PART 2 – INSPECTION

CHAPTER 2.6 – PLANNING, SCHEDULING, EQUIPMENT, AND MOBILIZATION

For an inspection to be executed properly, the team leader should follow a planning stage to prepare an appropriate schedule to mobilize resources efficiently, considering the equipment available.

2.6.1 PLANNING

The development of a detailed inspection schedule and accompanying work sequence is necessary to arrange that significant bridge components are inspected by the appropriate personnel. The inspection team leader is generally responsible for coordination of the planning effort and should brief all team members on known specific problems with the bridge. The following items should be accomplished during the planning stage:

- Assemble bridge plans, reports, maintenance and repair records, and other pertinent information.
- Determine the type of inspection required (initial, routine, in-depth, or special).
- Determine the number of personnel required for the inspection (team members, maintainers, machinists, electricians, bridge operator, etc.).
- Determine the safety equipment needs for inspection personnel (PPE protection equipment, lanyards, ropes, etc.), methods of access, as well as inspection access equipment needs.
- Prepare bridge-specific inspection field notes, forms, charts, and schematics.
- Prepare the inspection schedule/sequence.
- Determine if advance notice of inspection schedule is necessary to other government/regulatory departments (USCG, District Bridge Office, USACOE, state/county/local agencies, local or state police, fire departments, ambulance services, etc.).
- Determine if component disassembly is required for inspection and arrange to have the required tools, personnel, and spare parts available.
- Confirm the type of lubricants that may be required if the machine will be cleaned or disassembled.

2.6.1.1 Data Collection and Review

All available information on the subject structure should be reviewed to identify areas of the bridge that require special attention. These special attention areas should be scheduled first in the inspection sequence. The documents include, but are not limited to:

COMMENTARY

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During the initial stages of the planning phase, a reconnaissance (pre-inspection) visit to the structure should be undertaken. This includes observing general bridge configuration, current site conditions, methods of access, and traffic control necessary to enter areas on or below the structure with inspection vehicles and equipment. This is especially important if the team leader is unfamiliar with the structure and its surroundings. Further, since site conditions can significantly change due to reconstruction or environmental factors, a pre-inspection may be necessary even if the team leader has previously inspected the structure.

Fasteners or other parts may be damaged during disassembly of components. It is advisable to have replacement parts on site prior to disassembly of critical operating systems.

C2.6.1.1

The bridge operator, maintainers and the previous inspection team leader can provide additional information on existing bridge conditions. If possible, they should be interviewed prior to the inspection and asked

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- Design drawings of original and rehabilitation construction.
- Shop and working drawings (original and rehabilitation).
- As-built drawings (original and rehabilitation).
- Previous inspection reports (structural, mechanical, electrical).
- Maintenance records.
- Bridge operation records.
- Bridge logs/bridge operator's/maintenance manuals. Lubrication charts.
- Maintenance schedules.
- Geotechnical data.
- Deficiency reports.
- Evaluation reports.

A discussion of the three types of drawings listed above is appropriate to familiarize inspectors with them and their degree of reliability:

- **Design drawings** are prepared by the original designer of the bridge or by subsequent rehabilitation designers. These drawings represent the original design concept and are in general the least likely to represent the actual conditions on site.
- **Shop and working drawings** are prepared by the contractors and/or fabricators of the original bridge and any rehabilitations. These drawings represent the details of each individual bridge component and are generally more likely to represent actual bridge details than design plans, especially if they are copies of the final approved set of such drawings. Shop drawing details are subject to some modifications in the field if fit or operational problems were encountered.
- **As-built drawings** are prepared by one of the parties involved in construction; the owner, designer, or contractor. They are distinguished by a clear title or stamp that labels them "As-Built". They are intended to represent the exact details of the bridge upon completion of construction of the original bridge or any rehabilitations. When prepared as intended, they are the most accurate of the three listed types, but should be verified by on-site spot checking of dimensions and details.

Review of the available bridge documents provides initial understanding of bridge details and helps identify areas with chronic problems. Maintenance records may show components that receive more than usual service, indicating a potential problem area. The inspection team should study plans and records in detail and develop an inspection checklist of known and suspected bridge deficiencies (e.g., areas of repair, fatigue sensitive details, damaged areas, location of any cracks, *about recent repairs, whether or not maintenance schedules are followed, any unusual noises or problems noted, and if any recent vehicle or vessel impacts have occurred.*

When drawings are not available or are incomplete, it is recommended that the inspection team schedule several days at the bridge prior to the actual inspection to prepare as-built sketches and electrical/mechanical/hydraulic schematics.

All three types of drawings may be inaccurate, and there is no guarantee that any set of documents truly represents the structure currently on site. Modifications are often made without documentation. It is vital that any drawings believed to represent the structure be verified on site and that critical elements' dimensions and details be checked for accuracy by field measurement of a statistically significant sampling of such areas. If discrepancies are found between drawings and the field measurements, all critical data should be field measured.

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excessively worn components, vibration problems, location of any unusual noises, etc.).

If previous inspection or deficiency reports indicated potential trouble areas or recommended maintenance work, determine if the maintenance work has been accomplished. If it has not, be sure that these preexisting trouble areas are documented and thoroughly inspected. If maintenance records indicate frequent repair or replacement of a component, an attempt should be made to determine the cause during the inspection.

2.6.1.2 Identification of Site-specific Conditions

C2.6.1.2

The lists given are presented as a sample of the types of decisions that are generally necessary to properly prepare for an inspection. Movable bridges are unique individual structures, however, and no general listing can identify all of the factors that will be significant for a particular structure. Owners should develop site-specific data for each structure that takes all features into account during inspection planning.

The development of the inspection sequence requires addressing site specific factors including:

Site Conditions

- **Is it a difficult access structure?** Structures in this category require the use and coordination of personnel lift equipment, staging, rigging, scaffolding, rope access, etc. Some owners may have security-related background checks before inspectors will be granted access to the site.
- **Are traffic/navigation closures required?** Disassembly of machinery components or installing special access equipment may require temporary interruption of roadway or navigation traffic.
- **Is a bridge operator required?** Some movable bridges are not manned full-time and require a prior request to obtain an operator.
- **Is advance notice required?** USCG and other affected agencies often require advance notice if the inspection interrupts the normal operation of the bridge.
- **Is a staging area available?** Parking areas for inspection vehicles and storage of equipment should be surveyed in advance.

Structural, Mechanical, Electrical Considerations

- **Is nondestructive structural testing required?** The bridge may require special testing or inspection techniques to supplement the visual inspection (e.g. dye-penetrant, magnetic particle, ultrasonic).
- **Is special equipment or team staffing required?** Inspecting machinery components may require the need for special tools, equipment or personnel to perform disassembly of operating components prior to

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inspection, and reassembly after inspection.

- ❑ **Is a machinist, mechanical or hydraulic expert, or electrician required for inspection?** A specialist should be part of the inspection team if unusual problems have been noted that require such expertise.
- ❑ **Is mechanical or electrical testing equipment required?** (e.g. strain gauges, oil analysis, DC megger, ammeter, voltmeter).
- ❑ **Is temporary lighting required in the machinery area?** These areas are often poorly lit and require additional lighting to aid inspection.

2.6.1.3 Preparation of the Inspection Schedule and Sequence

C2.6.1.3

The team leader should prepare a brief inspection schedule and sequence for distribution to inspection team members and affected agencies. The schedule need not be elaborate, but should at least contain the following information:

- Brief scope of inspection.
- Inspection start and finish dates and milestones of the inspection.
- Dates of important events that affect bridge operation, such as special testing or bridges closures.
- Daily work schedule (information on where inspection personnel are scheduled to be on the structure at any given time).

When preparing the inspection sequence, it should be determined if there are periods when the bridge is always open, always closed, or cannot be operated. If there are no regular periods when the bridge is held out of service, it should be determined what is the maximum length of time that the bridge can be held open and/or held closed for inspection purposes. If the bridge cannot be held in a stable closed or open position for an hour or two, it may not be possible to thoroughly inspect many components. The inspection schedule should indicate limitations and list those components that cannot be completely inspected.

In preparing the inspection sequence, the logical format involves first inspecting bridge components that require the most attention. This generally involves scheduling the span-drive machinery first, followed by the other components. Any component that has been previously reported with known problems should receive top priority. Figure 2.6.1.3-1 has been prepared to show sample inspection sequences for the machinery components of the common movable bridge types.

The inspection schedule should include allowances for inclement weather, unforeseen problems or delays due to complexity and/or age of structure, coordination around bridge maintenance activities, and delays due to seasonal traffic.

Components with known defects, or those that require care to disassemble and inspect, should be scheduled early in the inspection effort. These components may create a need for unanticipated follow-up attention such as further testing or additional disassembly. If these components are inspected first, time remaining in the inspection schedule can be devoted to this necessary but unanticipated effort. If the inspection is scheduled over a duration of more than one day, additional personnel may be brought in to accomplish the additional tasks.

In instances when all components cannot be completely inspected, assistance should be sought from appropriate authorities to overcome any limitations identified during preparation of the inspection schedule. Special testing or other means not normally available during routine inspection may be needed to provide full inspection of all components.

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In a similar manner, logical inspection sequences can be developed for hydraulic, electrical and other systems.

SWING-SPANS

Pivot Pier

1. Drive Machinery–main reducer, gears, bearings, couplings, rack and pinion.
* 2. Wedge and operating machinery–reducers, gears, bearings, couplings, cranks, levers, connecting rods, and center wedge assemblies.
3. Center bearing and balance wheels or rim bearing tapered rollers.

Rest Piers

1. End wedges or shoes.
2. Centering latch machinery.
3. Buffer cylinders.

VERTICAL-LIFTS

Towers

1. Drive machinery (if tower-drive) and emergency drive.
2. Counterweight ropes, sheaves, and trunnions.
3. Span locks.
4. Tensioning devices.

Movable Span

1. Drive machinery, drums, operating ropes (if span-drive)
2. Guide rollers
3. Observe operation of balance chain as span travels up and down.

Piers

1. Buffers.
2. Strike plates and load shoes.
3. Centering devices
4. Span locks.

TRUNNION BASCULES

Machinery Pier

1. Drive machinery and emergency drive.
2. Trunnions and trunnion bearings.
3. Buffers (double-leaf only).
4. Load shoes and strike plates (double-leaf only).
5. Tail locks.

Forward End of Span (double-leaf)

1. Span locks.
2. Centering guides.

Rest Pier (single-leaf)

1. Buffers.
2. Strike plates and load shoes.
3. Centering device.
4. Span lock.

* New swings often use hydraulic operating systems.

Figure 2.6.1.3-1 – Sample inspection sequence. Problem components should be scheduled first, but all components in one area should be done at one time.

2.6.2 MOBILIZATION

Inspection mobilization involves assembly of the inspection personnel, special equipment, tools and the preparation of bridge-specific field notes and forms in sufficient quantity to assure completeness, uniformity and continuity of the inspection operation. Many factors influence these requirements including structure size, complexity, age, type of inspection and method of access. The following sections are considered to be the minimum guidelines for a typical movable

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Inspection mobilization should include coordination with bridge operation and maintenance personnel who will assist with the inspection. For instance, gear teeth and other machinery parts usually require cleaning before measurements can be taken, and maintenance personnel may be needed in conjunction with the inspection team to

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bridge inspection. The team leader should exercise judgment when determining the specific needs for each bridge inspection, and adjust these requirements accordingly.

2.6.2.1 Preparation of Inspection Notes

Preparation of bridge inspection field notes, forms, charts, and checklists is preferred for a well-organized and efficient inspection. Photocopies of sketches and details from previous inspection reports should be made for reference in order to update the condition of any defect or deficiency. If plans or previous sketches are unavailable, the team leader should develop a general set of framing plans, typical elevations and mechanical, hydraulic, and electrical schematics during the pre-inspection visit. Sample forms, which may be used as a guide for the preparation of movable bridge inspection and maintenance records and record keeping, are discussed in Chapter 2.7. Some of the general requirements that should be considered when preparing the field notes include:

- Uniform notation system for reporting condition of bridge elements and components should be known to all team members.
- Standard nomenclature and/or abbreviations for bridge elements and components should be known to all team members.
- Numbering sequence and format for photographs should be standardized.

The general requirements for the structural, mechanical and electrical bridge components are as follows:

Structural: Structural inspection forms and recording of data are covered extensively in Reference 9 and Reference 69. Inspectors may use the forms presented in those documents, supplemented by inspection task checklists, previous inspection and deficiency reports, and structural drawings.

Mechanical: Figure 2.6.2.1-1 shows sample machinery sketches prepared for a bascule bridge and Figure 2.6.2.1-2 shows operating machinery for a swing bridge. Dimension charts should be prepared for components to be measured, such as gears, bearings, and bushings. The charts should contain piece numbers for each component, the as-built or design dimension and clearance, and a column to record the actual

expedite this work. In addition, separate structural, mechanical, and electrical inspections may often be done concurrently. This type of coordination will reduce the inconvenience to bridge users by shortening the time when the span must be operated or not operated for inspection purposes.

C2.6.2.1

To ensure consistency throughout the bridge file, bridge component terminology, numbering and identification systems should be generally the same as the previous inspection(s), and should be consistent in structural, mechanical, hydraulic and electrical reports.

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measurements in the field. The piece numbers refer to the assembly drawings. For complete assemblies, such as gear reducers or mechanical lockbars, general inspection checklists containing items to be covered during the inspection are preferred.

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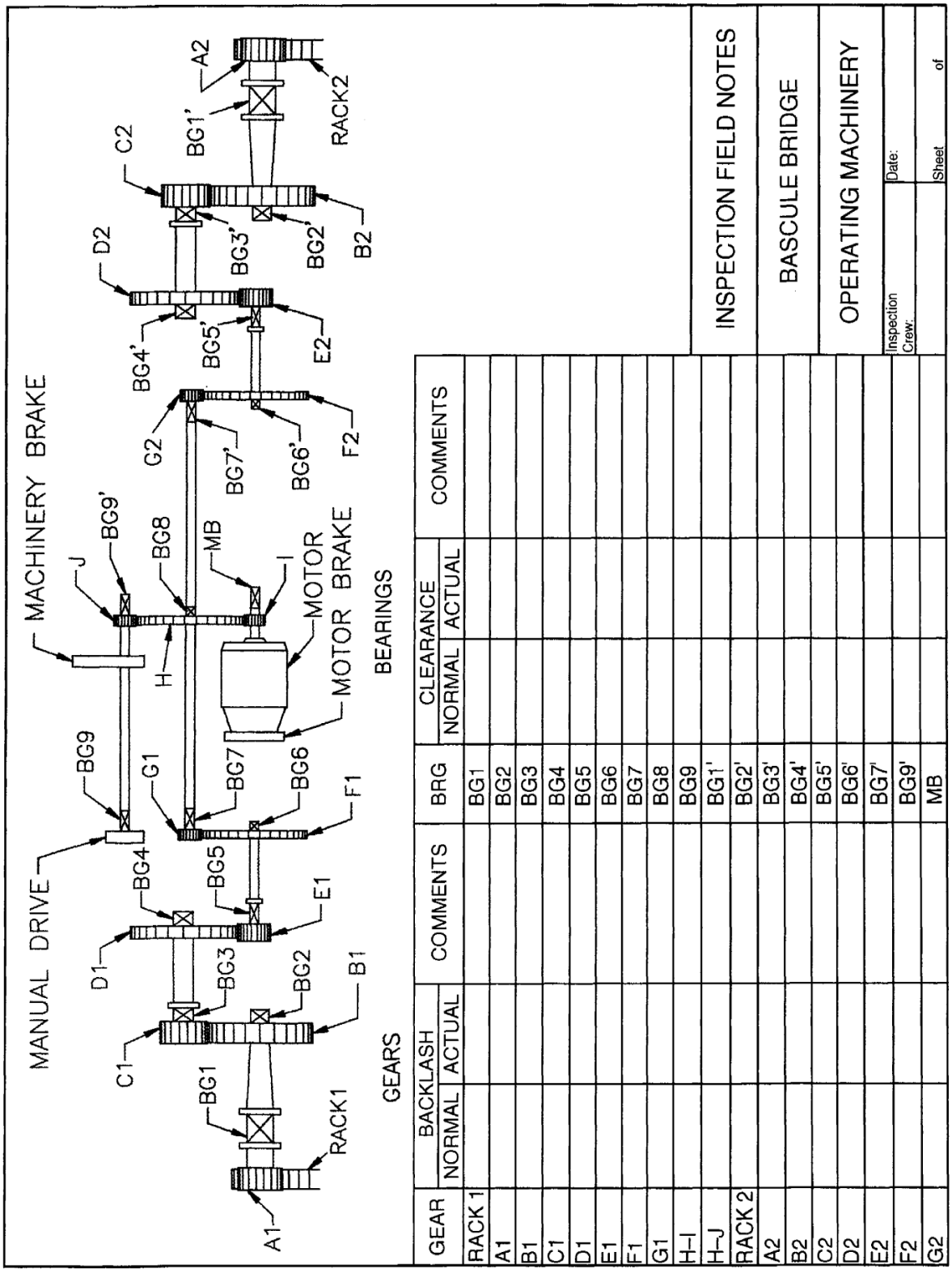

Figure 2.6.2.1-1 – Typical drive machinery layout sketch of a bascule bridge

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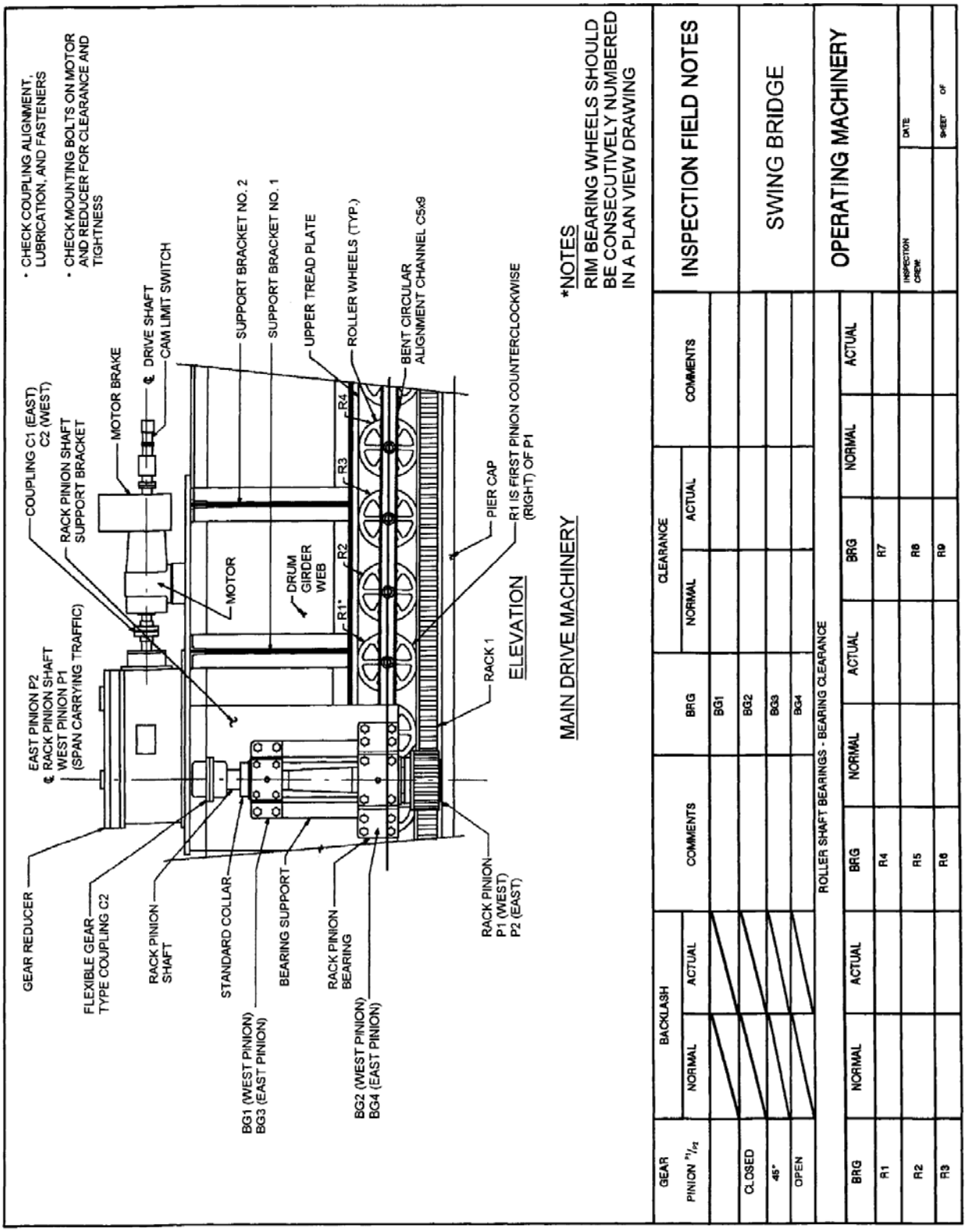

Figure 2.6.2.1-2 – Typical main drive machinery of a swing bridge

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Electrical

Figures 2.6.2.1-3, 2.6.2.1-4, and 2.6.2.1-5 show typical electrical schematic diagrams and physical layout drawings for conduit and electrical components in the various subsystems and panels. Checklists for inspection tasks should be prepared based on Chapters 2.7, 2.8.3, previous inspection and deficiency reports, and electrical drawings.

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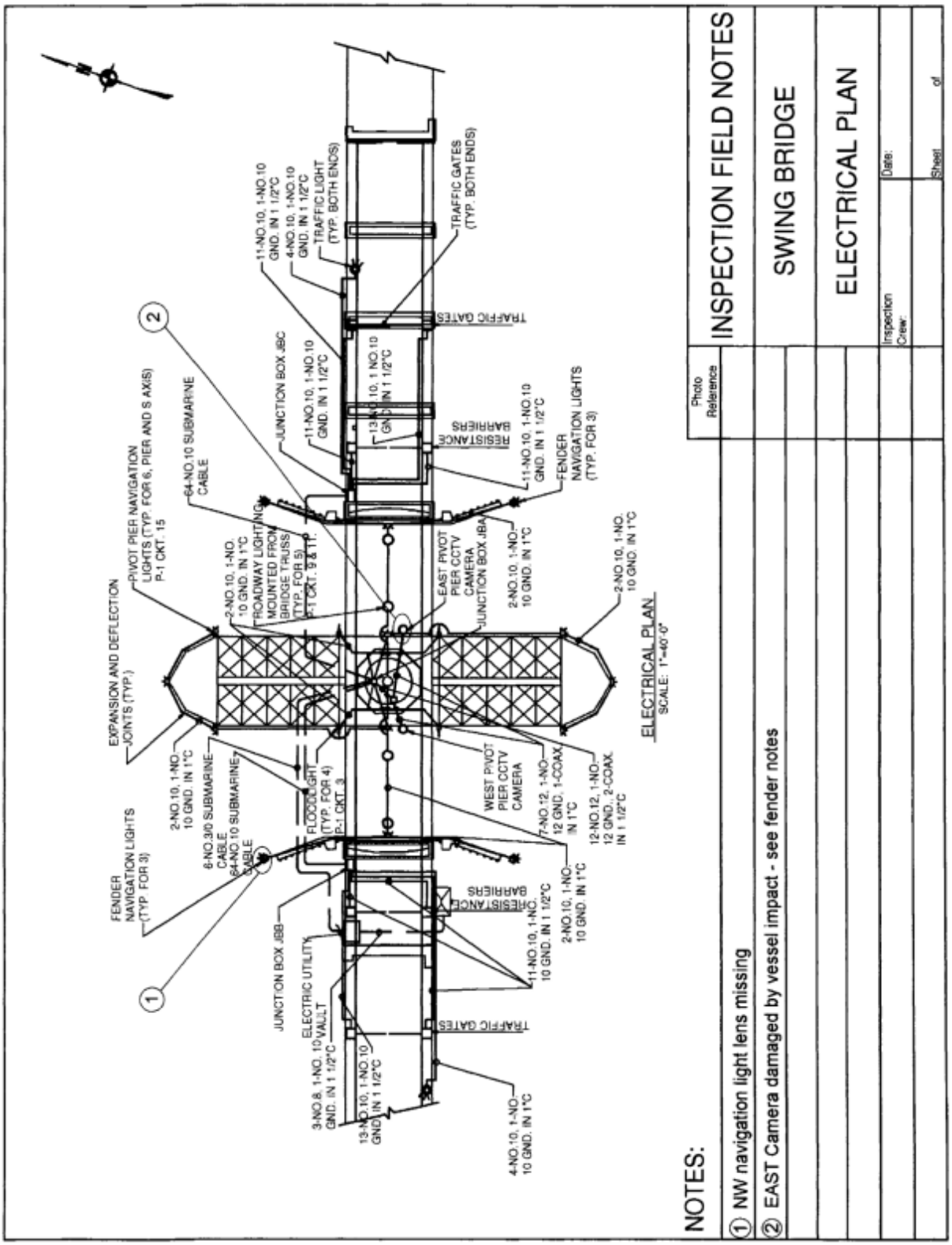

Figure 2.6.2.1-3 – Typical electrical plan

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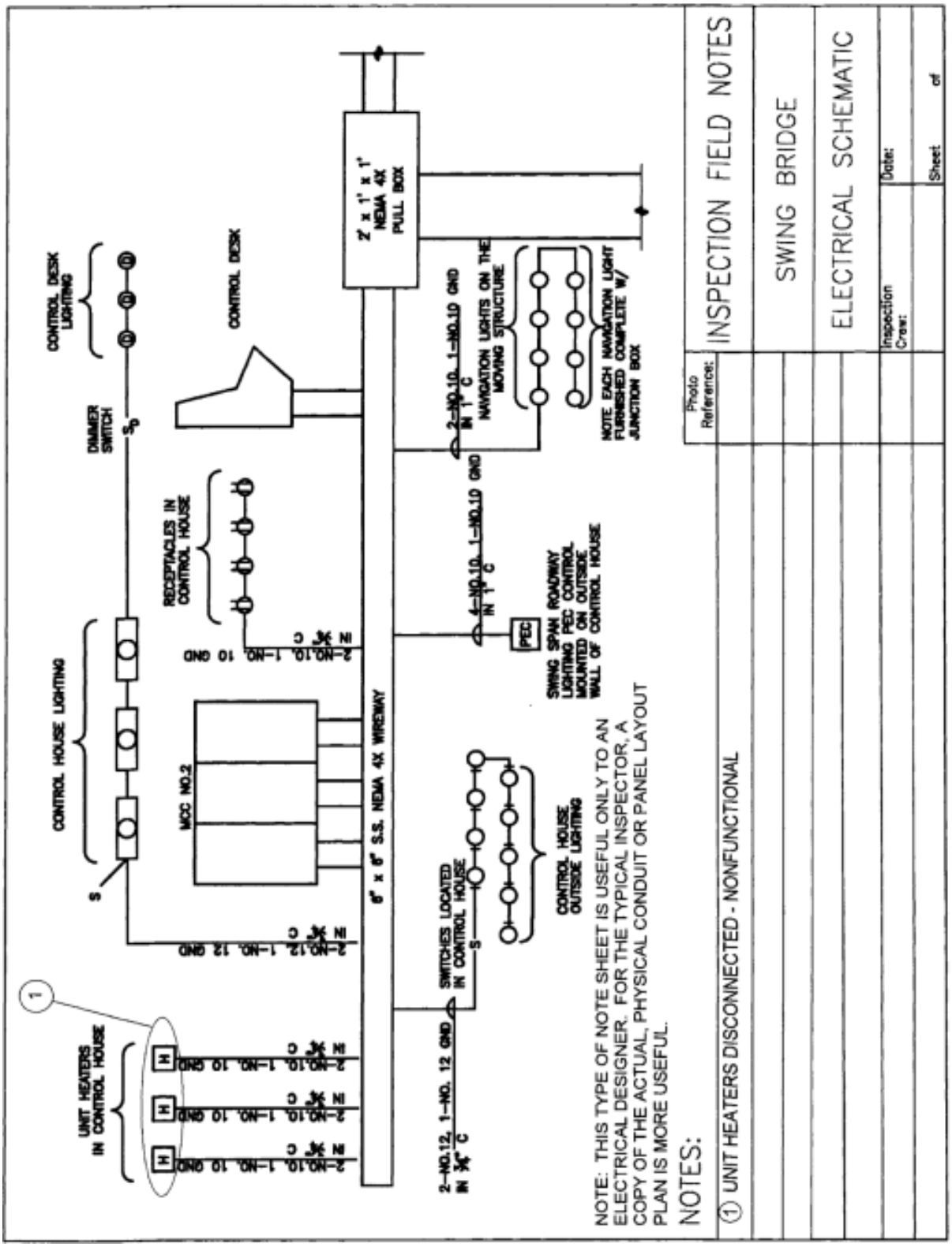

Figure 2.6.2.1-4 – Typical electrical schematic

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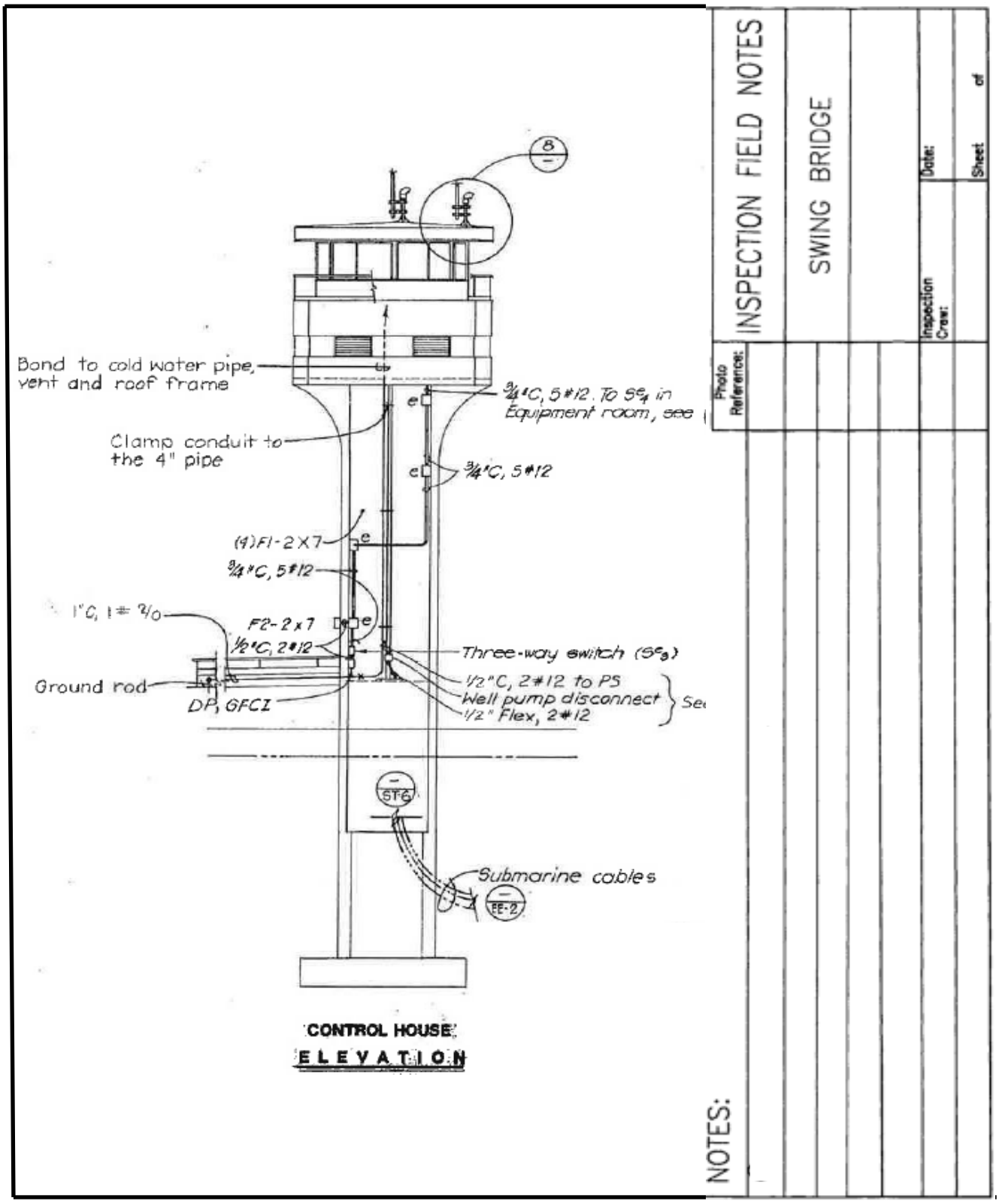

Figure 2.6.2.1-5 – Example field notes for typical movable bridge house

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2.6.2.2 Inspection Equipment

The availability of appropriate equipment makes the task of inspecting much easier, and also helps in obtaining accurate inspection data. A sample equipment checklist would include the following:

Mechanical and Electrical Tools

- ❑ 6.0 in. (150 mm) scale
- ❑ 24.0 in. (600 mm) scale with square
- ❑ 50.0 ft. (15 m) steel tape measure
- ❑ Feeler gauges, adjustable arm reach swivel head mirrors, etc.
- ❑ Stethoscope for listening to bearings etc.
- ❑ Standard vernier calipers.
- ❑ Machinists level.
- ❑ Multimeter.
- ❑ Clamp on ammeter.
- ❑ AC ammeter.
- ❑ DC megger.
- ❑ Flashlight and portable extension light.
- ❑ Tachometer.
- ❑ Equipment tags (Danger-Tag Out).
- ❑ Dew-check inspection kit.
- ❑ Piano wire for trunnion shafts.
- ❑ Screw drivers.
- ❑ Adjustable wrenches.
- ❑ Allen head wrenches.
- ❑ Files.
- ❑ Scrapers.
- ❑ Chalk.
- ❑ 2 lbs. machinist's hammer or the nearest metric equivalent.
- ❑ Nonflammable solvent and clean rags.
- ❑ Lubricant (per as-built drawings or latest approved maintenance practice by owner).
- ❑ Digital camera with flash.
- ❑ Two-way radio.
- ❑ Tablet and clipboard.

Testing and Instrumentation Equipment

- ❑ Dye penetrant, magnetic, ultrasonic or radiographic equipment for crack detection.
- ❑ Optical instruments such as a transit or theodolite (for checking alignment).
- ❑ DC ammeter.
- ❑ Oil testing unit.
- ❑ Oscilloscope (for solid state controls).
- ❑ Recording meter of instrument.
- ❑ Oil sampling containers.
- ❑ High voltage test probe.
- ❑ Low voltage high current supply.

COMMENTARY

C2.6.2.2

See Chapter 2.5 for additional information about safety.

See Chapter 2.10 for additional discussion of testing equipment.

Scale and tape sizes shown in the metric system are the nearest metric equivalent likely to be available.

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COMMENTARY

Personal Safety Equipment

All inspection team members should be outfitted with adequate personal safety equipment. Refer to Chapter 2.5 for guidelines on safety related issues.

See Chapter 2.10 for further details on special testing equipment and procedures.

2.6.2.3 Special Notifications

C2.6.2.3

Bridge inspection crews and maintainers must adhere to USCG (Reference 56), USACOE (Reference 57), and MUTCD (Reference 73) regulations. Should it be necessary for the movable bridge to be closed to vehicular and/or navigational traffic for an amount of time, local, city, and/or state highway and navigation regulatory officials should be notified in advance. The notification should detail the duration and frequency of the closure and specify a contact person in case of emergency.

See the selected reference list in the Appendix for full data concerning referenced regulations. Individual states may also have their own MUTCD and/or regulations pertaining to navigation.

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