general briefing by the CAS contractor at designated sites to instruct all key managers in the process and their responsibilities. DOE M&O management actions include training site set-up (to hold maximum of 25 students), arrangements for required A/V equipment (overheads, slide projectors, etc.), and CAS inspector candidate selection (see Guidelines for Implementation of CAS Certification Training under separate cover).

Setting Up CAIS:

In conjunction with CAIS programmers, DOE M&O managers will be instructed in the function and various uses of CAIS software. Data input, system operation, report generation with predetermined report format, and how data can be manipulated to customize reports, will be examined during this training.

ADF Selection & CAS Schedule:

A vital element of the CAS Program is the development of a CAS "strategy." DOE M&O managers will be instructed in the use of the Asset Determinant Factor (ADF) to sort site assets into varied inspection effort levels, See Section 1, Subsection 1.1 Asset Determinant Factor (ADF), CAS Repair Codes, and CAS Cost Factors. The ADF will guide the DOE M&O managers in scheduling the survey and assigning CAS Inspectors to various assets.

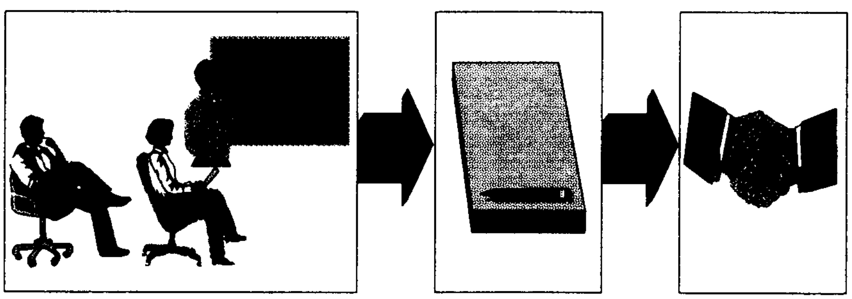
Report Analysis:

The process of up-loading CAS field data to the PC-based CAIS program will be demonstrated to the M&O CAS managers. Analysis processes will be examined using predetermined, formatted reports. Final management project "sorts" and prioritization schemes, and construction of summary reports for higher authorities, will comprise the basic CAS report development sequence.

INTRODUCTION

CAS INSPECTOR CERTIFICATION

- INSPECTOR CANDIDATES ARE TRAINED, TESTED, AND CERTIFIED USMG THE CAS PROGRAM



CLASSROOM TRAINING — TESTING — CERTIFICATION

INTRODUCTION

HOW IS CAS IMPLEMENTED? CAS Inspector **Certification**

While the CAS manuals, hand-held computer, and CAIS software program are the tools of the CAS system, the CAS Inspector is the system "operator." The old adage, "The data output is only as good as the data input," truly applies to the inspectors' role in the CAS process. As part of the effort to assure accurate, consistent results, the CAS Program includes an Inspector training phase that will "certify" all candidates in the use of the CAS system. It should be noted that it is not the training course's intent to train personnel to be inspectors: it is assumed that candidates will come to the CAS Program with a strong background and past experience in the disciplines they will inspect (see Guidelines for Implementation of CAS Certification Training (GICT) under separate cover for detailed information). Key phases of the course include:

Prequalification:

Based on experience levels set by GICT, candidates are selected by the M&O contractors and sent to the CAS training program.

Classroom Training:

Classroom instruction will be conducted at the sites selected by DOE. Course materials, based on the Deficiency Standards and Inspection Methods sections in the manuals, will clearly demonstrate the nature of the CAS system and how it is to be used. Hand-held computers will be used during the course. At course conclusion, these units will be turned over to the inspectors for use in the CAS Program and become the property of the site that the inspectors represent.

Field Exercise:

During the training course, a field exercise using the hand-held will be conducted at a predetermined test asset. This survey and its results will be an integral part of the inspection education program.

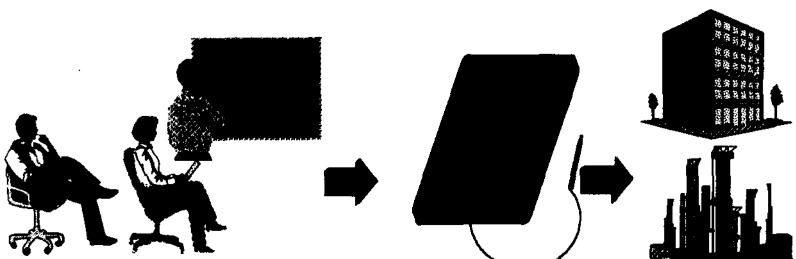
Certification Test:

At the completion of the CAS training, each candidate is required to take and pass a written examination based on the material covered in the class. It is the goal of the training team to pass 100% of the candidates. Those having difficulty will receive additional instructor attention during the class as required. After passing this examination, candidates will be fully certified CAS Inspectors.

INTRODUCTION

THE SURVEY PROCESS

- CERTIFIED CAS INSPECTORS FOR EACH MAJOR DISCIPLINE ARE ASSIGNED FACILITY ASSETS TO INSPECT
- PRE-LOADED SURVEY ROUTINES FOR EACH SYSTEM ARE PROVIDED THROUGH HAND-HELD COMPUTER CAS SOFTWARE PROGRAM



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HOW IS CAS IMPLEMENTED? - The Survey Process

At the completion of CAS training and upon the M&O managers' ADF asset selection and development of survey schedules, certified CAS inspectors will be assigned assets to inspect. This step initiates the CAS process, which will involve several major phases.

start-up:

The objective during start-up is to prepare a profile information file for the asset being surveyed and to verify preloaded information (RPIS data, name, and address, etc.). Such a review might include part and/or all of the material listed below:

- As-built and/or construction documents
- Square footage, type of construction, and age of each building
- Existing studies, surveys, and reports; and
- Existing repair, alteration, or construction projects

Conduct CAS Inspection/Evaluation:

With the benefit of the information contained in the asset file, the CAS Inspector will perform a thorough evaluation of the WBS systems required for each of the assigned assets. The inspector will initially review the asset file to note particular problems. With this accomplished, the CAS Inspector will methodically survey each of his assets and record deficiencies (in terms of severity and coverage) and other observations on the preprogrammed hand-held computer. He accomplishes this data recording through "menu" screens contained in the CAS hand-held computer software, which will guide the CAS Inspector through the process (see Section 3 for full detailed information outlining step-by-step the CAS inspection process).

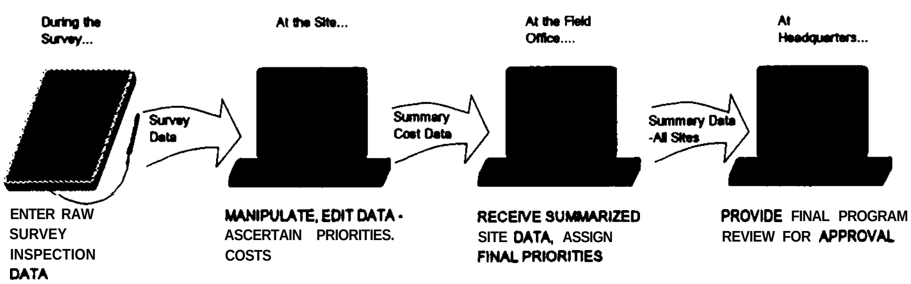
CAS **Report** Generated by **CAIS:**

After completing the CAS Inspection, information is uploaded to the PC-based CAIS system. "Universal" reports showing all asset deficiencies, observations, associated cost, scheduling priorities, and repair purposes will be produced. As part of the QA, the Inspector will review this information with the manager to ensure that all aspects of the inspection asset information are correct.

INTRODUCTION

SUMMARY REPORTS

- IMPROVE ACCURACY AND PROVIDE QA FOR ALL SITE INSPECTION DATA
- FINAL REVIEW OF PRELIMINARY REPORTS BY THE MANAGERS TO "PRIORITIZE" REPAIR/REPLACEMENT REQUIREMENTS FROM ASSET TO ASSET
- ISSUE SUMMARY RESULTS WITH FULL BACK-UP AT SITE



INTRODUCTION

HOW IS CAS IMPLEMENTED? - **Report** Development

With the completion of the CAS Inspector's survey, data uploaded into the PC-based CAIS program is analyzed to provide the survey reports. The primary preformatted reports include:

"Universal" Report:

This document contains all the information recorded concerning deficiencies found in the WBS systems surveyed in each asset. The report lists all deficiencies and observations system by system. The summary section provides the cost of repairing surveyed asset deficiencies and repair codes showing condition, purpose, and urgency. Costs are calculated in CAIS based on deficiencies noted. Inspectors can also directly input repair costs either as a percentage of replacement costs or as an absolute dollar value.

Asset Summary Report:

This report contains summary asset deficiency data at the WBS system level only. The report lists deficiency/corrective repair action by codes (see Subsection 1.1 for more information). All assets surveyed by the Inspector will be listed here. Manager input to these reports includes resorting the priority list (including additions and/or deletions) and recommendations.

Site Asset Summary Report:

After all inspector surveys have been processed, analyzed, and final recommendations input by the manager, this preliminary site-wide report lists all assets included and preliminary manager sorts (Asset Summary Report). Manager input includes selecting of final projects recommended for the budget cycle, including cost and priority schedules.

Site Summary Report:

This report, issued to DOE Headquarters, contains a site project summary and synopsis of back-up data. This report will serve as the basis for establishing the site maintenance and repair backlog which in turn supports funding recommendations to OMB and Congress,

OTHER REPORTS

QA Report:

As part of the QA process, the contractor QA team will randomly select assets inspected by site CAS Inspectors. Results will be analyzed to determine both accuracy and content of the CAS Program to ensure the validity of CAS procedures,

Custom **Reports:**

Data within the CAS/CAIS database can be manipulated to create various reports. Examples might include a report showing all site roofs, cost magnitude, and/or by building type.

INTRODUCTION

- STANDARD APPROACH TO CONDITION ASSESSMENT
- EASE/ACCURACY OF DATA COLLECTION
- SITE-CONTROLLED DATABASE
- SUMMARY DATA TO FIELD OPERATIONS & HQ LEVELS
- MORE CREDIBLE DOE BUDGET SUBMISSIONS

INTRODUCTION

THE CAS SYSTEM: . A **Summary**

In summary, the CAS System has been designed to support the vital process of creating a facility condition baseline that is founded on recognized, fully defined Standards. This established baseline will determine the direction and cost of future assets required to define the DOE's changing mission against a background of government fiscal constraint. As you have seen, your role in this overall program is vital if the CAS framework is to be created and supported. The CAS System is your tool for constructing the essential, realistic requirements needed to obtain budgetary funding. Obtaining these funds is the final measure of whether a site program will move forward or be eliminated.

We began this introduction by promising you a "new way" of seeing familiar things, The CAS Program's combination of state-of-the-art technology and the DOE M&O's talented professionals will be the essential mix to successfully initiate and sustain the CAS process.

INTRODUCTION

END OF SUBSECTION

ASSET DETERMINANT FACTOR/CAS REPAIR CODES/CAS COST FACTORS

GENERAL

The CAS Program is built on the physical analysis of each asset through the inspection of the major systems as defined by the WBS. System-specific deficiencies (as defined for each assembly/component in the Deficiency Standards section of this Manual) and the extent of their severity "bracket" the general asset conditions as of the inspection date. Recording actual deficiencies, however, is only part of the process. The CAS process also documents the urgency and purpose of repairs or replacements as well as the overall condition of the assembly/component surveyed.

The following elements are important parts of the CAS process and will be discussed in detail in this subsection:

- ASSET DETERMINANT FACTOR (ADF): Discusses various possible levels of CAS inspections, and the manager's role in determining the type survey appropriate for each asset.
- CAS REPAIR CODES: Describes categories used by the inspector to document the urgency and purpose of repairs and replacements, and the general condition of the assembly/-component.
- CAS COST FACTORS: The general overview of CAS cost development and the factors used to build project costs are outlined in this section.

CAIS Interface:

As outlined in the Introduction "A CAS Program Overview," the Condition Assessment Information System (CAIS) is a key element, CAIS software will provide critical data analyses required to process CAS raw field data, including repair codes and costing factors for recorded facility asset conditions, The CAS Manuals, the hand-held data collection device and software, and the CAIS Program together form the foundation of the CAS process.

In DOE's vast inventory, asset conditions vary widely in terms of age and use, new or renovated facilities are mixed with assets built during the 1940s and 1950s. It is therefore recognized that not all assets at a given site require the full CAS inspection. The ADF has been developed as a tool that provides site facility managers with a means to categorize each site asset by identifying the type of survey to conduct,

CAS Survev Levels:

For the purposes of allowing flexible CAS Program implementation, three broad categories of asset inspections are defined:

- CAS - Base Level: Assessment is primarily a visual inspection (augmented in some instances by simple testing; eg., light level measured by light meter) recorded at the assembly level of the Work Breakdown Structure (WBS). Deficiencies typical to each assembly are recorded in terms of severity and coverage.
- CAS - Component Level: Provides more extensive inspection information based on conducting the assessment at a component level. Components are defined as major parts of an assembly.
- CAS - Limited: Survey not requiring assessments of all systems for a given asset.

ASSET DETERMINANT FACTOR/CAS REPAIR CODES/CAS COST FACTORS

ASSET DETERMINANT FACTOR (ADF)

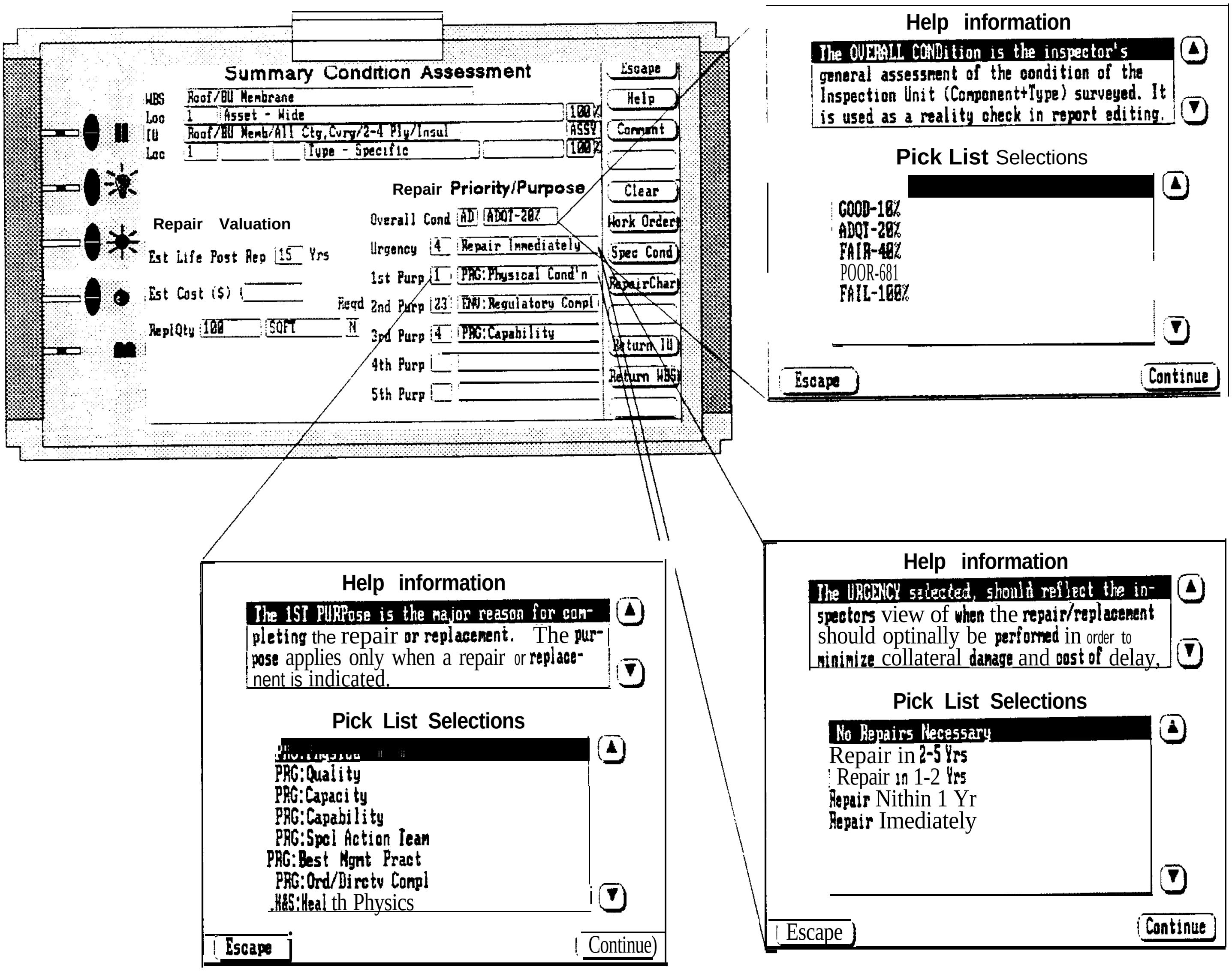
Ten key categories to be used as ADF guidelines are illustrated below. These classifications are sensitive to key DOE criteria, including short-term and mothballed facilities.

ADF#	Guidance	Description	Systems
1	Existing asset (>3 years), program projected to last 5 years	Full CAS Inspection (base CAS - assembly level or optional component level)[1]	ALL
2	Existing temporary asset (>3 years) program projected to last < 5 vears	Limited CAS Inspection (base CAS - assembly level only)	ALL
3	Asset decommissioned - "warm mothball" (maintained for future unidentified function)	ARCH(ext), MECH & ELEC (base CAS - assembly level or optional component level)'	0.04, 0.05, 0.08, 0.09
4	Asset decommissioned - "cold mothball" (to be removed, dismantled, destroyed at some future date)	Exterior envelope (base CAS - assembly level only)	0.04, 0.05
5	Asset ROOF inspection only	ROOF inspection (base CAS - assembly level or optional component level)[1]	0.05
6	Asset ARCHITECTURAL only	ARCH/STRUCTURAL inspection (base CAS - assembly level or optional component level)[1]	0.01) 0.02, 0.03, 0.04, 0.05, 0.06, and 0.11
7	Asset MECHANICAL only	MECHANICAL inspection (base CAS - assembly level or optional component level including incidental electrical)'	0.07, 0.08
8	Asset ELECTRICAL only	ELECTRICAL inspection (base CAS - assembly level or optional component level)'	0.09
9	Asset SITE inspection only	SITE inspection (base CAS - assembly or optional component level) [1]	0.12
10	As developed by each, site	As constructed by site[2]	As Reauired

GENERAL NOTES:
1. Survey may combine levels (eg., ADF #1, Systems 0.01-0.06, 0.11, and 0.12 Assembly level survey; 0.07, 0.08, and 0.09 Component level survey.)
2. Other surveys may be structured on an as-required by sites.
3. ADF values are guidelines only and systems may be added to base ADF values as required.

ASSET DETERMINANT **FACTOR/CAS** REPAIR **CODES/CAS** COST FACTORS

CAS REPAIR CODES



Refer to the following page for definitions of the three (3) major CAS Repair Codes.

ASSET DETERMINANT FACTOR/CAS REPAIR **CODES/CAS** COST FACTORS

CAS REPAIR CODES

One of the key aspects of the assessment process, once significant deficiencies are recorded, is determining the repair category. CAS defines three major repair codes: condition, purpose, and urgency. Condition is derived both by the CAIS algorithm based on raw deficiency data and by the inspector's subjective judgment. Purpose and urgency are each selected by the inspector. Definitions for each major code are listed as follows:

(CAS Repair Codes are **guidelines** only. Codes may vary as required by sites.)

CONDITION CODE	**DEFINITION**
A	Excellent: Performs to original specifications as measured using non-standard tests; easily restorable to "like new" condition; only minimal routine maintenance required at cost <2% of replacement value.
B	Good: Performs to original specifications as measured using historical data and non-standard tests; routine maintenance or minor repair required at cost <5% of replacement value.
C	Adequate: Performance meets requirements; some corrective repair and/or preventive maintenance required at cost <10% of replacement value.
D	**Fair:** Performance fails to meet code or functional requirement in some cases; failure(s) are inconvenient; extensive corrective maintenance and repair required at cost <25% of replacement value.
E	Poor: Consistent substandard performance; failures are disruptive and costly; fails most code and functional requirements; requires constant attention, renovation, or replacement. Major corrective repair or overhaul required at cost <60% of replacement value.
F	Fall: Non-operational or significantly substandard performance. Replacement required because repair cost is >60% of replacement cost.

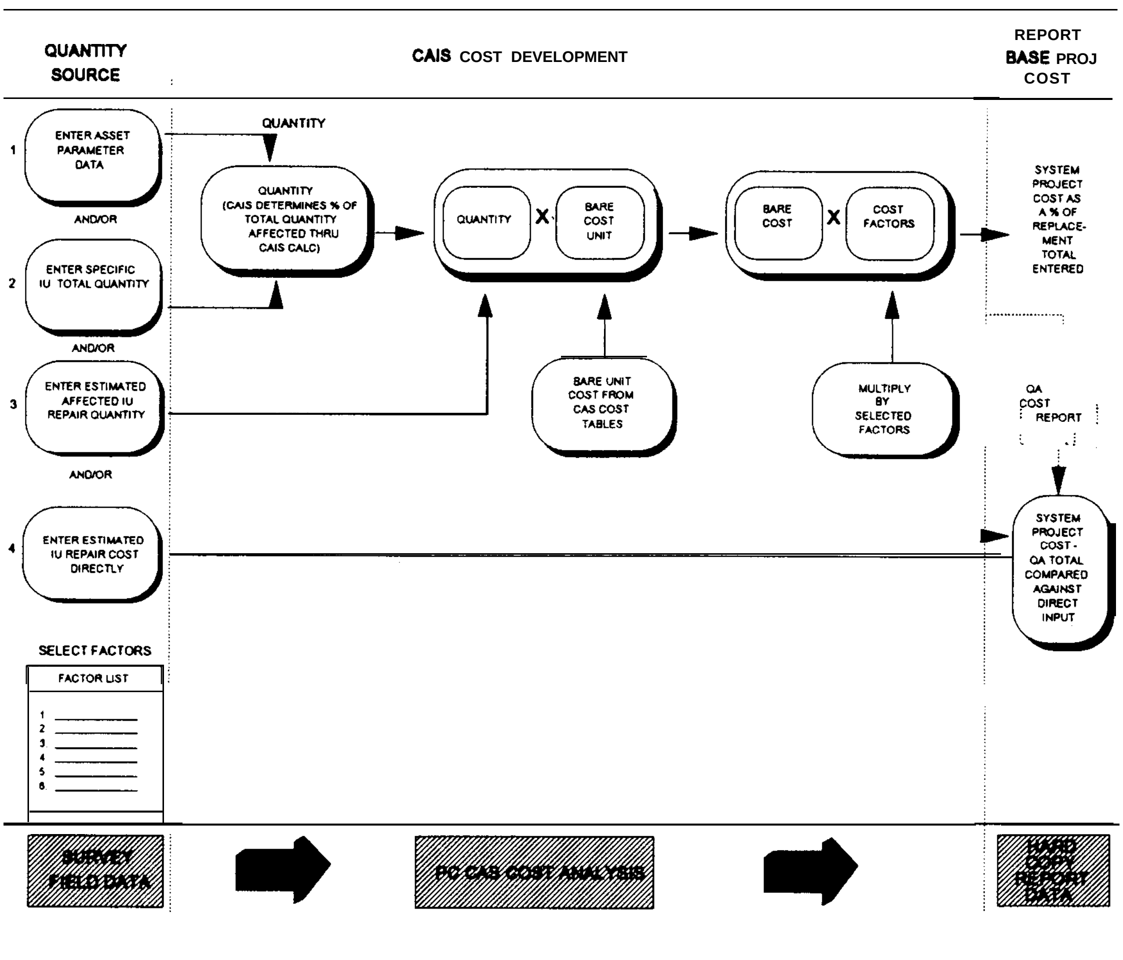
PURPOSE CODE*	**DEFINITION**
P2	PRG: Capacity
H2	H&S: Industrial Safety
E2	ENV: Solid Waste Management
S4	S&S: Security
*	Partial list based on CAMP Order DOE 4330.4A dated 10-I 7-90.

URGENCY CODE	**DEFINITION**
1	Repair Immediately: Asset condition critical; initiate corrective action immediately.
2	Repair within 1 Year: Asset condition serious; initiate corrective action within 1 year.
3	Repair in 1 to 2 Years: Asset condition degraded; initiate repair in 1 - 2 years.
4	Repair in 3 to 5 Years: Asset stable for period; integrate repairs into appropriate schedules.
5	No Repairs Necessary: Continue life cycle maintenance actions.

ASSET DETERMINANT **FACTOR/CAS** REPAIR CODES/CAS COST FACTORS

The following illustrates the cost development process for the Department of Energy CAS/CAIS Project and the various processes involved.

COST DEVELOPMENT PROCESS



END OF SUBSECTION

GUIDE SHEET TOOL & MATERIAL LISTING

SAFETY REQUIREMENTS

Inspections shall comply with all Federal, State, and Local regulations and all applicable safety and health regulations or requirements (including reporting requirements) of DOE.

TOOLS

This subsection contains tool and material listings for use in standard and non-standard inspection for 0.02 Substructure inspections in addition to the Basic Tool Group outlined below.

Accomplishing the activities identified in the inspection guides requires tools: basic, craft (standard), and specialized (non-standard). Specialized tools included in the non-standard tool group consist of special instruments as well as unique tools and are identified in the guides.

All crafts involved in substructure inspections employ a standard or basic tool set, which may vary somewhat between equally qualified personnel. However, the following is a representative set of common basic tools.

BASIC TOOL GROUP

- Standard & Phillips head screw drivers - various sizes
- 50' measuring tape
- Pocket knife
- Flashlight
- Extension cord & inspection lights
- Rags
- Ball peen hammer
- Claw hammer
- Small crowbar

STANDARD TOOL GROUP

- Pliers-vise grip (2), slipjoint, needlenose, diagonal, cutting pliers, side cutters
- Pipe wrenches to 14"
- Small and large level, and square
- Wire brush and stiff bristle brush
- Various cleaning tools - brushes, scrapers, etc.

NON-STANDARD TOOL GROUP

- Infrared measuring device (optional)
- Borescope or fiberscope
- Ultrasonic measuring device (optional)

The basic tool set must be augmented to accomplish inspection actions on a specific item of equipment or assembly. The guide sheets identify this augmentation. Test methods for Substructure systems are defined in Subsection 1.3.

NOTE: It is not the intent of this manual to have sites perform non-standard tests. These guidelines may be used in the event standard Inspection is not sufficient to determine system condition. Such non-standard inspections will be provided by others (e g consultants, outside labs)

GUIDE SHEET TOOL & MATERIAL LISTING

END OF SUBSECTION

TESTING METHODS

GENERAL

During the course of the Condition Assessment Survey, various tests will be employed to better ascertain the condition of the assets, These are Indicated on the Component Specific Guide Sheets included in Section 2 of this Manual. Testing will not be required on all assets.

The critical nature of concrete and its overall condition cannot be understated. Concrete compressive strength is vital to maintain structural Integrity. Where direct foundation characteristics can be observed, surface deficiencies such as cracks, spalling, and exposed reinforcing indicate hidden problems. In this case, underlying deterioration can be determined by further test measures. Testing concrete in-situ seeks to gauge current conditions including reinforcement position and size, poor consolidation areas, voids, cracks, honey-combing, and moisture content, will quantify current strength, durability, and elastic parameters as they exist in view of observed physical deficiencies.

Testing methods do not specify the following:

- Expertise of user (to use the instrument or interpret results).
- The advantage of one testing method versus another.
- The limitations of the testing method.
- Whether the user must be trained and licensed to operate (such as the Nuclear Moisture Meter Test, which requires licensing).

Variability

Estimating in-situ concrete strength using the following test methods may provide site readings that vary from lab test calibrations between 2 to 10%. Pulse velocity tests are the most accurate with a site and lab calibration difference of approximately 2%. Other methods will generally range from 6 to 10% between site and lab conditions.

Standard vs. Non-Standard

Inspection Methods are classified as Standard versus Non-Standard based on techniques employed.

Standard Methods are generally quick, visual, hands-off walk-throughs that do not require a component to be taken out of service. Few tests are required in the associated Guide Sheets. Where tests are indicated, they are non-invasive. An example is Stress Monitor Analysis.

Non-Standard Methods are generally those that require specialized equipment and analysis as well as destructive testing. Examples include Infrared, Nuclear Analysis, Core Sampling, Ultrasonic Pulse Velocity Testing and Surface Hardness Testing.

Some of the tests could be conducted as part of either type inspection. For discussion purposes, they will be classified according to their specialized equipment and analysis; i.e., if a test can be conducted without specialized services, it will be listed under Standard Test Methods.

STANDARD TEST METHODS

- Stress Monitor Analysis

STANDARD TEST DESCRIPTION

Stress Monitor Analysis

Stress analysis consists of documenting the location, pattern, depth, width, and presence of foreign materials, and elevation differences between two cracked concrete or masonry masses and other horizontal or vertical surfaces. Determine if crack is active or dormant using the following steps:

TESTING METHODS

STANDARD TEST DESCRIPTION (Continued)

Stress Monitor Analysis

- Mark the end of the crack and check after a few days to see if it has extended past the mark, Note direction.
- Place a notched piece of tape across the crack. Wait for a period of a month or more. If tape tears or compresses (wrinkles) the crack is active and if the tape shows no apparent change it is dormant.
- Drill gauge points and install pins on either side of the crack. Measure the distance between points at regular intervals with vernier calipers to determine the extent of movement.

NON-STANDARD TEST METHODS

- Acoustic Emission Testing
- Core Sampling
- Electrical Resistivity Testing
- Infrared Testing
- Magnetic Testing
- Maturity Concept Analysis
- Microwave Absorption Scanning
- Nuclear Analysis
- Radiography (X-Ray Testing)
- Surface Hardness Testing
- Ultrasonic Pulse Velocity Testing

NON-STANDARD TEST DESCRIPTION

Acoustic Emission Testing

Acoustic Emission testing measures the acoustic or stress emissions from cracks or surfaces under strain. The stresses are detected as small displacements by sensors positioned on the surface. This type of testing has been used in recent years, although its major drawback is that it can only be used during periods of high stress and deformations and does not work for static loading conditions.

Core Sampling

Core sampling involves taking core samples at various controlled sections to ascertain the condition or strength of the material by laboratory mechanical/chemical analysis. Sample holes must be patched immediately.

Electrical Resistivity Testing

Electrical resistivity testing involves passing electrical currents through the material to determine the resistance offered; it is used to determine reinforcement corrosion and thickness of concrete pavements. This method may also determine the moisture content or penetration of concrete surfaces. Even though this is relatively simple, it is highly dependent on moisture and salt content and the temperature of the material.

Infrared Testing

Infrared Testing measures heat loss or gain. Areas of the substructure system that absorb water will not insulate. Heat is lost more rapidly through these areas, and higher temperatures are detected with an infrared scanner. Cracks, voids, and other discontinuities in the surface all affect heat emissions, so scanners can show the difference between sound and unsound surfaces. Infrared testing is done by scanning the surface with a hand-held instrument. This method requires further research and development.

Source: School and College • "A Systematic Approach to Roofing.' October 1989, Mary E. **Skelly,** Author.

TESTING METHODS

NON-STANDARD TEST DESCRIPTION (Continued)

Magnetic Testing

Magnetic testing involves scanning concrete surfaces with a U-shaped magnetic core with two coils. An alternating current is passed through one coil and the current measured in the second. This test is used to determine reinforcement depth and position in concrete. It should be noted, however, that temperatures below freezing and heavily reinforced sections adversely affect the performance and results.

Maturity Concept Analysis

The maturity concept used in measuring in-situ concrete is based on the fact that concrete strength varies as a function of both time and temperature. These conditions are measured by thermocouples and/or instruments.

Microwave Absorption Scanning

Microwaves are electromagnetic in nature, and can be reflected, diffracted, and absorbed. Absorption by water can determine moisture content of the material. This is relatively new and unproven, while the technique based on electromagnetic wave reflection has been used successfully. This method is fast and easy to perform, although planning and skill are required to interpret and evaluate the results.

Nuclear Analysis

Nuclear analysis is accomplished using a mechanism that scatters neutrons on the substructure system surface. Where water is present, radiation or neutron energy is taken back into the unit. The surface is squared off in a grid pattern and readings are taken from various points. Another method (relatively new and underdeveloped) involves bombarding the concrete surface with neutrons, which causes the surface materials to become radioactive. A comparative analysis is performed as the radioisotopes decay to a stable state.

Radiography (X-Ray) Testing

Radiography testing involves passing radiation in the form of X-rays through an object to expose photographic film on the opposite side to detect cracking, voids, or position of reinforcing. It is seldom used for these building systems due to the cost and dangerous equipment required. Testing with gamma rays, on the other hand, is relatively portable and easier to use. The only limiting factors appear to be high cost and safety concerns.

Surface Hardness Testing

This test consists of impacting the concrete or masonry surface using standard instruments with a given energy pulse to measure the size of rebound. A rebound hammer is most commonly used. Problems and limitations of this test are affected by concrete surface smoothness, carbonation, and moisture condition as well as size, age, and aggregate type.

Ultrasonic Pulse Velocity Testing

Ultrasonic testing is done by passing ultra-high frequency sound waves through a material. An oscilloscope, chart recorder, or computer printout then records or displays the sound waves converted into electrical signals deflected off the rear surfaces and any defects within the material.

Source: School and College • “A Systematic Approach to Roofing.” October 1989, Mary E. **Skelly,** Author.

TESTING METHODS

NON-STANDARD TEST DESCRIPTION

Ultrasonic Pulse Velocity Testing (Contmued)

The basic concept used in the Ultrasonic Pulse Velocity Test consists of generating an ultrasonic wave through the concrete or masonry and measuring the travel time. This technique is excellent for establishing concrete or masonry uniformity and strength. It should be noted, however, that concrete conditions such as age, moisture, aggregate to cement ratio, aggregate type, and steel reinforcement location may adversely influence test results.

END OF SUBSECTION

INSPECTION FREQUENCY

CAS INSPECTION SCHEDULE

The following constitutes recommended inspection frequencies for the listed assemblies and components. The purpose of these inspections is to support the Condition Assessment Survey (CAS) and are not necessarily for maintenance purposes. Each site has the option of varying the inspection frequencies to meet individual site requirements.

The recommended Base CAS inspection frequencies are listed below in Table One for the system described in this manual. The base CAS constitutes standard inspections only and utilizes the standard guide sheets as a reference. All Non-Standard inspections are optional for Substructure System Assemblies and Components.

TABLE ONE

Assembly/Component	Year One	Year Two	Year Three	Year Five
Slabs-on-Grade	S			
Columns CIP Columns			S	
Loaded Precast Columns			S	
Steel Columns			S	
Wood Columns			S	
Column Fireproofing			S	

S - STANDARD INSPECTIONS — NS - NON-STANDARD INSPECTIONS

NOTES: 1. Severe weather or facility operational conditions may require additional inspections.
2. Non-Standard inspections will be provided on an as-required basis unless noted otherwise

INSPECTION FREQUENCY

END OF SUBSECTION

STANDARD SYSTEM DESIGN LIFE TABLES

GENERAL

The Standard (nominal) Design Life of a given System Assembly/Component is defined as the projected service design life measured from the date of installation to the date of replacement. These time periods are based on manufacturers' product specifications and tests which determine the average "outside" time parameter a given System Assembly/Component will last. The Standard Design Life Tables which follow lists design life and replacement cost parameters for WBS. TABLE ONE below illustrates key column headings.

TABLE ONE

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
Note 1:	Used to document the replacement life* of significant WBS System Assembly/Components.	
Note 2:		Used to estimate percent of WBS System Assembly/Component cost replaced at the year specified (measured from installation date to end date specified by the replacement life period*).

*Note The term Replacement Life is synonymous with Design Life

STANDARD SYSTEM DESIGN LIFE TABLES

TABLE TWO

ITEM DESCRIPTION	Replacement Life, Years*	Percent Replaced
0.02 SUBSTRUCTURE		
SLABS-ON-GRADE		
Standard 4" slab on grade floor	50	100
Standard 5" slab on grade floor	50	100
Structural 4" slab on grade floor	50	100
Structural 5" slab on arade floor	50	100
Concrete steps on grade	60	100
COLUMNS		
Wood columns, treated	50	100
Wood columns, untreated	30	100
Precast concrete columns	75	100
Prestressed concrete columns	75	100
Cast-in-place concrete columns	75	100
Steel pipe columns, concrete-filled	75	100
Steel pipe columns, nonfilled	75	100
Steel "H" columns	75	100

END OF SUBSECTION

SYSTEM WORK BREAKDOWN STRUCTURE

GENERAL

Facilities are composed of various assemblies/components which, in turn, form the primary facility systems. These systems, such as foundations, roofs, heating and cooling units, and electrical distribution, have varying life spans. They require maintenance, repair, and renovation over a period of time and do not all "fail" at the same time. Systems have varying life spans. Their condition may be influenced by the deterioration of other assembly/component parts within the systems.

To consider each facility and their major systems, the CAS Program uses the Work Breakdown Structure (WBS) based on the R.S. Means square foot costing system. This industry accepted standard, allows a logical "breakdown" of facilities into their major systems, assemblies, components, etc. The WBS is a heirarchical structure and this concept is illustrated in Figure 1. The development of project costs are then applied within this framework as shown in Figure 2.

The Work Breakdown Structure for this volume follows.

SYSTEM WORK BREAKDOWN STRUCTURE

0.02 SYSTEM. SUBSTRUCTURE

0.02.01	SLABS-ON-GRADE
0.02.02	COLUMNS
0.02.02.01	Cast-in-Place Concrete
0.02.02.02	Loaded Precast Concrete
0.02.02.03	Steel
0.02.02.04	Wood
0.02.03	COLUMN FIREPROOFING

SYSTEM WORK BREAKDOWN STRUCTURE

WBS LEVEL TABLE

0.05	*LEVEL I*	0.00
ROOFING	*SYSTEM*	MECHANICAL
0.05.01	*LEVEL 2*	0.08.01
WILT-UP	*ASSEMBLY*	PLUMBING
0.05.01.01	*LEVEL 3*	0.08.01.01
MEMBRANE	*COMPONENT*	DOM. WATER
0.05.01.01.01	*LEVEL 4*	0.08.01.01.01
3-PLY ASPHALT	*SUBCOMPONENT' TYPE*	PIPE
0.05.01.01.01.01	*LEVELS*	0.08.01.01.01.01
NOT USED	*TYPE*	3/4" DIA. C O -

WBS ORGANIZATION HIERARCHY

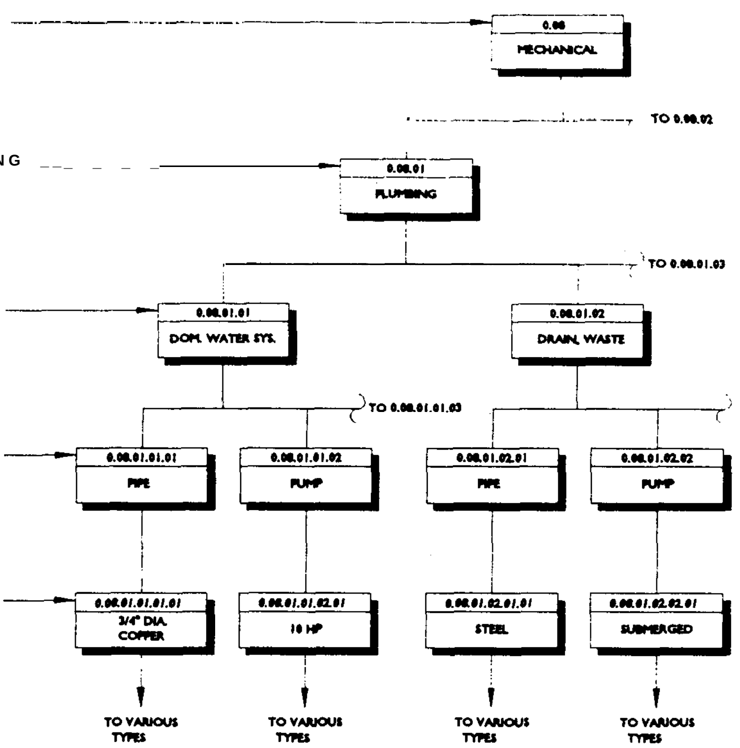


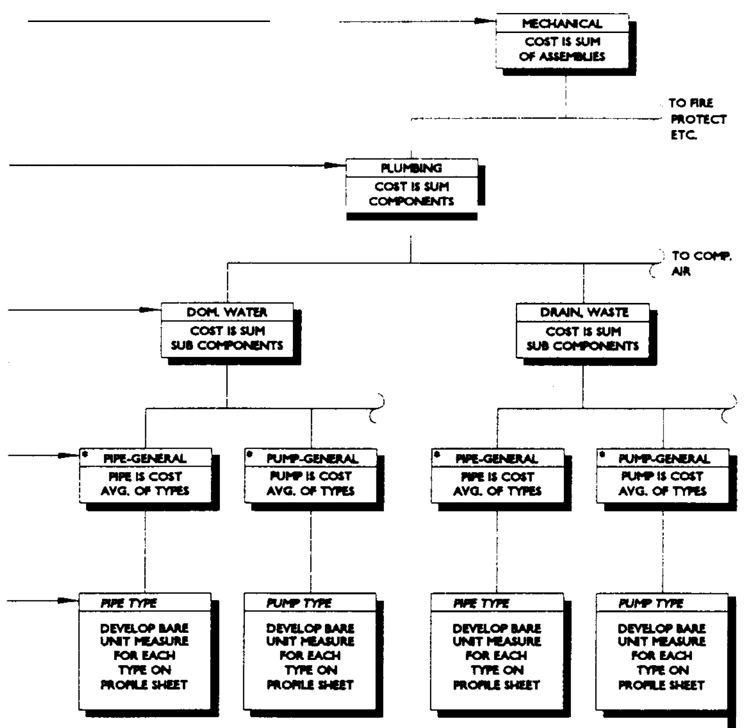
FIG. I

SYSTEM WORK BREAKDOWN STRUCTURE

WBS LEVEL TABLE

0.05	*LEVEL I*	0.08
ROOFING	*SYSTEM*	MECHANICAL
0.05.01	*LEVEL 2*	0.08.01
BUILT-UP	*ASSEMBLY*	PLUMBING
0.05.01.01	*LEVEL 3*	0.08.01.01
MEMBRANE	*COMPONENT*	DOM. WATER
0.05.01.01.01	*LEVEL 4*	0.08.01.01.01
3-PLY ASPHALT	*SUBCOMPONENT/ TYPE*	PIPE
0.05.01.01.01.01	*LEVELS*	0.08.01.01.01.01
NOT USED	*TYPE*	3/4" DIA. COPPER

WBS COST DEVELOPMENT HIERARCHY



* NOTE: IF COMPONENT/SUBCOMPONENT TYPE NOT KNOWN OR COMPONENT TYPE DATA NOT COMPILED, USE GENERAL COMPONENT PRICING.

FIG. 2

END OF SUBSECTION

GENERAL SYSTEM/MATERIAL DATA

INTRODUCTION

With the increasing cost of the new construction and equipment, it is becoming more of a necessity to ensure that existing buildings and systems are maintained at regular intervals and repairs are made to last over the long term. This section consists of several tables including Concrete Deterioration, Deterioration of Structural Steel, Imperfections in Wood, Causes of Timber Deterioration, Preservations, and Effects of Chemicals on Concrete.

The purpose of this section is to give a general description of damages, diagnosis, and causes of deterioration of building materials such as concrete, structural steel, and wood. This is orientated toward locating defects and potential material failure problems prior to major damage or complete system/component failure. Recognizing Substructure defects and their effects on the building and its occupants and contents are stressed. Special attention should be given to the causes and correction/repair of common defects.

GENERAL SYSTEM/MATERIAL DATA

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GENERAL SYSTEM/MATERIAL DATA

COMMON CAUSES OF CONCRETE DETERIORATION
(Similar for Pro-Cast Concrete)

Damaae	Diagnosis	Caure
Alkali-Aggregate Expansion	Slight cracking to complete breakup.	Chemical reaction between aggregate and cement paste.
Cavitation	Spalling around projections. Honey-combing. Popping and cracking noises when water moves over the surface.	Rapid movement of water or other liquids across the surface.
Cracks (Active and Dormant)	Random, isolated or patterned cracks.	Construction movement, settlement, shrinkage around reinforcement. Setting shrinkage due to inadequate finishing and curing.
Before hardening of the concrete:	Patterned cracking, protruding aggregate, popouts. Chemical analysis indicates deterioration of cement paste.	Chemical reactions, such as corrosion.
After hardening of the concrete:	Surface cracking, patterned.	Physical, such as drying shrinkage
	Extreme change in measured temperatures between inner and outer surfaces. Shallow cracking.	Thermal changes (subjected to temperature extremes, such as from freezing and thawing cycles).
	Localized cracking	Stress concentration.
	Cracks, usually isolated	Structural design.
	Cracks can be isolated or patterned depending on crack-producing agent.	Accidents from overload, vibration, fatigue and earthquake.
Corrosion of Reinforcing Steel	Cracks will occur at the level of the reinforcement and parallel to it. Rusting or discoloration will be evident.	Insufficient cover of steel. Quality of concrete. Over-use of calcium chloride as admixture.
Crazing	Shallow cracks forming a hexagonal pattern,	Surface shrinkage more rapid than interior of concrete to the surface and depositing salts.
Dusting	Appearance of a powdery substance on the surface of the concrete.	Too wet of a concrete mixture. Premature or excessive working of the surface. Organic materials in the aggregate. Inadequate curing.
Efflorescence	Appearance of crystalline salts on the concrete surface.	Water migrating from the interior mass of the concrete to the surface and depositing salts.
Fire	Charred and spalled surfaces.	Fire.
Form Scabbing	Difficult to remove forms. Uneven, spalled areas	Form oil improperly applied.
Holes (Small and Large)	Popouts, holes, random pattern or isolated in extreme.	Chemical reaction. Inadequate construction and design,
Honeycombing	Surface defects-voids. Coarse aggregate broken away from the surface.	Placing concrete aggregate with insufficient type of mortar. Improper placing techniques, such as inadequate vibration.

Source: Means Facilities Maintenance Standards • "R.S. Means Co., Inc., Kingston, Massachusetts'

GENERAL SYSTEM/MATERIAL DATA

COMMON CAUSES OF CONCRETE **DETERIORATION**

(Similar for Pre-Cast Concrete)

Damage	Diagnosis	Cause
Popouts	Breaking away of a particle near the surface. Excessive amount of moisture or temperature changes in the region.	Depressions left by material popping out. Presence of disintegrated material near the popout.
Sand Streaking	Vertical streaks of sand which appear on the surface, most noticeable when forms are immediately stripped.	Concrete mixed with a high water content or a deficiency of finer sand sizes are placed in a formwork that is not water-tight.
Scaling	Flaking or peeling away of thin layers of concrete.	Severe freeze/thaw conditions. Improper use of deicing salts. Repeated wetting and drying of concrete. Improper finishing. Chemical attack of concrete. Heat blast.
Spalling	Fragments of concrete that have been broken from the surface. Corrosion of reinforcement.	Corrosion of reinforcement. Mechanical damage. Incorrect form removal. Shock-waves
Stain and Uneven Color	Discoloration or lacking uniformity in appearance.	Chemical action of foreign materials on the surface. Mixing of different types of cement with each other. Reaction of materials comprising the concrete mixture.

A SUMMARY OF THE TYPES & CAUSES OF DETERIORATION OF STRUCTURAL STEEL

Type of Deterioration	Cause
Abrasion	Members subjected to contact with moving parts. Members subjected to wave action. Members immersed in a moving liquid. Worn, smooth appearance, general depression of the abraded area.
Corrosion	Resulting from a chemical or electro-chemical reaction which converts the metal into an oxide, carbonate and sulfides. Pitted, oxidized surface showing loose flakes, reddish-brown rust colored appearance.
Fatigue	Repetitive, cyclic loading occurring at stresses at or below allowable design values. Small fractures oriented perpendicular to the line of stress.
Impact	Local distortion of the member in the form of a sharp crimp. Will occur in a tension member of flange.
Lamellar Tearing	Minute, often times unseen cracking in the weldment. May need microscopic instruments to observe. Incorrect welding process.
Loosening of Connections	Impact and fatigue loading. Vibrations and improper tightness.

Source: Means **Facilities Maintenance** Standards • "**R.S.** Means Co., Inc.. Kingston, Massachusetts'

GENERAL SYSTEM/MATERIAL DATA

COMMON IMPERFECTIONS IN WOOD

Imperfection	Description	Effects on Strength	Effect on Grading Structural Lumber
Checks and Splits	Split in the wood.	In lumber subjected to bending, checks and splits reduce the resistance to shear; they do not affect the strength for longitudinal compression.	Checks and splits are restricted in those parts of a bending member where shearing stresses are highest.
Holes	Either a knothole or a hole caused by some other means.	Reduces tensile strength somewhat more than compressive and shear strength and affect stiffness.	The size, number and location of knots is restricted for structural lumber, cluster knots are prohibited.
Knots	Localized imperfections.	Same as for holes	Same as for holes.
Pitch Pockets	Opening between growth rings containing pitch or bark.	Little or no effect	Usually disregarded except if a large number occur; shake may be present or bond between annual growth rings mav be weakened.
Shakes	A separation of the wood between the annual growth rings.	Same as for checks and splits.	Same as for checks and splits
Slope of Grain	Areas where the direction of the wood grain is not parallel to the edges of the piece of lumber.	Will twist with changes in moisture content.	Cross-grained pieces are undesirable; reduction of strength due to cross grain in structure is taken as twice the reduction observed in tests of small clear specimens.
Wane	Bark or lack of wood on the edge or corner of the piece of lumber.	Affects nailing and bearing.	Limited in structural lumber require ments for fabrication, bearing, nailing and appearance and not for effect on strength.

SUMMARY OF CAUSES OF TIMBER **DETERIORATION WITH** SYMPTOMS

Cause of Deterioration	Symptoms
Carpenter Ants, Beetles & Carpenter Bees	Similar to termites.
Termites	Bore holes; lacing/cavitation of wood; connecter tunnels from grade to wood source (usually mud). Premature wood bowing and failure.
Decay (Rot) Due to Fungi	Softening and discoloration of wood, fluffy or cottony appearance, destruction of wood cells, appearance of fruity bodies in the form of mushrooms, incrustations in the advanced stage.
Excessive Splitting and Checking	Excessive relative amount of members at a joint, bowing of compression members (shown by broken paint lines or newly exposed wood), elongated bolt holes.
Fire Damage	Surface cellular damage, charred surfaces, easily probed with a knife.
Hardware	Loose connections, formation of rust on hardware surfaces, discoloration of wood adjacent to hardware.
Loosened Connections	Loose connections, excessive deflection
Marine Borers	Minute openings in the timber, hollow sound when struck with a hammer, a myriad of surface grooves, narrowing of a section giving it an hourglass appearance.

Source: Means **Facilities** Yaintenance Standards • "**R.S.** Means Co., Inc., Kingston, Massachusetts"

GENERAL SYSTEM/MATERIAL DATA

PRESERVATIVES -ADVANTAGES & DISADVANTAGES

Oil-Based Wood Preservatives

Type of Preservative	Advantages	Disadvantages
Anthracene Oils	High toxicity to wood-destroying organisms; insoluble in water; low volatility; ease of application; permanence.	Dark brown color, cannot be painted; strong, unpleasant odor; easily ignited when first applied.
Coal-Tar Creosotes	See Anthracene Oils.	See Anthracene Oils.
Copper Naphthenate	High protection against decay fungi and termites; can be painted; not unpleasant odor; less easily ignited than coal-tar creosotes.	Gives wood greenish or dark color and provides less protection against marine borers than creosote.
Creosotes Derived From Wood, Oil and Water Gas	Same as Anthracene Oils and Coal-Tar Creosotes.	About the same as Anthracene Oils and Coal-Tar creosotes, but less effective.
Creosote Solutions	See Anthracene Oils and Coal-Tar Creosotes.	About the same as Anthracene Oils and Coal-Tar creosotes, but less effective.
Water-Repellent Preservatives	Retards moisture changes in wood; good protection against decay and insects.	Cannot be used in contact with ground or areas where continual dampness can occur unless preservative is thoroughly applied.

Water-Based Wood Preservatives

Type of Preservative	Advantages	Disadvantages
Acid Copper Chromate	Provides protection against decay and insects; can be painted; no objectionable odor; if thoroughly impregnated has some resistance to marine borers.	Wood can be used in contact with ground, but generally not recommended for contact with water.
Ammonical Copper Arsenite	Good protection against decay and insects and some protection against marine borers.	Wood can be used in contact with ground, but generally not recommended for contact with water.
Chromated Zinc Chloride	Provides protection against decay, insects and fire; can be painted; no objectionable odor.	Wood cannot be used in contact with ground or water.
Chromated Zinc Chloride (FR)	See Chromated Zinc Chloride.	See Chromated Zinc Chloride.
Copperized Chromated Zinc Chloride	See Chromated Zinc Chloride.	See Chromated Zinc Chloride.
Tanalith (Wolman Salts)	Protects against decay and insects; can be painted; no objectionable odor.	Wood cannot be used in contact with ground or water.
Zinc Meta Arsenite	Good protection against decay and insects; can be painted; no objectionable odor.	Wood can be used in contact with ground, but generally not recommended for contact with water.

Source: Morns **Facilities Maintenance** Standards. **"R.S. Means** Co., Inc.. **Kingston, Massachusetts"**

GENERAL SYSTEM/MATERIAL DATA

Acetic Acid, ail **Concentrations**	Disintegrates slowly.
Acetone	Liquid loss by penetration. May contain acetic acid as impurity
Acid Waters	(pH of 6.5 or less) (a) Disintegrates slowly. In porous or cracked concrete, attacks steel.
Aluminum Chiorido	Disintegrates rapidly. In porous or cracked concrete, attacks steel.
Ammonia Vapors	May disintegrate moist concrete slowly or attack steel in porous c cracked moist concrete.
Ammonium **Bisulfate**	Disintegrates. In porous or cracked concrete, attacks steel.
Ammonium Carbonate	Not harmful.
Ammonium **Cyanide**	Disintegrates slowly.
Ammonium **Fluoride**	Disintegrates slowly.
Ammonium Nitrate	Disintegrates. In porous or cracked concrete, attacks steel.
Ammonium **Oxalate**	Not harmful.
Ammonium **Sulfide**	Disintegrates.
Ammonium Sulfite	Disintegrates.
Ammonium **Superphosphate**	Disintegrates. In porous or cracked concrete, attacks steel.
Ammonium **Thiosulfate**	Disintegrates.
Ashes	Harmful if wet, when sulfides anc sulfates leach out (see sodium sulfate).
Ashes, hot	Cause thermal expansion.
Automobiio and **Diesel** Exhaust **Gases (d)**	May disintegrate moist concrete by action of carbonic, nitric, or sulfurous acid.
Benzol (Benzene)	Liquid loss by penetration.
Bromine	Gaseous bromine disintegrates. Liquid bromine disintegrates if it contains hydrobromic acid and moisture.
Butyi **Stearate**	Disintegrates slowly.
Calcium **Bisulfite**	Disintegrates rapidly.
Chlorine Gas	Slowly disintegrates moist concrete.
Chrome Plating Solutions (e)	Disintegrates slowly
Chromic Acid, & Concentrations	Attacks steel in porous or cracked concrete.
Cinders	Harmful if wet, when sulfides and sulfates leach out (see, for example, sodium sulfate)
Coal	Sulfides leaching from damp coal may oxidize to sulfurous or sulfuric acid, or ferrous sulfate (see ferrous sulfate).
Coal Tar Oils	See anthracene, benzol, carbazole, chrysen, creosote, creosol, cumol, paraffin, phenanthrene, phenol, toluol, xylol.
Cobalt Sulfate	Disintegrates concrete of inadequate sulfate resistance.
Coke	Sulfides leaching from damp coke may oxidize to sulfurous or sulfuric acid.
Copper Chloride	Disintegrates slowly.
Copper Sulfate	Disintegrates concrete of inadequate sulfate resistance.
Copper Sulfide	Harmful if it contains copper sulfate.
Corrosive Sublimate	See mercuric chloride.
Creosote	Phenol present disintegrates slowly.
Cresoi	Phenol present disintegrates slowly.
Cumol	Liquid loss by penetration,
Deicing Salts	Scaling of non-air-entrained or insufficiently aged concrete (b).
Diesel Gases	See automobile and diesel exhaust gases.
Ferric Chloride	Disintegrates slowly.
Ferric Sulfate	Disintegrates concrete of inadequate quality.
Ferric Sulfide	Harmful if it contains ferric sulfate.
Ferrous Chloride	Disintegrates slowly.
Ferrous Sulfate	Disintegrates concrete of inadequate sulfate resistance.

GENERAL SYSTEM/MATERIAL DATA

Flue Gases	Hot gases (400-l 1 00^{O}F) causes thermal stresses. Cooled, condensed sulfurous, hydro-chloric acids disintegrate slowly.
Gas Water (e)	Ammonium salts seldom present in sufficient quantity to disintegrate.
Gasoline	Liquid loss by penetration.
Hydrofluoric Acid, all Concentrations	Disintegrates rapidly, including steel.
Hydrogen Sulfide	Not harmful dry. In moist, oxidizing environments converts to sulfurous acid and disintegrates slowly.
Hypochlorous Acid, 10 percent	Disintegrates slowly.
Iodine	Disintegrates slowly.
Kerosene	Liquid loss by penetration of concrete.
Lead Nitrate	Disintegrates slowly.
Lead Refining Solutions (t)	Disintegrates slowly.
Lignite Oils	If fatty oils are present, disintegrates slowly.
Locomotive Gases	May disintegrate moist concrete by action of carbonic, nitric or sulfurous acids (see also automobile and diesel exhaust gases).
Lubricating Oil	Fatty oils, if present, disintegrate slowly.
Machine **Oil**	Fatty oils, if present, disintegrate slowly.
Magnesium Nitrate	Disintegrates slowly.
Manganese Sulfate	Disintegrates concrete of inadequate sulfate resistance.
Mercuric Chloride	Disintegrates slowly.
Mercurous Chloride	Disintegrates slowly.
Methyl Alcohol	Liquid loss by penetration.
Methyl Ethyl Ketone	Liquid loss by penetration.
Methyl **Isobutyl** Ketone	Liquid loss by penetration.
Mine Water, Waste	Sulfides, sulfates, or acids present disintegrate concrete and attack steel in porous or cracked concrete.
Mineral Spirits	Liquid loss by penetration,
Muriatic Acid	See hydrochloric acid.
Nickel Plating Solutions	Nickel ammonium sulfate disintegrates slowly.
Nickel Sulfate	Disintegrates concrete of inadequate sulfate resistance.
Nitric Acid, all Concentrations	Disintegrates rapidly
ores	Sulfides leaching from damp ores may oxidize to sulfuric acid or ferrous sulfate.
Oxalic Acid	Not harmful. Protects tanks against acetic acid, carbon dioxide, salt water. Poisonous. Do not use with food or drinking water.
Paraffin	Shallow penetration not harmful, but should not be used on highly porous surfaces like concrete masonry (g).
Perchloric Acid, 10 percent	Disintegrates.
Perchloro- Ethylene	Liquid loss by penetration.
Petroleum Oils	Liquid loss by penetration. Fatty oils, if present, disintegrate slowly.
Phenanthrene	Liquid loss by penetration.
Phenol, 5-25 percent	Disintegrates slowly.
Potassium Cyanide	Disintegrates slowly.
Potassium Dithromate	Disintegrates.
Potassium Hydroxide, 25 percent or over	Disintegrates concrete.
Potassium Permanganate	Harmless unless potassium sulfate present.
Potassium Persulfate	Disintegrates concrete of inadequate sulfate resistance.
Potassium Sulfate	Disintegrates concrete of inadequate sulfate resistance.

GENERAL SYSTEM/MATERIAL DATA

Potassium Sulfide	Harmless unless potassium sulfate present
Pyrites	See ferric sulfide, copper sulfide.
Sal Soda	See sodium carbonate.
Salt for Deicing Roads	Also calcium chloride, magnesium chloride, sodium chloride.
Saltpeter	See potassium nitrate.
Sea Water	Disintegrates concrete of inadequate sulfate resistance. Attacks steel in porous or cracked concrete.
Sewage	Usually not harmful (see hydrogen sulfide).
Silage	Acetic, butyric, lactic acids (and sometimes fermenting agents of hydrochloric or sulfuric acids) disintegrate slowly.
Sodium Bisultate	Disintegrates.
Sodium Bisulfite	Disintegrates.
Sodium Bromide	Disintegrates slowly.
Sodium Carbonate	Not harmful, except to calcium aluminate cement.
Sodium Chiorlde	Magnesium chloride, if present, attacks steel in porous or cracker concrete. (b) Steel corrosion ma! cause concrete to spall.
Sodium Cyanide	Disintegrates slowly.
Sodium **Dichromate**	Dilute solutions disintegrate slowly.
Sodium **Hypochiorite**	Disintegrates slowly.
Sodium Nitrite	Disintegrates slowly.
Sodium Phosphate (Monobasic)	Disintegrates slowly.
Sodium Sulfate	Disintegrates concrete of inadequate sulfate resistance.
Sodium Sulfide	Disintegrates slowly.
Sodium **Thiosulfate**	Slowly disintegrates concrete of inadequate sulfate resistance.
Strontium Chloride	Not harmful.
Sulfite Liquor	Disintegrates.
Sulfite Solution	See calcium bisulfate.
Sulfurous Acid	Disintegrates rapidly.
Toluol (Toluene)	Liquid loss by penetration
Tung Oil	Liquid disintegrates slowly. Dried or drying films are harmless.
Turpentine	Mild attack. Liquid loss by penetration.
Urine	Attacks steel in porous or cracked concrete.
Xyiol (Xyiene)	Liquid loss by penetration.
Zinc Nitrate	Not harmful.
Zinc Refining Solutions (I)	Hydrochloric or sulfuric acids, if present, disintegrate concrete.
Zinc Slag	Zinc sulfate sometimes formed by oxidation.
Zinc Sulfate	Disintegrates slowly.

GENERAL SYSTEM/MATERIAL DATA

SPECIAL NOTATIONS

a. Waters of pH higher than 6.5 may be aggressive, if they also contain bicarbonates. (Natural waters are usually of pH higher than 7.0 and seldom lower than 6.0 though pH values as low as 0.4 have been reported. For pH values below 3, protect as for dilute acid.)

b. Frequently used as a deicer for concrete pavements. If the concrete contains too little entrained air or has not been aged more than one month, repeated application may cause surface scaling. For protection under these conditions, see “deicing salts.”

c. Water used for cleaning coal gas.

d. Composed mostly of nitrogen, oxygen, carbon dioxide, carbon monoxide, and water vapor. Also contains unburned hydrocarbons, partially burned hydrocarbons, oxides of nitrogen, and oxides of sulfur. Nitrogen dioxide and oxygen in sunlight may produce ozone, which reacts with some of the organics to produce formaldehyde, peracylnitrates, and other products.

e. These either contain chromium trioxide and a small amount of sulfate, or ammonium chromic sulfate (nearly saturated) and sodium sulfate.

f. Contains lead fluosilicates and fluosilicic acid.

g. Porous concrete which has absorbed considerable molten paraffin and then been immersed in water after the paraffin has solidified, has been known to disintegrate from sorptive forces.

h. Contains nickelous chloride, nickelous sulfate, boric acid, and ammonium ion.

i. Usually contains zinc sulfate in sulfuric acid. Sulfuric acid concentration may be low (about 6 percent in “low current density” process) or higher (about 22-28 percent in “high current density” process).

END OF SUBSECTION

0.02.01 SLABS-ON-GRADE (CSI 03300)

DESCRIPTION

Slabs are flat, horizontal (or nearly so), non-reinforced or reinforced concrete. Slabs-on-grade are usually of uniform but sometimes of variable thickness. Concrete slabs are placed or installed by pumping machines and other equipment. Concrete floor slab design is affected by formwork, yet is also directly influenced by types and brand of cement, admixtures, uniformity in mixing, placing technique. curing methods, and other quality control factors Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type. local requirements, and facility design

Non-industrial and light industrial slabs are minimum wear type slabs, usually 3000 psi with welded wire mesh. Non-industrial and light industrial floor slabs are used in light manufacturing, storage, and warehousing facilities. Traffic patterns are usually limited to foot and pneumatic wheel movements.

In non-industrial and light industrial buildings, slabs are usually sealed with a silicone sealer to minimize efflorescence, spalling, and weathering effects and help to prevent dirt accumulation on the surface. Silicone is a unique water repellent, neither organic nor mineral In nature. It is colorless and dispersed in several types of vehicles.

Industrial and heavy industrial slabs are maximum or extreme wearing surfaces compared to the non-industrial and light industrial buildings. Concrete mixture is usually a minimum of 4000 psi and reinforced with steel bars. Industrial and heavy industrial slabs have to support items such as manufacturing machinery, and heavy equipment loads. Traffic usage can vary from solid rubber or plastic wheels to steel wheels.

Slab coatings (applied to floor slabs) are water-based acrylic emulsions used to seal, dust-proof, enhance the beauty of concrete, and offer good resistance to water and other common chemicals. Metallic hardeners are a water-based solutions of magnesium and zinc silicofluorides, and are also used to harden and dust-proof concrete floors. Water-based epoxy-coatings are an excellent sealer for concrete floor application where chemical and abrasion resistance are important. Water-based epoxy-coatings resist most common acids, alkalies, salts and solvents which occur frequently in heavy and industrial facilities.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Reinforced Concrete (CSI 03300)

Because concrete has limited resistance to tensile and shear stresses, steel reinforcing material is necessary. Rebars and/or wire mesh must have a capability of developing a bond with the concrete and be so positioned that each element will be used efficiently. The cross-sectional area of the reinforcing bar should not be reduced in any way, because the tensile capacity of the material will be reduced. A thorough knowledge of contract requirements, construction documents including shop drawings, and the placement of reinforcing steel are very important.

The capability of the reinforcing materials to bond with the concrete must not be destroyed in any way. Before placement, the reinforcing must be thoroughly cleaned of loose or flaky rust, mill scale, ice, oil, or any other substance that might reduce or destroy the bond. This will include the cleaning of any steel that may have been contaminated after placement.

0.02.01 SLABS-ON-GRADE (CSI 03300)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS (Continued)

Non-Reinforced Concrete (CSI 03300)

Non-reinforced Concrete Slab-on-Grade is usually placed on compacted, granular fill such as gravel or crushed stone, which in turn is covered by a polyethylene vapor barrier. The slab thickness is based on use, supporting subsoil density, or in limited cases, hydrostatic pressure, Normally, recommended minimum concrete strength is 3500 psi. Concrete floors are usually placed in square sections that extend to the building column lines at 20 to 30 foot intervals. Non-reinforced concrete slabs-on-grade normally are used for walkways or minimum use areas

Concrete Slab Placement (CSI 03300)

Other considerations require emphasis when placing concrete slabs. Some relate to finishing and curing operations but be covered here for special emphasis.

A slump of no more than 4 inches is most frequently specified. The requirement is that the placement will be continuous and will terminate at an expansion, contraction, or construction joint.

During final placement, concrete under all conditions will be placed as close as practicable in its final position. When placing extremely thick slab sections, concrete must be placed in uniform lifts or layers not exceeding 12 inches thick to allow proper and effective compaction and segregation control is required.

Concrete Floor & Slab Finishes (CSI 03300)

The degree of level and smoothness required in the finished slab must be established at the beginning. The forms must be accurately and rigidly set to a true line and grade. To keep the surface level and uniform between forms in large areas, it will be necessary to set ends of drag-off level. Slabs should be pitched to drain. If this sloping surface is to have any degree of consistency and uniformity, screeds must be set from the line where slope begins to the drain.

The deviation from a true plane surface should not exceed 1/8 inch when tested with a IO-foot straight-edge. Concrete should be screeded and floated with straight-edges to bring the surface to the required finished level with no course aggregate visible. “Straight-edges” as used in this sentence is interpreted to mean screeds and bull-float instruments, etc. with straight and true edges.

Concrete Reinforcement (CSI 03200)

Concrete reinforcement consists of bars, wires, strands, and other slender members embedded in concrete in such a manner that the reinforcement and the concrete act together in resisting forces. This is done due to concrete’s limited resistance to tensile and shear stresses. Reinforcement must be accurately located to ensure proper cover and to reduce the chance of loss or corrosion of a structural section of reinforcing steel. When concrete is deposited directly against the earth for footings, at least 3 inches of concrete should exist between the steel and the earth. When concrete is deposited directly against formwork for footings there should be at least 2 inches of concrete between the steel and the formwork. Follow ACI 318 publication “Building Code Requirements for Reinforced Concrete.”

Reinforcing mesh should not be continuous between expansion joints in slabs. Mesh should be lapped at least 6 inches when more than one section is required to allow for continuous bonding of concrete. Welded wire mesh shall be supported on standard accessories or by precast concrete blocks. These supporting accessories are too frequently overlooked. Mesh normally used in building slabs for reinforcing will usually be furnished in rolls. It is difficult to support and hold roll-type mesh in position. Thicker mesh is furnished in flat sheets.

0.02.01 SLABS-ON-GRADE (CSI 03300)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Expansion, Construction, & Contraction Joints (CSI 03250)

An expansion joint is defined as a joint between two slab edges in which a compressive material is Inserted to accommodate both compression and expansion movement. Reinforcement, corner protection angles, and other embedded metal items should not run continuously through this joint. Joint width vanes with amount of movement anticipated.

The construction joint is defined as a joint which occurs at a placement stop form. Once the form is removed and a specified time has elapsed, new concrete will be placed directly in contact with the old concrete surface. Reinforcing and embedded items may continue through this joint, Construction joints in concrete are to be formed as adequately as other formwork and will incorporate the features shown on plans. Keyways and waterstops introduced into these joints must be well supported to ensure the necessary embedding, joint shape, and function.

The contraction joint is defined as a joint formed either by embedding a separating element through the depth of the slab or sawing joints in the slab after placement. This joint is planned for pattern uniformity and located so that shrinkage cracking can be controlled. Concrete placement is continuous through this joint. Reinforcing and embedded items such as wood strips should not continue through this joint. Joints of one type or a combination of types will be used to divide the slab into areas not to exceed 600 square feet.

Expansion joints and other joints to receive joint sealers should be properly placed with removable dressed and oiled wood strips attached to the top edge. The positioning of this item will be such that when removed, a 3/4 inch deep groove will remain.

Support for Reinforcement (Chairs, Spacers, & Bolsters) (CSI 03250)

Chairs are small metal supports for reinforcing steel used to maintain the proper positioning during concrete placement/pours. A spacer is used in the same fashion as a chair. Bolsters in concrete are continuous wire bars used to support bars in the bottom of footings. The top wire is corrugated at 1 inch centers to hold the bar in its position.

Admixtures (CSI 03370)

An admixture is an ingredient other than cement, aggregate, or water that is added to a concrete or mortar mix to affect the physical or chemical concrete characteristics. The most common affects the plasticity, air entrainment, and curing time.

Air-Entrainment Agents:

- Provide a more workable material.
- Definitely used when concrete surface will be exposed to freeze/thaw cycles.

Retarder & Densifying Agents:

- Retard the set; suggested in warm weather to reduce cracking due to rapid set-up.
- Increase the workability of the mix.
- Allow for delayed finishing, resulting in less permeable concrete.

Accelerator:

- Useful in winter (cold weather concreting).
- Useful when working to seal against the water-flow.
- Should be used sparingly because the admixture tends to increase shrinkage.

Granular Base (CSI 03300)

A granular base is a uniformly graded mixture of fine and course aggregates to provide, when compacted, a smooth and even surface below footings.

0.02.01 SLABS-ON-GRADE (CSI 033001

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Coating Types, Hardening Agents, & Sealers (CSI 03370)

Coatings can be adhered to the concrete surface by bonding, percolation into the pores, or chemical reaction. It should be understood that coatings give either permanent or temporary surface protection against fluids, chemicals, etc.; in the lafter case the slab must be re-coated according to the supplier's specification. The ACI has developed a list of substances that modify the condition of the concrete surface. Before trying any recommended treatment, it should be tested on a small patch of the surface for effectiveness.

The other type of concrete surface coating is referred to as sealants and finishes. Concrete floor sealants and finishes help eliminate dusting by filling concrete surface. Soil and dirt do not penetrate these coatings if properly applied. By applying additional coats, possible excessive wear can be prevented and thus prolong the life of the floor slab. Conditions to be considered when selecting a protective sealant and/or finish are as follows:

- The standard of maintenance required.
- The amount of traffic on the floor.
- The type of soilage that will occur on concrete surface.
- Existing floor conditions.
- Application requirements.
- The degree of maintenance required after application.

Coating Types, Hardening Agents, & Sealers (CSI 03370) (Continued)

Available sealants include chlorinated rubber, oleoresin, one-component epoxy esters, oil-modified urethanes, and acrylic resins. Floor finishes offer the best protection for any surface. The finish locks in the concrete and forms a second surface on top of an existing floor. Floor finishes available are one- and two-component epoxies and oil-free urethanes. Single-component epoxies have fairly good wear, but tend to yellow with age. The major types available are two-component type (epoxy resin and curing agent), three-component type, and uretrane-based. Two-component are tough, and wear resistant, and flexible. However, good wear characteristics can be adversely affected by moisture during application. Three-component toppings are normally more flexible than epoxy types. They are, however, affected by moisture during application. Other types of available toppings are latex modified concrete, which gives good adhesion and is somewhat flexible, and asphalt toppings, which are soft pliable, and therefore not as durable as other toppings.

Concrete Finishing Methods (CSI 03300)

Troweling:

A steel trowel is used where a smooth, hard, and dense surface is desired. The first troweling may be sufficient to produce the desired surface free of defects. Surface smoothness, density, and wear resistance can all be improved by timely additional troweling to permit the concrete to become harder. As the surface hardens, successive troweling can be done with smaller trowels using progressively more tilt on the trowel blade. When troweling is done with a machine, at least one passing should be done with a hand trowel to remove small irregularities.

Brooming:

A slip-resistant surface may be produced by brooming the surface before the concrete has thoroughly hardened, but should be sufficiently hard to retain the scoring. Rough scoring is achieved using steel wire or a stiff, coarse, fiber broom. Such brooming usually follows floating. If a finer texture is desired, the concrete is troweled to a smooth surface and then brushed with a soft-bristled broom. Best results are obtained using a broom specially made for texturing concrete. Slabs are usually broomed transversely to the main direction of traffic.

0.02.01 SLABS-ON-GRADE (CSI 03300)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Concrete Finishing Methods (CSI 03300) (Continued)

Patterned & Textured Finishes:

A variety of patterns and textures can be used to produce decorative finishes. Patterns are formed with divider strips or by scoring or stamping the surface just before the concrete hardens. Textures can be produced with little effort and expense using floats, trowels, and brooms. More elaborate textures can be achieved with special techniques using a mortar dash coat or rock salt.

An exposed-aggregate finish provides a ruggedly attractive surface. Select aggregates, usually of uniformed size such as 3/8 or 1/2 inch or larger, are evenly distributed on the surface immediately after the slab has been bull-foated or darbied. Flat or elongated aggregate particles should not be used because they may become dislodged while being exposed.

Timing is important, and test panels are usually made to determine the correct time for exposing the aggregate without dislodging the particles. On large areas, a reliable retarder may be sprayed or brushed on the surface immediately after floating, but this may not be necessary on small areas.

OTHER RELATED COMPONENTS

Refer to Foundations & Footings and Superstructure Systems, Volumes 1 and 3, for additional deficiencies that may impact this system.

0.02.01 SCABS-ON-GRADE (CSI 03300)

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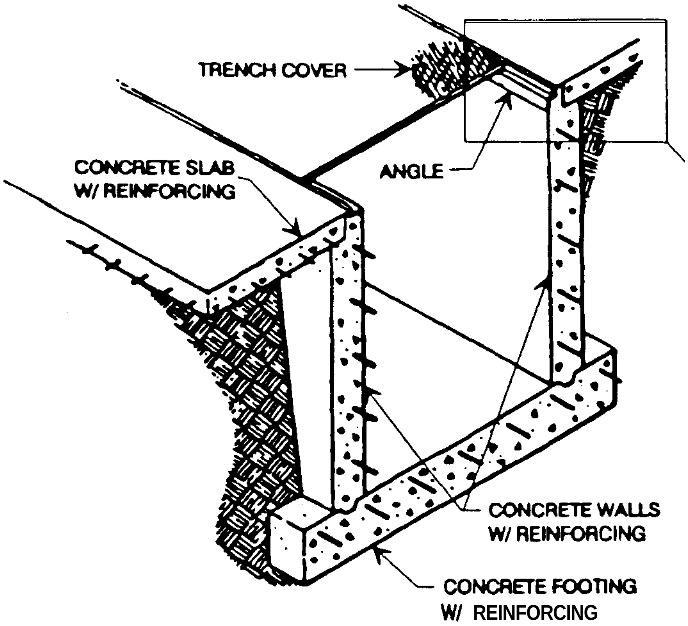
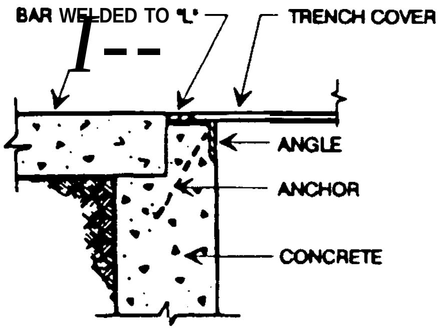
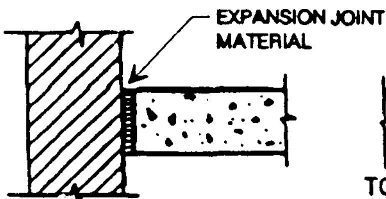


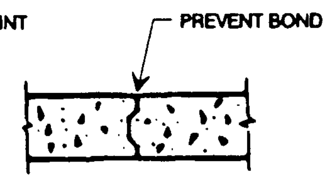
TRENCH OR PIT



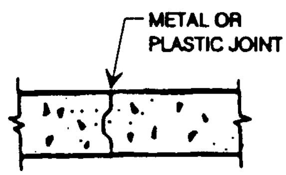
TRENCH PIT COVER DETAIL



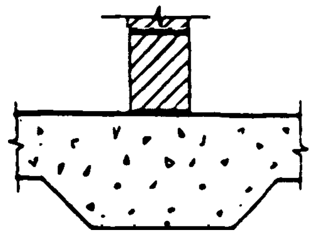
ISOLATION JOINT



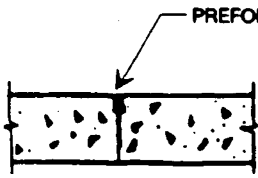
TONGUE AND GROOVE
CONSTRUCTION JOINT



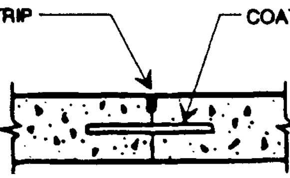
TONGUE AND GROOVE
CONTROL JOINT



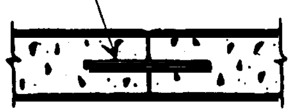
THICKENED SLAB



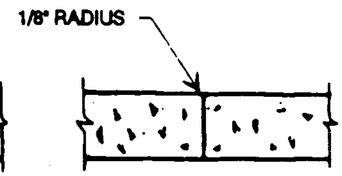
SAWED OR PREMOLDED
CONTROL JOINT



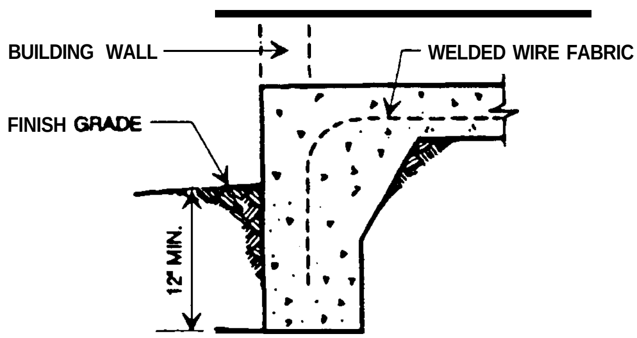
. CONTROL JOINT
WITH DOWELS



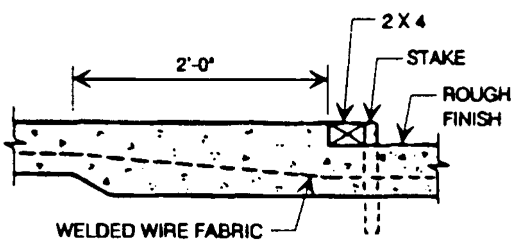
BUTT NPE CONSTRUCTION
JOINT WITH DOWELS



BUTT NPE
CONSTRUCTION JOINT



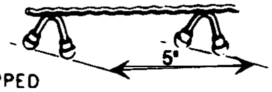
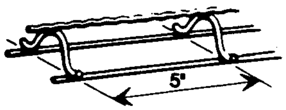
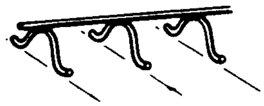
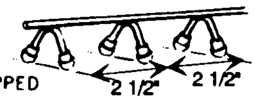
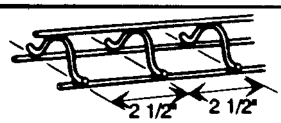
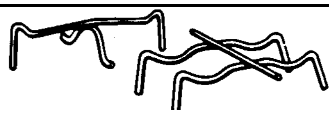
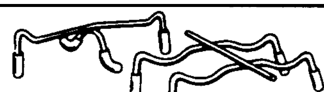
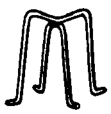
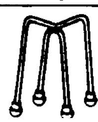
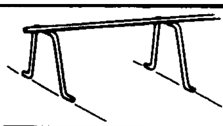
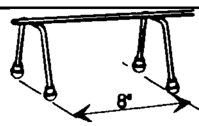
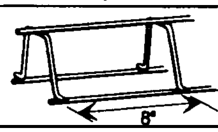
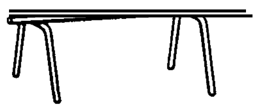
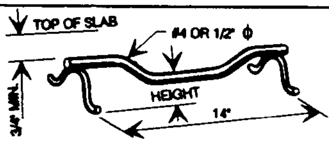
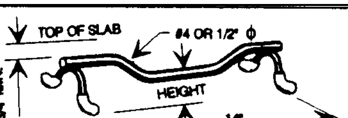
THICKENED EDGE SLAB



SLAB DEPRESSION

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION., "R.S. Means Co., Inc., Kingston, Massachusetts"

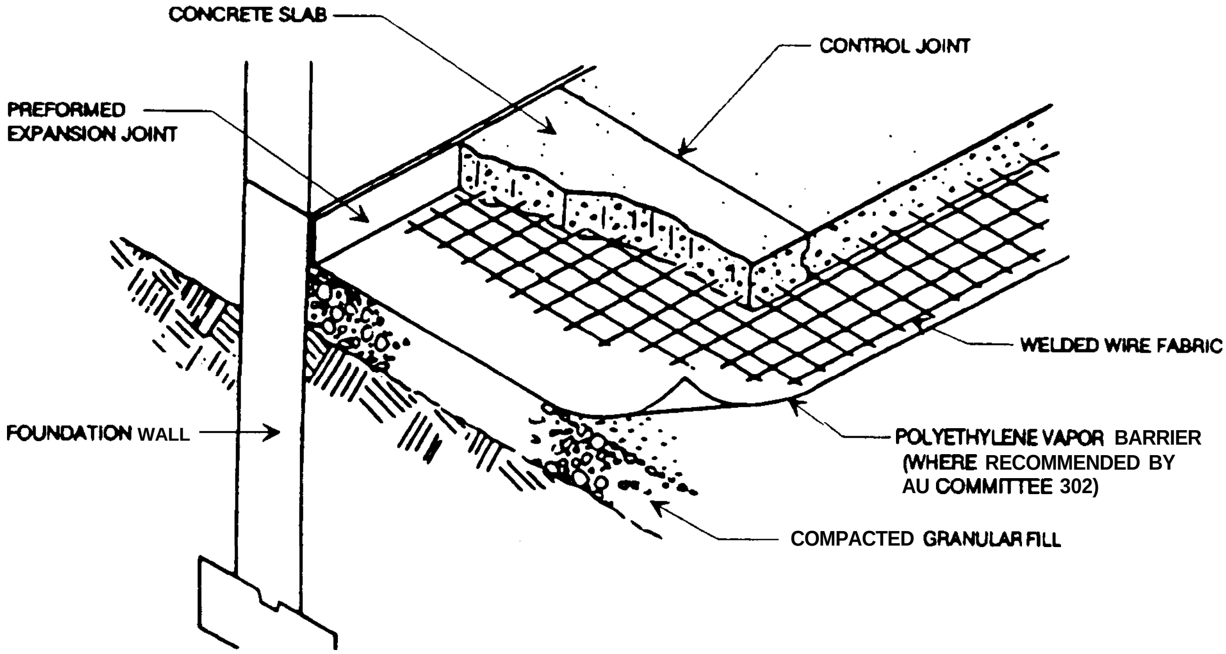
SYSTEM ASSEMBLY DETAILS-SUBSTRUCTURE	VARIOUS CONCRETE JOINTING AND MISC.		
SLABS ON GRADE (CSI 03300)	Revision No.	Issue Date 5/93	Drswing No. A0201-1

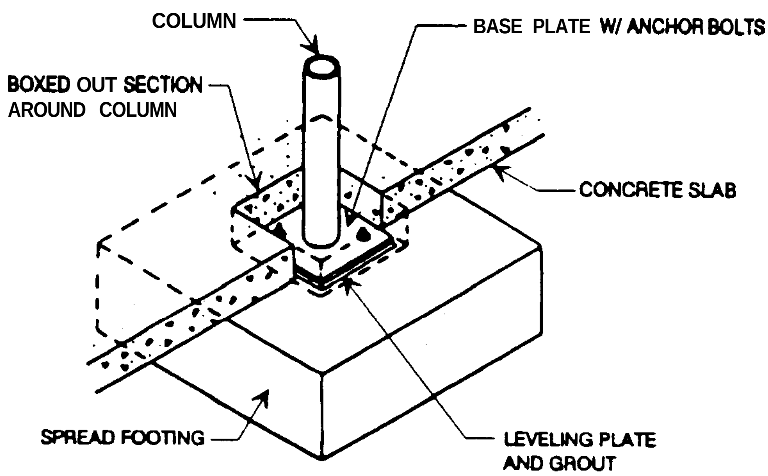
Symbol	Bar Support Illustration	Bar Support Illustration Plastic Capped or Dipped	Type of Support	Sizes
SB		 CAPPED	Slab Bolster	3/4, 1, 1-1/2, and 2' heights in 5' and 10 lengths
SBU*			Slab Bolster Upper	Same as SB
BB		 CAPPED	Beam Bolster	1, 1-112.2, over 2-t 5' heights in increments of 1 /4" ir lengths of 5'
BBU*			Beam Bolster Upper	Same as BB
BC		DIPPED 	lindividual Bar Chair	3/4, 1. 1-1/2, and 1-3/4" heights
IC		 DIPPED DIPPED	Joist Chair	4, 5, and 6' widths and 3/4, 1. and 1-1/2" heights
HC		CAPPED 	Individual High Chair	2 to 15" heigha in incremcnts of 1/4"
HCM*			High Chair for Metal Deck	2 to 15' heights in increments of 1/4"
CHC		CAPPED 	Continuous High Chair	Same as HC in 5' and 10' lengths
CHCU*			Continuous High Chair Upper	Same as CHC
CHCM*			Continuous High Chair for Metal Deck	Up to 5' heights in increments of 1 /4"
JCU**		 DIPPED	Joist Chair Upper	14' span. Heights - 1 • through +3-1/2" vary in 1/4" increments

* Usually available in Class 3 only. except on special order.
** Usually Available in Class 3 only. with upturned or end bearing legs.

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS. 1ST EDITION.. "R.S. Means Co., Inc., Kinaston, Massachusetts"

SYSTEM ASSEMBLY DETAILS-SUBSTRUCTURE	CHAIRS, SUPPORTS, REINFORCEMENT		
SLABS ON GRADE REINFORCED AND NONREINFORCED(CSI 05010)	Revision No.	Issue Date 5/93	Drawing No. A0201-2





CONTROL JOINT AROUND COLUMN

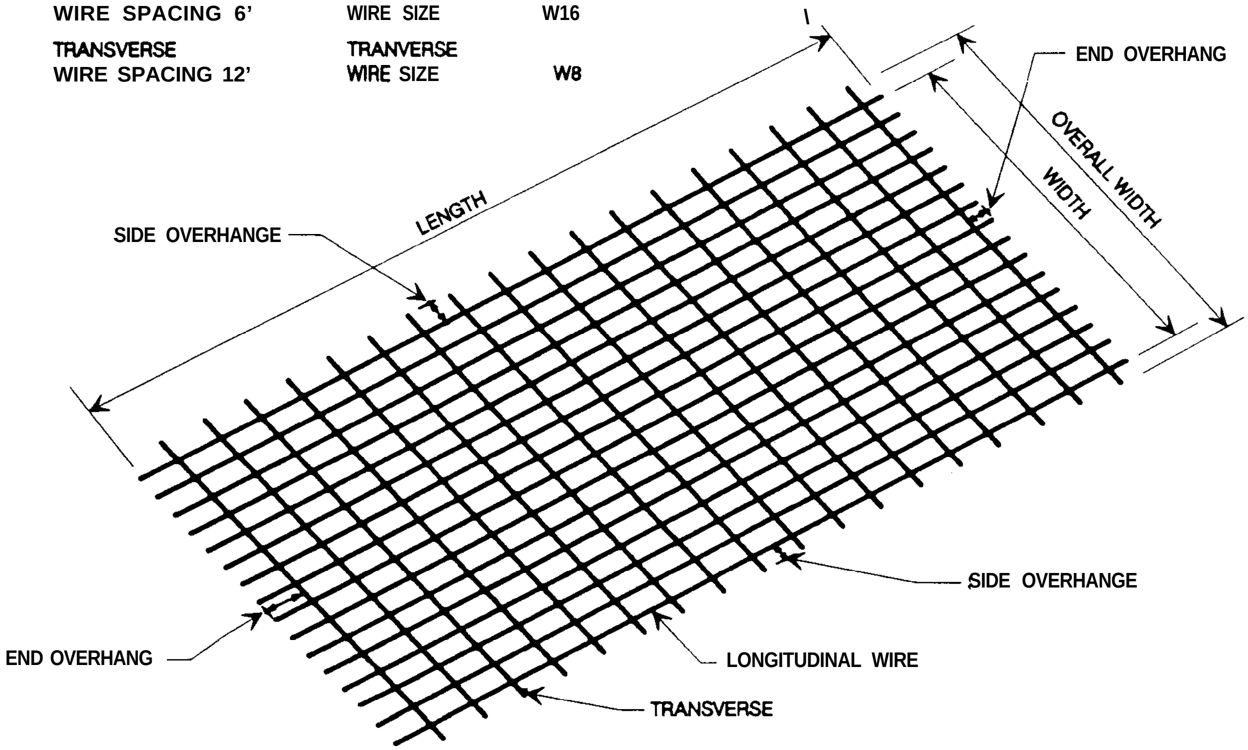
NON-REINFORCED CONCRETE

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION., "R.S Means Co., Inc Kingston, Massachusetts"

SYSTEM ASSEMBLY DETAILS-SUBSTRUCTURE	NON-REINFORCED SLAB ON GRADE		
SLABS ON GRADE (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. A0201-3

INDUSTRY METHOD OF DESIGNATING STYLE:
EXAMPLE-WWF6 X 12-W16 X W8

LOGITUDINAL WIRE SPACING 6'	LONGITUDINAL WIRE SIZE	W16
TRANSVERSE WIRE SPACING 12'	TRANVERSE WIRE SIZE	W8



WELDED WIRE FABRIC STANDARDS

SYSTEM ASSEMBLY DETAILS-SUBSTRUCTURE	WELDED WIRE MESH		
SLABS ON GRADE (CSI 05010)	Revision No.	Issue Date 5/93	Drawing No. A0201-4

DEFICIENCY FACTORS
0.02.01 SLABS-ON-GRADE (CSI 03300)

PROBABLE FAILURE POINTS

- Lack of curing resulting from accelerated curing, improper temperatures, procedures, mix, etc., will increase the degree of cracking in a concrete structure.
- Reinforcement corrosion causing cracking and/or deterioration of concrete from the presence of air and moisture.
- Weathering can cause cracking: 1) freezing and thawing, 2) wetting and drying, and 3) heating and cooling.
- A number of deleterious chemical reactions may result in concrete cracking. These reactions may be due to the aggregate used to make the concrete or chemically active materials that come into contact with it after it has hardened or cured.
- A wide variety of poor construction practices can result in cracked concrete or masonry structures, primarily adding water to improve workability. This practice reduces strength, increases deformation, and increases ultimate drying shrinkage.
- Construction overloads can be far more severe than those experienced in the lifetime of the structure. Unfortunately, these conditions may occur at early ages when the concrete is most susceptible to damage and often result in cracks.
- The effects of improper design and/or detailing range from poor appearance, lack of serviceability, to catastrophic failure.
- Externally applied loads induce tensile stresses that result in cracks propagation. Current ACI 318 design procedures for using reinforcing steel, not only to carry the tensile forces, but also to control both crack distribution and width.
- Improper compaction or soft spots in the grade result in uneven slab settling or slippage.
- Hydrostatic pressure from groundwater results in cracks to total failure.

SYSTEM ASSEMBLIES/DEFICIENCIES

Spalling:	Concrete fragments that have broken from the surface; caused by reinforcement corrosion.
Leaching:	Process of separating liquid from solid materials by allowing them to percolate into surrounding soil causing weak and brittle concrete.
Settlement:	Solid particles sink in fresh concrete, after placement and before initial set.
Dusting:	Surface deterioration and bonding breakdown that forms a powdery residue; usually caused by over-working surface or improper curing.
Exposed Reinforcing:	Insufficient steel cover. Concrete quality. Calcium chloride overuse as admixture.
Alkali-Aggregate Expansion:	Chemical reaction between aggregate and cement paste causing separation and break-up.
Cavitation:	Damage from rapid movement of water or other liquids across the surface causing surface breakdown and erosion.

DEFICIENCY FACTORS
0.02.01 SLABS-ON-GRADE (CSI 03300)

SYSTEM ASSEMBLIES/DEFICIENCIES (Continued)

Cracking (Active & Dormant):	Construction movement, settlement, shrinkage around reinforcement. Settling due to inadequate finishing and curing. Chemical reactions such as corrosion. Physical reactions such as drying shrinkage. Thermal changes (subjected to temperature extremes, such as freeze/thaw cycles). Stress concentration. Poor structural design. Accidents from overload, vibration, fatigue, and earthquake.
Crazing:	Surface shrinkage is more rapid than concrete mass interior. Too high a slump. Too rich a mix. Poor timing on finishing. Too rapid moisture absorption.
Holes (Small and Large):	Chemical reaction. Inadequate construction and design.
Staining:	Surface discoloration from a foreign substance or material eg., soil.
Efflorescence:	A whitish powdery deposit of soluble salts brought to the surface by moisture which leaves residue after evaporating.
Plant Growth Moss/Algae:	Moss or algae growth over the surface, usually from excessive moisture.
Corrosion of Rebar:	Metal rebar oxidation by chemical or electrochemical action after prolonged exposure to moisture.

CONCRETE SLAB DETERIORATION/EXPOSED REINFORCING

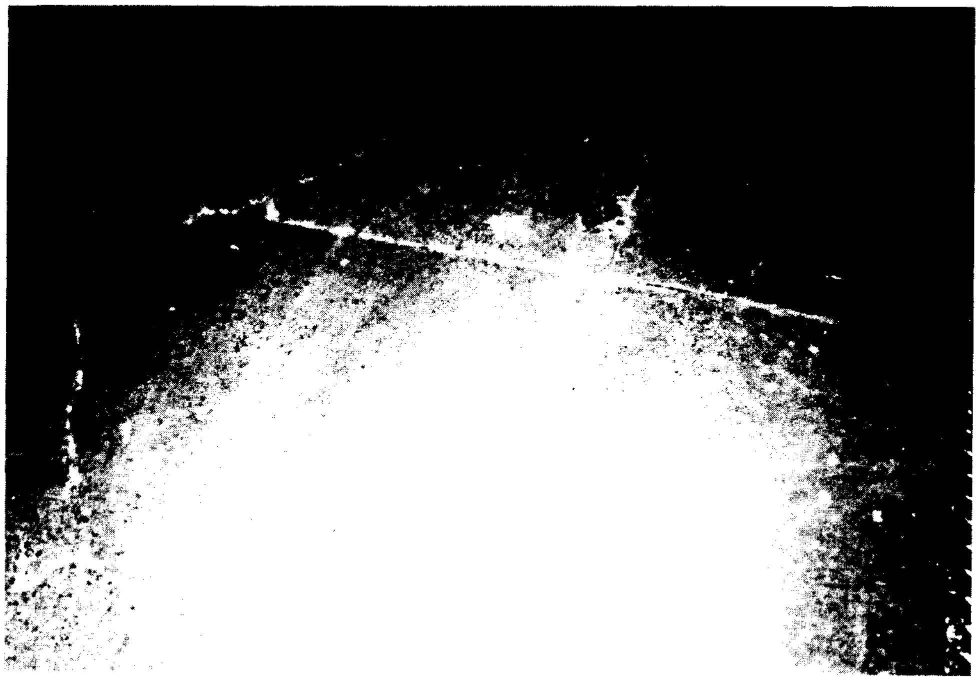
PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUBSTRUCTURE	SLAB ON GRADE DETERIORATION EXPOSED REINFORCING		
SLABS ON GRADE REINFORCED (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0201-1

SLAB SPALLING

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUBSTRUCTURE	SLAB ON GRADE SPALLING		
SLABS ON GRADE REINFORCED (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0201-2



SLAB ON GRADE CRACKS

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUBSTRUCTURE	SURFACE CRACKS		
SLABS ON GRADE NON-REINFORCED (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0201-3

SOIL SETTLEMENT

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUBSTRUCTURE	SOIL SETTLEMENT		
SLABS ON GRADE CONCRETE SLAB (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D0201-4

SOIL MOVEMENT

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUBSTRUCTURE	BEARING SOIL MOVEMENT		
SLABS ON GRADE (CSI 04210)	Revision No.	Issue Date 5/93	Drawing No. D0201-5

DEFICIENCY FACTORS
0.02.01 SLABS-ON-GRADE (CSI 03300)

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DEFICIENCY FACTORS
0.02.01 SLABS-ON-GRADE (CSI 03300)

END OF SUBSECTION

DEFICIENCY FACTORS
0.02.02.04 WOOD (CSI 06100)

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DEFICIENCY FACTORS
0.02.02.04 WOOD (CSI 06100)

END OF SUBSECTION

0.02.03 COLUMN FIREPROOFING (CSI 07250)

DESCRIPTION

Modern building codes and DOE requirements specify minimum fire-resistant requirements based on the degree of fire hazard in each occupancy class. These codes set the fire resistance requirement for main structural building elements. The ASTM Standard fire test specification (E 119-58) is the universally accepted standard for classifying the duration and intensity of fire resistance provided by building materials and constructions. These tests indicate the length of time that structural members, such as columns and beams, maintain their strength and rigidity before failure.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Construction Materials:

Materials must provide the following characteristics or properties to qualify as safe, dependable fireproofing:

- They must not burn or support combustion.
- They must prevent the rapid and excessive heat flow for a definite time period.
- They must be sufficiently standardized and controlled to ensure consistent, dependable protection.
- Their effective fire resistance must be determined by the ASTM standard time-temperature fire test for each type of construction in which they are to be used.

Gypsum (CSI 09250)

Gypsum is a mineral with unusual fire-resistant qualities when subjected to high temperatures in relation to its volume. Gypsum plaster, machine or manually applied to metal or gypsum lath, is very satisfactory fireproofing material. Gypsum wallboard (in the form of lath or finish material) and gypsum tile are commonly used in fire-resistant construction.

Vermiculite & Perlite (CSI 09250)

Vermiculite and perlite are lightweight aggregates possessing high thermal insulation qualities. They are used both in gypsum and cement plaster and in concrete. Their weight is one-tenth that of and they have excellent fire-resistant, acoustical, and insulating properties. The plaster may be machine-applied directly to the underside of light-gauge steel floor or roof decks, columns or beams, or to gypsum or metal lath.

Mineral Fiber (CSI 09250)

Mineral fiber combined with a mineral binder, air, and water, forms a very efficient fireproofing material. Applied with a special spray gun, the material will bond directly to steel, metal lath, and most other clean rigid surfaces such as gypsum lath and concrete. Mineral fiber has excellent fire-resistant qualities and acoustical qualities when applied to structural members such as columns, beams, girders, and trusses.

Portland Cement (CSI 04100)

Portland cement continues to be useful as a fireproofing material. When subjected to high temperatures, it releases water in a manner similar to gypsum, although to a lesser degree. The selection of aggregate is critical to the fire-resistance of concrete which is greatly improved with the use of light aggregates instead of stone. Portland cement plaster is also used for fire protection. Mixing it with lightweight aggregates and mineral fibers greatly improves its fire resistance. It is preferred to gypsum plaster if there is exposure to the weather or high humidity.

0.02.03 COLUMN FIREPROOFING (CSI 07250)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS (Continued)

Magnesium **Oxychloride** (CSI **07250)**

Sprayed-on magnesium oxychloride fireproofing is a special type of plaster that is conveniently sprayed on. It reacts to fire exposure differently than ordinary gypsum or Portland cement plasters. It is a much better protector, but more expensive. Compared to the aggregate type, it is heavier (but offers the same protection with less thickness), stronger, less affected by moisture, and bonds stronger to substrates (like plaster bond). Spraying produces a relatively clean application, and freshly placed material can be troweled, screeded, or leveled with a smooth paint roller. It is often used with metal lath boxing and corner beads as screeds, resulting in a finish plaster appearance. This product is of sufficient durability to replace thicker cast-in-place concrete for various uses; saving space, weight, and cost. It can be effectively combined with an intumescent top coating to provide the greatest amount of protection in the least amount of space (thickness), remaining weather resistant and durable.

Magnesium oxychloride formulations have been labeled corrosive. Thus, they must be prevented from contacting metals such as stainless steel, aluminum, and copper alloys. It is imperative that their use be limited to substrates whose compatibility with specific formulations has been documented by testing and in the field, despite manufacturers' claims that current formulations are not corrosive to listed substrates (including steel).

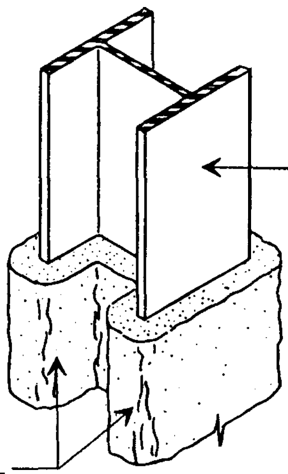
Intumescent Coatings (CSI 07250)

Sprayed-on intumescent coatings serve as a different type of fireproofing. They foam or expand under intense heat, forming a thick, inert insulator on substrates. Although a very practical material for perhaps one hour, they are less effective for higher fire ratings. Based on dollars per hour of protection, they are the most expensive system. However, benefits include being thin, lightweight, durable, and moisture/weather resistant. They bond strongly to substrates and are clean to use. These substrates, however, must not have a noncompatible primer or paint coat, presenting a coordination problem with structural steel, joists, steel deck, and other surfaces that need coating. Sprayed coats can be roller leveled to provide a smooth finish (recommended due to unsightly drips and runs resulting from application). One unique feature of intumescent coatings is that they must cure or age for about 30 days before reaching their nominal protective capacity, an inadvertent hazard for fast-track work.

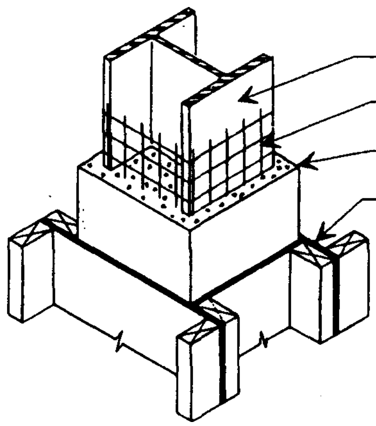
OTHER RELATED COMPONENTS

See the following subsections for related components:

0.02.02.01 Cast-in-Place Concrete Columns 2.2.1-l
0.02.02.02 Loaded Precast Columns 2.2.2-l
0.02.02.03 Steel Columns 2.2.3-l
0.02.02.04 Wood Columns 2.2.4-1

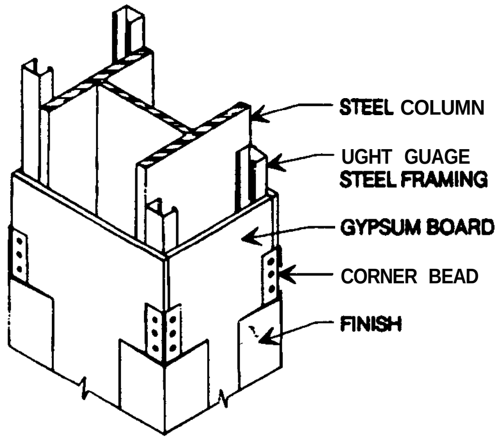


SPRAYED FIBER ON COLUMNS

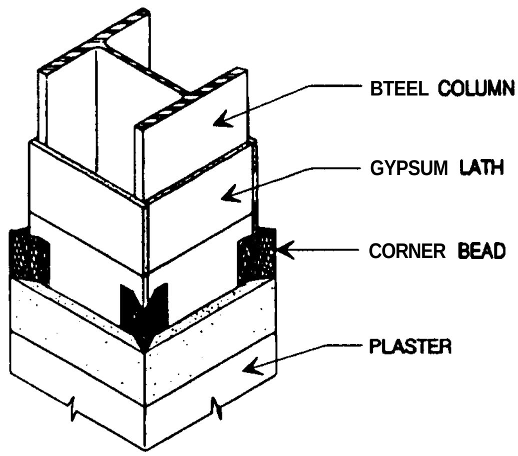


CONCRETE ENCASEMENT-ON COLUMNS

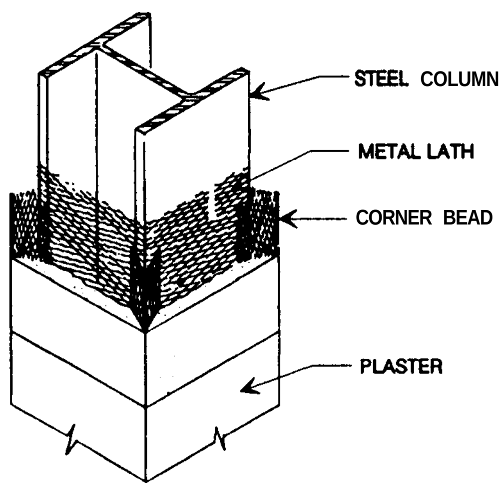
SYSTEM ASSEMBLY DETAILS-SUBSTRUCTURE	STEEL COLUMN FIREPROOFING		
COLUMN FIREPROOFING (CSI 07250)	Revision No.	Issue Date 5/93	Drawing No. A0203-1



GYPSUM BOARD ON COLUMNS



PLASTER ON GYPSUM LATH-COLUMNS



PLASTER ON METAL LATH-COLUMNS

SYSTEM ASSEMBLY DETAILS-SUBSTRUCTURE	STEEL COLUMN FIREPROOFING		
COLUMN FIREPROOFING (CSI 07250)	Revision No.	Issue Date 5/93	Drawing No. A0203-2

DEFICIENCY FACTORS
0.02.03 COLUMN FIREPROOFING (CSI 07250)

PROBABLE FAILURE POINTS

- Lack of curing resulting from accelerated curing, improper temperatures, procedures, mix, etc., will increase the degree of cracking in a concrete structure.
- Reinforcement corrosion causing cracking and/or deterioration of concrete from the presence of air and moisture.
- Unsealed or improperly sealed penetrations.
- Cracking caused by structural movement or improper joint compound application.
- Water damage caused by leaking piping or other sources.
- Impact damage from objects striking or impacting the surface.
- A number of deleterious chemical reactions may result in the cracking of concrete. These reactions may be due to the aggregate used to make the concrete or materials that come into contact with the concrete after it has hardened or cured.
- A wide variety of poor construction practices can result in cracked concrete or masonry structures, primarily adding water to improve workability. This practice reduces strength, increases deformation, and increases ultimate drying shrinkage.
- Construction overloads can be far more severe than those experienced in the lifetime of the structure. Unfortunately, these conditions may occur at early ages when the concrete or masonry is most susceptible to damage and often result in cracks.

SYSTEM ASSEMBLIES/DEFICIENCIES

Cementitious Alkali-Aggregate Expansion:	Chemical reaction between aggregate and cement paste causing separation and break-up.
Cracking (Active & Dormant):	Construction movement, settlement, shrinkage around reinforcement. Setting due to inadequate finishing and curing. Chemical reactions such as corrosion. Physical reactions such as drying shrinkage. Thermal changes (subjected to temperature extremes such as freeze/thaw cycles). Stress concentration. Poor structural design. Accidents from overload, vibration, fatigue, and earthquake.
Surface Deterioration:	Crazing from shrinkage more rapid than concrete mass interior. Too high a slump. Improper mix proportions. Poor timing on finishing. Too rapid moisture absorption. Cavitation from water or liquid action over surface. Chemical reactions.
Holes (Small & Large):	Chemical reaction. Inadequate construction and design.
Spalling:	Concrete fragments that have broken from the surface; caused by reinforcement corrosion.
Out -of-Alignment:	Bowing, deflection, or other movement that brings the surface out of plumb or not level in one or more directions.
Mortar/Joint Material Missing/Eroded:	Deteriorated or damaged joints that have fallen out or worn down. Excessive joint movement.

DEFICIENCY FACTORS
0.02.03 COLUMN FIREPROOFING (CSI 07250)

SYSTEM ASSEMBLIES/DEFICIENCIES (Continued)

Staining:	Surface discoloration from a foreign substance or material.
Efflorescence:	A whitish powdery deposit of soluble salts brought to the surface by moisture which leaves residue after evaporating.
Plant Growth Moss/Algae:	Moss or algae growth over the surface, usually resulting from excessive moisture.
Corrosion of Rebar:	Metal rebar oxidation by chemical or electrochemical action after prolonged exposure to moisture.
Gypsum	
Penetration/Holes:	Unsealed or improperly sealed penetration through wall for pipes, ducts, or cable.
Impact Damage:	Damage caused by objects striking or impacting the surface.
Water Damage:	Bulging, sagging, discoloration, softened material caused by leaking pipes, standing water, or other leaks.
Cracking:	Settlement/movement, joint compound shrinkage, supporting structure sag or warp, or inferior workmanship.
Loose Fastener:	Improper framing or fastener application.
Mineral Fiber	
Cracking:	Settlement/movement, member deflection.
Bond Failure:	Poor material application, improper preparation.
Surface Deterioration:	Surface breakdown from abrasive action, exposure to elements, or improper mixture and application.
Impact Damage:	Damage caused by objects striking or impacting the surface.
Water Damage:	Bulging, sagging, discoloration, softened material caused by leaking pipes, standing water, or other leaks.

-END OF SUBSECTION

INSPECTION METHODS - STANDARD

GUIDE SHEETS

The following Guide Sheets provide a general overview of inspection methods and requirements used to provide a general Substructure inspection. Sheets have been developed for each major type and associated assembly components as follows:

TABLE ONE

Assembly/Component	Control Number
Slabs-on-Grade	GSS 0.02.01
Cast-in-Place Concrete	GSS 0.02.02.01
Loaded Precast Concrete	GSS 0.02.02.02
Steel	GSS 0.02.02.03
Wood	GSS 0.02.02.04
Column Fireproofing	GSS 0.02.03

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0.02.02.01 CAST-IN-PLACE COLUMNS (CSI 03300)

DESCRIPTION

Cast-in-Place Columns are part of the support structure and are usually loaded axially in compression and transfer structural loads to the footings. The design of the Cast-in-Place Columns is affected by the framework, yet also directly influenced by type and brand of cement, admixtures, uniformity in mixing and technique, curing methods, and other quality control factors. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Cast-In-Place Concrete (CSI 03300)

Concrete is a composite material that consists of essentially a binding medium with embedded particles or fragments of aggregate; in Portland cement concrete,. the binder is a mixture of Portland cement and water. See ACI publications 318 "Building Code Requirements for Reinforced Concrete" and 301 "Specifications for Structural Concrete Buildings" indicate a preference for proportioning and design.

Design Mixes Providing Normal Weiaht Concrete:

- 4000-psi, 28-day compressive strength w/c ratio; 0.44 max
- 3500-psi, 28-day compressive strength w/c ratio; 0.51 max
- 3000-psi, 28-day compressive strength w/c ratio; 0.58 max
- 2500-psi, 28-day compressive strength w/c ratio; 0.67 max

Reinforced Concrete (CSI 03300)

Because concrete has limited resistance to tensile and shear stresses, steel reinforcing material is necessary. Rebars and/or wire mesh must have a capability of developing a bond with the concrete and be so positioned that each element will be used efficiently. A thorough knowledge of contract requirements, construction documents including shop drawings, and the placement reinforcing steel are very important.

The cross-sectional area of the reinforcing bar should not be reduced in any way, because the tensile capacity of the material will be reduced.

Formwork (CSI 03100)

Forms are a temporary structure or mold for support of concrete while it is setting and gaining sufficient strength to be self supporting. It is the total system of support for freshly placed concrete, including the mold or sheathing which contacts the concrete, as well as all supporting members, hardware, and necessary bracing. For cast-in-place stairs form anchors are used to secure formwork to previously placed concrete of adequate strength. The device is embedded in the concrete during placement. Also a form coating, a liquid is applied to the interior of the formwork surfaces for a specific purpose, usually to promote easy release from the concrete, to preserve the form material, or retard the set of the near-surface matrix for preparation of exposed aggregate finishes.

0.02.02.01 CAST-IN-PLACE COLUMNS (CSI 03300)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS (Continued)

Admixtures (CSI 03370)

An admisture is an ingredient other than cement, aggregate, or water that is added to a concrete mortar mix to affect the physical or chemical concrete characteristic. The most common affects are plasticity, air entrainment, and curing time.

Air-Entrainment Aaents:

- Provide a more workable material.
- Definitely used when concrete surface will be exposed to freeze/thaw cycles.

Retarder & Densifvina Aoents:

- Retard the set; suggested in warm weather to reduce cracking due to rapid set-up.
- Increase the workability of the mix.
- Allow for delayed finishing, resulting in less permeable concrete.

Accelerator:

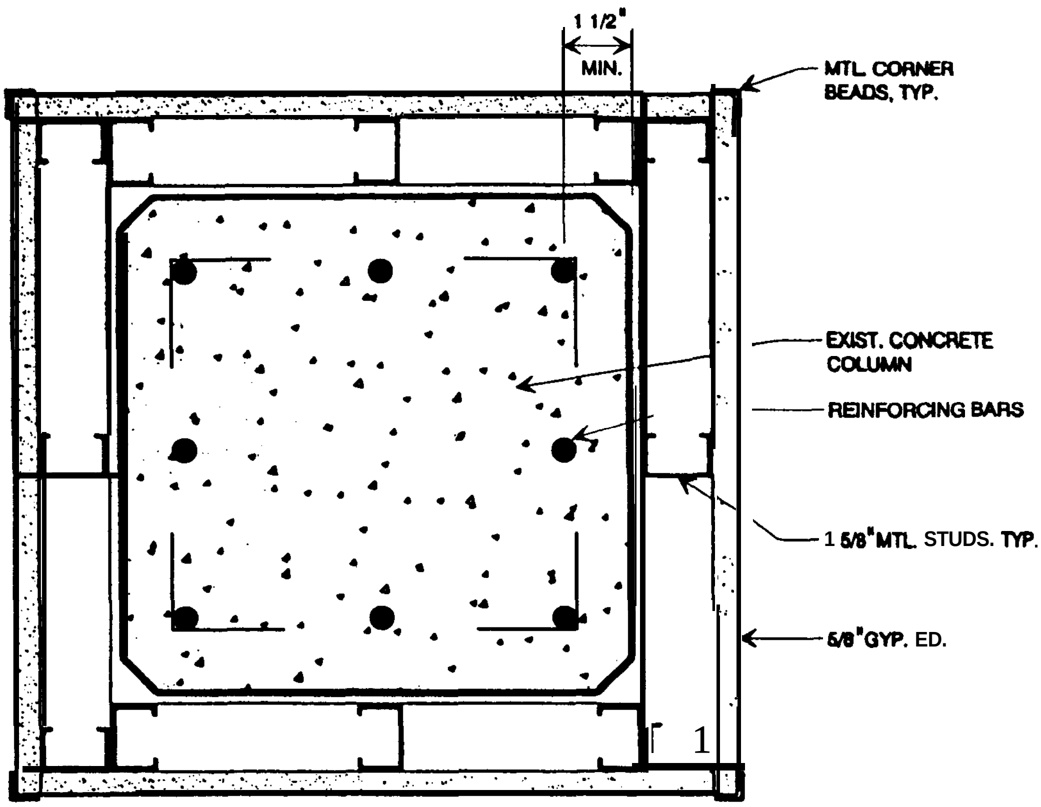
- Useful in winter (cold weather concreting).
- Useful when working to seal against the water-flow.
- Should be used sparingly because the admixture tends to increase shrinkage.

OTHER RELATED COMPONENTS

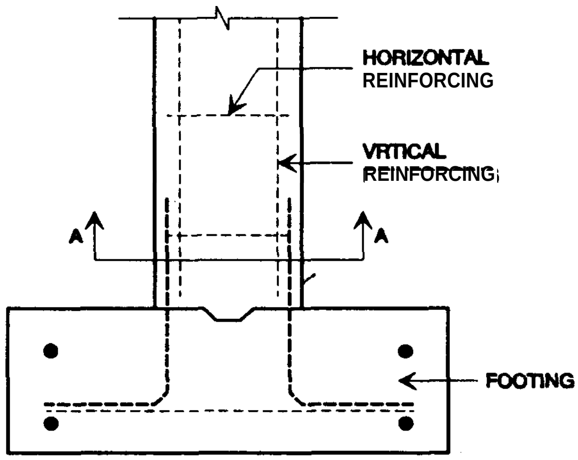
See the following subsections for related components:

0.02.01 Slabs-on-Grade 2.1-1
0.02.03 Column Fireproofing 2.3-l

Refer to Foundations & Footings and Superstructure Systems, Volumes 1 and 3, for additional deficiencies that may impact this system.



CONCRETE COLUMN
SECTION AA



SYSTEM ASSEMBLY DETAILS-SUBSTRUCTURE	CAST IN PLACE CONCRETE COLUMN		
COLUMNS CIP COLUMNS (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. A020201-1

DEFICIENCY FACTORS
0.02.02.01 CAST-IN-PLACE CONCRETE (CSI 03300)

PROBABLE FAILURE POINTS

- Lack of curing resulting from accelerated curing, improper temperatures, procedures, mix, etc., will increase the degree of cracking in a concrete structure.
- Reinforcement corrosion causing cracking and/or deterioration of concrete from the presence of air and moisture.
- Weathering processes that can cause cracking: 1) freezing and thawing, 2) wetting and drying, and 3) heating and cooling.
- A number of deleterious chemical reactions may result in concrete cracks. These reactions may be due to the aggregate used to make the concrete or materials that come into contact with it after it has hardened.
- A wide variety of poor construction practices can result in cracked concrete structures, primarily adding water to concrete to improve workability. This process reduces strength, increases settlement, and increases ultimate drying shrinkage.
- Construction overloads can be far more severe than those experienced in the lifetime of the structure. Unfortunately, these conditions may occur at early ages when the concrete is most susceptible to damage and often result in cracks.
- Errors in design and detailing range from poor appearance to lack of serviceability to catastrophic failure.
- Externally applied loads are known to induce tensile stresses that result in cracks. Current ACI 318 design procedures use reinforcing steel, not only to carry the tensile forces, but to obtain both an adequate crack distribution and reasonable limit on crack width.

SYSTEM ASSEMBLIES/DEFICIENCIES

Spalling:	Fragments that have broken from the surface, caused by reinforcement corrosion, impact damage, freeze/thaw cycles, etc.
Settlement:	Solid particles sink in fresh concrete, after placement and before initial set.
Exposed Reinforcing:	Insufficient steel cover. Concrete quality. Calcium chloride overused as admixture.
Alkali-Aggregate Expansion:	Chemical reaction between aggregate and cement paste causing separation and break-up.
Cavitation:	Damage from rapid movement of water or other liquids across the surface causing breakdown and erosion.
Cracking (Active & Dormant):	Construction movement, settlement, shrinkage around reinforcement. Setting due to inadequate finishing and curing. Chemical reactions such as corrosion. Physical reactions such as drying shrinkage. Thermal changes (subjected to temperature extremes, such as freeze/thaw cycles). Stress concentration. Poor structural design. Accidents from overload, vibration, fatigue, and earthquake.
Crazing:	Surface shrinkage more rapid than concrete mass interior. Too high a slump. Too rich a mix. Poor timing on finishing. Too rapid moisture absorption.

DEFICIENCY FACTORS
0.02.02.01 CAST-IN-PLACE CONCRETE (CSI 03300)

SYSTEM ASSEMBLIES/DEFICIENCIES (Continued)

Holes (Small and Large):	Chemical reaction. Inadequate construction and design.
Form Scabbing:	Form oil improperly applied.

COLUMN CRACKING/CHIPPING

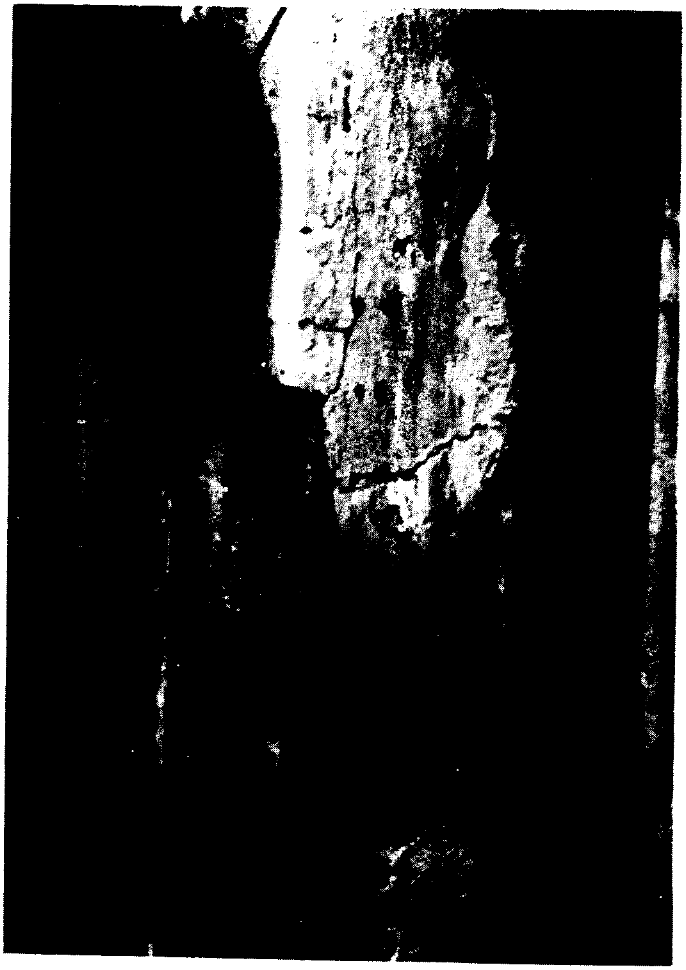
PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUBSTRUCTURE	CONCRETE COLUMN CRACKING/CHIPPING		
COLUMNS CIP COLUMNS (CSI 03300)	Revision No.	issue Date 5/93	Drawing No. 0020201-I

COLUMN REINFORCING EXPOSED

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAIL-SUBSTRUCTURE	CONCRETE COLUMN REINFORCING EXPOSED		
COLUMNS CIP COLUMNS (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D020201-2



REINFORCING EXPOSED/DETERIORATION

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUBSTRUCTURE	REINFORCING EXPOSED/ COLUMN DETERIORATION		
COLUMNS CIP COLUMNS (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D020201-3

COLUMN CRACKING

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUBSTRUCTURE	CONCRETE COLUMN CRACKING		
COLUMNS CIP COLUMNS (CSI 03300)	Revision No.	Issue Date 5/93	Drawing No. D020201-4

EXPOSED REINFORCING/CORROSION

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAIL-SUBSTRUCTURE	EXPOSED REINFORCING CORROSION		
COLUMNS CIP COLUMNS (CSI 03300)	Revirion No.	Issue Date 5/93	Drawing No. D020201-5

DEFICIENCY FACTORS
0.02.02.01 CAST-IN-PLACE CONCRETE (CSI 03300)

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DEFICIENCY FACTORS
0.02.02.01 CAST-IN-PLACE CONCRETE (CSB 03300)

END OF SUBSECTION

0.02.02.02 LOADED PRECAST CONCRETE (CSI 03400)

DESCRIPTION

Precast columns are either reinforced or prestressed in a manufacturer/casting plant and then shipped to the project site. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Loaded Precast Columns (CSI 03400)

Precast concrete columns may be solid or hollow. The hollow type is formed using heavy cardboard tubing to form the core. A looped rod is cast in the column footing and projects upward into the hollow core to help hold the column upright. An opening left in the side of the column is filled with grout to embed the looped rod and form an anchor. (The opening is dry-packed .)

Advantaaes:

Precast has the greatest advantage when there are numerous members to be cast, since the same forms can be used several times. In addition to using the same forms other advantages include:

- Control of the concrete quality.
- Smoother surfaces; plastering is not necessary.
- Less storage space.
- Concrete member can be cast under all weather conditions.
- Improved curing.
- Weather conditions have little or no effect on erection.
- Faster erection time.

Precast members should not be skidded, rolled, driven, or subjected to full design load until they have attained their 28-day strengths as indicated by cylinders made from the same concrete, at the same time as the precast concrete, and cured in the same manner. Delivery of precast members should be after the 28-day cure time.

Reinforced Precast **Concrete** (CSI 03300)

Because concrete has limited resistance to tensile and shear stresses, a composite material may be necessary to take advantage of maximum capability of the ingredients in the composite.

Reinforcing steel should be placed in accordance with engineer requirements. Laps, tying, and hook, tie, and stirrup positioning should conform to shop drawings, the ACI, and' the Precast Concrete Institute codes and design standards. Concrete covering over steel reinforcement is critical due to the protection afforded the steel: the bond that must be developed between the steel and the concrete around it.

The cross-sectional area of the reinforcing should not be reduced in any way because the tensile capacity of the material will be affected. Support and tying for reinforcing materials are specified to conform to ACI 315.

0.02.02.02 LOADED PRECAST CONCRETE **(CSI 03400)**

OTHER RELATED COMPONENTS

See the following subsections for related components:

0.02.01 Slabs-on-Grade 2.1-l
0.02.03 Column Fireproofing 2.3-l

Refer to Foundations **&** Footings and Superstructure Systems, Volumes 1 and 3, for additional deficiencies that may impact this system.

DEFICIENCY FACTORS
0.02.02.02 LOADED PRECAST CONCRETE (CSI 03400)

PROBABLE FAILURE POINTS

- Lack of curing resulting from accelerated curing, improper temperatures, procedures, mix, etc., will increase the degree of cracking in a concrete structure.
- Reinforcement corrosion causing cracking and/or deterioration of concrete from the presence of air and moisture.
- Weathering processes that can cause cracking: 1) freezing and thawing, 2) wetting and drying, and 3) heating and cooling.
- A number of deleterious chemical reactions may result in concrete cracks. These reactions may be due to the aggregate used to make the concrete or chemically active materials that come into contact with it after it has hardened.
- A wide variety of poor construction practices can result in cracked concrete structures, primarily adding water to concrete to improve workability. This practice reduced strength, increases settlement, and increases ultimate drying shrinkage.
- Construction overloads can be far more severe than those experienced in the lifetime of the structure. Unfortunately, these conditions may occur at early ages when the concrete is most susceptible to damage and often results in cracks.
- The effects of improper design and/or detailing range from poor appearance, lack of serviceability, to catastrophic failure.
- Externally applied loads induce tensile stresses that result in cracks. Current ACI 318 design procedures for using reinforcing steel, not only to carry the tensile forces, but also to control both crack distribution and width.

SYSTEM ASSEMBLIES/DEFICIENCIES

Spalling:	Concrete fragments that have broken from the surface; caused by the reinforcement corrosion, impact damage, freeze/thaw cycles, etc.
Settlement:	Solid particles sink in fresh concrete, after placement and before initial set.
Exposed/Corroded Reinforcing:	Insufficient steel cover. Concrete quality. Calcium chloride overuse as admixture.
Alkali-Aggregate Expansion:	Chemical reaction between aggregate and cement paste causing separation and break-up of bond.
Cavitation:	Damage from rapid movement of water or other liquids across the surface causing breakdown and erosion.
Cracking (Active & Dormant):	Construction movement, settlement, shrinkage around reinforcement, Setting due to inadequate finishing and curing. Chemical reactions such as corrosion. Physical reactions such as drying shrinkage. Thermal changes (subjected to temperature extremes, such as freeze/thaw cycles). Stress concentration. Poor structural design. Accidents from overload, vibration, fatigue, and earthquake.
Crazing:	Surface shrinkage more rapid than concrete mass interior. Too high a slump. Too rich a mix. Poor timing on finishing. Too rapid moisture absorption.

DEFICIENCY FACTORS
0.02.02.02 LOADED PRECAST CONCRETE **(CSI 03400)**

SYSTEM ASSEMBLIES/DEFICIENCIES (Continued)

Holes (Small & Large):	Chemical reaction. Inadequate construction and design. Broken or missing sections.
Form Scabbing:	Form oil improperly applied.
Damaged Anchorage:	Loose, missing, or corroded anchors and clips. Inadequate construction and design:.

END OF SUBSECTION

0.02.02.03 STEEL (CSI 05120)

DESCRIPTION

A steel column is a compression member whose element of slenderness must be taken into account when determining allowable loads. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Steel Columns (CSI 05120)

Column Shapes:

Because of the tendency to bend, the safe load on a column depends not only on the number of square inches in the cross-section, but also on the manner that the material is distributed with respect to the axis of the cross-section; that is, the shape of the column section is an important factor. Axially loaded columns tend to bend in a plane perpendicular to the axis. Except for H-columns, a column's cross-section is seldom symmetrical with respect to both axes, the ideal section would provide an equal moment of inertia for each. Pipe columns and structural tubing meet this condition, but are somewhat limited because of difficulties in making connections.

Steel Shapes:

An I-Beam is a structural member of rolled steel whose cross-section resembles the capital letter I. Formerly, these were referred to as I-Beams. Today, there are several shape classifications, including W-shapes, S-shapes, M-shapes, and HP-shapes. Currently, W-shapes are primarily used for steel beam construction. Built-up sections were used extensively in the past, but wide flange sections are now rolled in a large variety of sizes and are used universally because they require minimal fabrication. They are sometimes called H-columns. For excessive loads or usual conditions plates are welded to the flanges of wide flange sections to give added strength.

Steel Pipe Columns:

Round steel pipe columns are frequently installed in both steel and wood frame building. In routine work they are designed for simple axial loads. The outside diameters at the head are nominal dimensions that designate the pipe sizes. The AISC Manual contains additional tables that list allowable loads for the two heavier weight groups of steel pipes: extra strong and double extra strong.

Structural Tubina Columns:

Steel columns are fabricated from structural tubing in both square and rectangular shapes. Square tubing is available in sizes of 2 to 16 inches and rectangular sizes ranges from 3x2 to 20x12 inches. Sections are produced with various wall thicknesses, thus allowing a considerable range of structural capacities. Although round pipe is specified by nominal outside dimension, tubing is specified by its actual outside dimensions. Both pipe and tubing are available in various steel strengths.

Column Base Plates & Connections:

Steel columns bear on and are generally welded to steel base plates. These plates must be designed to transfer all loads (axial, flexural, and shear) to the supporting foundation. Anchor bolts are used to connect the base plate to the foundation and are designed to transmit any shear or bending forces at the base of the column.

0.02.02.03 STEEL (CSI 05120)

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Steel Columns (CSI 05120)

Column Base Plates & Connections (Continued):

Shop and field connections may be either bolted or welded, as determined by the engineer. Connections are not provided by proprietary fastening devices, which must be specified to suit the project. Combinations of connections and types of connections must be coordinated with structural requirements. Pre-approved connections are not acceptable.

Welded connections are generally governed by the American Welding Society document D1.I-88, "Structural Welding Code, Steel." Full and complete information regarding weld location, size, type, and extent including shopwelds and special field welds, must be clearly shown on drawings.

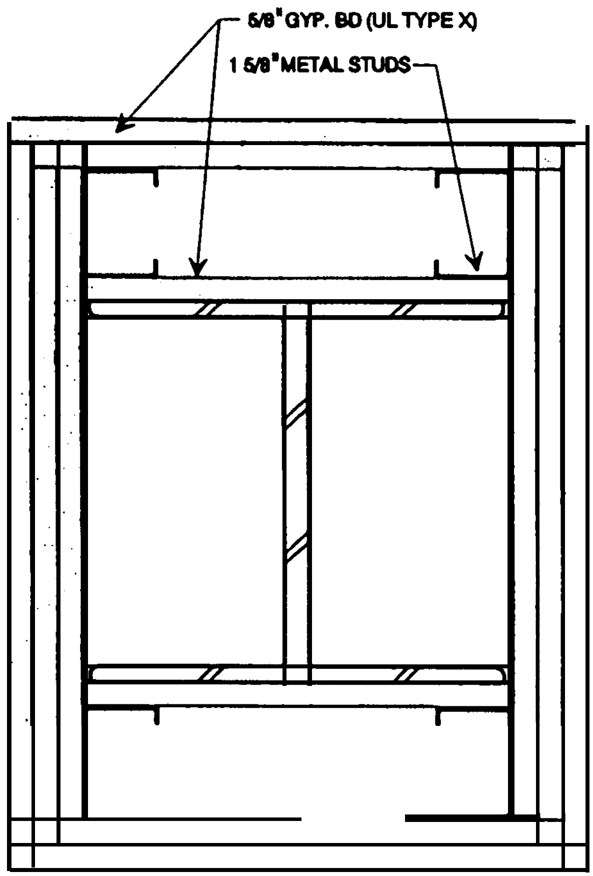
Bolted connections consist of unfinished threaded fasteners (ASTM A307) and high-strength bolts (ASTM A325 and A490), either shop- or field-installed. Unfinished threaded fasteners are generally used for connections of secondary framing members to primary members and for temporary bracing. High-strength threaded fasteners are usually used for primary bolted connections.

OTHER RELATED COMPONENTS

See the following subsections for related components:

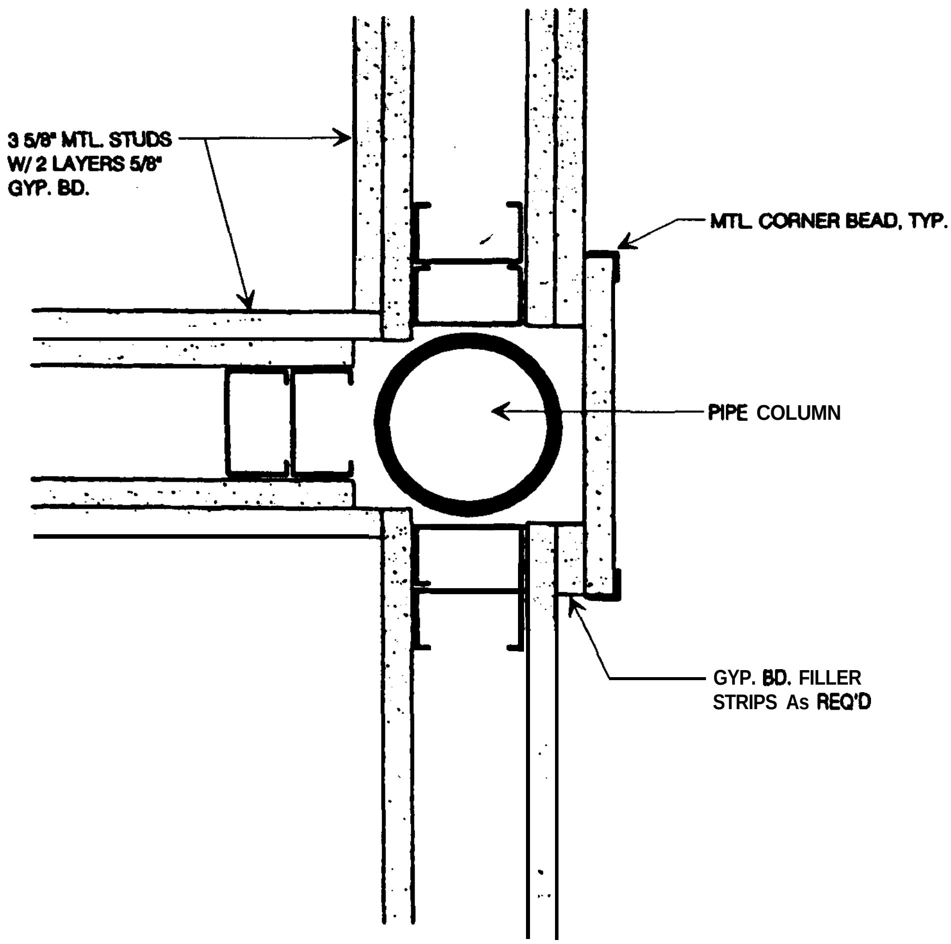
0.02.01 Slabs-on-Grade 2.1-1
0.02.03 Column Fireproofing 2.3-l

Refer to Foundations & Footings and Superstructure Systems, Volumes 1 and 3, for additional deficiencies that may impact this system.



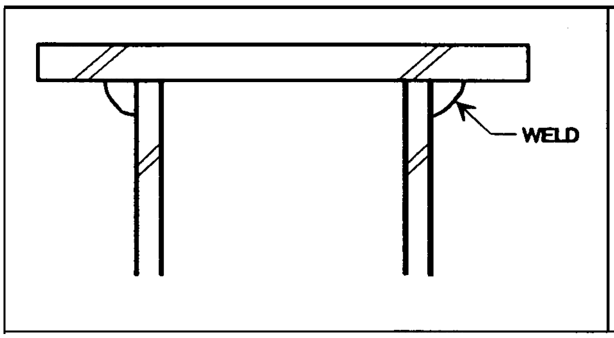
STEEL "H" COLUMN AND FIREPROOFING

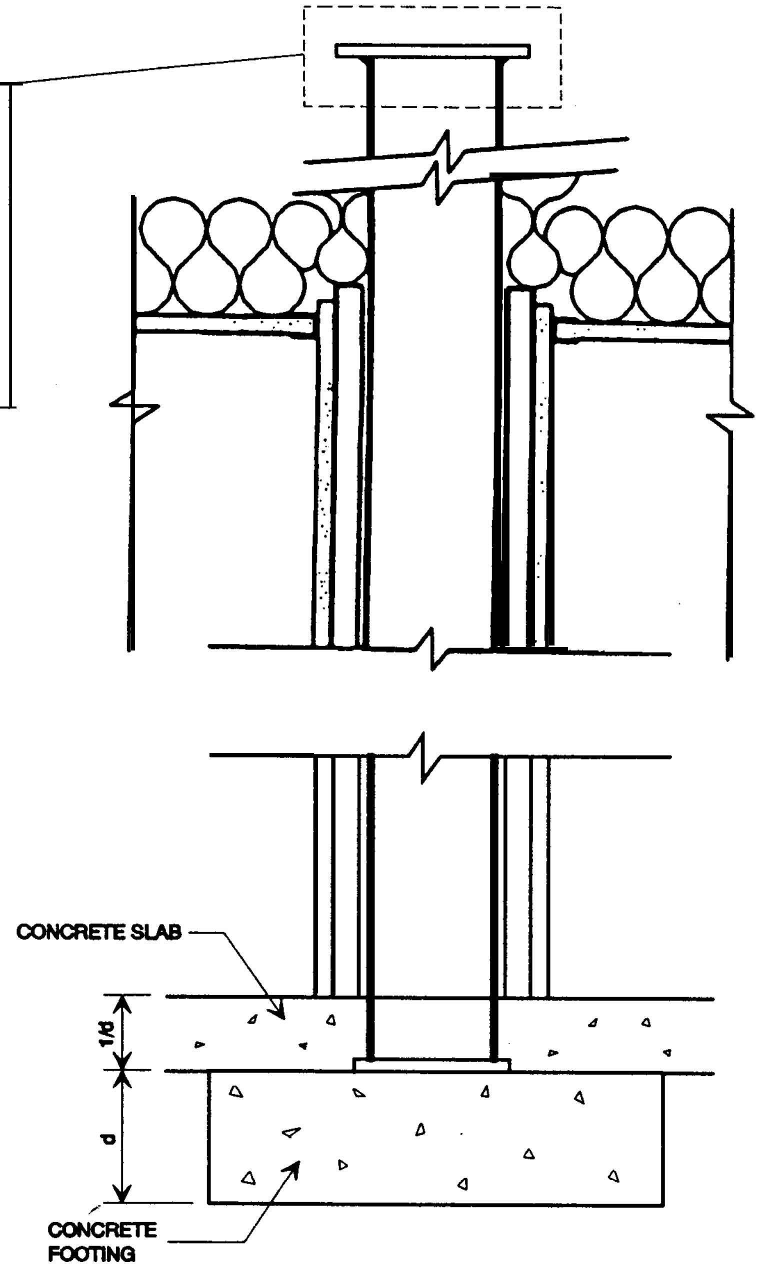
SYSTEM ASSEMBLY DETAILS-SUBSTRUCTURE	H SHAPE COLUMN		
COLUMNS STEEL COLUMNS (CSI 05120)	Revision No.	Issue Date 5/93	Drawing No. A020203-1

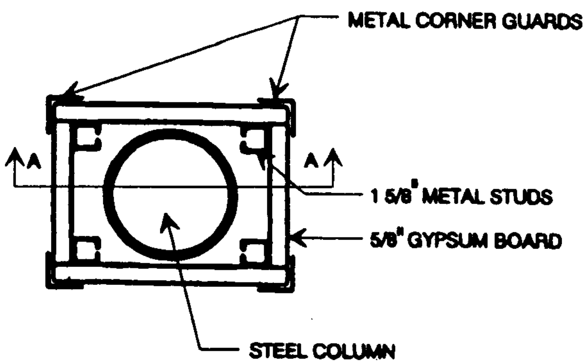


STEEL PIPE COLUMN AND FIREPROOFING

SYSTEM ASSEMBLY DETAILS-SUBSTRUCTURE	STEEL PIPE COLUMN		
COLUMNS STEEL COLUMNS (CSI 05120)	Revision No.	Issue Date 5/93	Drawhg No. A020203-2



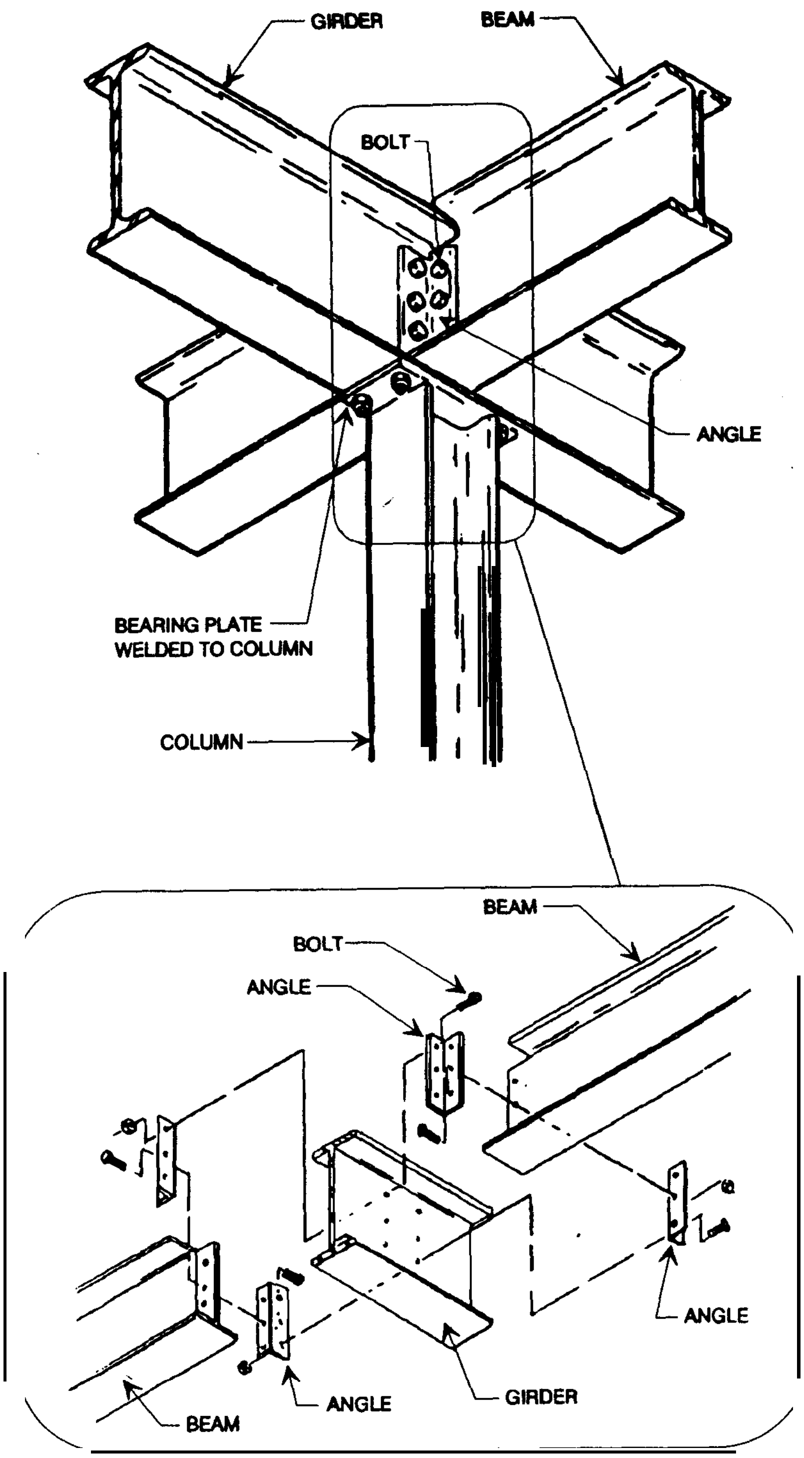




PLAN/SECTION

SECTION AA

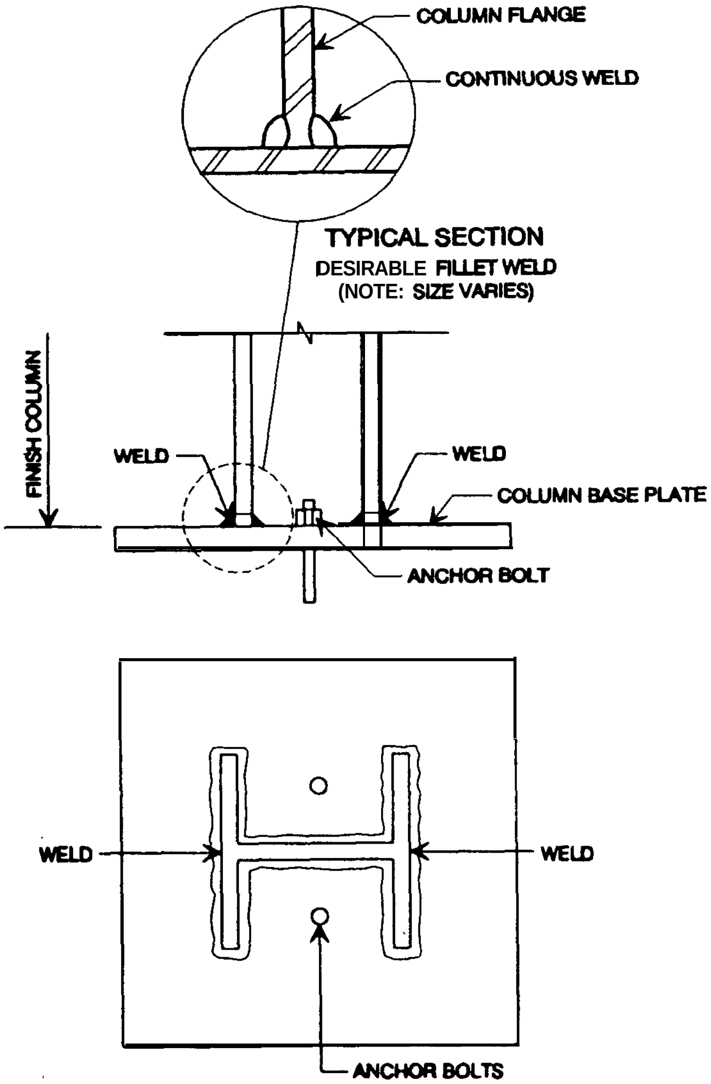
SYSTEM ASSEMBLY DETAILS-SUBSTRUCTURE	STEEL PIPE COLUMN		
COLUMNS STEEL COLUMNS (CSI 05120)	Revision No.	Issue Date 5/93	Drawing No. A020203-3



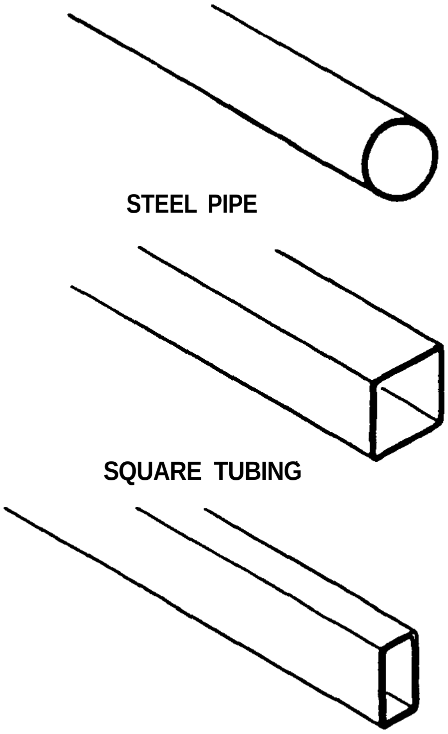
ROOF GIRDER, BEAM, COLUMN ASSEMBLY

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION., "R.S. Means Co., Inc., Kingston, Massachusetts"

SYSTEM ASSEMBLY DETAILS-SUBSTRUCTURE	STEEL COLUMNS & BEARING PLATE		
COLUMNS STEEL COLUMNS (CSI 05100)	Revision No.	Issue Date 5/93	Drawing No. A020203-4



COLUMN BASE PLATE
(NON-MOMENT RESISTING)



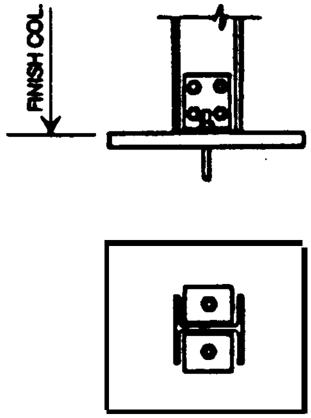
STEEL PIPE

SQUARE TUBING

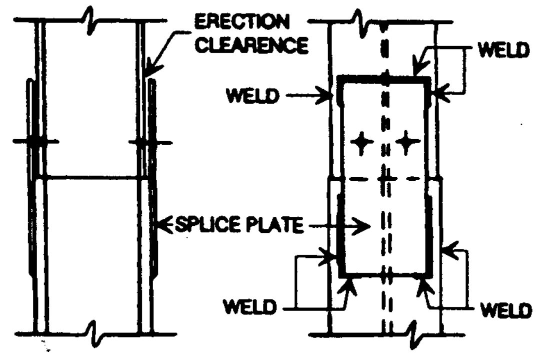
RECTANGULAR TUBING

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION., "R.S. Means Co., Inc., Kingston, Massachusetts"

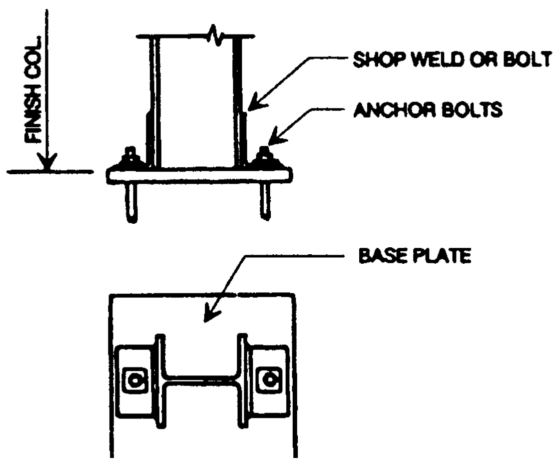
SYSTEM ASSEMBLY DETAILS-SUBSTRUCTURE	STEEL COLUMNS & BASE PLATE		
COLUMNS STEEL COLUMNS (CSI 05100)	Revision No.	Issue Date 5/93	Drawing No. A020203-5



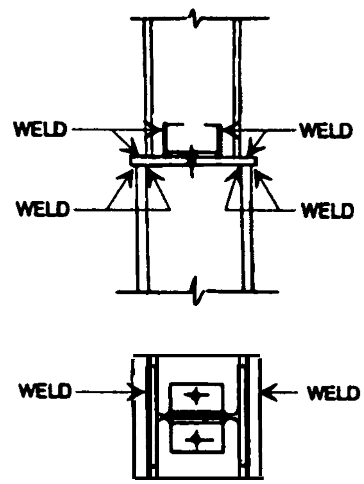
COLUMN BASE PLATE
(MOMENT RESISTING)

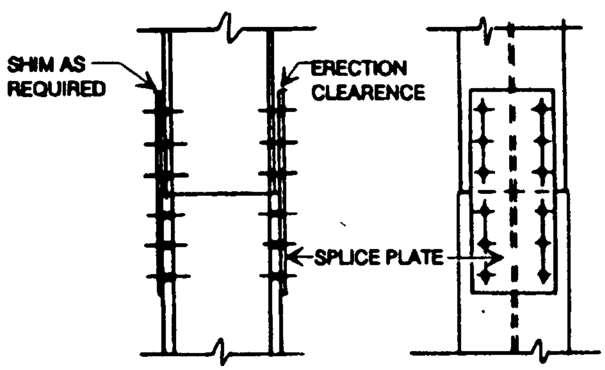


COLUMN SPLICE-WELDED
(NOTE: CHECK FOR '0' CLEARANCE AT JOINT)

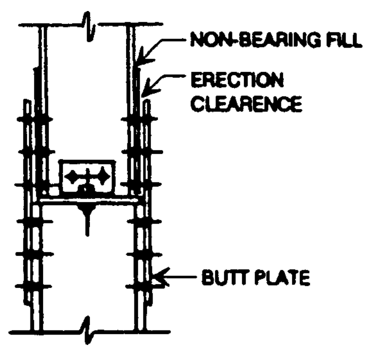


COLUMN BASE PLATE





COLUMN SPLICE-BOLTED



COLUMN BUTT SPLICE-BOLTED

SOURCE: MEANS GRAPHIC CONSTRUCTION STANDARDS, 1ST EDITION., "R.S. Means Co., Inc., Kingston, Massachusetts"

SYSTEM ASSEMBLY DETAILS-SUBSTRUCTURE	STEEL COLUMN TO COLUMN CONNECTION		
COLUMNS STEEL COLUMNS (CSI 05100)	Revision No.	Issue Date 5/93	Drawing No. A020203-6

DEFICIENCY FACTORS
0.02.02.03 STEEL (CSI 05120)

END OF SUBSECTION

0.02.02.04 WOOD (CSI 06100)

DESCRIPTION

Wood columns are usually loaded axially in compression and transfer loads to footings and/or foundations. Graphic assembly details that follow illustrate general assembly/component types only and are not meant as a definitive, exhaustive, in-depth system breakdown. Field conditions will vary and are subject to project type, local requirements, and facility design.

ASSOCIATED ASSEMBLY/STANDARD COMPONENTS

Wood Columns (CSI 06100)

Types &Shapes of Columns:

The most common wood column is a solid member of rectangular or round cross-section. Under certain conditions, members may be nailed or bolted together to form larger columns but due to the possibility of movement along the joint, such members have lower load capacity than sawed or round columns.

Spaced Columns:

Spaced columns consist of two or more pieces with spacer blocks between. They are frequently used as top chords of wood trusses. Because end members of a spaced column are restrained, the degree of end fixity for a spaced column is greater than for the type of simple column described in the preceding paragraph. The side members and spacer blocks of spaced columns are connected by bolts or bolts and split-ring connectors.

Built-Up Columns with Mechanical Fastenings:

Built-up columns consist of pieces joined by nails, bolts, or other mechanical fasteners into a column "assembly." A column created in this manner is not fully equal in strength to a one-piece member of comparable material and dimensions. However, this type of built-up column is sometimes used with parallel planks and cover plates, or with planks boxed around a solid core.

Spaced Columns, Connector Joined:

Spaced columns are formed by two or more individual solid members with their longitudinal axes parallel, separated by blocking at the ends and at one or more intermediate points of their length. The ends are joined by timber connectors capable of developing the required shear resistance.

Location of Spacer & End Blocks:

Connectors are required with two or more spacer blocks. The distance between two adjacent blocks may not exceed one-half the distance between the centers of connectors in the end blocks.

Investigating the strength of a wood column or other member loaded to induce compression parallel to grain should take the following factors into consideration:

- Types of columns: whether solid, spaced, or built-up member.
- Shape of cross-section: whether rectangular, round, or other form.
- Cross-sectional area of column.
- Amount and type of loading.
- Design values for species and grade of lumber used.

0.02.02.04 WOOD (CSD 06100)

OTHER RELATED COMPONENTS

See the following subsections for related components:

0.02.01 Slabs-on-Grade 2.1-l
0.02.03 Column Fireproofing 2.3-l

Refer to Foundations & Footings and Superstructure Systems, Volumes 1 and 3, for additional deficiencies that may impact this system.

DEFICIENCY FACTORS
0.02.02.04 WOOD (CSI 00100)

PROBABLE FAILURE POINTS

- Lack of curing resulting from accelerated curing, improper temperatures, procedures, mix, etc., will increase the degree of cracking in a concrete structure.
- Reinforcement corrosion causing cracking and/or deterioration of concrete from the presence of air and moisture.
- Termite and boring insect damage causing breakdown of structural integrity.
- Decay (rot) due to fungi, mildew, or dry rot causing surface deterioration.
- Fire damage or charred surfaces causing flaking or surface breakdown.
- Loose connections caused by vibration, temperature changes, or improper tightness.
- Splitting or checking caused by stress, bending, or twisting.
- Cracking caused by stress, settlement/movement, poor materials, or improper construction.
- Impact damage caused by objects striking or impacting the surface.

SYSTEM ASSEMBLIES/DEFICIENCIES

Out-of-Alignment:	Bowing, deflection, or other movement that brings the surface out of plumb or not level in one or more directions.
Cracking:	Cracking, usually structural in nature, which results in tearing, ripping, or shearing. Cracks can be random, horizontal, vertical, or diagonal.
Surface Deterioration:	Crazing, small surface cracks, corrosion, and surface breakdown due to weather, pressure, or other actions.
Impact Damage/Denting:	Depressions, punctures or buckled surface from objects striking or impacting the surface.
Staining:	Surface discoloration of a material from a foreign substance or material.
Plant Growth Moss/Algae:	Moss or algae growth over the surface, usually resulting from excessive moisture.
Insufficient Anchors/Connections:	Broken, damaged, loose, corroded, or missing anchorage or fasteners caused by vibration, excessive deflection, or improper tightness.
Dry Rot/Decay:	Breakdown of structural integrity from mold/mildew or dry rot.
Loss of Protective Coating/Paint:	Chalking, peeling, chipping, blistering, or deterioration.
Splitting:	Surface splitting or tearing.
Insect Damage:	Holes, cracks, or punctures from burrowing insects.
Burned or Charred Surface:	Damage from fire or excessive heat on surface.

DEFICIENCY FACTORS
0.02.02.04 WOOD (CSI 06100)

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ROTTED COLUMN BASE

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAILS-SUBSTRUCTURE	ROTTED WOOD COLUMN BASE		
COLUMNS WOOD COLUMNS (CSI 06100)	Revision No.	Issue Date 5/93	Drawing No. 0020204-I

CRACKED/ROTTED COLUMN BASE

PHOTO ILLUSTRATION

SYSTEM ASSEMBLY DEFICIENCY DETAIL-SUBSTRUCTURE	ROTTED WOOD COLUMN BASE		
COLUMNS WOOD COLUMNS (CSI 06100)	Revision No.	Issue Date 5/93	Drawing No. D020204-2

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: SLABS-ON-GRADE
CONTROL NUMBER: GSS 0.02.01

APPLICATION

This guide applies to all Slabs-on-Grade including reinforced, non-reinforced, and associated components.

SPECIAL INSTRUCTIONS

1. This is a general inspection, and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Refer to references and glossaries as needed.

CONCURRENT ACTIONS

Inspect foundations and footings for signs of damage or deterioration that may be traced to slabs-on-grade deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Slabs-on-Grade to include visual survey, examination of building records, and analysis. Points include:

1. Check for overall water tightness, including presence of, or location and duration of, any water leaks. Verify any historical information concerning leaks. Leaks can signify cracks or excessive hydrostatic pressures.
2. Check general appearance of foundation wall or substructure for any stress-related conditions. Determine type of stress as tension, compression, shear, bending, or buckling.
3. Check for uneven settlement by observing condition of existing grade on exterior, foundation, or slab surface.
4. Check for uplift or presence of hydrostatic pressure causing upward movement of existing grade, foundation wall, or slab.
5. Check slab for any structural modifications, new equipment on old slabs, old equipments since removed, sub slab pits (new or filled-in), and traffice usuage changes.
6. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth and width, presence of foreign materials, and elevation differences between two cracked surfaces. Determine if crack is active or dormant by following these steps:
   a. Mark the end of the crack and check over time to determine if cracks are active or dormant.
   b. Place a notched piece of tape across the crack, wait for a period of a month or more. If tape tears or compresses (wrinkles) the crack is active, and if the tape shows no apparent change the crack is dormant.
   c. Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.
7. Check for exposure conditions, specifically chemical attack and freeze-thaw action.
8. Check all previous repairs for conditions of any possible cracking or deterioration.

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: SLABS-ON-GRADE (Continued)
CONTROL NUMBER: GSS 0.02.01

TOOLS & MATERIALS

1. Standard Tools - Basic
2. Level

INSPECTION METHODS . STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: CAST-IN-PLACE CONCRETE COLUMNS
CONTROL NUMBER: GSS 0.02.02.01

APPLICATION

This guide applies to all Cast-in-Place Concrete Columns.

SPECIAL INSTRUCTIONS

1. This is a general inspection and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types; and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Slabs-on-Grade. (See GSS 0.02.01)
2. Inspect Column Fireproofing. (See GSS 0.02.03)
3. Inspect foundations and footings and superstructure for signs of damage or deterioration that may be related to Cast-in-place concrete columns deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Cast-in-Place Concrete Columns to include visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking but usually no spalling; compression (pushing or crushing force), which causes crushing and spalling; shear (slicing action), which causes diagonal or stepped cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking with no spalling. Buckling is a form of bending, the condition is most visible at the outermost fibers on one side of the member. Bending is usually associated with a high probability of failure.
2. Check for uneven settlement by observing condition of existing grade on exterior or condition of foundation slab.
3. Check for uplift or presence of hydrostatic pressure causing upward movement of existing grade or slab.
4. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), impact exposure, efflorescence, staining and rust, dusting, surface deterioration, decay, splitting, operation or misuse of material, and extent of each.,
5. Check all previous repairs for conditions of any possible cracking or deterioration.
6. Check for any exposed reinforcement and extent of rust or deterioration.
7. Check all sealant, expansion/contraction joints, or mortar/grout joints for deterioration or cracking.

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: CAST-IN-PLACE CONCRETE COLUMNS (Continued)
CONTROL NUMBER: GSS 0.02.02.01

INSPECTION ACTIONS

8. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth and width, presence of foreign materials, and elevation differences between two cracked surfaces. Determine if crack is active or dormant by following these steps:
   a. Mark the end of the crack and check to see if crack has extended past mark.
   b. Place a notched piece of tape across the crack and wait for a period of a month or more. If tape tears or compresses (wrinkles) the crack is active, and if the tape shows no apparent change the crack is dormant.
   c. Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. Level

INSPECTION METHODS ▪ STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: LOADED PRECAST CONCRETE COLUMNS
CONTROL NUMBER: GSS 0.02.02.02

APPLICATION

This guide applies to all Loaded Precast Concrete Columns.

SPECIAL INSTRUCTIONS

1. This is a general inspection and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Slabs-on-Grade. (See GSS 0.02.01)
2. Inspect Column Fireproofing. (See GSS 0.02.03)
3. Inspect foundations and footings and superstructure for signs of damage or deterioration that may be related to Cast-in-place concrete columns deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Loaded Precast Concrete Columns to include visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking but usually no spalling; compression (pushing or crushing force), which causes crushing and spalling; shear (slicing action), which causes diagonal or stepped cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking with no spalling. Buckling is a form of bending, the condition is most visible at the outermost fibers on one side of the member. Bending is usually associated with a high probability of failure.
2. Check for uneven settlement by observing condition of existing grade on exterior or condition of foundation slab.
3. Check for improper design and construction conditions that can cause deficiencies such as cracking and surface deterioration.
4. Check for uplift or presence of hydrostatic pressure causing upward movement of existing grade or slab.
5. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), impact exposure: efflorescence, staining and rust, dusting, surface deterioration, decay, splitting, operation or misuse of material, and extent of each.
6. Check all previous repair and patches for any possible cracking or deterioration.
7. Check for any exposed reinforcement and extent of rust or deterioration.
8. Check for improperly designed or placed anchorage components. Verify that anchorage is intact and properly tightened.
9. Check all sealant, expansion/contraction joints, or mortar/grout joints for deterioration or cracking.

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: LOADED PRECAST CONCRETE COLUMNS (Continued)
CONTROL NUMBER: GSS 0.02.02.02

INSPECTION ACTIONS

10. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth and width, presence of foreign materials, and elevation differences between two cracked surfaces. Determine if crack is active or dormant by following these steps:
    a. Mark the end of the crack and check to see if crack has extended past mark. Note direction.
    b. Place a notched piece of tape across the crack. Wait for a period of a month or more. If tape tears or compresses (wrinkles) the crack is active, and if the tape shows no apparent change the crack is dormant.
    c. Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. Level

INSPECTION METHODS . STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: STEEL COLUMNS
CONTROL NUMBER: GSS 0.02.02.03

APPLICATION

This guide applies to all steel columns.

SPECIAL INSTRUCTIONS

1. This is a general inspection and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies.
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Slabs-on-Grade. (GSS 0.02.01)
2. Inspect Column Fireproofing. (GSS 0.02.03)
3. inspect foundations and footings and superstructure for signs of damage or deterioration that may be related to steel column deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Steel Columns to include visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes stretching, compression (pushing or crushing force), which causes crushing; shear (slicing action), which causes diagonal cracks and distortion which is a combination of bending, buckling, and twisting of the member. Buckling is usually associated witha high probability of failure.
2. Check for uneven settlement by observing condition of existing grade on exterior or foundation slab.
3. Check for uplift or presence of hydrostatic pressure causing upward movement of existing grade or slab.
4. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), impact exposure, staining and rust, corrosion, surface deterioration, operation or misuse of material, and extent of each.
5. Check all previous repairs for conditions of any possible failures or deterioration.
6. Check for improper or damaged welds and "Lamellar" tearing of weld joints.
7. Check condition of anchorage to verify that it is intact and properly tightened.
8. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth and width, presence of foreign materials, and elevation differences between cracked surfaces. Determine if crack is active or dormant by following these steps:
   a. Mark the end of the crack and check after a few days to see if crack has extended past mark. Note direction.
   b. Place a notched piece of tape across the crack and wait for a period of a month or more. If tape tears or compresses (wrinkle) the crack is active, and if the tape shows no apparent change the crack is dormant.
   c. Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.

INSPECTION METHODS . STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: STEEL COLUMNS (Continued)
CONTROL NUMBER: GSS 0.02.02.03

TOOLS & MATERIALS

1. Standard Tools - Basic
2. Level

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: WOOD COLUMNS
CONTROL NUMBER: GSS 0.02.02.04

APPLICATION

This guide applies to all structural/non-structural wood columns.

SPECIAL INSTRUCTIONS

1. This is a general inspection and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Consult a licensed structural engineer for significant deficiencies,
4. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Slabs-on-Grade. (GSS 0.02.01)
2. Inspect Column Fireproofing. (GSS 0.02.03)
3. Inspect foundations and footings and superstructure for signs of damage or deterioration that may be related to wood column deficiencies.

INSPECTION ACTIONS

Condition Assessment Survey of Wood Columns to include visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes splitting; compression (pushing or crushing force) which causes crushing; shear (slicing action), which causes diagonal or perpendicular to the member cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking or splitting. Buckling is a form of bending, most visible at the outermost fibers on one side of the member. Bending is usually associated with a high probability of failure.
2. Check for uneven settlement by observing condition of existing grade on exterior or foundation slab.
3. Check for improper design and construction conditions that can cause deficiencies such as cracking and surface deterioration.
4. Check for uplift or presence of hydrostatic pressure causing upward movement of existing grade or slab.
5. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), impact exposure, staining, dry rot, surface deterioration, decay, splitting, operation or misuse of material, and extent of each.
6. Check all previous repairs for conditions of any possible cracking or deterioration.
7. Check for improperly designed or placed anchorage components to verify that it is intact and properly tightened.
8. Check for any splitting, cracking, or deterioration of surface.

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: WOOD COLUMNS (Continued)
CONTROL NUMBER: GSS 0.02.02.04

INSPECTION ACTIONS

9. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Stress analysis consists of documenting the location, pattern, depth and width, presence of foreign materials, and elevation differences between cracked surfaces. Determine if crack is active or dormant by following these steps:
   a. Mark the end of the crack and check after a few days to see if crack has extended past mark. Note direction.
   b. Place a notched piece of tape across the crack and wait for a period of a month or more. If tape tears or compresses (wrinkle) the crack is active, and if the tape shows no apparent change the crack is dormant.
   c. Apply pins and gauge points on either side of crack. Measure distance between points at regular intervals with vernier calipers to determine the extent of movement.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. Level

INSPECTION METHODS - STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: COLUMN FIREPROOFING
CONTROL NUMBER: GSS 0.02.03

APPLICATION

This guide applies to all column fireproofing systems and associated work.

SPECIAL INSTRUCTIONS

1. This is a general inspection and deficiencies should be handled on a service call or repair basis.
2. Review any as-builts and other data to determine locations, types, and construction.
3. Refer to references and glossaries as needed.

CONCURRENT ACTIONS

1. Inspect Cast-in-Place Concrete Columns. (GSS 0.02.02.01)
2. Inspect Loaded Precast Concrete Columns. (GSS 0.02.02.02)
3. Inspect Steel Columns. (GSS 0.02.02.03)
4. Inspect Wood Columns. (GSS 0.02.02.04)

INSPECTION ACTIONS

Condition Assessment Survey of Column Fireproofing to include visual survey, examination of building records, and analysis. Points include:

1. Check general appearance for any stress-related conditions. Determine type of stress as tension (pulling force), which causes cracking but usually no spalling; compression (pushing or crushing force), which causes crushing and spalling; shear (slicing action), which causes diagonal or stepped cracking from point of maximum load or shear; and bending (combination of tension and compression), which causes cracking with no spalling. Buckling is a form of bending, the condition is most visible at the outermost fibers on one side of the member. Bending is usually associated with, a high probability of failure.
2. Check for uneven settlement by observing condition of existing grade or foundation walls.
3. Check for uplift or presence of hydrostatic pressure causing upward movement of existing grade or slab.
4. Check for exposure conditions, specifically chemical attack (i.e., is surface material resistant to process contamination), impact exposure, efflorescence, staining and rust, dusting, surface deterioration, decay, splitting, operation or misuse of material, and extent of each.
5. Check for water or moisture damage causing material deterioration and breakdown,
6. Check all previous repairs and patches for any possible cracking or deterioration,.
7. Perform stress analysis and monitor cracking to determine if cracks are active or dormant. Results of this test can indicate condition of substrate (i.e., column).

TOOLS & MATERIALS

1. Standard Tools - Basic
2. Level

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEETS

The following Guide Sheets outline an overview of inspection methods and requirements used in providing a general non-standard inspection. For these non-standard inspections, it is assumed that all standard inspections will be completed in order to determine non-standard methodology. (However, non-standard methods may be implemented as a non-contingent option.) Non-standard Guide Sheets have been developed for each major assembly type and associated assembly components as follows:

TABLE TWO

Assembly/Component	Control Number
Slabs-on-Grade	GSNS 0.02.01
Cast-in-Place Concrete	GSNS 0.02.02.01
Loaded Precast Concrete	GSNS 0.02.02.02
Steel	GSNS 0.02.02.03
Wood	GSNS 0.02.02.04
Column Fireproofing	GSNS 0.02.03

INSPECTION METHODS ▪ NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: SLABS-ON-GRADE
CONTROL NUMBER: GSNS 0.02.01

APPLICATION

This guide applies to all non-standard inspection procedures for Slabs-on-Grade including reinforced, non-reinforced, and associated components.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to references and glossaries as needed.

CONCURRENT ACTIONS

1. Inspect foundations and footings for signs of damage or deterioration that may be related to or result in slab-on-grade deficiencies.
2. Complete inspection requirements listed in GSS 0.02.01.

INSPECTION ACTIONS

Based on results of GSS 0.02.01 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions,
2. Perform Infrared or Nuclear Analysis Testing to determine if water or moisture is present, indicating general location of internal cracks or voids.
3. Perform Ultrasonic Pulse Velocity Test to locate defects within the material and to determine internal discontinuity.
4. Take core samples to determine condition or strength of the material. Patch sample holes immediately.
5. Perform Magnetic Particle Test to determine material thickness and reinforcement location.
6. Perform Electrical Resistivity Test to determine moisture content, material thickness and degree of corrosion or deterioration of reinforcing steel.
7. Perform Surface Hardness Testing or Maturity Concept Analysis to determine material condition and locate possible defects or deficiencies within the material.
8. Perform Acoustic Emission Test or Microwave Absorption Scanning if conditions allow. Both methods are relatively new, and results are questionable.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS - NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: CAST-IN-PLACE CONCRETE COLUMNS
CONTROL NUMBER: GSNS 0.02.02.01

APPLICATION

This guide applies to all non-standard inspection procedures for cast-in-place concrete columns.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Consult a licensed structural engineer for significant deficiencies.
3. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Slabs-on-Grade. (See GSNS 0.02.01)
2. Inspect Column Fireproofing. (See GSNS 0.02.03)
3. Inspect foundations and footings and superstructure for signs of damage or deterioration which may be related to Cast-in-Place Concrete Column deficiencies.
4. Complete inspection requirements listed in GSS 0.02.02.01.

INSPECTION ACTIONS

Based on results of GSS 0.02.02.01 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Surface Hardness Testing or Maturity Concept Analysis to determine material condition and locate possible defects or deficiencies within the material.
3. Take core samples to determine condition or strength of the material. Patch sample holes immediately. Use great care when performing this work and consult a licensed structural engineer before proceeding.
4. Perform Infrared or Nuclear Analysis Testing to determine if water or moisture is present, indicating general location of internal cracks or voids.
5. Perform Ultrasonic Pulse Velocity Test to locate defects within the material and to determine internal discontinuity.
6. Perform Magnetic Particle Test to determine reinforcement location.
7. Perform Electrical Resistivity Test to determine moisture content, material thickness and degree of corrosion or deterioration.
8. Perform Radiography (X-Ray) Testing to detect cracking, internal defects, and deficiencies.
9. Perform Microwave Absorption Scanning to d&ermine moisture content and material defects. This is a relatively new method still under development.
10. Perform Acoustic Emission Test to determine high stress concentration points and material deformations. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS • NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: LOADED PRECAST CONCRETE COLUMNS
CONTROL NUMBER: GSNS 0.02.02.02

APPLICATION

This guide applies to all non-standard inspection procedures for Loaded Precast Concrete Columns.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Consult a licensed structural engineer for significant deficiencies. `
3. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Slabs-on-Grade. (See GSNS 0.02.01)
2. Inspect Column Fireproofing. (See GSNS 0.02.03)
3. Inspect foundations and footings and superstructure for signs of damage or deterioration that may be related to cast-in-place concrete columns deficiencies.
4. Complete inspection requirements listed in GSS 0.02.02.02.

INSPECTION ACTIONS

Based on results of GSS 0.02.02.02 and/or as directed, proceed to non-standard. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Surface Hardness Testing or Maturity Concept Analysis to determine material condition and locate possible defects or deficiencies within the material.
3. Take core samples to determine condition or strength of the material. Patch sample holes immediately. Use great care when performing this work and consult a licensed structural engineer before proceeding.
4. Perform infrared or Nuclear Analysis Testing to determine if water or moisture is present, indicating general location of internal cracks or voids.
5. Perform Ultrasonic Pulse Velocity Test to locate defects within the material and to determine internal discontinuity.
6. Perform Magnetic Particle Test to determine material thickness and reinforcement location.
7. Perform Electrical Resistivity Test to determine moisture content, material thickness, and degree of corrosion or deterioration of reinforcing steel.
8. Perform Radiography (X-Ray) Testing to detect cracking, internal defects, density and material thickness.
9. Perform Microwave Absorption Scanning to determine moisture content and material defects. This is a relatively new method still under development.
10. Perform Acoustic Emission Test. to determine high stress concentration points and material deformations. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS - NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: STEEL COLUMNS
CONTROL NUMBER: GSNS 0.02.02.03

APPLICATION

This guide applies to all non-standard inspection procedures for steel columns.

SPECIAL INSTRUCTIONS

1. Review any as-buiits and other data to determine locations, types, and construction.
2. Consult a licensed structural engineer for significant deficiencies.
3. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Slabs-on-Grade. (GSNS 0.02.01)
2. Inspect Column Fireproofing. (GSNS 0.02.03)
3. Inspect foundations and footings and superstructure for signs of damage or deterioration that may be related to steel column deficiencies.
4. Complete inspection requirements listed in GSS 0.02.02.03.

INSPECTION ACTIONS

Based on results of GSS 0.02.02.03 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Ultrasonic Pulse Velocity Test to locate subsurface defects within the material and to determine internal discontinuity.
3. Perform Magnetic Particle Test to determine subsurface cracks, laminations and porosities.
4. Perform Radiography (X-Ray) Testing to detect cracking, material defects, or deficiencies.
5. Perform Liquid Penetrant Test to determine surface discontinuities, laminations, and incomplete fusion of welds.
8. Perform Acoustic Emission Test to determine high stress concentration points and material deformations. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS • NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: WOOD COLUMNS
CONTROL NUMBER: GSNS 0.02.02.04

APPLICATION

This guide applies to all non-standard inspection procedures for structural/non-structural columns.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Consult a licensed structural engineer for significant deficiencies.
3. Refer to glossary and references as needed.

CONCURRENT ACTIONS

1. Inspect Slabs-on-Grade. (GSNS 0.02.01)
2. Inspect Column Fireproofing. (GSNS 0.02.03)
3. Inspect foundations and footings and superstructure for signs of damage or deterioration that may be related to wood column deficiencies.
4. Complete inspection requirements listed in GSS 0.02.02.04.

INSPECTION ACTIONS

Based on results of GSS 0.02.02.04 and/or as directed, proceed to non-standard inspections Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Ultrasonic Pulse Velocity Test or stress wave propagation test to locate defects within the material; to determine the degree of deterioration, and estimate modulus of elastity and strength.
3. Perform Radiography (X-Ray) Testing to detect cracking, material defects, or deficiencies including grain irregularities, decay, internal splits, and insect damage.
4. Take core sample to determine condition of strength of the material, extent of internal decay, or extent of surface charring from fire damage..
5. Use a Moisture Meter to verify moisture level within the material.
6. Perform a Probe Test with a sharp instrument i.e., awl to locate areas of decay or soft spots in the material.
7. Perform Microwave Absorption Scanning to determine material defects. This is a relatively new method still under development.
8. Perform Acoustic Emission Test to determine stress points and material deformations. This is a difficult test requiring dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed.

INSPECTION METHODS - NON-STANDARD

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INSPECTION METHODS - NON-STANDARD

GUIDE SHEET

SYSTEM/COMPONENT: COLUMN FIREPROOFING
CONTROL NUMBER: GSNS 0.02.03

APPLICATION

This guide applies to all non-standard inspection procedures for column fireproofing systems and associated work.

SPECIAL INSTRUCTIONS

1. Review any as-builts and other data to determine locations, types, and construction.
2. Refer to references and glossaries as needed.

CONCURRENT ACTIONS

1. Inspect Cast-in-Place Concrete Columns. (GSNS 0.02.02.01)
2. Inspect Loaded Precast Concrete Columns. (GSNS 0.02.02.02)
3. Inspect Steel Columns. (GSNS 0.02.02.03)
4. Inspect Wood Columns. (GSNS 0.02.02.04)
5. Complete inspection requirements listed in GSS 0.02.03.

INSPECTION ACTIONS

Based on results of GSS 0.02.03 and/or as directed, proceed to non-standard inspections. Points include:

1. Perform an environmental data analysis to determine the effects of external environmental conditions.
2. Perform Infrared or Nuclear Analysis Testing to determine if water or moisture is present, indicating general location of internal cracks or voids.
3. Perform Ultrasonic Pulse Velocity Test to locate defects within the material and to determine internal discontinuity.
4. Take core samples to determine condition or strength of the material. Patch sample holes immediately to maintain fireproofing rating.
5. Use a moisture meter tp verify moisture level within the material.
6. Perform Electrical Resistivity Test to determine moisture content, material thickness, and degree of deterioration.
7. Perform Radiography (X-Ray) Testing to detect cracking, internal defects, and deficiencies.
8. Perform Microwave Absorption Scanning to determine moisture content and material defects. This is a relatively new method still under development.
9. Perform Acoustic Emission Test to determine high stress concentration points and material deformations. This is a difficult test requiring ‘dynamic loading conditions.

TOOLS & MATERIALS

1. Standard Tools - Basic
2. As required for the type of test being performed

INSPECTION METHODS • NON-STANDARD

END OF SUBSECTION

DATA COLLECTION METHODS

GENERAL

The heart of the CAS System is built around the hand-held data collection device and the CAIS software that supports it. As discussed in the Introduction, this is a "new way" of seeing and recording specific standardized information. Several phases are involved in the CAS inspection process. They include:

PHASE I — PRESURVEY

- Facility managers review assets and assign each an Asset Determinant Factor (ADF) to define the level and type of inspection to be accomplished (see Subsection 1 .1 for definition).
- Facility managers assign specific assets to CAS inspectors.
- The CAS Inspector reviews existing asset data (including as-builts and past repair reports) and the Work Breakdown Structure (WBS) systems requiring inspection, which are then subdivided as necessary. (For example, a large roof may be subdivided into four (4) WBS items such as North, South, East and West sections.)
- The inspector establishes the Inspection Units (IU) to be surveyed based on the WBS (or multiple WBS). IUs may also be added in the field.
- Facility manager and/or staff downloads asset data into the hand-held data collection device.

PHASE 2 — SURVEY

- Conduct CAS inspection.
- Upload data into PC-based CAIS.
- Review raw data "universal" reports.

PHASE 3 — **POSTSURVEY**

- Correct data, as necessary, issue final "universal" report, and create other required reports for facility managers.
- Data and reports are created and issued through DOE hierarchy (see Introduction).

DATA COLLECTION METHODS

ENTERING DATA: DATA COLLECTION MENU

SURVEY STEP: **LOGIN** SCREEN 1.0

The screen contains identification data including the inspector's name, ID number, and discipline to be inspected. This data may be input or preloaded. From this screen, several information and help pop-up aids can be accessed. Help functions would provide screen-specific instructions, and information functions would list special management instructions and/or schedules specifically for the inspector.

SURVEY STEP: ASSET' IDENTIFICATION SCREEN 2.0

Asset identification including class, type, ADF number (see subsection 1.1 for ADF description), and asset ID numbers are captured on this screen. Pop-up screens with preformatted picklists (for type and class) are provided for the inspector's review and selection. Additional support screens include ASSET DIMENSIONS indicating key elements required for inspection (such as asset gross square footage, perimeter, height, etc.); and ASSET DESCRIPTION for recording asset name and address. Such information would be entered (or verified) by the inspector prior to the actual asset CAS inspection.

SURVEY STEP: WBS SELECTION SCREEN 3.0

This screen displays the preselected systems and WBS listings based on the ADF selected for the particular asset. Although all WBS assemblies for a system will be listed, the inspector selects only assemblies applicable to the specific asset. For example, although all system 0.05 Roof WBS categories are listed, the inspector would eliminate all non-applicable categories by "de-selecting" non-applicable items. Once this process is complete, the inspector can re-sort the included WBS items. Columns are also provided that indicate the survey status for each WBS item.

At this point, the inspector can subdivide the WBS. For example, the inspector may elect to split a large roof into four sections, each as a separate WBS, or isolate a pump from a WBS containing several pumps. This feature will allow the inspector to logically build his survey based on the unique properties and requirements of each asset.

Finally, while most WBS structuring will be accomplished prior to the CAS inspection, WBS subdivision can also be done in the field.

DATA COLLECTION METHODS

ENTERING DATA: DATA COLLECTION MENU (Continued)

SURVEY STEP: INSPECTION UNIT (IU) SELECTION SCREEN 4.0

While screen 3.0 defines the WBS structure, screen 4.0 concerns selecting the IU for each WBS category. In the CAIS software, the base CAS (see subsection 1.1 for definition) is preset at the assembly level for all systems. For example, a WBS Roof System, Built-up Membrane Roofing (0.05.01), is set at the assembly level. At this point the inspector would select the type of assembly based on a preselected picklist. (Such a picklist at the assembly level might include various roof assembly groupings; eg., 3 to 5-ply asphalt with gravel coating and composite insulation.) If a more detailed inspectron is required, the inspector would "de-select" the base CAS assembly level by crossing through the LVL Box "Assy." This action would bring up the next level "component." In our roof example, this would mean that the inspector would now assess the membrane, flashing, and insulation as separate components. As with the assembly level, the inspector would choose a type from a selected picklist for each component. Although IUs are usually determined prior to the survey, multiple IUs may also be developed during the inspection. For example, a WBS of the south quadrant built-up roof may be divided into two IUs (eg., sw corner and remaining roof) if the inspector chooses to highlight and isolate some abnormal conditions from the main IU.

Additional information developed on this screen would include the percentage of WBS served by the IU, the estimated quantity (this figure will also be independently generated by CAIS status (see subsection 1.1), estimated life remaining useful without repair (WOR), and estimated age.

SURVEY STEP: DEFICIENCY ASSESSMENT SCREEN 4.1

With the WBS and IU established, the inspector now conducts the CAS inspection for each WBS IU. As the inspector surveys the asset, a preformatted picklist containing all deficiencies that may affect the particular WBS IU is reviewed. The default setting shows a zero in each coverage block, indicating no deficiencies. As the survey proceeds, the inspector "de-selects" this normal setting by entering a percentage of coverage under condition categories listed (light, moderate, severe, and fail). For example, inspector entries for WBS roofing, IU built-up membrane, deficiency "splitting" of 10% light, 0% moderate, 0% severe, 0% fail, would be interpreted by CAIS software as 90% normal, and light splitting occurring over 10% of the membrane. If the inspector cannot determine the condition using standard inspection methods, he can indicate the need for a non-standard inspection (NSIP) by de-selecting the "NO" in the NSIP column. To complete the inspection, the aforementioned procedures would be carried out for each deficiency noted by the inspector.

DATA COLLECTION METHODS

ENTERING DATA: DATA COLLECTION MENU (Continued)

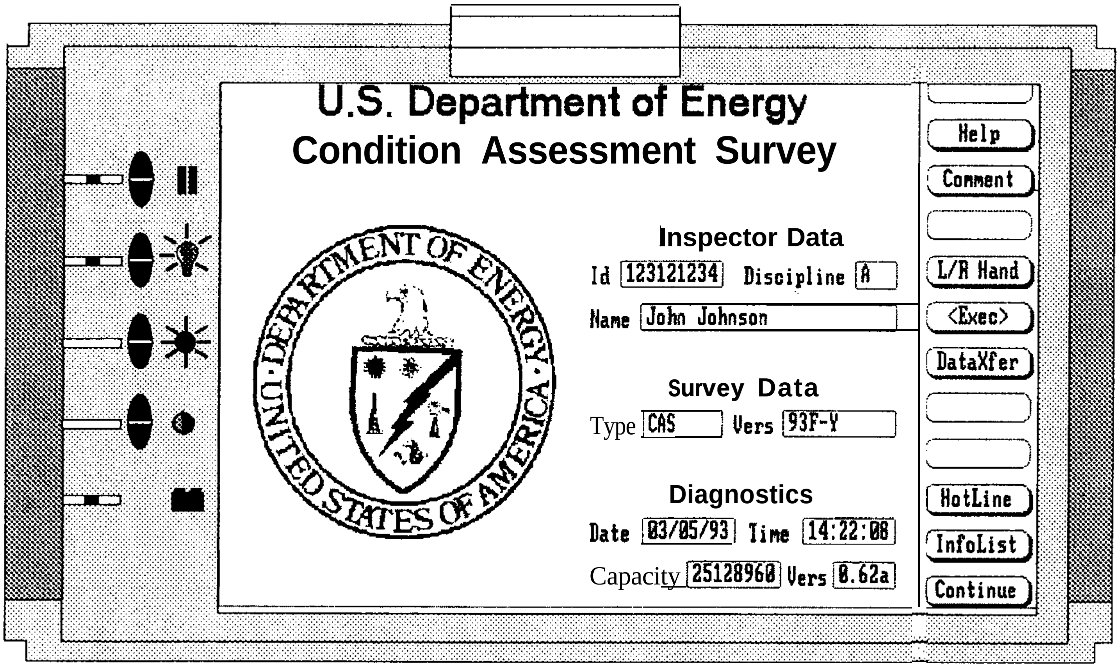
SURVEY STEP: SUMMARY CONDITION ASSESSMENT SCREEN 5.0

This final screen summarizes the WBS IU in three major categories: urgency, purpose, and condition. In each category, the inspector will call up a picklist and select the category he feels is most appropriate for the WBS IU surveyed. (For the purpose category, the inspector may select multiple headings.) Additionally, the inspector may elect to enter an estimated cost and/or quantity. (This is optional as CAIS will generate these data based on the inspector's survey information.) The inspector will also enter an estimated remaining life post-repair. As an option, a work order may be generated based on the CAS survey information. This option is generated by selecting the WORK ORDER function key and filling out pertinent data. Finally, the inspector may choose to describe the repair more fully by selecting the REPAIR CHARACTER key.

After completing all WBS IUs, the CAS inspection for the system is complete. This procedure is repeated for each applicable system. Once all systems for the asset are complete, the information is uploaded to the PC-based CAIS program for data analysis and report generation.

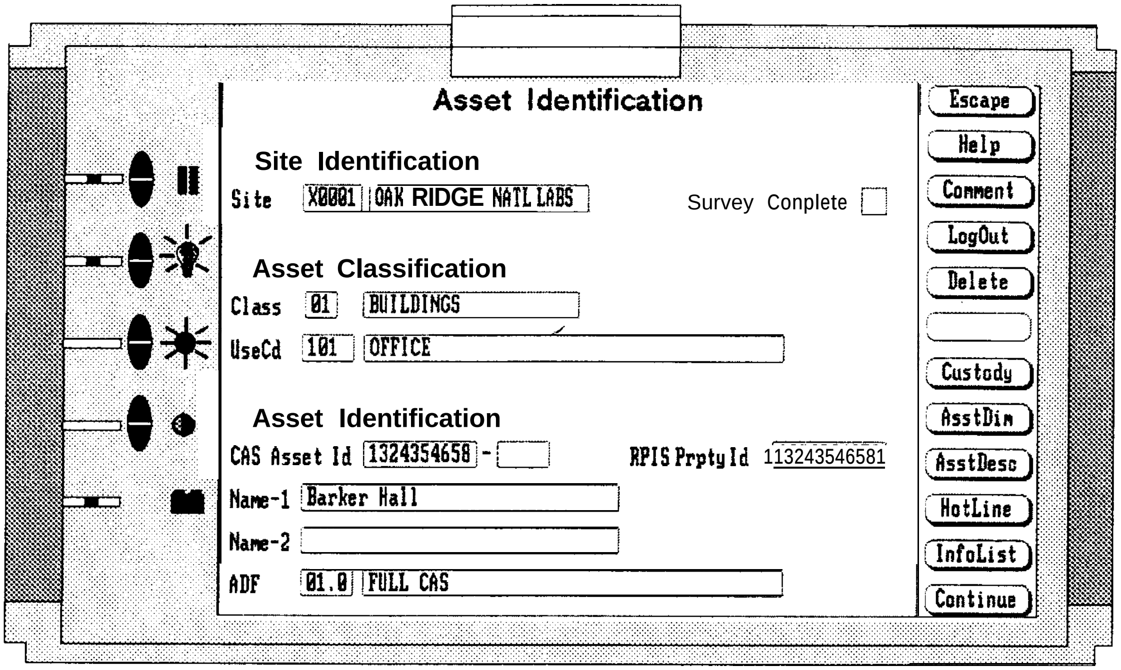
In the remainder of this subsection, actual data screens, as they will appear to the inspector, are displayed to illustrate a typical inspection. As previously noted, five main screens are used in the system supported by numerous "pop-up" lists, information, comment, and other auxiliary screens. In our examples, main screens are numbered 1.0 - 5.0; secondary screens are labeled 1.1, 1.2, etc.; and general support screens use the series 99.0. Key inspector actions on each screen are highlighted. Support function keys are listed below these main functions.

SURVEY STEP LOGIN **Screen 1.0**



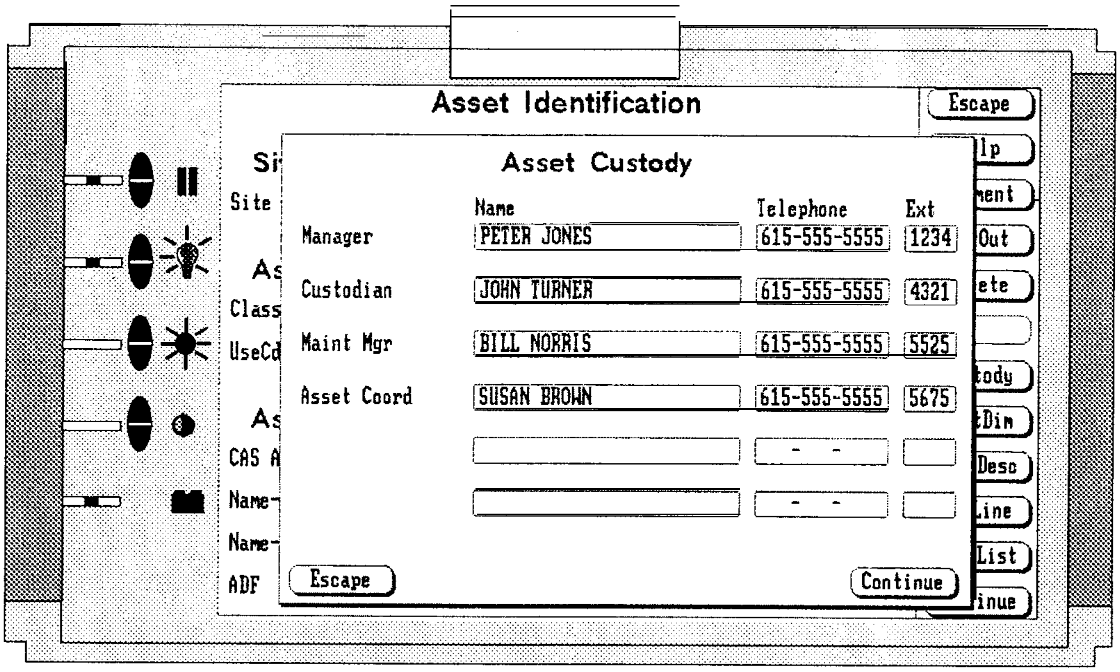
SCREEN	ACTION	COMMENT
1.0	1. Enter Name and Employee Id #	May be preloaded for security
	2. Tap "Discipline" title for picklist, cursor select or enter by pen	Picklist preformatted A=Arch, C=Site/Civil, E=Elec, M=Mech
	3. Tap "Type" and "Vers" title under Survey Data for picklist cursor select or enter by pen	Picklist preformatted for type of survey to be performed and version date for record
	4. Diagnostics data is system generated and for information purposes only	N/A
	5. Press (Continue) to go to Screen 2.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information.
(Help)	Press to bring up screen help	Screen 99.1
(Comment)	Press to bring up screen for entering inspector comments	Screen 99.2
(LH/RH)	Press to change screen between Left or Right Hand use	N/A
(<Exec>)	Press to exit to the Grid System Menu	This option can be password protected
(DataXfer)	Press to transfer data to site computer	Used for data upload/download procedures
(Hotline)	Press for important contacts and telephone numbers	Screen 99.3
(InfoList)	Press to bring up information/directions preloaded for inspector	Screen 99.4

SURVEY STEP ASSET IDENTIFICATION. Screen 2.0



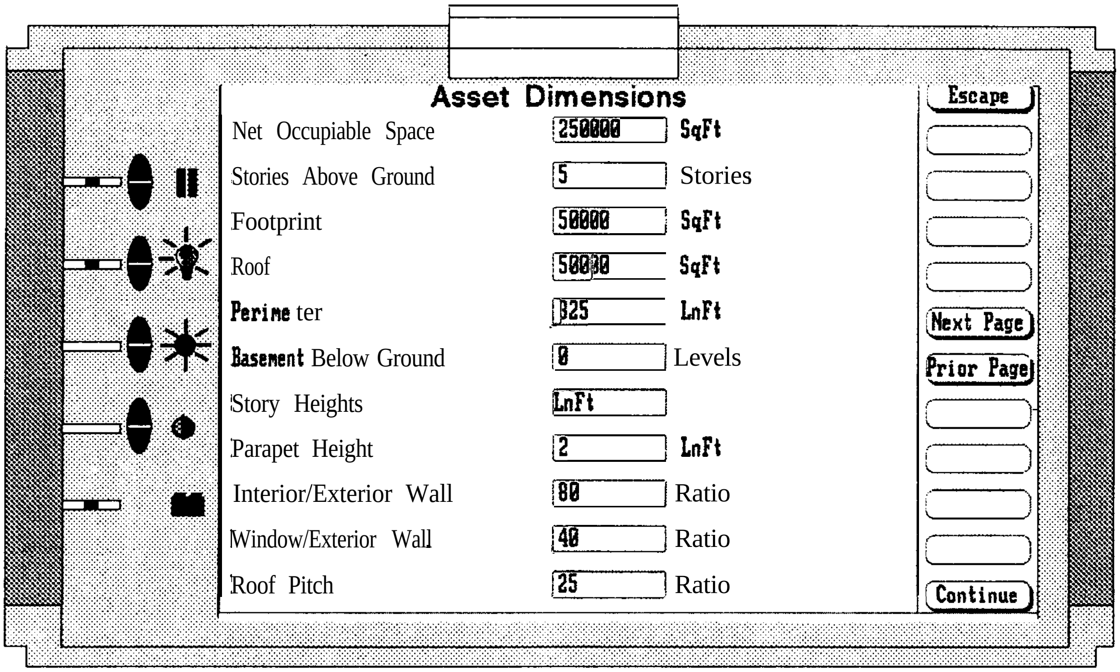
SCREEN	ACTION	COMMENT
2.0	1. Tap "Site" title for picklist Cursor select or enter by pen	Picklist can be preloaded, site code appears automatically to match name selected
	2. Tap "Class" title for picklist Cursor select or enter by pen or skip to item 4	Picklist preformatted based on RPIS categories
	3. Tap "Use Cd" title for picklist Cursor select or enter by pen or skip to item 4	Picklist preformatted based on RPIS categories
	4. Enter Asset Identification information by selecting "CAS Asset Id" corresponding "RPIS Prpty Id" and "Name-1 or Name-2" will be generated	This data can be preloaded
	5. Enter a Split Asset by creating an extension to "CAS Asset ID" and selecting a new name	This data can be preloaded or created by inspector
	6. Enter Asset Determinant Factor "ADF" provided by Site Mgr.	Determined by Site Manager prior to survey
	7. Press box next to Survey Complete upon completion of Asset Survey	N/A
	8. Press (Continue) to go to Screen 3.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
(Escape)	Press to return to Screen 1.O	By pressing-information is not verified and any changes made are lost
(Help)	Press to bring up screen help	Screen 99.1
(Comment)	Press to bring up screen for entering inspector comments	Screen 99.2
(Logout)	Press to save all data entered and leave survey	N/A
(Custody)	Press to bring up asset contact names	Screen 2.1 This data can be preloaded
(AssetDim)	Press to bring up screen for entering or verifying key asset dimensions	Screen 2.2 This data can be preloaded
(AssetDes)	Press to bring up screen for entering or verifying asset name, address and descriptions	Screen 2.3 This data can be preloaded
(HotLine)	Press for important contacts and telephone numbers	Screen 99.3
(InfoList)	Press to bring up information/directions preloaded for inspector	Screen 99.4

SURVEY STEP ASSET CUSTODY SCREEN — Screen 2.1



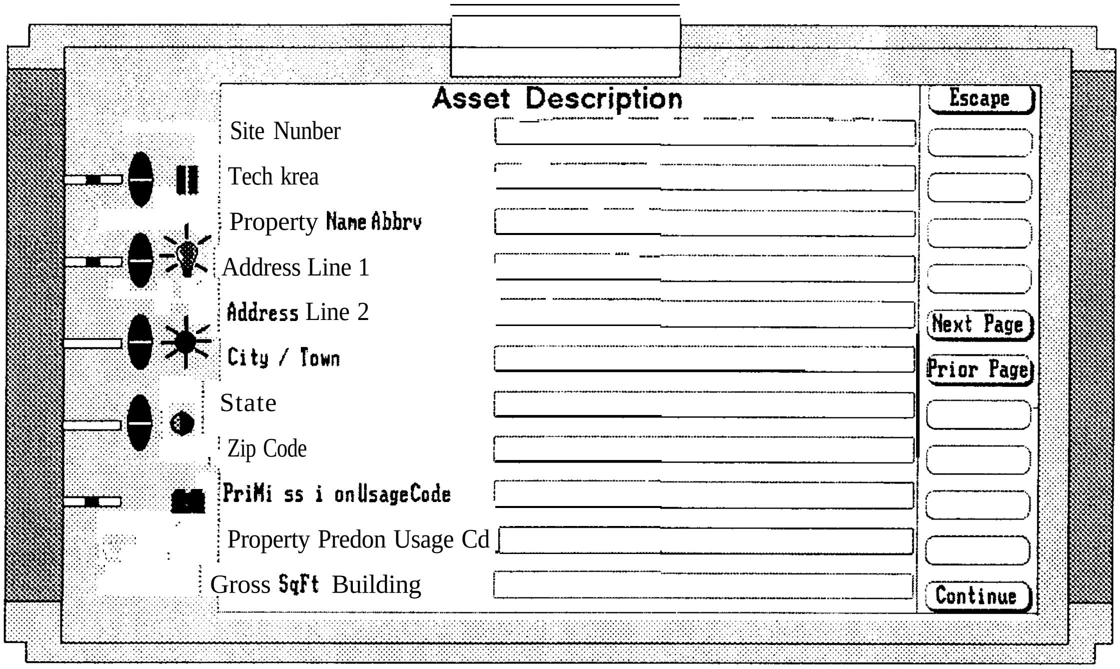
SCREEN	ACTION	COMMENT
2.1	1. Pop up window displays important names and numbers for asset. Cross through data and make any changes	Data can be either preloaded or inspector generated.
	2. Press (Continue) to return to Screen 2.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information.
(Escape)	Press to return to Screen 2.0	By pressing- information is not verified and any changes made are lost.

SURVEY STEP ASSET DIMENSIONS Screen 2.2



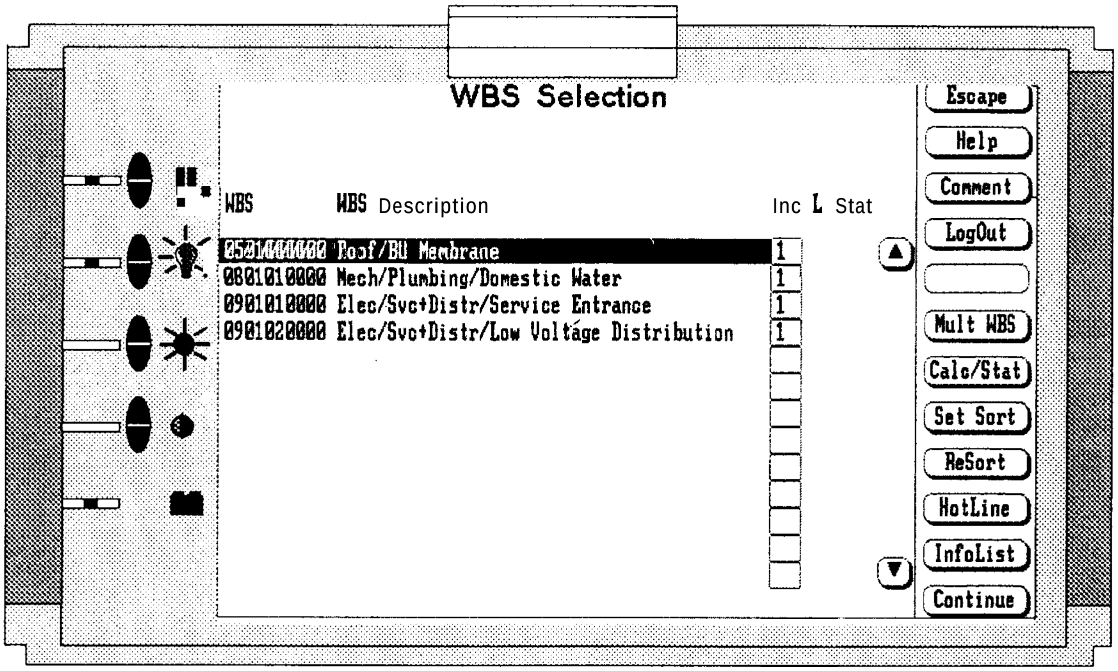
SCREEN	ACTION	COMMENT
2.2	1. Screen displays important dimension related to the asset verify data or cross through data and make any changes	Data can be either preloaded or inspector generated.
	2. Press (Continue) to return to Screen 2.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information.
(Escape)	Press (Escape) to return to Screen 2.0	By pressing (Escape) information is not verified and any changes made are lost.
(NextPage)	Press to bring up next screen of important dimensions	Data can be either preloaded or inspector generated.
(PriorPage)	Press to return to previous asset dimension screen	Data can be either preloaded or inspector generated.

SURVEY STEP ASSET DESCRIPTION Screen 2.3



SCREEN	ACTION	COMMENT
2.3	1. Screen displays important asset description information verify data or cross through and make changes	Data can be either preloaded or inspector generated
	2. Press (Continue) to return to Screen 2.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
(Escape)	Press to return to Screen 2.0	By pressing (Escape) information is not verified and any changes made are lost
(NextPage)	Press to bring up next screen of important descriptions	Data can be either preloaded or inspector generated
(PriorPage)	Press to return to previous asset description screen	Data can be either preloaded or inspector generated

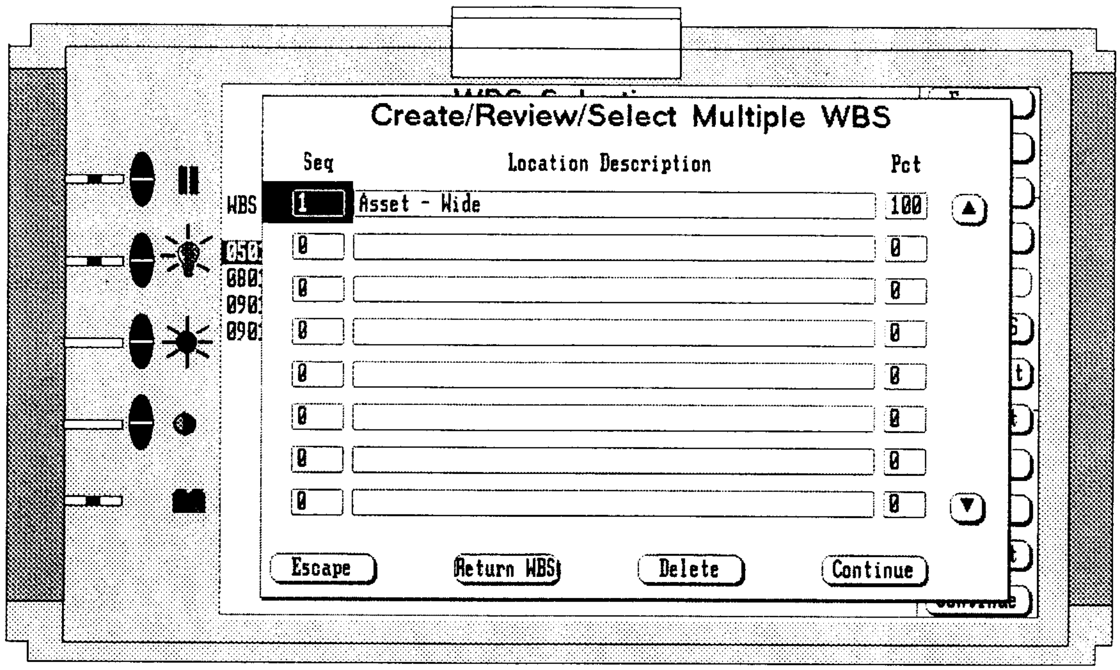
SURVEY STEP WBS SELECTION Screen 3.0



SCREEN	ACTION	COMMENT
3.0	1. Select WBS item to inspect from picklist	Picklist preformatted and is presorted by ADF numbers. Columns at end of WBS list show; "inc" (included) by sort order 1,2,3...; "M" (multiple items); and "Stat" (Status) (In Progress, Complete, or Not Started [*])
	2. All WBS for ADF included on screen; cross through number in "inc" column to deselect	By crossing through "inc" number, WBS item is deselected
	3. Press (Continue) to go to Screen 4.0	By pressing (Continue) information is verified and inspections units under the selected WBS are loaded
(Escape)	Press to return to Screen 2.0	By pressing (Escape) information is not verified and any changes made are lost.
(Help)	Press to bring up screen help	Screen 99.1
(Comment)	Press to bring up screen for entering inspector comments	Screen 99.2
(Logout)	Press to save all data entered and leave survey	N/A
(Multi WBS)	Press to create, view or select multiple WBS and locations	Screert3.1
(CalcSort)	Press to recalculate the status of or number of multiple locations	N/A
(SetSort)	Resets the sort sequence of systems, etc. by accessing a pop-up window	N/A
(Resort)	Press to resort list in order of priority of WBS items selected	N/A
(HotLine)	Press for important contacts and telephone numbers	Screen 99.3
(InfoList)	Press to bring up information/directions preloaded for inspector	Screen 99.4
▲	Press Scroll Up button	Used to scroll up through information.
▼	Press Scroll Down button	Used to scroll down through information.

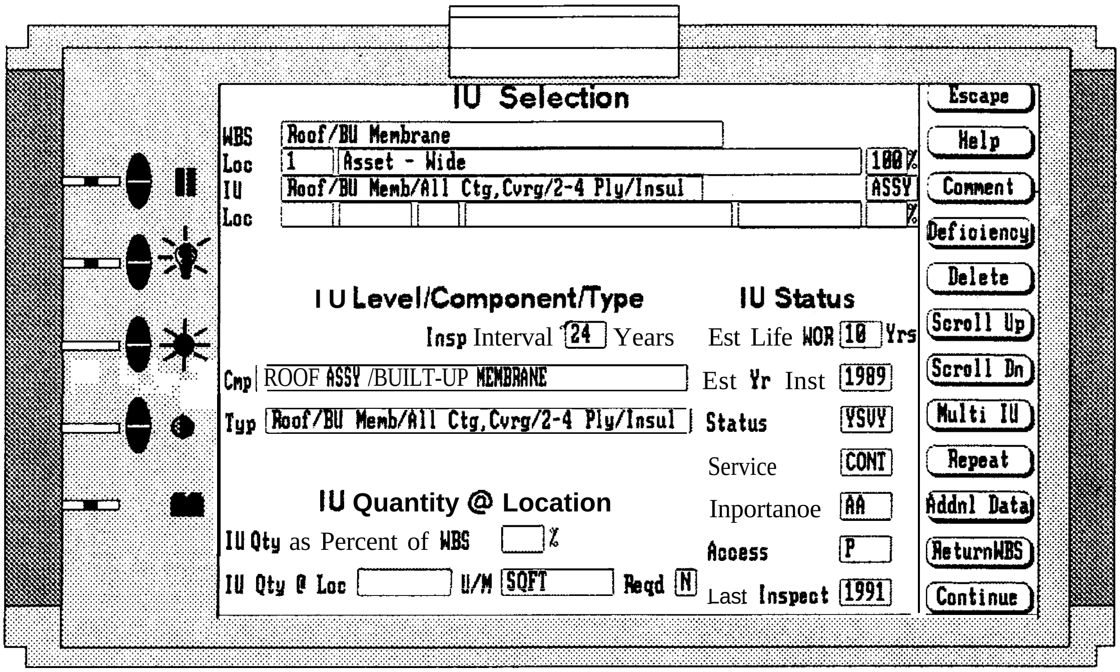
SURVEY STEP CREATE/REVIEW/SELECT MULTIPLE WBS

Screen 3.1



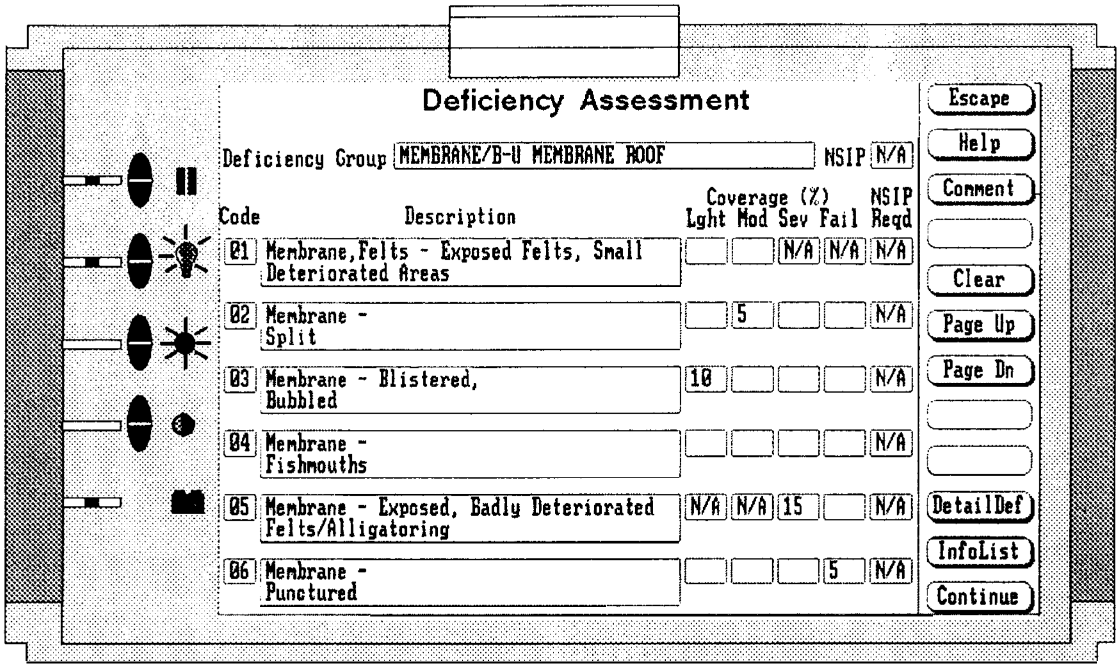
SCREEN	ACTION	COMMENT
3.1	1. Define locations of multiple WBS. Could be multiple systems or multiple parts of single system.	Inspector developed
	2. Define percentage of Asset serviced by WBS section	Inspector developed
	3. Press (Continue) after selecting multiple WBS locations from list and continue to Screen 4.0 to select Inspection Unit (IU).	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information or selecting another item
(Escape)	Press to return to Screen 3.0	By pressing (Escape) information is not verified and any changes made are lost
(RtrnWBS)	Press to return to WBS selection screen to make additional selections	N/A
(Delete)	Press to delete a highlighted entry on screen	N/A
▲	Press scroll up button	Used to scroll up through information.
▼	Press scroll down button	Used to scroll down through information.

SURVEY STEP IU SELECTION Screen 4.0



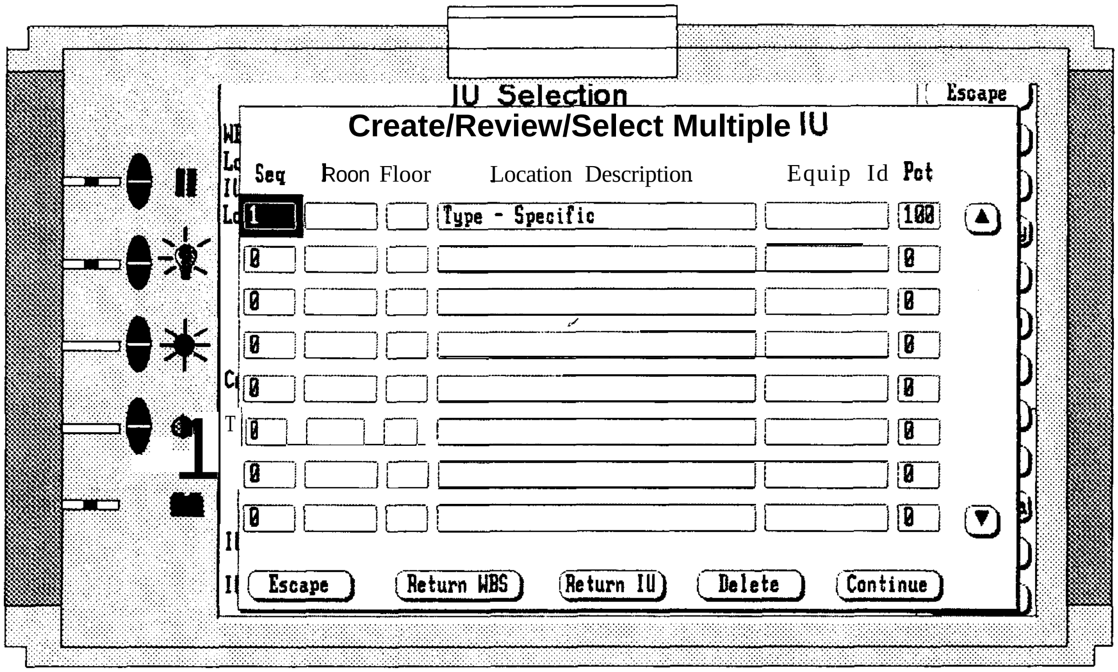
SCREEN	ACTION	COMMENT
4.0	1. Tap "Cmp" title for component picklist Cursor select or enter by pen	Picklist is preformatted
	2. Tap "Typ" title for type of component picklist Cursor select or enter by pen	Picklist is preformatted
	3. Press (Deficiency) to bring up deficiency assessment screen	Screen 4.1 brings up deficiency picklist for WBS IU
	4. Enter estimated life without repair	Inspector generated
	5. Enter estimated year "IU" installed	Inspector generated
	6. Tap "Status" title for picklist Cursor select or enter by pen	Picklist is preformatted
	7. Tap "Service" title for picklist Cursor select or enter by pen	Picklist is preformatted
	8. Tap "Importance" title for picklist	Picklist is preformatted
	9. Tap "Access" title for picklist Cursor select or enter by pen	Picklist is preformatted
	10. Enter year "IU" last inspected	Inspector generated
	11. Enter percentage of WBS served by inspection unit	Inspector generated
	12. Enter quantity of inspection unit at location as required	Inspector generated
	13. Press (Continue) to go to Screen 5.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
(Escape)	Press to return to Screen 3.0	By pressing (Escape) information is not verified; and any changes made are lost
(Help)	Press to bring up screen help	Screen 99.1
(Comment)	Press to bring up screen for entering inspector comments	Screen 99.2
(Delete)	Press to delete an inspection unit record	N/A
(Scroll Up)	Press to scroll up thru inspection units selected	N/A
(Scroll Dn)	Press to scroll down thru inspection units selected	N/A
(Multi IU)	Press to create, view, or select multiple IU's and locations	Screen 4.2
(Repeat)	Press to repeat or copy inspection unit selection data as a new entry	N/A
(AddnlData)	Press to bring up Additional Data screen and enter boiler plate information	Screen 4.3 - Inspector generated
(RtrnWBS)	Press to save data entered and go to Screen 3.0 for next selection	By pressing (RtrnWBS) information is verified; corrections made by crossing through data and entering new information

SURVEY STEP DEFICIENCY ASSESSMENT Screen 4.1



SCREEN	ACTION	COMMENT
4.1	1. Select deficiency from list	Picklist preformatted
	2. Select degree of severity of deficiency	Inspector developed
	3. Enter percentage of coverage under selected severity	Inspector developed
	4. Indicate whether non-standard inspection/test procedures are required or recommended	Inspector choice, preset at "No": line through to deselect
	5. Press (Continue) to go to Screen 5.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
(Escape)	Press to return to Screen 4.0	By pressing (Escape) information is not verified and any changes made are lost
(Help)	Press to bring up screen help	Screen 99.1
(Comment)	Press to bring up screen for entering inspector comments	Screen 99.2
(Clear)	Press to unselect a deficiency	N/A
(Page Up)	Press to scroll up though data by page	N/A
(Page Dn)	Press to scroll down through data by page	N/A
(Detail Def)	Press to bring up long description of selected deficiency	N/A
(InfoList)	Press to bring up information/directions preloaded for inspector	Screen 99.4

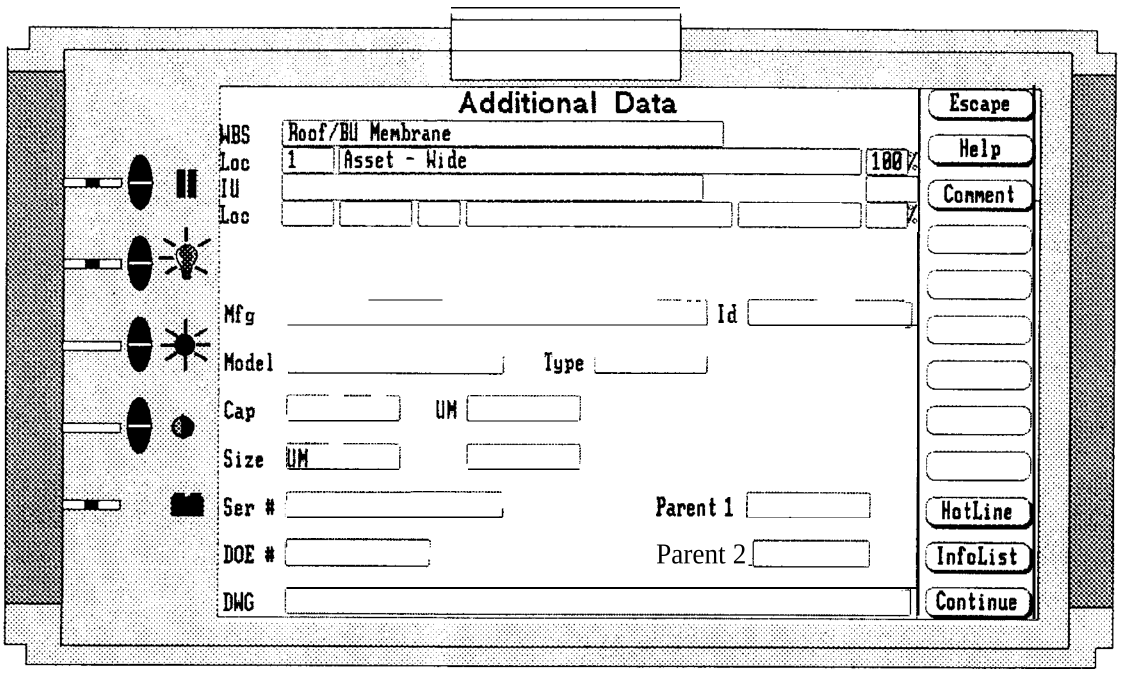
SURVEY STEP CREATE/REVIEW/SELECT MULTIPLE I U Screen 4.2



SCREEN	ACTION	COMMENT
4.2	1. Define locations of Multiple IU's by room, floor and/or location description - optional equipment identification number can be added	Inspector developed
	2. Define percentage of Asset or WBS serviced by IU	Inspector developed
	3. Press (Continue) after selecting Multiple IU location from list and continue to Screen 4.1 to select deficiencies	By pressing (Continue) information is verified; corrections made by crossing thru data and entering new information or selecting another item
(Escape)	Press to return to Screen 4.0	By pressing (Escape) information is not verified and any changes made are lost
(RtrnWBS)	Press to return to Screen 3.0	WA
(RtrnIU)	Press to return to Screen 4.0	N/A
(Delete)	Press to delete a highlighted entry on screen	WA
▲	Press scroll up button	Used to scroll up through information
▼	Press scroll down button	Jsed to scroll down through Information

SURVEY STEP ADDITIONAL DATA

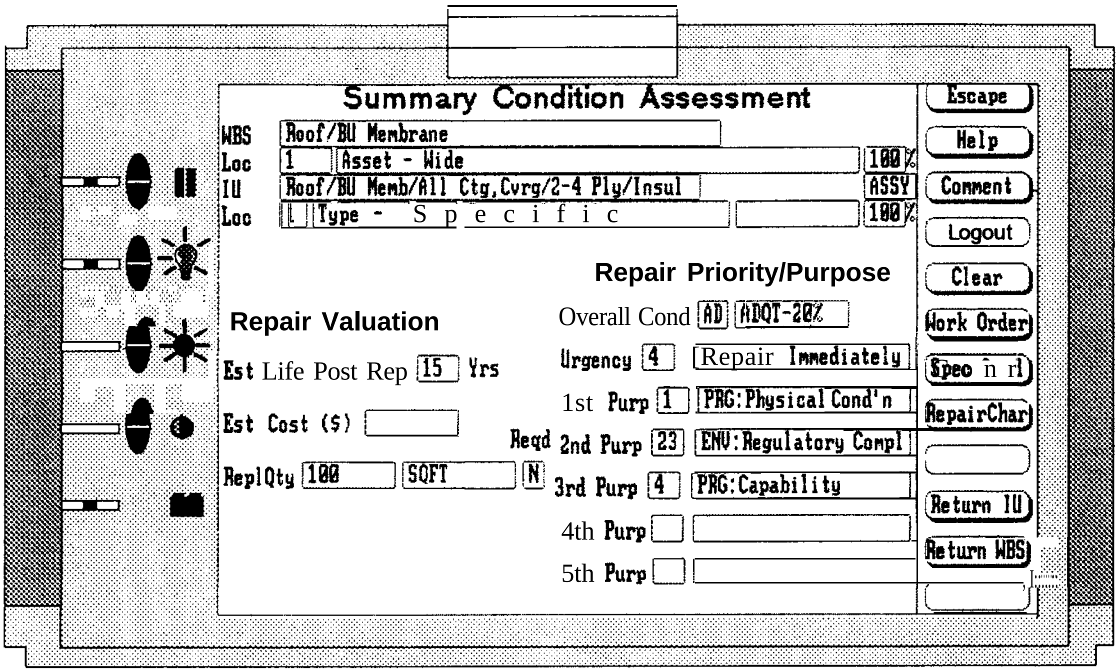
Screen 4.3



SCREEN	ACTION	COMMENT
4.3	1. Enter boiler plate data about component being inspected	Inspector generated from data on the component, drawing specifications or determined in the field. This data can be used for inventorying inspection units
	2. Press (Continue) to go to Screen 4.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
(Escape)	Press to return to Screen 4.0	By pressing (Escape) information is not verified; and any changes made are lost
(Help)	Press to bring up screen help	Screen 99.1
(Comments)	Press to bring up screen for entering inspector comments	Screen 99.2
(Hotline)	Press for important contacts and telephone numbers	Screen 99.3
(InfoList)	Press to bring up information/directions preloaded for inspector	Screen 99.4

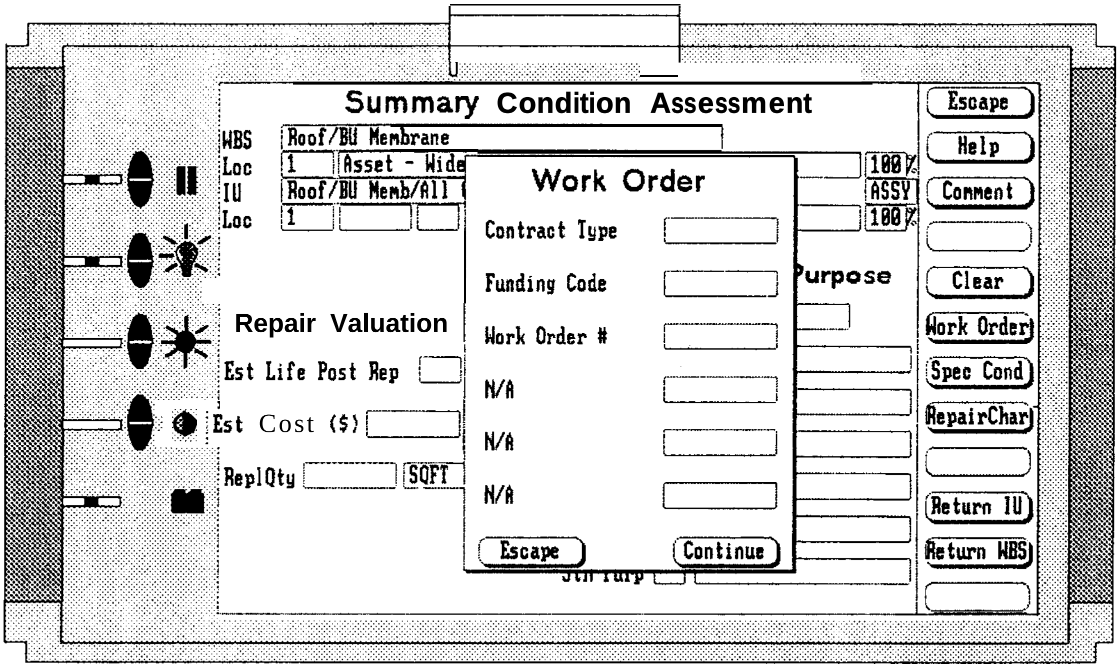
SURVEY STEP SUMMARY CONDITION ASSESSMENT

Screen 5.0



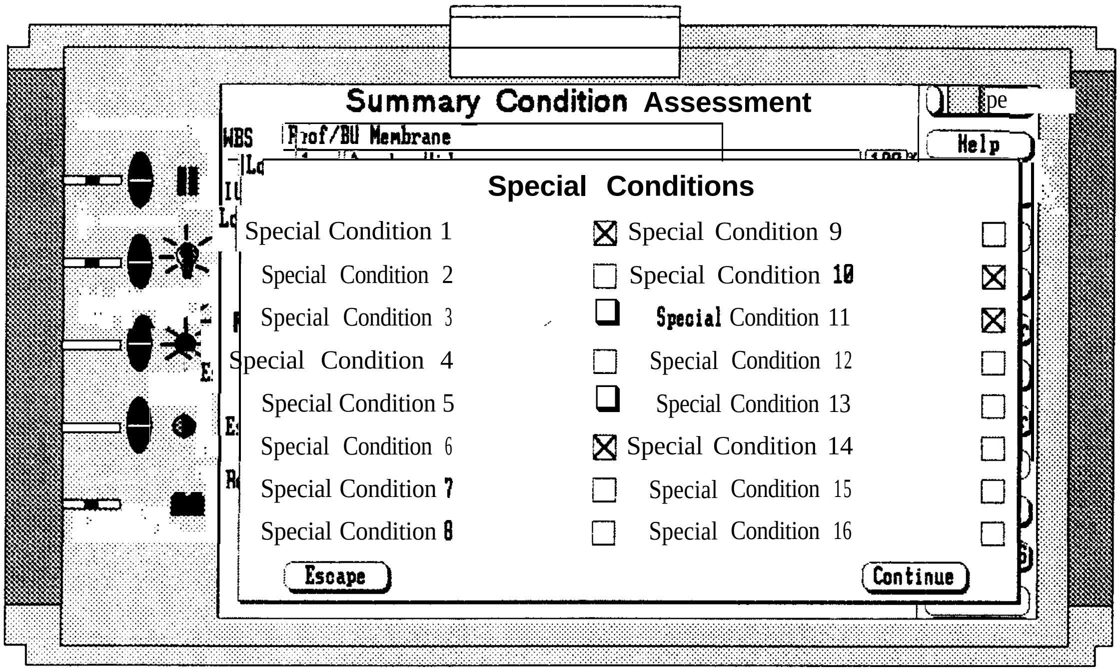
SCREEN	ACTION	COMMENT
5.0	1. Tap "Overall Condition" title for picklist Cursor select or select by pen	Picklist preformatted, inspector determined
	2. Tap "Urgency" title for picklist Cursor select or enter by pen	Picklist preformatted, inspector determined
	3. Tap "Purp" title for picklist Cursor select or enter by pen Multiple purposes can be specified	Picklist preformatted inspector determined
	4. Enter estimated life of IU after repairs in years	Inspector determined
	5. Enter an estimated cost for repairs (optional)	Inspector determined
	6. Enter repair quantity as required	Inspector determined
	7. Press to save data entered and go to Screen 4.0 for next selection	By pressing (ReturnIU) information is verified; corrections made by crossing through data and entering new information
	8. Press to save data entered and go to Screen 3.0 for next selection	By pressing (ReturnWBS) information is verified; corrections made by crossing through data and entering new information
(Escape)	Press to return to Screen 4.0	By pressing (Escape) information is not verified and any changes made are lost
(Help)	Press to bring up screen help	Screen 99.1
(Comment)	Press to bring up screen for entering inspector comments	Screen 99.2
(Logout)	Press to save all data entered and leave survey	N/A
(Clear)	Press to clear or delete an entry	N/A
(Work Order)	Press to bring up work order screen pop-up	Screen 5.1
(Spec Cond)	Press to bring up special condition screen pop-up	Screen 5.2
(Repair Char)	Press to bring up special repair characteristics screen pop-up	Screen 5.3

SURVEY STEP WORK ORDER GENERATION **Screen 5.1**



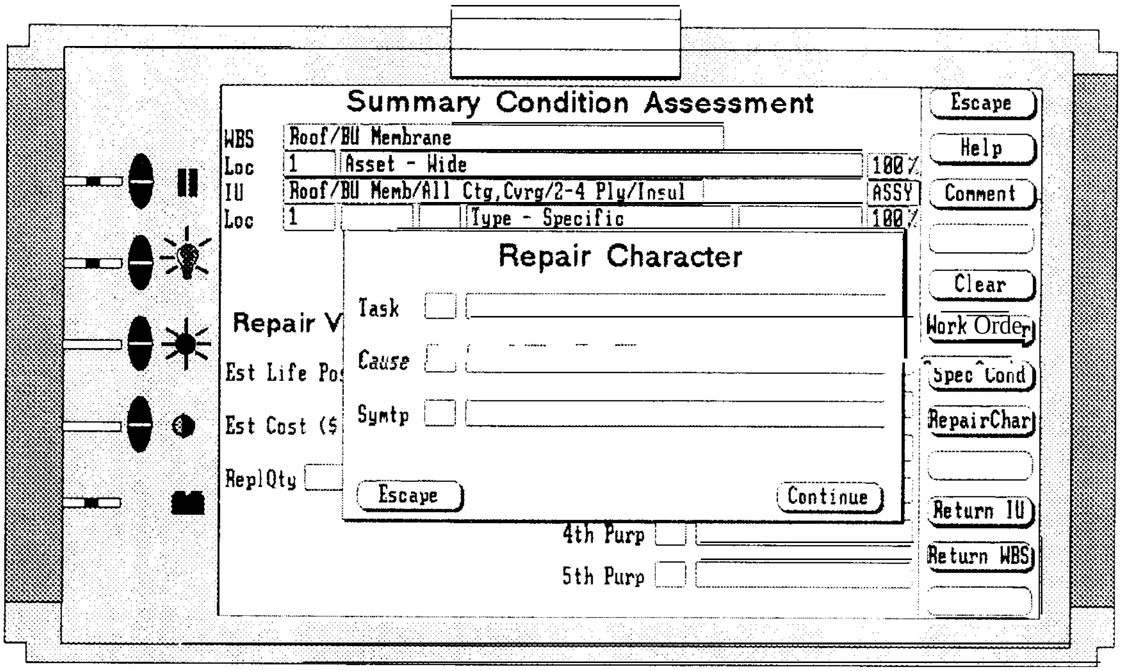
SCREEN	ACTION	COMMENT
5.1	1. Enter data to define Work Order number to tag repair to create a job estimate for repairs	Inspector generated as determined by Site Manager prior to survey
	2. Press (Continue) to go to Screen 5.0	By pressing (Continue) information is verified: corrections made by crossing through data and entering new information
	3. Press (Escape) to return to Screen 5.0	By pressing-information is not verified; and any changes made are lost

SURVEY STEP SPECIAL CONDITIONS SELECTION Screen 5.2



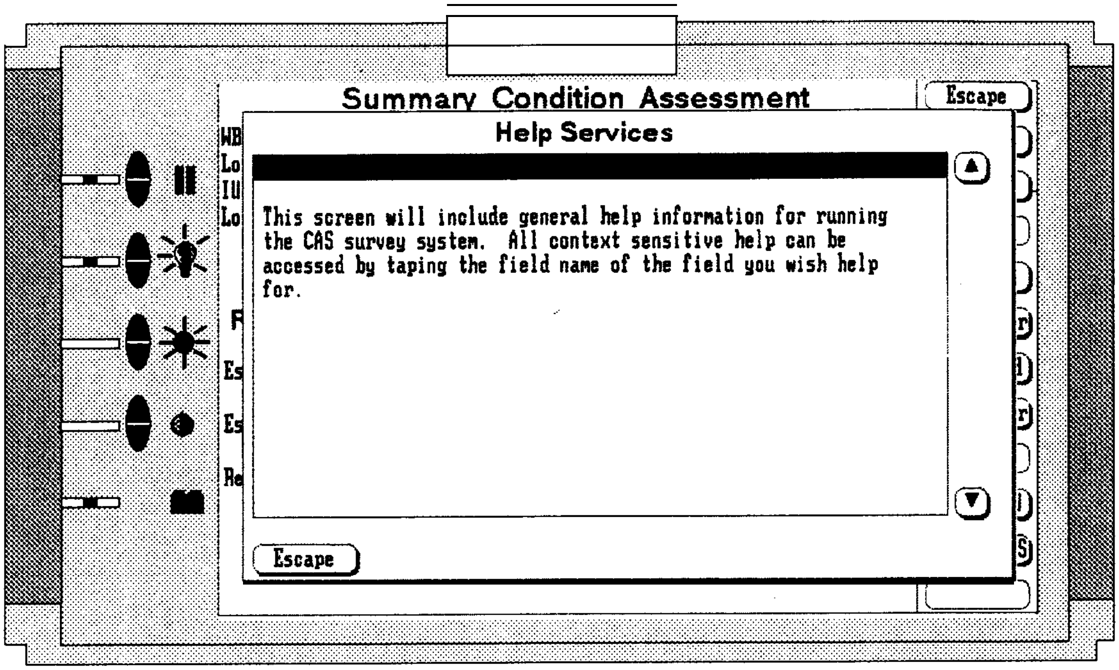
SCREEN	ACTION	COMMENT
5.2	1. Press box next to special condition to select	Picklist is preloaded by site. Selections determined by Site Manager prior to survey
	2. Press (Continue) to go to Screen 5.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
	3. Press (Escape) to return to Screen 5.0	By pressing (Escape) information is not verified; and any changes made are lost

SURVEY STEP REPAIR CHARACTER DOCUMENTATION Screen 5.3



SCREEN	ACTION	COMMENT
5.3	1. Enter repair characteristics for tracking related deficiencies	Inspector generated from input of asset users to document what is deficient, what caused deficiency and any symptoms. Picklist can be preformatted
	2. Press (Continue) to go to Screen 5.0	By pressing (Continue) information is verified; corrections made by crossing through data and entering new information
	3. Press-to return to Screen 5.0	By pressing-information is not verified; and any changes made are lost

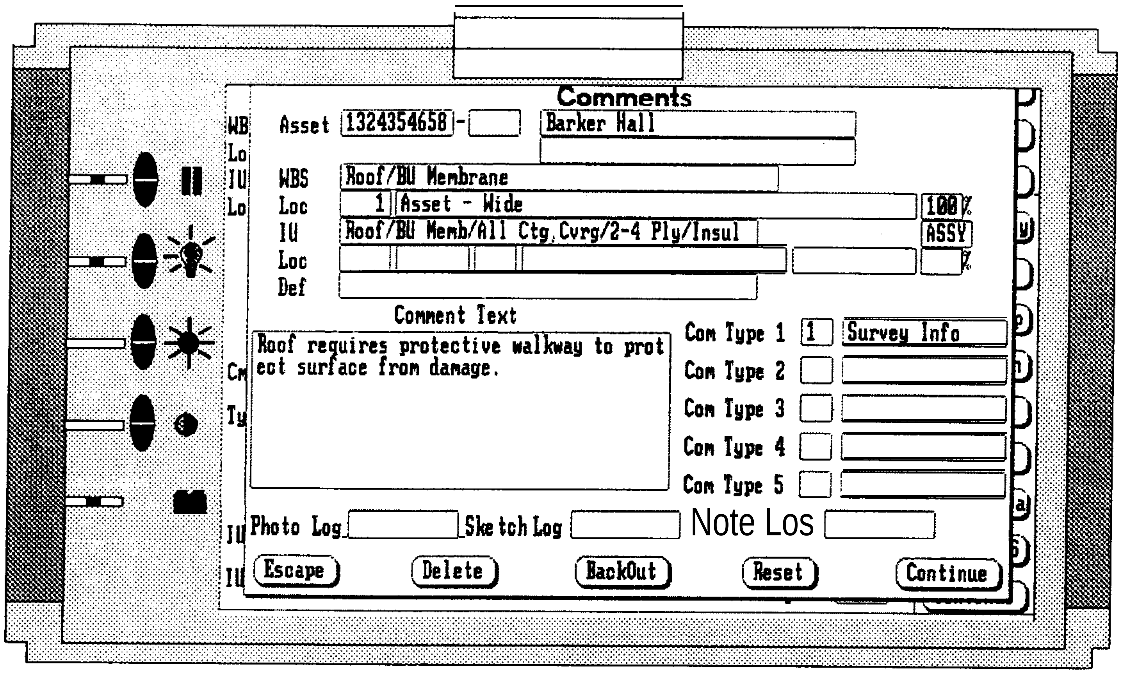
SURVEY STEP HELP Screen 99.1



SCREEN	ACTION	COMMENT
99.1	N/A	Screen pop-up help information Dynamic help for locations selected Screen data cannot be changed
(Escape)	Press to exit Help Screen and return to previous screen	N/A
▲	Press scroll up button	Used to scroll up through information
▼	Press scroll down button	Used to scroll down through information

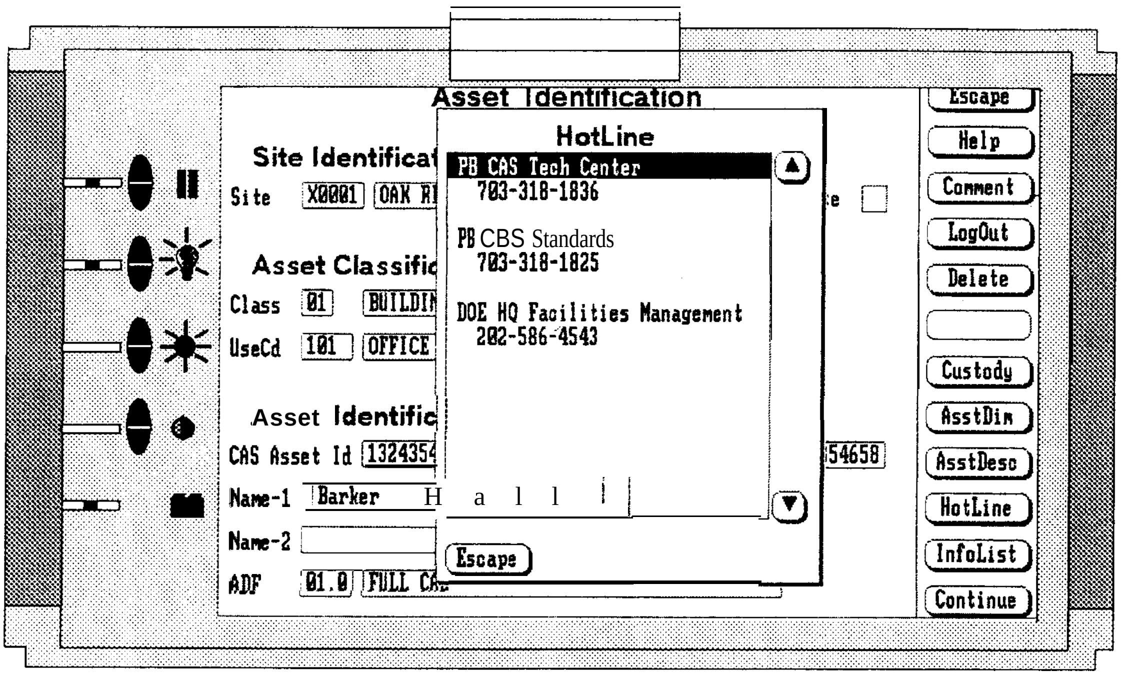
SURVEY STEP COMMENT SCREEN

Screen 99.2



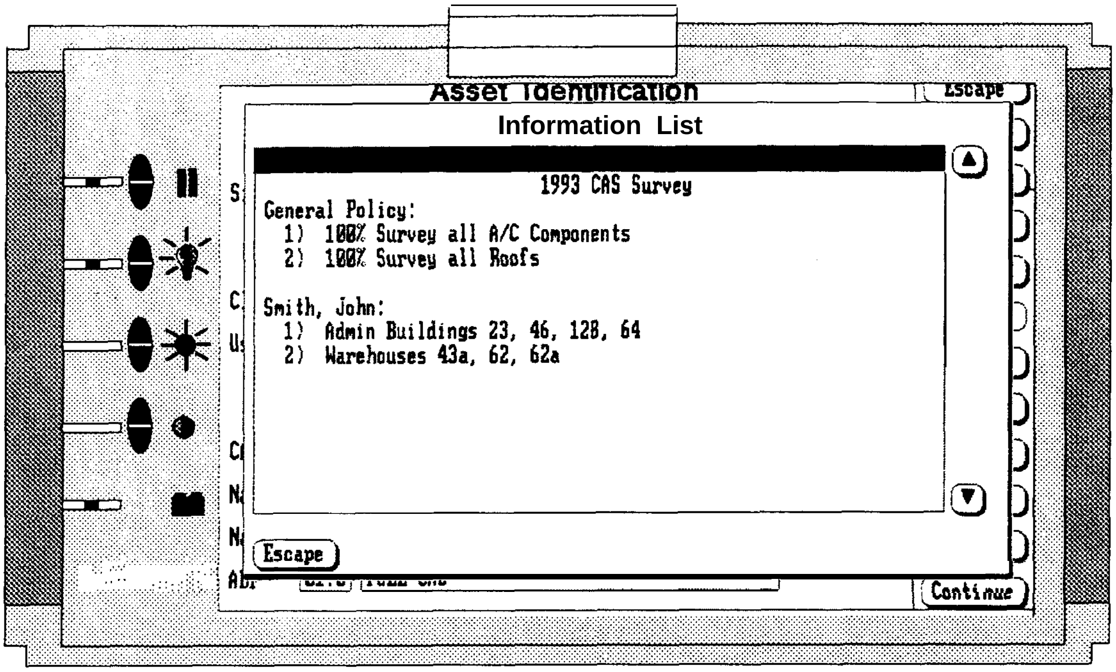
SCREEN	ACTION	COMMENT
99.2	1. Select a Comment Type Selection	Picklis[redacted]d
	2. Enter Comment inside comment text field (QWERTY keyboard can be called in to use)	Text field expands as required
	3. Enter a Photo, Sketch, or Note Log tag number	Can be standardized or inspector generated
	4. Press (Continue) to return to previous screen	By pressing (Continue) information is verified; corrections made by crossing thru data and entering new information
(Escape)	Press to exit comment screen and return to previous screen	By pressing- information is not verified and any changes made are lost
(Delete)	Press to delete a selected comment	N/A
(Backout)	Press to move backwards through the navigation screen at top	This option allows an inspector to move backwards to enter or change a comment tagged to a previous screen
(Reset)	Press to move forward through the navigation screen at top	This option allows an inspector to move forward after entering a comment on a previous screen to continue the inspection

SURVEY STEP HOTLINE SCREEN Screen 99.3



SCREEN	ACTION	COMMENT
99.3	N/A	Screen pop-up for important contacts and telephone numbers Preformatted and adjusted by Site Manager. Screen data cannot be changed by inspector
(Escape)	Press to exit Hotline screen and return to previous screen	N/A
▲	Press scroll up button	Used to scroll up through information
▼	Press scroll down button	Used to scroll down through information

SURVEY STEP INFO SCREEN Screen 99.4



SCREEN	ACTION	COMMENT
99.4	1. CAS inspection parameters & schedules as inputted by site manager	Cannot be changed by inspector
(Escape)	Press to exit InfoList screen and return to previous screen	N/A
▲	Press scrdl up button	Used to scroll up through information
▼	Press scroll down button	Used to scroll down through information

DATA COLLECTION METHODS

END OF SUBSECTION

FEDERAL SPECIFICATIONS

FEDERAL SPECIFICATION	TITLE
FS HH-Y-622	(Rev D) Mortar, Refractory, Heat Setting, Bonding (Wet and Dry Types)
FS MMM-A-001993	(Basic) Adhesive, Epoxy, Flexible, Filled (for Binding, Sealing and Grouting)
FS QQ-S-763	(Rev E; Am 1; Notice 1) Steel Bars, Wire, Shapes, and Forgings, Corrosion Resisting
FS QQ-S-775	(Rev E; Int Am 1) Steel Sheets, Carbon, Zinc-Coated (Galvanized) by the Hot-Dip Process
FS QQ-W-461	(Rev H) Wire, Steel, Carbon (Round, Bare, and Coated)
FS RR-B-191	(Rev B) Bedpan, Corrosion-Resisting Steel
FED-STD 66	(Rev D; Notice 1) Steel, Chemical Composition and Hardening Ability
FS SS-C-156	Federal Specification for Cements, Hydraulic, General Specifications (Methods for Sampling, Inspection, and Testing)
Fs ss-c-191	Federal Specification for Cement, Masonry
FS SS-C-192	Federal Specification for Cements, Portland (10 types)
Fs ss-c-206	Federal Specification for Cement, Portland, Pozzolana
USCE CRD-Cl3	Test for Evaluation of Air-Entraining Admixtures for Concrete
USCE CRD-C109	Field Test for Absorption by Aggregates
USCE CRD-Cl19	Test for Flat and Elongated Particles in Coarse Aggregates
USCE CRD-C129	Test for Particles of Low Specific Gravity in Coarse Aggregate (Sink-Float Test)
USCE CRD-C213	Test for the Presence of Sugar in Cement, Mortar, Concrete, and Aggregates
USCE CRD-C248	Corps of Engineers Specifications for Slag Cement
USCE CRD-C300	Specifications for Pigmented Membrane-Forming Compounds for Curing Concrete
USCE CRD C400	Requirements for Water for Use in Mixing or Curing Concrete

FEDERAL SPECIFICATIONS

END OF SUBSECTION

NATIONAL STANDARDS

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.89	Standard Practice of Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 211.2	Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 211.3	Standard Practice for Selecting Proportions for No-Slump Concrete
ACI 301	Specifications for Structural Concrete for Buildings
ACI 304	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI **305R-89**	Hot Weather Concreting
ACI **306R-88**	Cold Weather Concreting
ACI 308	Standard Practice for Curing Concrete
ACI 309	Standard Practice for Consolidation of Concrete
ACI 318	Recommendations for Construction of Concrete Pavements and Concrete Bases
ACI 318	Building Code Requirements for Reinforced Concrete
ACI **336.1-89**	Standard Specification for the Construction of End Bearing Drilled Piers
ACI 347	Recommended Practice for Concrete Formwork
ACI 508	Guide to Shotcrete

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (MSHTO)

AASHTO M73	Specifications for Cotton Mats for Curing Concrete Pavements
AASHTO M74	Specifications for Subgrade Paper
AASHTO T26	Test for Quality of Water to be Used in Concrete
AASHTO 1103	Test for Soundness of Aggregates by Freezing and Thawing

AMERICAN SOCIETY FOR TESTING & MATERIALS (ASTM)

ASTM A38-89	Specification for Structural Steel
ASTM A82-88	Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM AI 84	Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM AI 85	Specification for Welded Steel Wire Fabric for Concrete Reinforcement
ASTM **A416-88**	Specification for Uncoated Seven-Wire Stress-Relieved Steel for Prestressed Concrete
ASTM A421	Specification for Uncoated Stress-Relieved Wire for Prestressed Concrete
ASTM A498	Specification for Deformed Steel Wire for Concrete Reinforcement
ASTM A497	Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement
ASTM A81 5-89	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A817	Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A787-99	Standard Specification for Zinc-Coated (Galvanized) Bars for Concrete Reinforcement
ASTM **C5**	Specification for Quicklime for Structural Purposes
ASTM C8	Specification for Normal Finishing Hydrated Lime
ASTM C29	Test for Unit Weight and Voids in Aggregate
ASTM **C33**	Specification for Concrete Aggregates

NATIONAL STANDARDS

AMERICAN SOCIETY FOR TESTING & MATERIALS (ASTM)

ASTM **C40**	Test for Organic Impurities in Sands for Concrete
ASTM **C70**	Test for Surface Moisture in Fine Aggregate
ASTM C87	Test for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM **C88**	Test for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM **C91**	Specification for Masonry Cement
ASTM C94	Specification for Ready-Mixed Concrete
ASTM **C109**	Test for Compressive Strength of Hydraulic Cement Mortars
ASTM CI 14	Methods for Chemical Analysis of Portland Cement
ASTM CI 15	Test for Fineness of Portland Cement by the Turbidimeter
ASTM CI 17	Test for Materials Finer Than No. 200 Sieve in Mineral Aggregates by Washing
ASTM CI 23	Test for Lightweight Pieces in Aggregate
ASTM CI25	Definitions of Terms Relating to Concrete and Concrete Aggregates
ASTM CI27	Test for Specific Gravity and Absorption of Coarse Aggregate
ASTM CI28	Test for Specific Gravity and Absorption of Fine Aggregate
ASTM CI31	Test for Resistance to Abrasion of Small Size Coarse Aggregate by use of the Los Angeles Machine
ASTM CI38	Test for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM CI41	Specification for Hydraulic Hydrated Lime for Structural Purposes
ASTM CI50	Specification for Portland Cement (8 types)
ASTM CI51	Test for Autoclave Expansion of Portland Cement
ASTM CI58	Test for Water Retention by Concrete Curing Materials
ASTM CI 71	Specification for Sheet Materials for Curing Concrete
ASTM CI83	Methods. of Sampling Hydraulic Cement
ASTM CI84	Test for Fineness of Hydraulic Cement by the No. 100 and No. 200 Sieves
ASTM CI88	Test for Heat of Hydration of Hydraulic Cement
ASTM CI87	Test for Normal Consistency of Hydraulic Cement
ASTM CI88	Test for Density of Hydraulic Cement
ASTM CI90	Test for Tensile Strength of Hydraulic Cement Mortars
ASTM CI91	Test for Time of Setting of Hydraulic Cement by Vicat Needle
ASTM **C204**	Test for Fineness of Portland Cement by Air Permeability Apparatus
ASTM **C206**	Specification for Finishing Hydrated Lime
ASTM **C207**	Specification for Hydrated Lime for Masonry Purposes
ASTM **C2** 19	Definitions of Terms Relating to Hydraulic Cement
ASTM C228	Specification for Air-Entraining Additions for Use in the Manufacture of Air-Entraining Portland Cement
ASTM C227	Test for Potential Alkali Reactivity of Cement-Aggregate Combinations
ASTM **C230**	Specification for Flow Table for Use in Tests of Hydraulic Cement
ASTM C233	Method of Testing Air-Entraining Admixtures for Concrete
ASTM C243	Test for Bleeding of Cement Pastes and Mortars
ASTM **C260**	Specification for Air-Entraining Admixtures for Concrete
ASTM C265	Test for Calcium Sulfate in Hydrated Portland Cement Mortar
ASTM **C266**	Test for Time of Setting of Hydraulic Cement by Gillmore Needles
ASTM C287	Test for Chemical Resistance of Mortars
ASTM C295	Recommended Practice for Petrography Examination of Aggregates for Concrete
ASTM **C309**	Specification for Liquid Membrane-Forming Compounds for Curing Concrete

NATIONAL STANDARDS

AMERICAN SOCIETY FOR TESTING & MATERIALS (ASTM)

ASTM **C311**	Sampling and Testing Fly Ash and Raw or Calcined Natural Pozolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM **C330**	Specification tor Lightweight Aggregates for Structural Concrete
ASTM C332	Specification for Lightweight Aggregates for Insulating Concrete
ASTM C465	Specification for Processing Additions tor Use in Manufacture of Hydraulic Cements
ASTM C535	Test for Resistance to Abrasion of large Size Coarse Aggregate by use of the Los Angeles Machine
ASTM C595	Specification for Blended Hydraulic Cements
ASTM C851	Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
ASTM C3 I-90	Standard Methods of Making and Curing Concrete Test Specimens in the Field
ASTM **C33-90**	Specification for Concrete Aggregate
ASTM **C39-86**	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM **C94-86**	Standard Test Method for Ready-Mixed Concrete
ASTM **C94-90**	Specification for Ready-Mixed Concrete
ASTM C **143-90**	Standard Test Method for Slump of Portland Cement Concrete
ASTM C 150-89	Specification for Portland Cement
ASTM C **150-90**	Standard Specification for Portland Cement
ASTM CI **72-90**	Standard Method of Sampling Freshly Mixed Concrete
ASTM **C260-86**	Specification for Air-Entraining Admixtures for Concrete
ASTM **C494-86**	Specification for Chemical Admixtures for Concrete
ASTM D75	Methods of Sampling Aggregates
ASTM **D98**	Specification for Calcium Chloride
ASTM **D1143-81**	Method of Testing Piles Under Static Axial Compressive Load
ASTM **D2166-85**	Standard Test Methods for Unconfined Compressive Strength of Cohesive Soil
ASTM **D2216-80**	Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
ASTM EI 1	Specification for Wire Cloth Sieves for Testing Purposes

AMERICAN WOOD-PRESERVERS ASSOCIATION (AWPA)

AWPA M4-84	Care of Pressure Treated Wood Products

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI	Specifications for Placing Reinforcement

PORTLAND CEMENT ASSOCIATION (PCA)

PCA	Specifications for Plain and Reinforced Concrete
PCA	Architectural Concrete Specifications

NATIONAL STANDARDS

END OF SUBSECTION

INDUSTRY PUBLICATIONS

PUBLICATION	PUBLISHER
1991 ASTM Standards in Building Codes	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
Index of Federal Specifications, Standards and Commercial Item Descriptions	General Services Administration Office of Federal Supply and Services 7th & D Streets, S.W. Washington, DC 20202
UL Building Materials Directory	Underwriters Laboratories, Inc. 333 Pfingsten Road Northbrook, IL 60062
FM Approval Guide and FM Loss Prevention Data Sheets	Factory Mutual Research Norwood, MA 02062
ACI Detailing Manual and Structural Concrete for Buildings	American Concrete Institute P.O. Box 19150 Detroit, MI 48219-0150

INDUSTRY PUBLICATIONS

END OF SUBSECTION

OTHER RELATED REFERENCES

ACI 1974. Guide to Cast-in-Place Architectural Concrete Practices. Detroit, MI. American Concrete Institute.

ACI Manual of Concrete Inspection, Detroit, MI. American Concrete Institute.

ADAMS, J T. 1983. The Complete Concrete, Masonry and Brick Handbook. New York, NY Van Nostrand Co.

Architectural Precast Concrete, 2nd ed. 1989. Chicago. IL: Precast/Prestressed Concrete Institute.

KAISER, Harvey H. PhD. 1989. The Facilities Manager's Reference. Kingston, MA: R.S. Means Company, Inc.

LISKA, Roger W. 1988. Means Facilities Maintenance Standards. Kingston, MA: R.S. Means Company, Inc.

LOWING, A.N. et al: American Society of Civil Engineers; Guideline for Structural Condition Assessment of Existing Buildings; ANSI/ASCE 11-90. Aug. 1991.

Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products. Prestressed Concrete Institute MNL-116.

MATULIONIS, Raymond C. and Freitag, Joan C. 1991. Preventive Maintenance of Buildings. New York, NY: Van Nostrand Reinhold.

Means Graphic Construction Standards, 1986. Kingston, MA: R.S. Means Company, Inc.

Means Facilities Cost Data, 1991. Kingston, MA: R.S. Means Company, Inc.

PCI Design Handbook -- Precast and Prestressed Concrete, 3rd ed. 1985. Chicago, IL: Precast/Prestressed Concrete Institute.

Removing Stains and Cleaning Concrete Surfaces. 1988. Skokie, IL: Portland Cement Association.

SACK, Thomas F. 1971. A Complete Guide to Building and Plant Maintenance. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Time-Saver Standards, 1974. McGraw-Hill, New York, NY.

Magazine Articles:

Annual Checkups Maintain Crack Repairs. Parking Technology. July, 1991

Minimizing Concrete Surface Abrasion. Plant Engineering. July 3, 1991.

The Performance of Portland Cement. ASTM Standardization News. January, 1992.

OTHER RELATED REFERENCES

END OF SUBSECTION

APPENDIX A

ABBREVIATIONS

A, Amp	Ampere, Area
A/E	Architect-Engineer
AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ABMA	American Boiler Manufacturers Association
ABS	Acrylonitrile-Butadiene-Styrene
AC	Alternating Current, Air Conditioning
ACFM	Actual Cubic Feet per Minute
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
ACSM	American Congress on Surveying and Mapping
ADF	Asset Determinant Factor
ADJ	Adjustable
ADM	Action Description Memorandum
ADP	Automated Data Processing
AEC	U.S. Atomic Energy Commission
AFM	U.S. Air Force Manual
AFR	U.S. Air Force Regulation
AFWL	U.S. Air Force Weapons
AGA	American Gas Association
AHU	Air Handling Unit
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ALARA	As Low as Reasonably Achievable
Allow	Allowance
Amb	Ambient
AMC	U.S. Army Materiel Command
AMCA	Air Movement Contractors Association
AMC-R	Army Materiel Command Regulation
Amp	Ampere
ANS	American Nuclear Society
ANSI	American National Standards Institute
API	American Petroleum Institute
Approx.	Approximately
AR	U.S. Army Regulation
AREA	American Railway Engineering Association
ARI	American Refrigeration Institute
ARMA	Asphalt Roofing Manufacturers Association
ASBC	American Standard Building Code
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration & Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATM	Atmosphere
AVG	Average
AVLIS	Atomic Vapor Laser Isotope Separation
AWG	American Wire Gauge
AWS	American Welding Society
AWWA	American Water Works Association

APPENDIX A

BAT	Best Available Technology
BATEA	Best Available Technology Economically Achievable
BCPCT	Best Conventional Pollutant Control Technology
BESEP	Base Electronic System Engineering Plan
BHP	Brake Horsepower
BI	Black Iron
BIA	Brick Institute of America
BIL	Basic Impulse Insulation Level
BKRS	Breakers
BLDG	Building
BOCA	Building Official Code Association
BOD	Biochemical Oxygen Demand
	Building Research Advisory Board (now Building Research Board)
BRB	Building Research Board
BRG	Bearing
BTU	British Thermal Unit
°C	Degrees Centigrade (Celsius)
C&GS	U.S. Coast and Geodetic Survey (now National Geodetic Survey)
C M	Clean Air Act
CAMS	Continuous Air Monitoring System
CAS	Condition Assessment Survey
CCTV	Closed Circuit Television
CDR	Conceptual Design Report
CEM	Continuous Emissions Monitoring
CERC	U.S. Army Coastal Engineering Research Center
CERCLA	Comprehensive Environmental Response, Compensation, & Liability Act
CF	Cubic Feet
CFC	Chlorofluorocarbon
CFM	Cubic Feet per Minute
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
CHW	Chilled Water
CI	Cast Iron
CIP	Cast-in-Place, Cast Iron Pipe
CISCA	Ceiling and Interior Systems Contractors Association
CISPI	Cast Iron Soil Pipe Institute
CMP	Corrugated Metal Pipe
CO_2	Carbon Dioxide
COE	U.S. Army Corps of Engineers
COMPR	Compressor
COP	Coefficient of Performance
CP	Concrete Pipe
CPLG	Coupling
CPSC	Consumer Product Safety Commission
CPVC	Chlorinated Polyvinyl Chloride
CRI	Carpet and Rug Institute
CRT	Cathode Ray Tube
C_v	Flow coefficient
c w	Cold Water
CWA	Clean Water Act
CYL	Cylinder
DAC	Derived Air Concentration
DARCOM	U.S. Army Development, Acquisition and Readiness Command

APPENDIX A

DB	Dry Bulb, Decibel
DBA	Design Basis Accident
DBE	Design Basis Earthquake
DBF	Design Basis Fire
DBFL	Design Basis Flood
DBG	Distance Between Guides
DBT	Design Basis Tornado
DBW	Design Basis Wind
DC	Direct Current
DCG	Derived Concentration Guide
DCPA	Defense Civil Preparedness Agency
DL	Dead Load
DM	NAVFAC Design Manual
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOP	Dioctylphthalate
DOT	U.S. Department of Transportation
DP	Differential Pressure
DP-1	Assistant Secretary for Defense Programs
DP-34	Director of Safeguards and Security Agreement
DPDT	Double-Pole Double-Throw
DSC	Differential Scanning Calorimetry
DTA	Differential Thermal Analysis
DWT	Double Wrap Traction
DWV	Drain, Waste & Vent
DX	Direct Expansion
DYN	Dyne
EA	Each
ECC	Emergency Control Center
ECP	Entry Control Point
EMCS	Energy Monitoring and Control System
ECS	Emergency Control Station
EDE	Effective Dose Equivalent
EED	Electroexplosive Device
EIA	Electronics Industries Association
EIFS	Exterior Insulation and Finish System
EIMA	Exterior Insulation Manufacturers Association
EIS	Environmental Impact Statement
Elev	Elevator
EM	US. Army Engineering Manual
EMS	Energy Management System
EMT	Electrical Metallic Tubing
EO	Executive Order
EOC	Emergency Operating Center
EPA	U.S. Environmental Protection Agency
EPS	Emergency Power System
Equip	Equipment
ERDA	Energy Research and Development Administration (precursor to DOE)
ESF	Engineered Safety Feature
Est	Estimated
Ext	Exterior
°F	Degrees Fahrenheit
FAA	Federal Aviation Administration

APPENDIX A

FAI	Fauske and Associates, Inc.
FAR	Federal Acquisition Regulation
FCC	Federal Construction Council
FEMA	Federal Emergency Management Agency
FGA	Flat Glass Marketing Association
FGCC	Federal Geodetic Control Committee
FGD	Flue Gas Desulphurization
FHWA	Federal Highway Administration
FHDA	Fir and Hemlock Door Association
Fig	Figure
FIPS	Federal information Processing Standards
Fixt	Fixture
Flr	Floor
FM	Factory Mutual
Fndtn	Foundation
FPM	Feet Per Minute
FPT	Female Pipe Thread
FR	Federal Register
fr	Frame
FS	Federal Specifications
FSAR	Final Safety Analysis Report
Ft	Foot, feet
Ft/lb	Foot-Pound
FWPCA	Federal Water Pollution Control Act
fy	Yield strength
G	Gauss
g	Gram
GA	Gypsum Association
ga	Gauge
Gal	Gallon
Galv	Galvanized
GDC	General Design Criteria, DOE 6430.1A
GPD	Gallon Per Day
GPH	Gallon Per Hour
GPM	Gallons Per Minute
GSA	General Services Administration
HE	High Explosives
HE-Pu	High Explosives-Plutonium
HF	High Frequency, Hydrogen Fluoride
HI	Hydraulic Institute
HID	High Intensity Discharge
HLW	High-Level Waste
HOA	Hand-Off-Automatic
HP	Horsepower
HR	Hour
Htg	Heating
Htr	Heater
HTW	High Temperature Water
HVAC	Heating, Ventilating, and Air-Conditioning
Hvy	Heavy
HW	Hot Water
Hyd	Hydraulic
HX	Heat Exchanger

APPENDIX A

Hz	Hertz, frequency
IAPMO	International Association of Plumbing and Mechanical Officials
IAS	Intrusion Alarm System
ICBO	International Conference of Building Officials
ICRP	International Commission on Radiological Protection
ID	Inside Diameter
IDA	Intrusion Detection and Assessment
IDS	Intrusion Detection System
IEEE	Institute of Electrical and Electronic Engineers
IES	Illumination Engineering Society
IFM	Irradiated Fissile Material
IFMSF	Irradiated Fissile Material Storage Facility
IHE	Insensitive High Explosives
IMC	Intermediate Metal Conduit
In	Inch
Incl	Installed, Including
Inst	Installation
Insul	Insullation
IP	Iron Pipe
IPS	Iron Pipe Size
IPT	Iron Pipe Threaded
ISDSI	Insulated Steel Door Systems Institute
IU	Inspection Unit
IUEC	International Union of Elevator Contractors
J	Joule
°K	Degrees Kelvin
K	Subgrade modulus, Thousand, heavy wall copper tubing
Kg	Kilogram
kHz	Kilohertz
Klp	1000 pounds
Km	Kilometer
kPa	kilo Pascal
KV	Kilovolt
kVA	kiloVolt Ampere
kW	kilowatt
kWh	kilowatt hour
Ib	Pound
Ib/hr	Pounds Per Hour
Ibf	Pounds Per Foot
LCC	Life-Cycle Cost
LCD	Liquid Crystal Display
LF	Linear Feet
LL	Live load psf - pounds per square foot
LLW	Low-Level Waste
LP	Liquid Petroleum, Low Pressure
LPG	Liquified Petroleum Gas
Lt	Light
LV	Low Voltage
MA	Management and Administration (U.S. DOE)
mA	milliAmpre
MAA	Material Access Area
Mach	Machine
Maint	Maintenance

APPENDIX A

MAWP	Maximum Allowable Working Pressure
MBA	Material Balance Area
MBH	Thousand BTUs per Hour
MBMA	Metal Building Manufacturers' Association
MC&A	Material Control and Accountability
MCF	Thousand Cubic Feet
M fg	Manufacturing
Mfr	Manufacturer
MCC	Motor Control Center
mg	Milligram
mg/l	Milligrams per liter
MGPH	Thousand Gallons Per Hour
Mhz	Megahertz
MI	Miles, total level route
MIL-HDBK	U.S. DOD military handbook
MIN	Minute
mIn	Minimum
MIsc	Miscellaneous
ml	Millileter
ML/SFA	Metal Lath/Steel Framing Association
mm	Millimeter
M&O	Management and Operations
MPH	Miles Per Hour
MPT	Male Pipe Thread
mr/h	milli roentgen/hour
mrad/h	milli roentgen, absorbed dose/hour
mrem	milli roentgen equivalent man
MSSA	Master Safeguards and Security Agreement
Mtng	Mounting
MVA	Million-Volt-Amps
N_2	Nitrogen
N/A	Not Applicable
NAAMM	National Association of Architectural Metal Manufacturers
NACE	National Association of Corrosion Engineers
NAD	North American Datum
NAEC	National Association of Elevator Contractors
NAESA	National Association of Elevator Safety Authorities
NAPHCC	National Association of Plumbing-Heating-Cooling Contractors
NASA	National Aeronautics and Space Administration
NAVFAC	Naval Facilities Engineering Command
NBC	National Building Code
NBS	National Bureau of Standards
NC	Noise Criteria
NCEL	Naval Civil Engineering Laboratory (references listed under NAVFAC)
NCMA	National Concrete Masonry Association
NDA	Non-Destructive Assay
NEC	National Electrical Code
NEII	National Elevator Industry Incorporated
NEMA	National Electrical Manufacturers Association
NEMI	National Elevator Manufacturing Industry, Inc. (now NEII)
NEPA	National Environmental Policy Act
NFGS	Naval Facilities Guide Specification (references listed under NAVFAC)
NFPA	National Fire Protection Association

APPENDIX A

NGS	National Geodetic Survey (formerly U.S.Coast and Geodetic Survey)
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NIJ	National Institute of Justice
NIST	National Institute of Standards and Technology (see NBS)
N O M	National Oceanic and Atmospheric Administration
NO	Normally Open
NO_x	Oxides of Nitrogen
NPDES	National Pollutant Discharge Elimination System
NPDWS	National Primary Drinking Water Standards
NPSH	Net Positive Suction Head
NPT	National Pipe Thread
NRC	Nuclear Regulatory Commission
NRCA	National Roofing Contractors Association
NRTA	Near-Real-lime Accountancy
NRTL	Nationally Recognized Testing Laboratory
NSA	National Security Agency
NSPC	National Standard Plumbing Code
NSPS	New Source Performance Standards
NTIA	National Telecommunications and Information Administration
NTMA	National Terrazzo and Mosaic Association
NUREG	Nuclear Regulatory Commission-produced reference document
NWWDA	National Wood Window and Door Association
OA	Outside Air
OBA	Operating Basis Accident
OBE	Operating Basis Earthquake
o c	On Center
o c s	Office of Computer Services (U.S. DOE)
OD	Outside Dimension
ODH	Oxygen Deficiency Hazards
O & M	Operations and Maintenance
OMB	Office of Management and Budget
OP AMP	Operational Amplifier
Oper	Operator
OPFM	Office of Project and Facilities Management (U.S. DOE)
OS&Y	Outside Screw and Yoke
OSHA	Occupational Safety and Health Administration
OSR	Operational Safety Requirement
o s s	Office of Safeguards and Security (U.S. DOE)
OSTI	Office of Scientific and Technical Information (U.S. DOE)
OWG	Oil, Water, or Gas
Oz	Ounce
p	Minimum reinforcing ratio
PA	Protected area
PB	Polybutylene
PCB	Polychlorinated biphenyls
PCI	Prestressed Concrete institute
PEL	Permissible Exposure Limit
PF	Protection Factor
Ph	Phase
PI	Point of Intersection, Proportional-plus Integral
PIV	Post Indicator Valve
PLF	Pounds per Linear Foot

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Pkg	Package
PMFL	Probable Maximum Flood
POL	Petroleum, Oil, and Lubricants
POTW	Publicly-Owned Treatment Works
PPHF	Plutonium Processing and Handling Facility
PPM	Parts Per Million
PRV	Pressure Regulating Valve
PSAR	Preliminary Safety Analysis Report
PSF	Plutonium Storage Facility, Pound-force per square foot
PSI	Pound-force per square inch
PSIA	Pounds per square inch absolute
PSIG	Pound-force per square inch gauge
PTI	Post Tensioning Institute
Pu	Plutonium
PUBN	Publication
PURPA	Public Utility Regulatory Policy Act
PVC	Polyvinyl Chloride
QA	Quality Assurance
Qty	Quantity
R	Resistance
R12, R22	Refigerant (12,22, etc.)
°R	Degrees Rankine
RCP	Reinforced Concrete Pipe
RCRA	Resource Conservation and Recovery Act
RDF	Refuse-Derived Fuel
REM	Roentgen Equivalent Man
Reqd	Required
RFCI	Resilient Floor Covering Institute
RG	Regulatory Guide
RLWF	Radioactive Liquid Waste Facility
RPFM	Real Property and Facilities Management (U.S. DOE)
RPIS	Real Property Inventory System (U.S. DOE)
RPM	Revolutions Per Minute
RSWF	Radioactive Solid Waste Facility
RTD	Resistance Temperature Detector
S&S	Safeguards and Security
SAR	Safety Analysis Report
SARS	Safety Analysis and Review System
SAS	Secondary Alarm Station
SC	Safety Class
SCFM	Standard Cubic Feet per Minute
SCR	Sillicon Control Rectifier
SCS	U.S. Department of Agriculture, Soil Conservation Service
SDI	Steel Deck Institute, Steel Door Institute
SDWA	Safe Drinking Water Act
SF	Safety Factor
SGFT	Structural Glazed Facing Tile
SISL	Special Isotope Separation Laser
SJI	Steel Joist Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SNG	Supplementary Natural Gas
SNM	Special Nuclear Materials

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SO_2	Sulfur dioxide
SOP	Standard Operating Procedure
SP	Special Publication (of the American Concrete Association)
SPCC	Spill Prevention Control and Countermeasure
SPDT	Single-Pole Double-Throw
SPRI	Single Ply Roofing Institute
SPST	Single-Pole Single-Throw
ssco	Single Speed Center-Opening
SQFT	Square foot
SSE	Safe Shutdown Earthquake
SSFI	Scaffolding, Shoring, and Framing Institute
SSSP	Site Safeguards and Security Plan
SSPC	Steel Structures Painting Council.
ssss	Single Speed Side-Sliding
STC	Sound Transmission Classification
Std	Standard
STP	Standard Temperature and Pressure
Sys	System
SWI	Steel Window Institute
SWP	Safe Working Pressure
SWT	Single Wrap Traction
T	Ton, Temperature
TCA	Tile Council of America, Inc.
TCDD	Tetrachlorodibenzo-p-dioxin
TDS	Total Dissolved Solids
TEC	Total Estimated Cost
TID	Tamper Indicating Device
TIMA	Thermal Insulation Manufacturers Association
TLV	Threshold Limit Value
TM	U.S. Army technical manual
tot	Total
TR	DOD technical report
Transf	Transformer
TRU	Transuranic
TSCA	Toxic Substances Control Act
TSD	Treatment, Storage and Disposal
Tstat	Thermostat
TYP	Typical
TV	Television
U value	Overall heat transfer coefficient value
UBC	Uniform Building Code
UCRF	Uranium Conversion and Recovery Facility
UEF	Uranium Enrichment Facility
UEU	Unirradiated Enriched Uranium
UEUSF	Unirradiated Enriched Uranium Storage Facility
UF_4	Uranium tetrafluoride
UF_6	Uranium hexafluoride
UFAS	Uniform Federal Accessibility Standards
UHF	Ultra High Frequency
UL	Underwriters Laboratory
UMC	Uniform Mechanical Code
UO_2	Uranium dioxide
UO_3	Uranium trioxide

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UPA	Unit Process Area
UPC	Uniform Plumbing Code
UPHF	Uranium Processing and Handling Facility
UPS	Uninterruptible Power Supply
URF	Uranium Recovery Facility
USC	U.S. Code
USCE	US. Army Corps of Engineers
USGS	U.S. Geological Survey
USPHS	U.S. Public Health Service
USPS	U.S. Postal Service
V	Volt
VA	Volt-Ampere
Vac	Vacuum
VAV	Variable Air Volume
VCT	Vinyl Composition Floor Tile
Vel	Velocity
Vent	Ventilating
VHF	Very High Frequency
Vol	Volume
W	Watt
WB	Wet Bulb
WBT	Wet Bulb Temperature
WC	Water Column
WG	Water Gauge
WB	Wet Bulb
WBS	Work Breakdown Structure
WPCF	Water Pollution Control Federation
WRC	Water Resources Council
Yd	Yard
Yr	Year

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SYMBOLS

°R'	Degrees Rankine
°K	Degrees Kelvin
°F	Degrees Fahrenheit
°C	Degrees Centigrade (Celcius)
>	Greater Than
<	Less Than
≥	Greater Than or Equal To
≤	Less Than or Equal To
%	Percent
#	Pound, Number
α, Α	Alpha
β, Β	Beta
φ, Φ	Theta
λ, Λ	Lambda
μ, Μ	Mu
π, Π	Pi
σ, Σ	Sigma
ω, Ω	Omega

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END OF SUBSECTION

APPENDIX B

GLOSSARY

Abutment:	That part of a structure which takes the thrust of a beam, arch, vault, truss, girder or foundation wall.
Accelerator:	Any material added to concrete that speeds the natural setting.
Admixture:	Act of mixing or the compound formed by mixing different substances together.
Aggregates:	Inert minerals such as sand, gravel, and crushed stone. The aggregates are divided into two sizes - fine and coarse.
Anchor:	A piece or connected pieces of metal used for tying together two or more pieces of masonry materials.
Anchor Bolts:	Bolts to secure a wooden sill plate to concrete or masonry floor or wall. A threaded bolt, usually embedded in a foundation or footing to secure a column base.
Arris:	A sharp edge forming an external corner at the junction of two surfaces.
Backfill:	The replacement of excavated earth into a trench around and against a basement foundation.
Backfilling:	(1) Earth, soil, or other material used to replace excavated materials around a newly constructed wall, (2) Rough masonry laid behind a facing, or between two faces; (3) brickwork laid in the space between structural timbers.
Base:	The lowest part, or the lowest main division, of a building, column, pier or wall.
Base Plate:	See Bearing Plate.
Batter Board:	One of a pair of horizontal boards nailed to post set at the corners of an excavation, used to indicate the desired level; also as a fastening for stretched strings to indicate outlines of foundation walls.
Beam:	A structural member transversely supporting a load.
Bearing:	That part of a lintel, beam, girder or truss, which rests upon a column, pier or wall.
Bearing Plate:	A piece of steel, iron, or other material which receives the load concentration and transmits it to the masonry or concrete.
Bevel:	The angle that one surface or line makes with another, when they are not at right angles.
Block:	A unit in terra cotta or cement building, differing from a brick in being larger and, usually, hollow.
Block (Hollow):	A shape made of clay, terra cotta or other material fashioned with one or more openings in its body for lightness, whose net sectional area does not exceed 75 percent of its gross sectional area.

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Blocking:	A method of bonding two adjoining or intersecting walls, not built at the same time, by means of offsets and overhanging blocks consisting of several courses of masonry each
Bond Beam:	A horizontally reinforced concrete or concrete masonry beam built to strengthen and tie a masonry wall together. A bond beam is often placed at the top of a masonry wall with continuous reinforcing around the entire perimeter.
Bugged Finish:	A smooth finish produced by grinding with power sanders.
Bull Nose:	Convex rounding of a member.
Buttress:	A piece of masonry, like a pier, built against and bonded into a wall to strengthen the wall against side thrust.
Calcite Streaks:	Description of a white or milky streak occurring in stone. It is a joint plane usually wider than a glass seam which has been recemented by deposition of calcite in the crack. It is structurally sound.
Camber:	A slight upward curve of a structural member so that it becomes horizontal, or nearly so, when loaded.
Cap:	The upper member of a column, pilaster, pile, caisson molding, and the like.
Capital:	Column cap.
Caulking:	The operation or method of rendering a joint tight against water by means of some plastic substances such as oakum and pitch, elastic cement, and the like.
C/B Ratio:	The ratio of the weight of water absorbed by cold immersion (usually 24 hours) to the weight absorbed by immersion in boiling water (usually 5 hours). This ratio is also known as the saturation coefficient.
Check Cracks:	Shrinkage cracks in concrete still bonded to its base.
Chip Cracks:	Similar to check cracks, except that the bond has been partially destroyed, causing eggshelling. Sometimes referred to as fire cracks, map cracks, crazing, fire checks, or hair cracks.
Column:	A pillar or pier of rather slender proportions which carries a load and acts as an upright support.
Concrete:	A mixture of two components, cement paste and aggregates.
Concrete Plain:	Concrete either without reinforcement, or reinforced only for shrinkage or temperature changes.
Construction Joint:	The interface/meeting surface between two successive concrete pours.
Connectors:	A device that holds two or more structural members intact.
Coping:	The material or member used to form a capping or finish on top of a wall, pier, or the like, to protect the masonry below by throwing off the water to one or more sides.

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Counterfort: A buttress or portion projecting from a wall and upward from the toundation to provrde additional resistance to thrusts.

Creep: The time-dependent deformation of steel or concrete due to sustained load.

Crown: The top or hrgh point of a horizontal surface

Damp Course: A course or layer of impervious materıal in a wall or floor to prevent the entrance of moisture trom the ground or trom a lower course.

Deformed Bars: Reinforcing bars with closely spaced shoulders, lugs or projections formed integrally with the bar during rolling so as to firmly engage the surrounding mortar. Wire mesh with welded intersections not farther apart than 12 inches (30 cm.) in the direction of the principal reinforcement and with cross wires not smaller than No. 10 may be rated as a deformed bar.

Diamond Sawed: Finish produced by sawing with diamond toothed saws (either circular or gang).

Dope: Term used for additives used either to accelerate or retard the set of any type of mortar.

Drip: Any projecting piece of material, member or part of a member so shaped and placed as to throw off water and prevent its running down the face of a wall or other surface of which it is a part.

Dry-out: Soft, chalky mortar caused by water evaporating before setting.

Dry Seam: Unhealed fracture which is a plane of weakness.

Dusting: The development of dust on the surface of concrete. Dusting can be the result of trowelling too soon, too much water in the mix, improper mix design, or other reasons.

Effective Area of Reinforcement: The area obtained by multiplying the right cross-sectional area of the metal reinforcement by the cosine of the angle between its direction and that for which the effectiveness of the reinforcement is to be determined.

Effective Depth: The distance from the center of gravity of tensile reinforcement to the compression surface of a structural member.

Efflorescence: Mortars or cements which contain an excess of soluble salts will contribute to efflorescence of the masonry. Efflorescence can only occur when water penetrates the masonry or concrete, dissolves the salts and upon evaporation deposits them on the face of the wall. The surest preventative of efflorescence is to keep water out of masonry or concrete.

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Eggshelling:	Refers to the condition of chip-cracked concrete, mortar or plaster. The form taken is concave to the surface and the bond is partially destroyed.
Enclosure Wall:	An exterior non-bearing wall in skeleton construction, anchored to columns, piers or floors, but not necessarily built between columns or piers nor wholly supported at each story.
Entablature:	Consists of an architrave, frieze, and cornice.
Entasis:	The curve resulting from the gradual diminishing of the diameter of the upper two-thirds of a column.
Epoxy Resin:	A flexible usually thermal setting resin made by polymerization of an epoxide and used as an adhesive.
Expansion Anchor:	A metal expandable unit inserted into a drilled hole that grips stone by expansion.
Expansion Joint:	A bituminous fiber strip used to separate blocks or units of concrete to prevent cracking due to expansion as a result of temperature changes. Also used in concrete slabs.
Exterior Wall:	Any outside wall or vertical enclosure of a building other than a party wall.
Fat:	Material accumulated on the trowel during the finishing operation and used to fill in small imperfections. Also a term to describe working characteristics of any type mortar.
Fire Division Wall:	Any wall which subdivides a building so as to resist the spread of fire, but is not necessarily continuous through all stories to and above the roof.
Fire Resistance:	The property of a material or assembly to withstand fire, characterized by the ability to confine a fire and/or to continue to perform a given structural function.
Fire stop:	Any piece or mass of fire resistant material used for filling in open spaces or close openings in order to prevent the passage of fire.
Fire Wall:	Any wall which subdivides a building so as to resist the spread of fire, by starting at the foundation and extending continuously through all stories to and above the roof.
Fireproofing:	Any material or combination of materials used to enclose structure members so as to make them fire resistant.
Flashing:	The material used and the process of making watertight the roof intersections and other exposed places on the outside of the house.
Footing:	A masonry section, usually concrete, in a rectangular form wider than the bottom of the foundation wall or pier it supports.
Footing Form:	A wooden or steel structure, placed around the footing that will hold the concrete to the desired shape and size.

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Formwork: The total system of support for freshly placed concrete including the mold or sheathing which contacts the concrete, as well as all supporting members, hardware and necessary bracing.

Foundation: The supporting portion of a structure below the first-floor construction, or below grade, including the footings.

Foundation Wall: That portion of a load-bearing wall below the level of the adjacent grade, or below the first tier of floor beams or joists, which transmits the superimposed load to the footing.

Frostline: The depth of frost penetration in soil. This depth varies in different parts of the country. Footings should be placed below this depth to prevent movement.

Gang Saw: A machine with multiple blades used to saw rough quarry blocks into slabs.

Glass Seam: Vein fillings of coarsely crystalline calcite, that do not necessarily decrease the strength of stone.

Granular Base: Evenly graded mixture of fine and course aggregates to provide, when compacted, a smooth and even surface below footings.

Grout: A mixture of cementitious material (cement, lime), sand and sufficient water to make a consistency that will flow without separation of ingredients.

High-Strength Adhesive: A bonding agent of high ultimate strength used to join individual pieces of stone into preassembled units.

Incise: To cut inwardly or engrave - as in an inscription.

Incombustible (Building Material): Any building material which contains no matter subject to rapid oxidation within the temperature limits of a standard fire test of not less than 2.5 hours duration. NOTE: Materials which continued burning after this time period are combustible.

Inscription: Lettering cut in stone.

Interior Wall: Any wall entirely surrounded by the exterior walls of a building.

Joint: The space between the adjacent surfaces of two members or components joined and held together by nails, glue, cement, mortar, or other means.

Key: A section of concrete formed to lock into another pour to stop water penetration or provide easier joining of pieces.

Masonry: Stone, brick, concrete, hollow-tile, concrete-block, gypsum-block, or other similar building units or materials or a combination of the same, bonded together with mortar to form a wall, pier, buttress, or similar mass.

Mastic: A pasty material used as a cement (as for setting tile) or a protective coating (as for thermal insulation or waterproofing).

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Mineral Fiber:	Fibers formed from mineral slag, the most common being glass wool, which is used in loose or batt form for thermal and/or fireproofing.
Miter:	The junction of two units at an angle. The junction line usually bisects on a 45 degree angle.
Mortar:	A mixture of cementitious materials and aggregate, with or without the addition of plasticizers or other admixtures, reduced to a plastic state by the addition of water and suitable for use to bind masonry units together.
Neat:	Generally, basecoat plaster, mortar or grout, to which sand is added at the job.
Non-Bearing Wall:	Any wall which carries no load other than its own weight.
Panel Wall:	A non-bearing wall in skeleton construction, built between columns or piers, and wholly supported at each story.
Parging:	To coat or plaster with mortar or grout.
Party Wall:	A wall used, or adapted for use for joint service by adjoining buildings.
Paste:	Composed of Portland cement, water, and air.
Perm:	A measure of water vapor movement through a material (grains per square foot per hour per inch of mercury difference in vapor pressure).
Pier:	A column of masonry, usually rectangular in horizontal cross section, used to support other structural members.
Piers:	Masonry or concrete supports, set independently of the main foundation.
Pilaster:	A pier, built as an integral part of a wall, and projecting slightly from either vertical surface thereof.
Piles:	Long posts driven into the soil in swampy locations or whenever it is difficult to secure a firm foundation, upon which the footing course of masonry or other timbers is laid. Consists of concrete, metal or wood.
Pipe Column:	A column made of steel pipe and often filled with concrete.
Plumb:	Exactly perpendicular; vertical.
Pointing:	Pushing mortar into a joint after masonry is laid.
Preassembled Units:	Two or more stones combined into a single unit by the use of epoxy resins, steel framing, or concrete backing.
Precast Concrete:	A concrete member that is cast and cured in other than its final position.
Quarry:	The location of an operation where a natural deposit of stone is removed from the ground.
Raggle:	A groove or channel made in a mortar joint, or in the solid masonry material, to receive roofing, metal flashing or other material which is to be sealed in the masonry.

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Recess: A srnkage

Reglet: A recess to receive and secure metal flashing

Reinforcing: Steel rods or metal fabric placed in concrete slabs, beams, or columns to increase their strength.

Reinforcement: Structural steel shapes, steel bars, rods, wire mesh, or expanded metal imbedded or encased in brick or other masonry or concrete to increase its strength.

Relief or Relieve: Projection of ornamentation.

Retarder: Any material added to concrete, mortar or grout that slows up its natural set.

Rustication: A recessed surface cut around or across the face of a stone to produce shadow accent.

Sand Float Finish: Lime mixed with sand, resulting in a textured finish.

Scaffold or Staging: A temporary structure or platform enabling workmen to reach high places.

Sealant: A resilient compound used as the final weatherface in stone joints. (This term is sometimes misused to indicate clear water-repellent treatments which are sometimes sprayed or otherwise applied to masonry.)

Shot Sawed: Description of a finish obtained by using steel shot in the gang sawing process to produce random markings for a rough surface texture.

Shrinkage: The volume change in concrete caused by drying normally occurring during the hardening process.

Skeleton Construction: A type of building construction in which all loads are transmitted to the foundations by a rigidly connected framework of suitable material.

Skew: Inclination in any direction.

Slab-on-Grade: A concrete slab placed on grade, sometimes having insulation board or an impervious membrane beneath it, on a granular base.

Slip Joint: A connection which permits vertical or horizontal movement of the cladding with respect to the structural frame.

Smooth Finish: A finish of minimum textural quality, presenting the least interruption of surface. Smooth finish may be applied to any surface, flat or molded. It is produced by a variety of machines.

Spall: A small fragment removed from the face of stone, brick, masonry or concrete material by a blow or by the action of the elements.

Span: The distance between structural supports such as walls, columns, piers, piles, beams, girders, and trusses.

Splay: A beveled or slanted surface.

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Springing Line:	A line marking the level from which the curve of an arch or vault rises from the upright or impost.
Structural lube Columns:	Structural column shaped as a square or rectangle.
support:	An angle, plate or other stone which carries a gravity load.
Surround:	An enframement.
Sweat-Out:	Soft, damp mortar caused by poor drying conditions.
Tail Beam:	A relatively short beam or joist supported in a wall on one end and by a header at the other.
Temper:	To moisten and mix clay, plaster, mortar and similar materials to the proper consistency for working.
Template:	A pattern used in the fabrication operation.
Texture:	Any finish other than a smooth finish.
Throat:	The undercut of a projected molding to form a drip.
Tolerance:	Acceptable dimensional allowance, under or over ideal net sizes.
Tooling:	Compressing and shaping the face of a mortar joint, usually with a special tool, other than a trowel.
Tuck Pointing:	A method of refinishing old mortar joints, the loose mortar is dugout and the tuck is filled with fine mortar which is left projecting slightly or tooled.
Undercut:	Cut or molded so as to present an overhanging part, as a drip mold.
Vapor Barrier:	Material used to retard the movement of water vapor into walls, and prevent condensation in them. Usually considered as having a perm value of less than 1 .0. Applied separately over the warm side of exposed walls or as a part of batt or blanket insulation.
W Shaped (Beam):	A structural member of rolled steel whose cross section resembles the capital letter I.
Wall Plate Anchor:	A machine bolt anchor, with a head at one end and threaded at the other, and fitted with plate or punched washer so as to securely engage the brickwork or concrete and hold the wall plate or other member in place.
Wall Tie:	Strip of metal used for tying a facing veneer to the body of a wall.
Waterproofing:	(See Dampproofing.)
Water Repellent:	Any of several types of clear liquids used to render masonry walls less absorptive. These treatments are said to maintain a material's ability to breathe away moisture, as distinct from "sealers" which form impervious, non-breathing coatings,
Water Retentivity:	Flow and resistance to segregation are factors affecting workability, which in turn are affected by the properties of both the cementitious materials and the aggregate.

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Water Table:	A slight protection of the lower masonry or brickwork on the outside of a wall and slightly above the ground as a protection against water.
Weep Hole:	A drainage openrng usually inserted at the base of a stone unit to release moisture accumulating between the stone and backup.
Welded Wire Mesh:	A series of longitudinal and transverse wires arranged substantially at right angles to each other and welded together at all points of intersection.
Workability:	That property of freshly mixed concrete or mortar which determines the ease and homogeneity with which it can be mixed, placed, compacted and finished.

APPENDIX B

END OF SUBSECTION

APPENDIX C

TECHNICAL BULLETINS/UPDATES/ADVISORIES

Index of Bulletins/Advisories
followed by Bulletins/Advisories
as developed

APPENDIX C

TECHNICAL ADVISORY **T0501-1**

DATE: 10/91
SYSTEM: Roofing (CSI 07000)
ASSEMBLY: Built-Up (CSI 07510)
SUBJECT: Roof Top Lighting and Insect Damage

"In March, 1988 a professional roofing magazine article described a bizarre but apparently avoidable, phenomenon. In about a dozen documented cases ranging from Washington State to Florida, beetles have bored through roof membranes, causing leaks. It was determined that the beetles are attracted to lights (especially mercury vapor) mounted on, over, or near roof surfaces, including nearby billboard lighting. Falling to the roof, they burrow into the roof substrate, seeking protection from the sun during the day. The types of roof membrane affected were asphaltic BUR, modified bitumen, and single-ply roofing. Evidently, no instance has yet been found among coal tar BUR. It is advisable to exercise care in the selection of roof membranes where billboards may exist adjacent to a planned roof installation, or when rooftop lighting is required. The roof specifier should discuss the types of luminaire to be used with project electrical engineers before mercury vapor fixtures are specified."

Source: Roofing Design Criteria Options. RD. Herbert II

EXAMPLE: TECHNICAL ADVISORY BULLETIN

END OF SUBSECTION

APPENDIX D

REVISIONS SUMMARY

AT A GLANCE SUMMARY OF ALL

REVISIONS UP TO LATEST REVISION DATE