Northwest Territories Power Corporation

Bluefish Dam

Operations, Maintenance, and Surveillance (OMS) Manual

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Northwest Territories Power Corporation
P.O. Box 2250
Yellowknife, Northwest Territories
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Gamini Hettiarachchige, M.Eng., P.Eng.
Senior Hydro Engineer - Civil

Dear Mr. Hettiarachchige:

Bluefish Dam
Operations, Maintenance, and Surveillance (OMS) Manual

The final OMS Manual for Bluefish Dam is appended to this letter.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Chris Gräpel, M.Eng., P.Eng.
Senior Civil Engineer

CKG:kc

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Northwest Territories Power Corporation

Bluefish Dam

Operations, Maintenance, and Surveillance (OMS) Manual

Table X.1 Record of OMS Manual Holders

Name and Address	Volume Number
Colin Steed, Manager System Control	

Table X.2 Record of Revisions

Record of Revisions						
Section	Page	Table	Figure	Revision Number	Date Issued	Inserted

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List of Acronyms and Abbreviations

CDA	Canadian Dam Association
CMMS	Central Maintenance Management System
DFO	Fisheries and Oceans Canada
EBA	EBA Engineering Consultants Ltd. (now Tetra Tech Canada Inc.)
EoR	Engineer of Record
EPRP	Emergency Preparedness and Response Plans
FSL	Full Supply Level
GEA	Gygax Engineering Associates Ltd.
GFCI	Ground Fault Circuit Interrupter
HSPA	High Speed Packet Access
IDF	Inflow Design Flood
IFC	Issued for Construction
IFR	Instream Fisheries Release
KCB	Klohn Crippen Berger
LAN	Local Area Network
MVLWB	Mackenzie Valley Land and Water Board
MW	Megawatts
NAC	North America Constructors
NTPC	Northwest Territories Power Corporation
NWT	Northwest Territories
OMS	Operations, Maintenance, and Surveillance
PMF	Probable Maximum Flood
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
QPO	Quantifiable Performance Objective
RCMP	Royal Canadian Mounted Police
RFC	Reserve Firm Capacity

1 INTRODUCTION

1.1 Purpose and Overview

The purpose of the Bluefish Dam Operations, Maintenance, and Surveillance Manual (OMS Manual) is to provide information on operation, maintenance, and surveillance from a dam safety perspective for Bluefish Dam and its ancillary facilities. The current version of the Canadian Dam Association (CDA) Dam Safety Guidelines (2007, revised 2013) (CDA Guidelines 2013) indicates that the operation, maintenance and surveillance (OMS) of a dam and its appurtenant structures should be documented to ensure the safe operation of these facilities during various conditions that could impact the public, environment or other stakeholders. The Northwest Territories Power Corporation (NTPC) is the owner of the Bluefish Dam and its associated components and is therefore responsible for its operation, maintenance and surveillance.

The CDA Guidelines 2013 indicate that such operation, maintenance, and surveillance procedures be documented in an OMS manual or equivalent. This OMS Manual addresses the requirements of 2007 CDA principle 2a which states:

> *"Requirements for the safe operation, maintenance, and surveillance of the dam shall be developed and documented with sufficient information in accordance with the impacts of operation and consequences of dam failure."*

The purpose of this manual is therefore to provide the personnel responsible for the operation, maintenance and surveillance of the project facilities with those basic guidelines, procedures and instructions required to facilitate the proper performance of their duties. While the means of dealing with most usual operation and maintenance situations and problems are described in this manual, unusual or unforeseen occurrences which are not specifically discussed may arise. When in doubt about an operation or procedure, the operation personnel should consult their corresponding supervisor for advice or consult the engineer or record or the design engineer.

The Engineer of Record (EoR) for Bluefish Dam is Gamini Hettiarachchige, P.Eng. of NTPC. The EoR has the following responsibilities (Alberta Chamber of Resources, Dam Integrity Advisory Committee, 2017):

- on behalf of the Owner, provides technical direction for the safety of one or more dams;
- assesses the dam conformance with design, construction specifications, operational plans, regulations and standards;
- confirms that maintenance of the dam is conducted as per design requirements;
- OMS procedures;
- implements the surveillance program. Assesses the performance against the Quantifiable Performance Objectives (QPOs), reviews and interprets construction and instrumentation performance data, and recommends changes to the design or operation to maintain the safety of the dam and compliance with regulations, guidelines and standards;

- reports any deficiencies to the Owner and Director, Hydro Operations;
- assesses risk associated with dam safety and communicates risk to the Owner;
- provides recommendations to and supports development of risk mitigation strategies; and
- maintains and submits construction quality, performance and dam safety documentation.

The lead-design engineer for Bluefish Dam is Chris Gräpel, P.Eng., who lead a team of design engineers from EBA Engineering Consultants Ltd. (now Tetra Tech Canada Inc.) and their structural-engineering subconsultant, Gygax Engineering Associates Ltd.

In addition, all work should be performed in accordance with the Occupational Health and Safety Act as well as other applicable legislation, and good workmanship.

This OMS Manual does not include information on operating the hydro plants at Bluefish.

1.2 Personnel

The NTPC Hydro organizational chart, from June 2017, is included in Appendix I. The organizational chart will require updating with NTCP personnel changes.

1.3 Scope

The primary facilities covered by this manual include the Bluefish Lake reservoir, Bluefish Dam, overflow spillway and concrete reconstitutive sill, bottom-outlet and instream fisheries release (IFR) structure, and access roads. Other components (e.g., structures or earthworks) are discussed in general terms in this manual, however, detailed procedures for operation, maintenance and surveillance of these other facilities are not included in this OMS Manual. The following components are excluded from detailed description of their associated operation, maintenance and surveillance activities in this manual but are discussed in general terms throughout the document as they affect the facilities associated with Bluefish Dam:

- Duncan Dam and its reservoir, Duncan Lake;
- the Bluefish power tunnel and associated gate structure, penstock, and hydro plants; and
- the Water Survey of Canada lake-level-monitoring station (Station 07SB015) located near the power-tunnel-intake structure.

This OMS Manual includes nine sections about the following topics:

- Section 1 – Introduction;
- Section 2 – Project Description;
- Section 3 – Operation;
- Section 4 – Maintenance – General;
- Section 5 – Maintenance – Flow Control and Support Equipment;

- Section 6 – Inspection;
- Section 7 – Instrumentation – Dam;
- Section 8 – Supplementary Documents; and
- Section 9 – Reference Drawings.

1.4 Staff Training

The operation, maintenance and surveillance requirements for Bluefish Dam and associated facilities are described within this OMS Manual. Job training for specific roles in the operation, maintenance, and surveillance of Bluefish Dam is conducted internally by NTPC's EoR. The training is a one-time session focused on dam safety activities. Records of staff training and qualifications are on file with NTPC's Safety Training Coordinator.

1.5 User's Guide

Operations and maintenance staff must read and become thoroughly familiar with the contents of this manual. The table of contents provides a quick reference to the various subjects covered in each Section. The tables and figures pertaining to a particular section are numbered sequentially with a prefix corresponding to the section number.

1.6 Manual Format

This manual is the primary document which incorporates the critical information for the operation, maintenance and surveillance of the project components during normal, unusual and emergency situations. Hard copies or electronic versions of the documents on CD or DVD should be stored on site in the event of an emergency. However, these documents are not controlled and site staff should exercise vigilance in updating these documents based on any new revisions as recorded in the list of revisions.

1.7 Manual Holders and Revisions

A complete listing of manual holders is found in Table X.1 at the beginning of this document. Colin Steed, Manager System Control, is responsible for the issue of all revisions or addenda to the registered holders of this manual. Matt Miller, Environmental Licensing Specialist; Gamini Hettiarachchige, Senior Civil Engineer Hydro; and Scott Spenser, Chief Technical Officer; may identify or request specific changes or updates to the OMS Manual based on observations recorded during the annual inspections or due to specific engineering studies conducted to address dam safety deficiencies. Site personnel may also request revisions to operation, maintenance or surveillance procedures. The individual holder is responsible for placing the insertions in the manual and recording receipt on Table X.2 provided at the beginning of this document. Revisions will always be made by correcting a page or drawing and re-issuing it in complete form so that the "old" or superseded copy can be removed from the manual and destroyed.

2 PROJECT DESCRIPTION

2.1 General

Bluefish Dam is located 25 km north-northeast of the City of Yellowknife, NWT, as shown in Figure 2.1. Bluefish Dam was constructed in 2012 and is owned and operated by NTPC.

Figure 2.1 Bluefish Dam location

Bluefish Dam is located on the Yellowknife River, approximately 600 m north of where the Yellowknife River discharges into Prosperous Lake. Bluefish Dam impounds the Bluefish Lake reservoir. Bluefish Lake was enlarged by the 1940 construction of the original Bluefish Dam, a timber-crib rockfill-buttress dam. Before dam construction in 1940, there was a waterfall at the outlet from Bluefish Lake. Prosperous Lake is approximately 38 m lower than Bluefish Lake. The original Bluefish Hydro facility was constructed to generate electricity for a gold mine in Yellowknife that was last operated by Miramar Con.

The facilities associated with the Bluefish site include:

- the reservoir;
- Bluefish Dam, a rockfill dam with a stainless-steel membrane constructed on a greywacke bedrock foundation;
- the overflow spillway excavated into bedrock with energy-dissipation steps and a rip-rap-armoured apron into the lower pool of the Yellowknife River;

- the bottom-outlet structure and IFR and discharge channel excavated into bedrock;
- performance monitoring instrumentation; and
- access roads.

The CDA Guidelines 2013 uses a system of assigning dams to categories, usually based on the consequences of failure, so that appropriate dam safety standards can be applied. During the design of Bluefish Dam, it was determined the dam is a "High" consequence classification (EBA 2011). The Stantec (2017) dam safety review agreed with the "High" design consequence classification for Bluefish Dam. The inflow design flood (IDF) corresponds to a discharge of 1/3 of the way between the 1000-year flood and the Probable Maximum Flood (PMF) as per the Canadian Dam Association Guidelines (2013).

The original timber-crib rockfill-buttress dam provided reservoir impoundment during the construction phase of Bluefish Dam. The original dam was breached when Bluefish Dam construction was completed.

All design coordinates used are to reference NAD 83 UTM Zone 11 and geodetic elevation (EBA 2011). EBA (2011) also references the "old datum", which is shifted from the geodetic datum. The shift applied to the datum during design is geodetic plus 17.15 m. The "old datum" is referred to by Water Survey of Canada as the Miramar Con Mine Datum.

Pertinent data for the project components are summarized in Table 2.1 and further descriptions of the project components are provided in the following sections.

Table 2.1 Pertinent Data for the Bluefish Dam Components

Description	Parameter
Reservoir	
Normal Operating Level, or Full Supply Level (FSL)	168.78 m
Minimum design operating level	165.73 m
Maximum allowable flood level	170.22 m
Reservoir Volume at FSL[1]	23,536,415 m^3
Reservoir Area at FSL[1]	292.6 ha
Length of Reservoir	3.50 km
Catchment Area	11,300 km^2
Flood of Record (Instantaneous)	Low inflow and reservoir level have been experienced since construction was completed
Inflow Design Flood (IDF) @ 170.22 m -Overflow Spillway Flow -Head on overflow spillway crest -Minimum Freeboard to crest of dam	 387 m^3/s 1.44 m 1.0 m
Probable Maximum Flood (PMF) discharge in Yellowknife River @170.87 m	662 m^3/s
Main Dam	
Top of Dam Crest Elevation (minimum)	171.22 m
Crest Length	164 m

Description	Parameter
Crest Width	5.50 m
Maximum Height	11.20 m
Design Freeboard	1.00 m
Dam Upstream and Downstream Side Slopes	2.0H:1V; 2.5H:1V
Riprap Extent – Upstream Slope	164.90 m to 171.22 m (crest)
Design elevation of top of stainless-steel membrane	170.92 m
Overflow Spillway	
Overflow spillway Elevation	168.78 m
Approach channel crest elevation	166.80 m
Overflow spillway chute width	25.00 m
Overflow spillway slope	2%
Stepped channel elevations -1st step -2nd step -Overflow spillway channel	 162.60 m 159.60 m 156.60 m
Crest Length (at the base of the overflow spillway)	136.0 m (in a horseshoe configuration)
Bottom-Outlet Structure	
Bottom-outlet crest elevation	166.67 m
Bottom-outlet width	7.50 m
Bottom-outlet slope	0.5%
Side slopes	0.25H:1V
Bottom-outlet plunge pool depth	1.00 m
Bottom-outlet plunge pool elevation	159.99 m
Riprap thickness	1.20 m
Bottom of riprap elevation	155.15 m
Number of stainless steel gates (Series 20 stainless steel fabricated slide gate manufactured by Fontaine Aquanox)	1
Bottom-outlet gate height	108 in. (2.74 m)
Bottom-outlet gate width	108 in. (2.74 m)
Bottom-outlet gate bottom elevation	161.00 m
Stop logs (Series 95 stainless steel fabricated slide gate manufactured by Fontaine Aquanox) width	3.00 m
Stop logs (Series 95 stainless steel fabricated slide gate manufactured by Fontaine Aquanox) height	1.00 m
Stop logs bottom elevation	161.00 m
Top of removable stop logs elevation	170.22 m
Instream-Fisheries Release Structure	
IFR bypass elevation	165.15 m
Number of stainless steel gates (Series 20 stainless steel fabricated slide gate manufactured by Fontaine Aquanox)	1
IFR design discharge (with reservoir at minimum operating elevation)	7.6 m^3/s
IFR gate dimensions	36 in. x 54 in. (0.91 m x 1.37 m)
Breach Geometry of Original Dam	
Number of notches	2
Notch Geometry -Top width -Bottom width -Bottom elevation	 20 m 10 m 164.5 m

Description	Parameter
-Notch slopes -Height	1.17H:1V 4.28 m
Space between notches	30 m

[1] The volume and surface area are based on 2010 and 2013 bathymetry data obtained by Golder Associates. The bathymetry data covers Bluefish Lake, but does not include part of the volume between Bluefish Dam and the original dam. Volumes and surface areas were extrapolated using vertical sides.

2.2 Design History

EBA was retained by NTPC to design a replacement dam and overflow spillway for the Bluefish Hydroelectric site. The initial design was started in May 2009 and construction of Bluefish Dam and overflow spillway was completed in mid-October of 2012, with first filling conducted in late October 2012. EBA was the prime consultant, with structural-engineering sub-consulting services provided by Gygax Engineering Associates Ltd. (GEA).

In late 2008 and early 2009 a variety of design concepts were considered and preliminary-comparative-cost estimates were prepared by EBA to aid NTPC in their selection of the design option. The design concepts considered by EBA were:

- zoned rock fill with galvanized sheet-pile, asphalt, concrete, and plastic-liner membranes;
- concrete-gravity dam; and
- concrete-buttress dam.

The assessments of these options were submitted by EBA to NTPC in an Issued for Use report "Evaluation of Dam/Spillway Concepts" dated February 2009. The design option selected by NTPC was the zoned-rock-fill dam with a vertical galvanized-sheet-pile membrane. Due to the advanced state of deterioration of the Bluefish Dam, the need for replacing the timber-crib rock-fill buttress dam at the Bluefish site was judged by NTPC to be an emergency due to a reasonable apprehension of impending failure.

Upon review of the submitted tenders in late winter/spring of 2010, NTPC elected to close the tendering process without award and instead pursued discussions with two of the bidders to assess which of them could be selected for further negotiations under an Alliance Contract model. North America Constructors (1993) (NAC) was selected by NTPC in mid-summer 2010. As part of the Alliance Contract, a value-engineering-design phase was undertaken by EBA in discussion with NAC and NTPC. One of the changes made during the value-engineering phase was replacement of the galvanized sheet-pile membrane with a stainless-steel membrane.

During construction, a bedrock fault was encountered in the dam foundation that was parallel to the key trench. The dam and key trench were shifted to avoid the fault. The IFC drawings were re-issued in 2012 with the revised dam footprint.

The original timber-crib rockfill-buttress dam was breached at the end of the construction phase of Bluefish Dam. Two notches were excavated through the dam to permit passage of the IDF without water impounding upstream of the original dam and to prevent water from flooding the intake structure. Figure 1 in The Existing Bluefish Dam Decommissioning Plan (NTPC 2012a), which is included in Appendix III, shows the two notches used to breach the dam.

2.3 Reservoir

2.3.1 General

The design reservoir operating level for Bluefish Lake is El. 168.78 m, and was defined by the elevation of the overflow spillway crest at the original Bluefish Dam. The minimum-design-operating level is 165.73 m, as per the water license requirements included in Appendix IV when the replacement dam was designed. The maximum allowable flood level in the reservoir, 170.22 m, was chosen by NTPC during the design phase to limit potential flooding of the concrete floor in the power-tunnel-intake structure (intake structure) to a depth of 0.15 m.

Part of the flow of the Yellowknife River is diverted through the fore bay gate in the intake structure. The amount of water entering the intake is controlled by the two turbines and generators. Both units at full load will pass 28.4 m^3/s or 1,003 cubic feet per second. The intake structure is located at the entrance of a 760 m long unlined rock tunnel. From the tunnel outlet, a 3-m diameter, 150 m long penstock connects to two powerhouses. The old power plant had a generating capacity of 3.2 MW, while the new plant has a capacity of 4.0 MW. The Bluefish Hydro facility operates on the new plant and utilizes the old plant as a variable flow unit to optimize flows that exceed the requirements of the new unit.

The main water storage area for the Bluefish Hydro facility is at Duncan Lake. Duncan Dam, a concrete gravity dam approximately 5.0 m high with a stop log controlled outlet structure, is located at the outlet of Duncan Lake. Depending on the amount of water entering the Duncan Lake catchment, NTPC can raise and lower the Duncan Lake between Elevation 209.3 and 212.4 m by adding and removing stop logs from Duncan Dam. This 3.1 m difference in the Duncan Lake water level represents a volume of 207.2 million m^3. The operation of Duncan Lake Dam is excluded from this OMS, and will not be discussed further.

2.3.2 Reservoir Volume and Area Data

The reservoir volume and reservoir area can be estimated from the bathymetric surveys completed by Golder Associates Ltd. on October 18, 2010 and July 23, 2013. The bathymetry data covers Bluefish Lake, but does not cover part of the area between Bluefish Dam and the original dam. Based on aerial imagery, the area where bathymetry data is not available is approximately 0.6% of the surface area of Bluefish Lake. Volumes and surface areas were extrapolated using vertical sides above the water surface on the days of the survey up to the FSL elevation. At FSL, the volume of water in Bluefish Lake is approximately 23,536,415 m^3 and the surface area is approximately 292.6 ha.

2.3.3 Freeboard Criteria

The design of the replacement dam including a dam crest elevation of 171.22 m, which is 1.0 m higher than the maximum flood level of 170.22 m. The elevation of the top of the stainless-steel membrane is 170.92 m (as shown in the As-Built Report Figure 5 (EBA 2013), which is included in Appendix V), which is 0.5 m above the design reservoir elevation during the IDF (EBA 2011). The additional height of stainless-steel was included to account for potential settlement of the dam over shear zones/faulting, any wind set up and a contingency in reservoir elevation (EBA 2011).

2.4 Bluefish Dam

Bluefish Dam is a zoned-rock-fill dam with a stainless-steel water retaining membrane keyed into a concrete-backfilled key trench. The maximum height of the dam is 11.2 m with a design crest width of 5.5 m. The embankment side slopes were 2H:1V and 2.5H:1V for the upstream and downstream side slopes respectively. An access road berm was constructed on the downstream side of the dam to allow vehicle access to the downstream toe area. Non-acid-generating blast rock from overflow spillway-channel excavation were stockpiled in the access road berm located at the downstream toe of the dam. Figure 2.2 and Figure 2.3 show the aerial views of the dam, bottom-outlet structure, and overflow spillway.

Figure 2.2 Air photo of Bluefish Dam (photo taken looking southwest)

Figure 2.3 Air photo of Bluefish Dam (photo taken looking southeast)

As per EBA's 2011 design, the zones of rock fill within Bluefish Dam are:

- **Zone A** (outer shell) – 1.0 m minus quarry run material;
- **Zone A1** (outer riprap) – 0.5 m to 1.0 m riprap;
- **Zone B** (transition material) – minus 200 mm rock fill; and
- **Zone C** (cushioning against the stainless-steel membrane) – minus 20 mm gravel.

IFC Drawing C202, included in Appendix II shows the typical section of the dam.

The rockfill was produced from drill-and-blast excavation of the greywacke bedrock at the overflow spillway. Geochemical testing was conducted on core samples of the greywacke during the design, permitting, and construction phases. The geochemical testing of the rock fill indicated that most of the greywacke rock mass encountered during the subsurface investigation and construction was non – reactive and non-acid generating with some zones that could potentially generate acid. Continuous on-site quality assurance/quality control (QA/QC) geochemical testing and monitoring of the rock fill resulted in periodic rejection of potentially-acid-generating rock fill. The width of the Zone C 20-mm-minus material on the downstream side of the stainless-steel membrane was designed so that, in the unlikely event of deterioration of the stainless-steel membrane, it would be possible to construct a concrete-backfilled slurry trench on the downstream side of the stainless-steel membrane or jet grout the Zone C material downstream of the stainless-steel membrane.

The design of the stainless-steel membrane and the concrete-backfilled key trench was completed by GEA. A corrosion specialist, Dr. Pierre Roberge, P.Eng. of the Royal Military College in Kingston, ON, was retained by GEA to conduct a corrosion assessment for the stainless-steel membrane. The result of corrosion assessment was that the stainless-steel membrane proposed in the design had sufficient thickness and metallurgical properties to provide a 100-year service life.

The dam foundation is a strong to very strong, slightly-weathered to un-weathered weakly-metamorphosed greywacke bedrock with sub-vertical joints. Occasionally, infilled joints were observed or inferred to be present in the dam foundation. Faults were also located before construction and during construction, with some infilling.

A double-row grout curtain was constructed with inclined grout holes drilled to a depth of 5 m and 10 m below the base of the key trench (upstream and downstream, respectively). The grouting in the 10 m holes was stopped part way up the left abutment where the depth of impounded water at normal operating level was less than 5.0 m. The shallow 5.0 m deep holes were continued up to the point at which the dam crest met the left abutment. On the right abutment, the grout-curtain holes were extended from the dam to the IFR structure constructed within the bottom-outlet channel. The depth of these grout holes was to be 3 m below the base of the bottom-outlet channel but an error was made during construction that resulted in them being 3 m ***above*** the base of the bottom-outlet channel. Additionally, the number of deeper grout holes was reduced by NTPC near the former Yellowknife River channel during the time that the cofferdam was in place and the dam was being constructed across the river channel. This decision and other details on the grouting program is documented in greater detail in the As-Built report (EBA 2013).

In order to direct water infiltrating from surface on the downstream end away from the membrane, a positive downstream drainage course of leancrete was placed between Sta. 0+130 and Sta. 0+155 on top of the downstream Stage 2 concrete, sloping away from the stainless-steel membrane.

2.5 Overflow Spillway

The overflow spillway has a design crest elevation of 168.78 m and a discharge capacity of 387 m^3/s at a reservoir elevation of 170.22 m. A reservoir elevation of 170.22 m is 1.44 m above the overflow spillway crest). The overflow spillway is referred to as a “bathtub-type” spillway.

The overflow spillway was excavated into bedrock with drill-and-blast excavation methods, with anchors installed to maintain the stability of the rock cut slopes. The rock cuts in the overflow spillway are up to 15 m high, sloped on average at 0.25H:1V. Rock bolts were used in parts of the spillway. IFC drawings C302, C303, C305, and C308, which are included in Appendix II, show the spillway and rock bolt details.

During construction, the design length of the spillway, as shown on IFC drawing C301 in Appendix II, was shortened from 128.8 m to approximately 102.9 m as shown on As-Built drawing C301 included in Appendix V. A memo from Meco Engineering Co. Ltd. (2012) indicated that the alignment of the reconstitutive sill can be considered less important, as compared to elevation, and should be chosen to provide the most feasible construction in terms of cost.

Overbreak of bedrock during drill-and-blast excavation of the overflow spillway required the use of a reinforced-concrete reconstitutive sill to maintain a FSL of 168.78 m. The reinforced-concrete reconstitutive sill is U-shaped, 128.8 m long, and approximately one meter in height, with a crest elevation at 168.78 m. The base of the overflow spillway chute is at the toe of near-vertical (0.25H:1V, design) rock cut 2 m to 3 m high, located downstream of the reconstitutive sill, as shown in Figure 2.4 and Figure 2.5.

Figure 2.4 Overflow spillway and bottom-outlet structure (photo taken looking west)

Figure 2.5 Looking northeast at the bottom of the overflow spillway and bottom-outlet structure

The overflow spillway chute downstream of the reconstitutive sill is 25 m wide, has a 2% channel slope with 0.25H:1V side slopes.

Near the downstream end of the overflow spillway channel, the flow drops down to the lower pool elevation through two 3 m high drops in the channel floor that were included to dissipate energy before flow enters the lower pool. The outlet of the overflow spillway passes over sediments left in place at NTPC's direction. The sediments were armoured with Zone A1 riprap (0.5 m to 1.0 m diameter) placed on geogrid and nonwoven geotextile. The riprap placed in 2012 to protect the sediments from erosion has been displaced in some areas of the apron, exposing the underlying nonwoven geotextile and geogrid, since completion of construction.

Downstream of the reconstitutive sill, the excavation for the overflow spillway channel merges with the excavated channel for the bottom-outlet and IFR structure.

2.6 Bottom-Outlet and IFR Structure

A reinforced-concrete bottom-outlet and IFR structure is located between the reconstitutive sill for the overflow spillway and the main dam. The bottom-outlet and IFR structure is constructed within a channel excavated into bedrock using drill-and-blast-excavation techniques. The excavated channel is 7.5 m wide at the bottom with 0.25H:1V side slopes. The excavation was widened to 7.9 m near the bottom-outlet and IFR structure. The invert of the elevation of the bottom-outlet gate will be 161.0 m.

The bottom-outlet and IFR structure was constructed as a two-bay structure with both bays being used for water diversion when a cofferdam was constructed upstream of the replacement dam to permit closing the dam across the Yellowknife River channel. The south bay (below the IFR) was blocked with leancrete and the second was equipped with a pre-fabricated, stainless-steel 108-inch square (2.74 m square) vertical lift gate. As per the design drawings (drawing S401, included in Appendix II), the gate is a Series 20 stainless-steel gate manufactured by Fontaine Aquanox.

The IFR was designed to discharge 7.6 m^3/s with the reservoir at its minimum-operating level (El. 165.73 m), with an IFR invert of 165.15 m. The IFR is controlled with a 36 inch x 54 inch (0.91 m x 1.37 m) stainless-steel slide gate. As per the design drawings (drawing S401, included in Appendix II), the gate is a Series 20 stainless-steel gate manufactured by Fontaine Aquanox.

2.7 Breach Geometry for Original Bluefish Dam

As part of the plan for decommissioning the existing dam (NTPC 2012a), the original timber-crib rockfill-buttress dam was breached at the end of construction of Bluefish Dam to prevent water from flooding the intake structure. When the existing dam was breached, it also provided habitat compensation as required for the Fisheries Act Authorization. The existing dam was decommissioned using the following steps:

- water levels were equalized on the upstream and downstream sides of the existing dam following completion to the new Bluefish Dam;
- a 70-m wide length of the dam was excavated to El. 168.7 m;
- two notches with a bottom width of 10 m, a bottom elevation of 164.5 m, a top width of 20 m, and approximately 1.17H:1V side slopes were excavated 30 m apart within the 70-m wide zone that was excavated to 168.7 m;
- surface wood structures and other unstable components of the original dam were removed; and
- excavated material was placed on the ice on the upstream side of the original dam and sunk during spring break-up, creating new fish spawning habitat.

Additional details and a figure of the breach geometry for the original Bluefish Dam can be found in Appendix III.

2.8 Communications

The following communication/notification systems are used by NTPC and are available for use at the Bluefish Dam site for either direct or indirect communication with personnel on or off site:

- telephone – Bell, Rogers, and Telus all show there is LTE or 4G HSPA cellular phone coverage in at the Bluefish Dam site;
- radio phone network;

- two-way portable radios are available for use on site;
- a Local Area Network (LAN) is available for data communication between NTCP facilities via staff computers, providing communication links for email and internet access; and
- an audible signal and strobe light system is used to warn when the bottom-outlet gates are being opened.

Although all the above communication systems are available to NTPC staff, the staff typically perform duties for the Bluefish Dam and its ancillary structures using cellular phones and LAN for email communications.

2.9 Access Roads

Access roads 5 m wide constructed as part of the Bluefish Dam construction include:

- a main access road to the dam that branches off the access road between the hydro plants and the penstock intake structure,
- an access road along the dam crest to the bottom-outlet structure and overflow spillway, and
- an access road down the right abutment to an access road located on a rockfill berm constructed at the downstream toe of the dam.

Site access roads constructed when Bluefish Dam was constructed have 150 mm of 50 mm-minus road gravel placed on at least 1 m of 1.0 m minus rockfill. Access roads constructed in fill have 1.5H:1V side slopes on both sides.

2.10 Public Safety Management and Site Security

A public safety management plan for Bluefish Dam was prepared by EBA during the design phase (EBA 2011). Due to the remoteness of the Bluefish Dam, there is some risk of unauthorized access by the public. EBA's recommended public safety management plan was based on the CDA Guidelines (CDA 2007) and associated technical bulletins. NTPC incorporated the following public safety features into operations and maintenance activities:

- security fencing – placed around the overflow spillway and bottom-outlet;
- warning signs – signs indicating "Danger" and "Keep Out" are placed near the existing Bluefish Dam, the new Bluefish Dam, and overflow spillway;
- warning buoys – placed upstream of the existing Bluefish Dam;
- a waterway boom – there are three waterway booms to restrict public access via boat in the area upstream of the existing Bluefish Dam, upstream of the entrance to the bottom-outlet structure, and downstream of the new Bluefish Dam overflow spillway, and bottom-outlet; and

- staff and personnel visiting the Bluefish site must check-in with the operator, have a valid NTPC orientation, get a site orientation and hazard assessment from the operator, have proper identification, and wear personal protective equipment (PPE).

2.11 Emergency Preparedness and Response Plans

An “emergency” means a present or imminent event that requires prompt coordination of action or special regulation of persons or property. NTPC (2012b) has established procedures for emergency situations and has outlined emergency preparation and response requirements in the Emergency Preparedness and Response Plans (EPRP). The EPRP includes contact names and phone numbers for emergency response organizations (i.e. fire rescue, RCMP, ambulance, hospitals, etc.) and other stakeholders. In the event of a flood event, inundation maps are also provided in the EPRP documents included as Appendix VI.

3 OPERATION

3.1 Introduction

This section describes the “normal”, “unusual”, and “emergency” operation modes that Bluefish Dam and Bluefish Lake are operated under. Roles and responsibility during operation of Bluefish Dam and ancillary structures are described in Section 3.2. Normal operation, which is discussed in Section 3.3, includes situations in which the overflow spillway and bottom-outlet structure would be capable of handling the incoming water flow. Normal operations include almost all types of operations that meet requirements for the water license. Unusual and emergency operations, which are discussed in Section 3.4, would involve higher than normal flows requiring the use of the overflow spillway and bottom-outlet structure to pass significant flows exceeding a prescribed amount. Unusual operations also include periods with abnormally low inflows during a drought condition when minimum flows cannot be met. Emergency operations are different than unusual operations in that there is a threat of a failure. Operation of all components of Bluefish Dam should follow NTPC safe work policies and Occupational Health and Safety Guidelines (OHS).

3.2 Roles and Responsibilities

NTPC personnel identified in Appendix I are involved in the operation of Bluefish Dam and its ancillary structures are identified. The successful operation of the Bluefish Dam requires that all staff know their roles and responsibilities.

NTPC has a water license, which is included in Appendix IV, through the Mackenzie Valley Land and Water Board (MVLWB). Operational requirements of the water license include:

- The Bluefish Lake Reservoir water level does not fall below 182.88 m (NTPC “old datum” at Bluefish Lake).
- The minimum release from the IFR structure is 0.75 m^3/s, as per the Fisheries and Oceans Canada (DFO) directive.
- A minimum flow of 6 m^3/s shall be maintained in the Yellowknife River below the Bluefish powerhouses and above the inlet to Prosperous Lake.
- If the power station is shut down, the full amount of 6 m^3/s must be released from the IFR and the bottom-outlet gates.
- NTPC shall install and maintain a guard on all water intakes to prevent entrainment of fish in accordance with the Fisheries Act and any other applicable legislation.
- NTPC shall submit to the MVLWB, prior to June 1 and December 1 of each year, a Reservoirs Operation Plan for the next six months period, showing the forecasted monthly average river inflow and outflow values and subsequent reservoir levels.
- NTPC shall have detailed geotechnical inspections of all power-generation facilities undertaken every four years (starting in 2009) by a qualified geotechnical engineer registered in the Northwest Territories. Inspections are to take place at Bluefish Dam when the annual

water level in the Yellowknife River is high. The engineer's report shall be submitted to the MVLWB no later than sixty days after the inspection, and shall include a covering letter from NTPC outlining an implementation plan to respond to any recommendations made by the engineer.

3.3 Normal Operation

3.3.1 Water Use License

NTPC operates Bluefish Dam and Bluefish Lake under a license from MVLWB. A copy of the water license is included in Appendix IV. The current water license was granted on April 3, 2006 and expires on April 2, 2021.

Monitoring of water usage and release at the Bluefish site is conducted by NTPC staff in accordance with the requirements of the water license.

3.3.2 Operating Objectives

The objectives during normal operating conditions at Bluefish Dam are to manage normal or moderate inflows and outflows from Bluefish Lake, optimize flows for power production, and maintain reservoir levels at or near the normal operating elevation of 168.78 m. Flow requirements are met by having the IFR open to release water downstream. To achieve the operating objectives, the following guidelines should be considered:

- During periods of low inflow, or low water levels, only the minimum required flow should be discharged from the IFR at Bluefish Dam. During this situation, it will be inevitable that the water levels in Bluefish Lake will drop below FSL due to a lack of sufficient recharge. If the water deficit becomes significant, this may become an unusual operation as discussed under drought conditions in Section 3.4.2.
- During periods of high or increased inflow, such as during the spring freshet, and Bluefish Lake is at a level below FSL, the release of the flow through the IFR should maintain the minimum flow required, while allowing the reservoir levels to rise back to near FSL.
- During periods when the inflow is greater than the volume of water that can be released through the IFR and the water level in Bluefish Lake is at or near FSL, the excess flow should be diverted through the overflow spillway.

Summer operation typically passes whatever inflows come into Bluefish Lake. During the winter, the reservoir is maintained at FSL, or as high as possible to meet the power plant Reserve Firm Capacity (RFC) of 6MW if the main power line from NTPC's Snare-Hydro system is down.

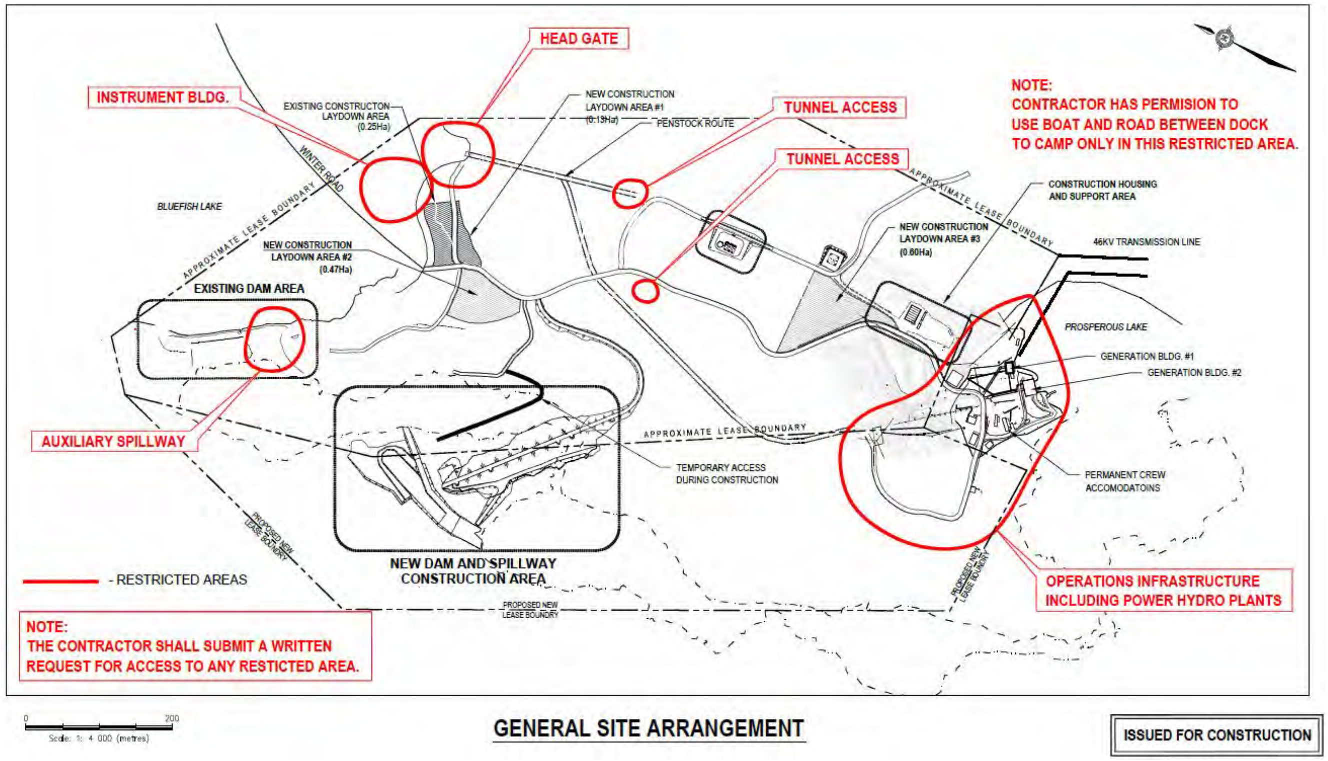
3.3.3 Reservoir Level Monitoring

The normal operating water level of Bluefish Lake is 168.78 m (geodetic datum). Environment Canada provides daily water level data is given in the "old datum", which is shifted from the geodetic datum by adding 17.15 m. Environment Canada's daily water level data for Bluefish Lake (station 07SB015 –

Bluefish Lake near Yellowknife, which is available from https://wateroffice.ec.gc.ca/report/real_time_e.html?stn=07SB015). The water level monitoring station is located close to the intake structure, as shown in Figure 3.1 and Figure 3.2 (which is from drawing C101 of the IFC drawings). Daily water level data is available from 1988 to 2016, and real-time data is also available. Historically, the reservoir has been operated at levels typically ranging between elevations 165.401 m (November 1, 1994) and 169.884 m (June 29, 1991).

Figure 3.1 Location of the Environment Canada hydrometric station in relation to Bluefish Dam

Figure 3.2 Bluefish Dam general site arrangement (from IFC drawing C101)



Checks on the water level are completed by NTPC at the power station intake by a water level measurement system. Some small variances are noted but the Environment Canada measurements are reported. NTPC have not installed a manual measurement system (i.e. staff gauge) at the dam or intake structure.

3.3.4 Streamflow Monitoring

Water flowing into Bluefish Lake comes from its approximately 11,300 km^2 catchment area, which includes Yellowknife River, McRae River, and Nicholson River.

Environment Canada has a gauge station (station 07SB003, available from https://wateroffice.ec.gc.ca/report/historical_e.html?stn=07SB003), which is located downstream of Bluefish Dam on Yellowknife River near the inlet to Prosperous Lake, as shown in Figure 3.3. This Environment Canada gauge station measures flow and water level, is still active, and has data dating back to 1939.

Figure 3.3 Bluefish Dam and both hydrometric stations

3.3.5 Downstream Water Demand

The downstream water demand is based on the requirements of the water license to maintain minimum flow in the Yellowknife River above the Bluefish powerhouses and into Prosperous Lake. As indicated in Section 3.2, the minimum release from the IFR structure is 0.75 m^3/s and the minimum flow in the Yellowknife River downstream of the Bluefish powerhouses and above the inlet to Prosperous Lake is 6 m^3/s.

3.3.6 Alarms and Warning

There are currently no alarms or automated flood warning systems in place at Bluefish Dam.

3.3.7 Bluefish Dam Operation

There are no operational requirements for Bluefish Dam. Periodic inspection, as described in Section 6, is required to ensure satisfactory performance of the embankment dam. Instrumentation has been installed to monitor the embankment and foundation performance. Refer to Section 7 for operation, maintenance, and testing of the geotechnical instrumentation for surveillance purposes of the dam.

3.3.8 Overflow Spillway Operation

The overflow spillway is a “bathtub-type” spillway with a U-shaped reconstitutive sill. The spillway is an uncontrolled overflow section. Therefore, no operation of the overflow spillway is necessary to discharge water.

Figure 3.4 shows the overflow spillway rating curve. The rating curve is based on the As-built length (As-built drawing C301 in Appendix V) of the overflow spillway, which is 102.9 m, and has an estimate of the overflow spillway capacity. Table 3.1 shows the overflow spillway discharge capacity for various water surface elevations.

Figure 3.4 Overflow spillway rating curve

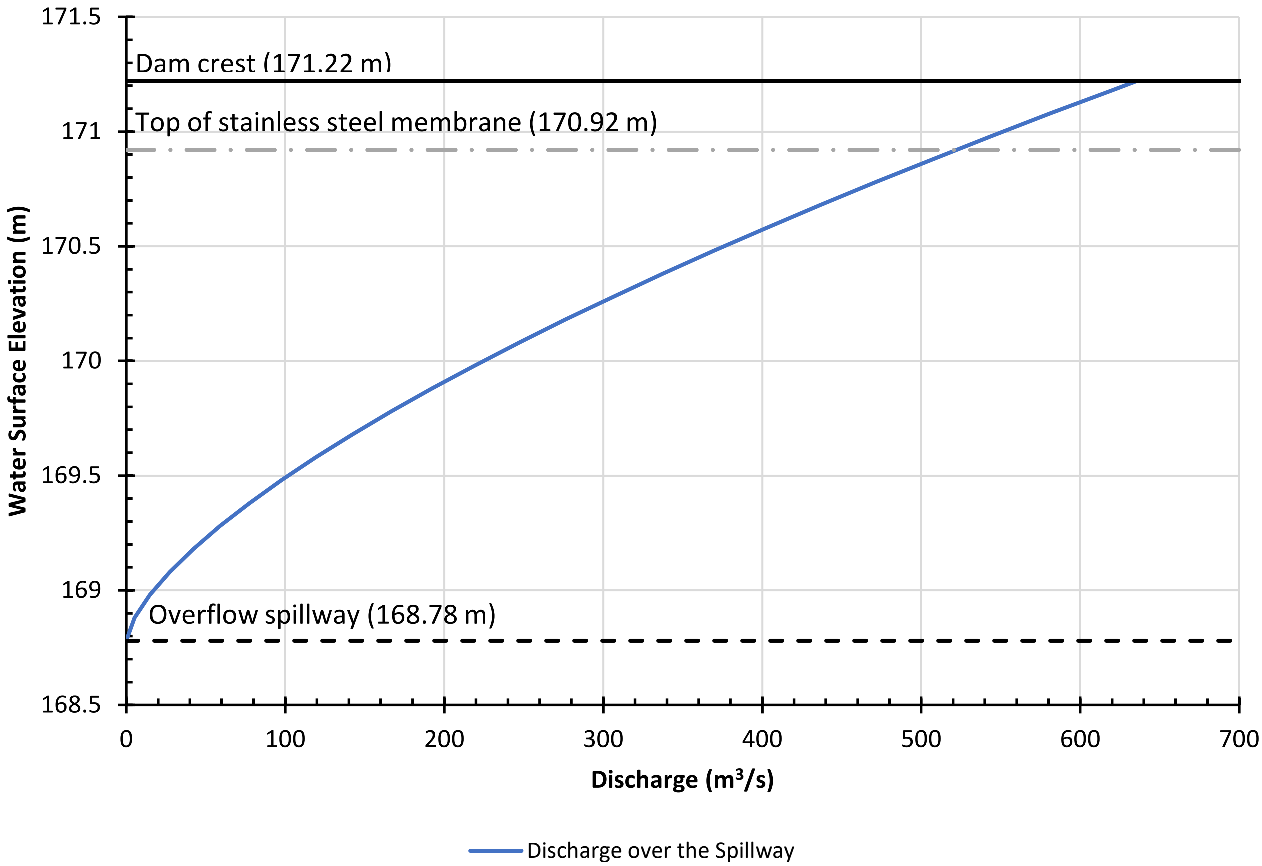


Table 3.1 Overflow spillway discharge capacity for various water surface elevations

Head Depth (m)	Water Surface Elevation (m)	Discharge, Q (m^3/s)
0.00	168.78	0.0
0.10	168.88	5.3
0.20	168.98	14.9
0.30	169.08	27.4
0.40	169.18	42.2
0.50	169.28	58.9
0.60	169.38	77.5
0.70	169.48	97.6
0.80	169.58	119.3
0.90	169.68	142.3
1.00	169.78	166.7
1.10	169.88	192.3

1.20	169.98	219.1
1.30	170.08	247.1
1.40	170.18	276.1
1.44 (maximum allowable flood level)	170.22	288.1
1.50	170.28	306.2
1.60	170.38	337.4
1.70	170.48	369.5
1.80	170.58	402.6
1.90	170.68	436.6
2.00	170.78	471.5
2.10	170.88	507.3
2.20	170.98	544.0
2.30	171.08	581.5
2.40	171.18	619.8
2.44 (dam crest)	171.22	635.4

3.3.9 Bottom-Outlet Gate Operation

General

The design of the bottom-outlet gate, and location of the actuator used to lift the gate are shown in Figure 3.5 and Figure 3.6, which are taken from the IFC drawings. The gate is a 2.74 m wide by 2.74 m high stainless-steel gate, as shown in Figure 3.5.

Figure 3.5 Bottom-outlet gate dimensions (from IFC drawing S803)

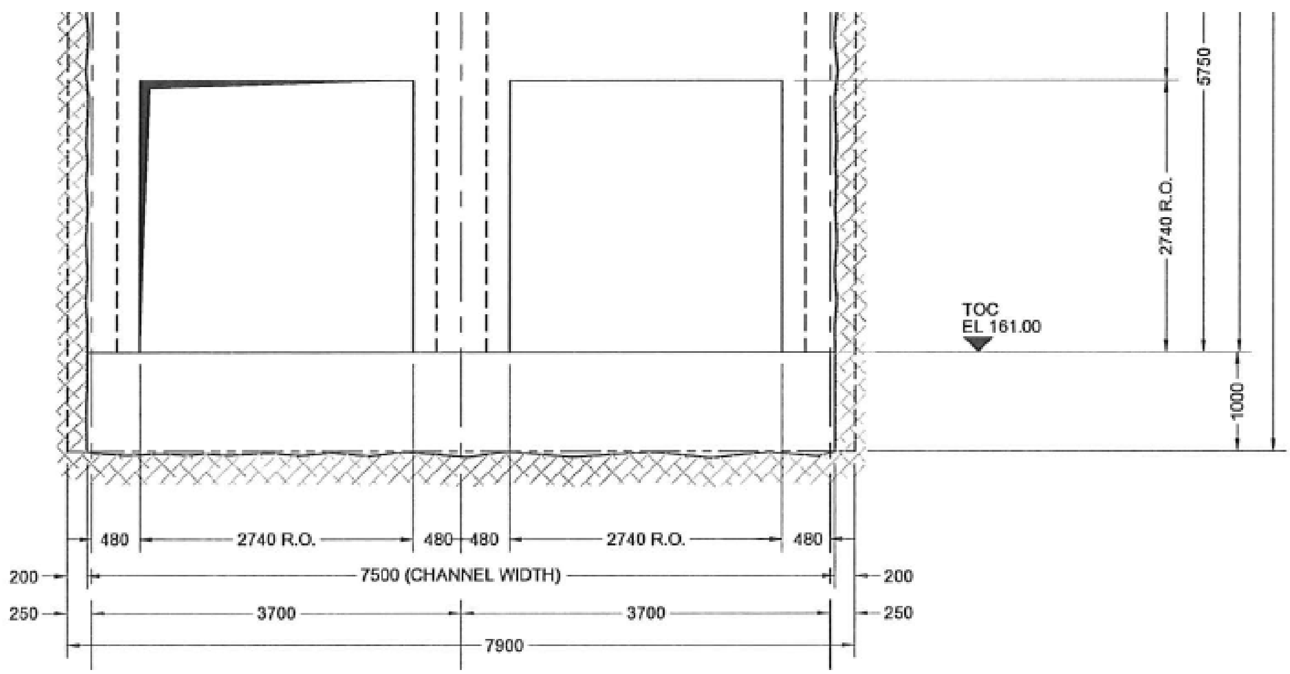
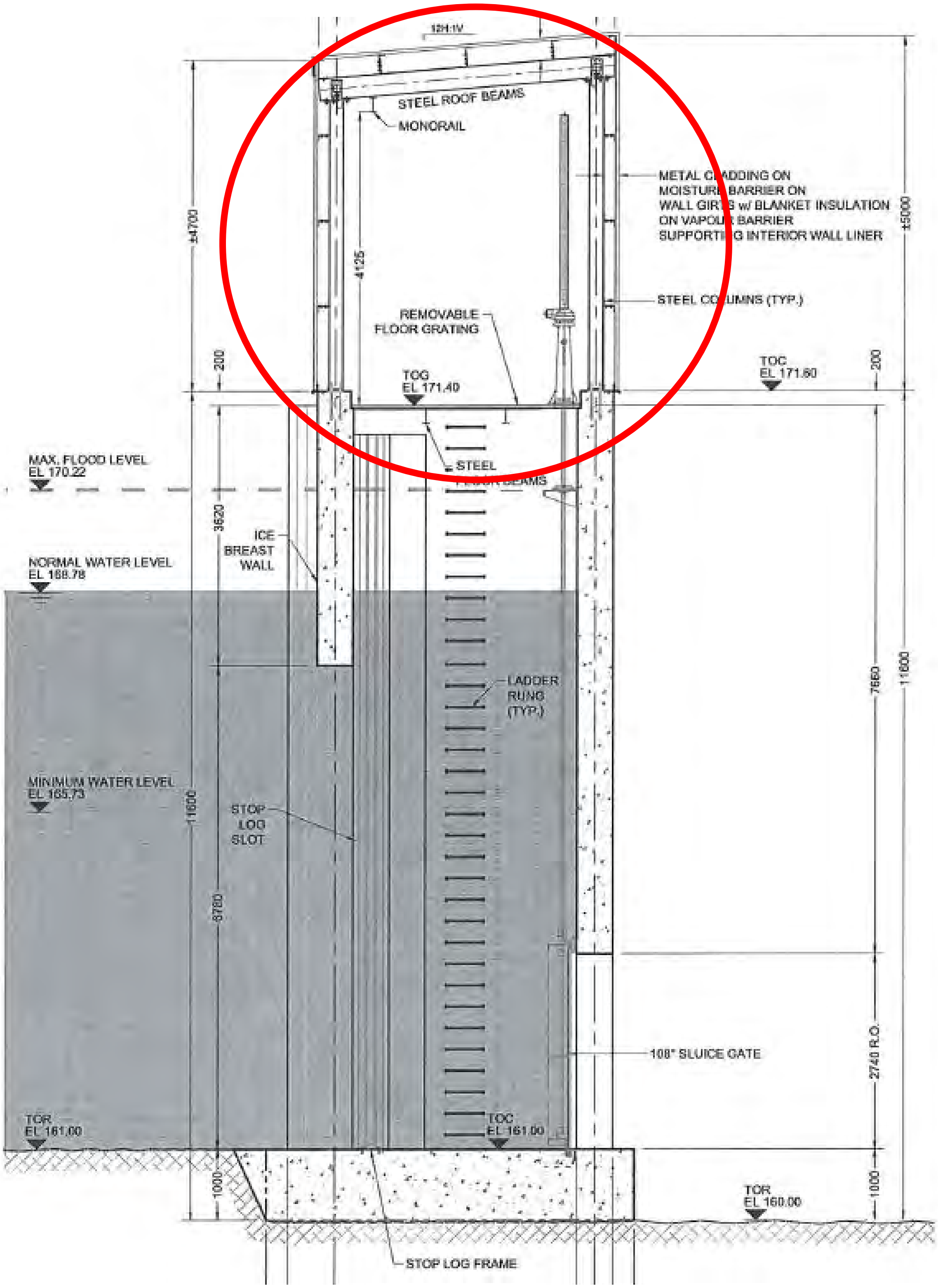


Figure 3.6 Bottom-outlet structure section (building circled in red not constructed in 2012).



Equipment

The bottom-outlet gate is operated using an electric multi-turn actuator manufactured by Auma Actuators Inc. (Auma). The actuator is Auma's model number SA 14.5, and is constructed of stainless-steel. The operator's manual for the actuator is included in Appendix VII. The actuator is located at the top of the bottom-outlet structure, as shown in Figure 3.7. Figure 3.8 and Figure 3.9 show the actuator used to operate the bottom-outlet gate.

Figure 3.7 The platform, bottom-outlet and IFR gate actuators

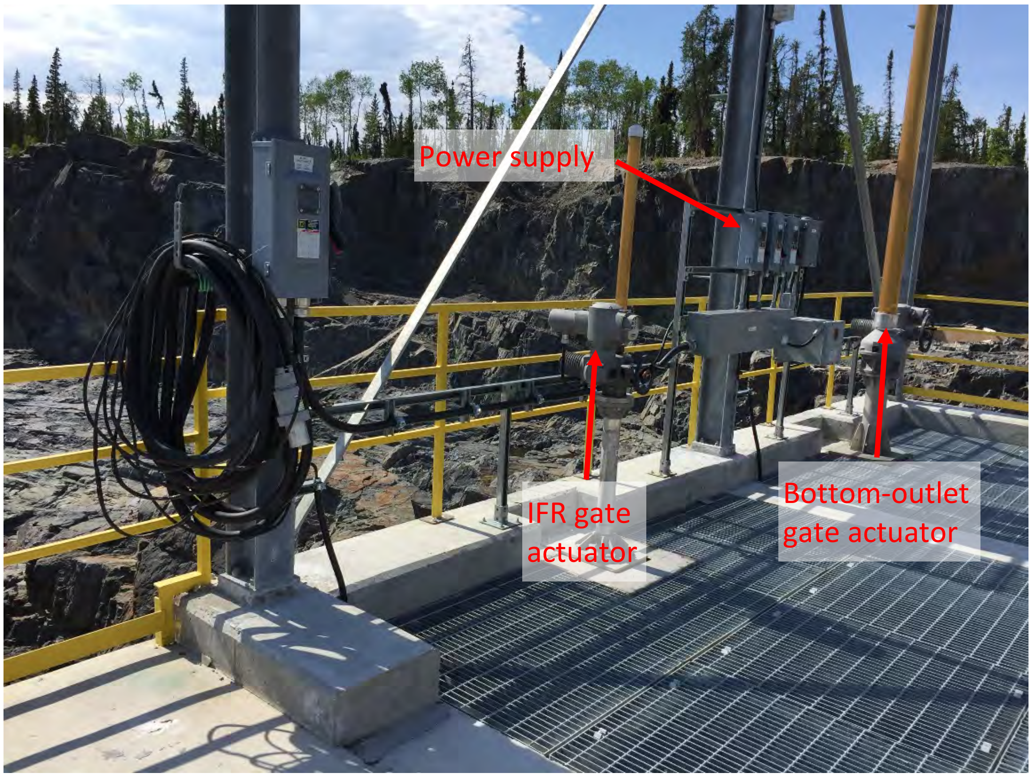


Figure 3.8 Auma actuator used to lift the bottom-outlet gate

Figure 3.9 Identification information for the bottom-outlet gate actuator

Operation

The NTPC operating procedure for the bottom-outlet gate is included in Appendix VIII. The bottom-outlet gate in the bottom-outlet structure is typically closed. The bottom-outlet gate can be opened using the actuator described in the previous section. The actuator can be operated using portable generators, or by manually turning a hand wheel on the actuator in the event the generators are not available. Care must be taken when operating the gates that unrestrained operation of the gates does not occur. A locking mechanism within the actuator prevents back drive of the hoist with uncontrolled lowering of the gate. Figure 3.10 shows the power supply for the bottom-outlet gate. Figure 3.11 shows the connection for the generator to the actuators. Auma indicated (personal communication), a portable air-pack with a 2-inch adaptor can be used to turn the actuator to open or close the gate.

Figure 3.10 Power Supply for the bottom-outlet and IFR gates

Figure 3.11 The power connection for the generator to the actuators

Prior to operating the bottom-outlet gate, the following equipment must be on site:

- keys for the storage facility;
- a Wacker G25 20kW portable generator with the required power adaptor;
- fuel to power the portable generator during operation;
- portable light plants (if required); and
- depending on the time of year, a grader or loader may be required to clear snow to access the hoist.

The steps outlined in NTPC's operating procedure for the bottom-outlet gate, which is included in Appendix VIII, should be followed for normal operation.

Before each bottom-outlet gate or stop log operation:

- Consideration should be given to what testing opportunities and/or maintenance requirements may exist that could be coordinated with the bottom-outlet gate operation.
- Refer to Section 5 for testing and maintenance requirements for the flow control equipment.
- Determine and record reservoir elevation at the time of the gate operation using data from Environment Canada monitoring station 07SB015.

- Ensure the discharge requirements from DFO and the MVLWB are met.
- The IFR bypass is normally left open, but it should be checked before operating the gate.
- Using the discharge rating curve, (see Figure 3.12), determine how far the gates should be opened to pass the flow required.

The maximum flow achievable through the bottom-outlet gate, with water level at FSL (168.78 m) and the bottom-outlet gate fully opened is approximately 51.4 m^3/s, as shown on the rating curve in Figure 3.12.

When closing the bottom-outlet gate:

- unlock and disengage the locking mechanism on the actuator, if necessary;
- engage the actuator to close the bottom-outlet gate;
- visually check the gate to see that leakage is minimal, as excessive leakage could indicate the gate did not close properly, possibly due to debris caught below the gate; and
- at completion of the bottom-outlet gate closing, re-engage the locking mechanism on the actuator.

The procedures for observing flow characteristics during operation are as follows:

- Dependent on the target flow to be passed through the bottom-outlet gate, increase the gate opening in increments whereby changes in flow do not exceed 0.5 m3/s for each stage.
- The changes in flow can be determined from the rating curve in Figure, which KCB is working to produce after inquiring about the rating curve data which could not be found by EBA).
- At each stage of gate opening, visually observe and listen for audible noises that may indicate pulsing or surging of flow within the structure.
- If observations indicate the flow is surging or pulsing in a manner that may adversely affect the structure, the flow rate should be decreased (or alternatively increased) until the performance improves (i.e. pulsing flow stops).
- Operation at high flows that significantly surge or pulse should only be conducted if the integrity of the dam is potentially impacted due to high reservoir levels and passage of additional flow is deemed necessary through this structure.
- Record all visual and audible observations for each flow rate on the inspection forms discussed in Section 6.

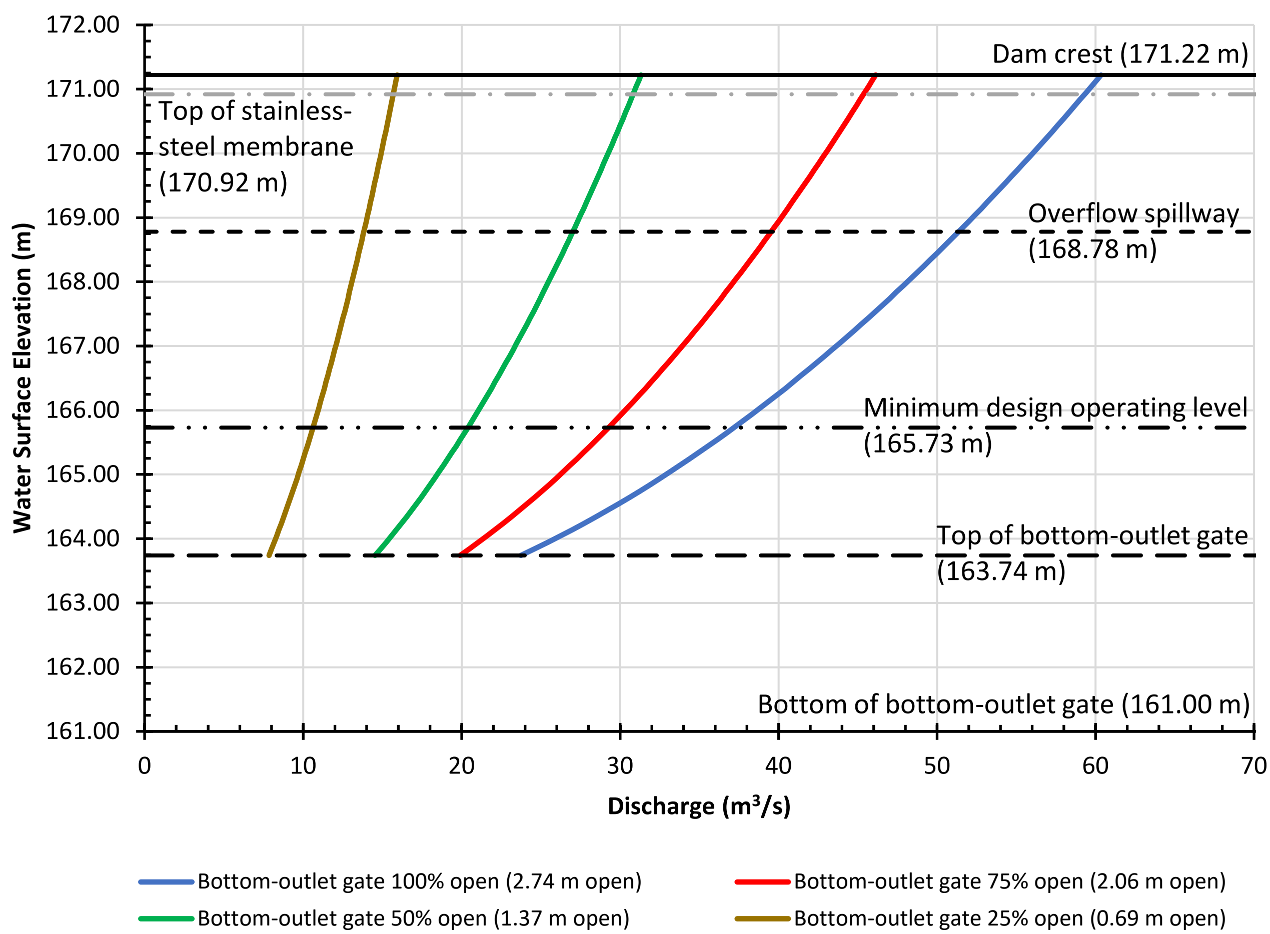
Before and during operation of the bottom-outlet gate, observe the areas upstream and downstream of the bottom-outlet structure. Prior to operation, check to see if the reservoir is ice-covered and if ice pans are floating upstream of the bottom-outlet structure and IFR. The bottom-outlet gate should not be continuously operated unless necessary to release water when the reservoir level is below the reconstitutive sill and IFR elevations. This will minimize the risk of ice being drawn through the gate(s) and the possible negative impact on the bottom-outlet structure.

The operators should monitor the reservoir surface upstream of the gate for vortices. Vortices can occur at large gate openings and can create unpredictable vibrations in the gate and hoist system. Open gates are required to prevent vibrations. Observations of vortices should be reported to NTPC's EoR.

Operating Rating Curve

Figure 3.12 shows the bottom-outlet gate rating curve, assuming the IFR gate is closed.

Figure 3.12 Bottom-outlet gate rating curve



3.3.10 IFR Gate Operation

General

The design of the IFR gate, and location the actuator used to lift the IFR gate are shown in Figure 3.13 and Figure 3.14, which are taken from the IFC drawings. The gate is 1.37 m wide by 0.91 m high stainless-steel gate, as shown in Figure 3.13.

Figure 3.13 The IFR gate (image take from IFC drawing S803)

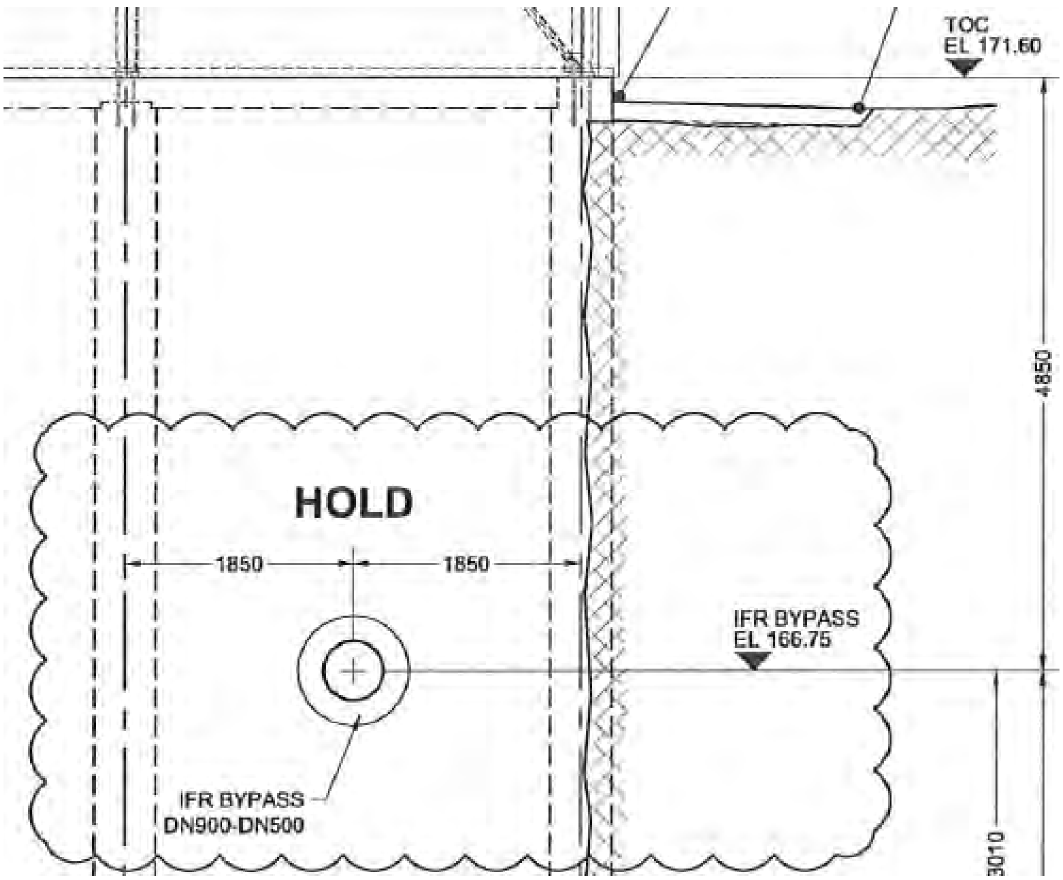
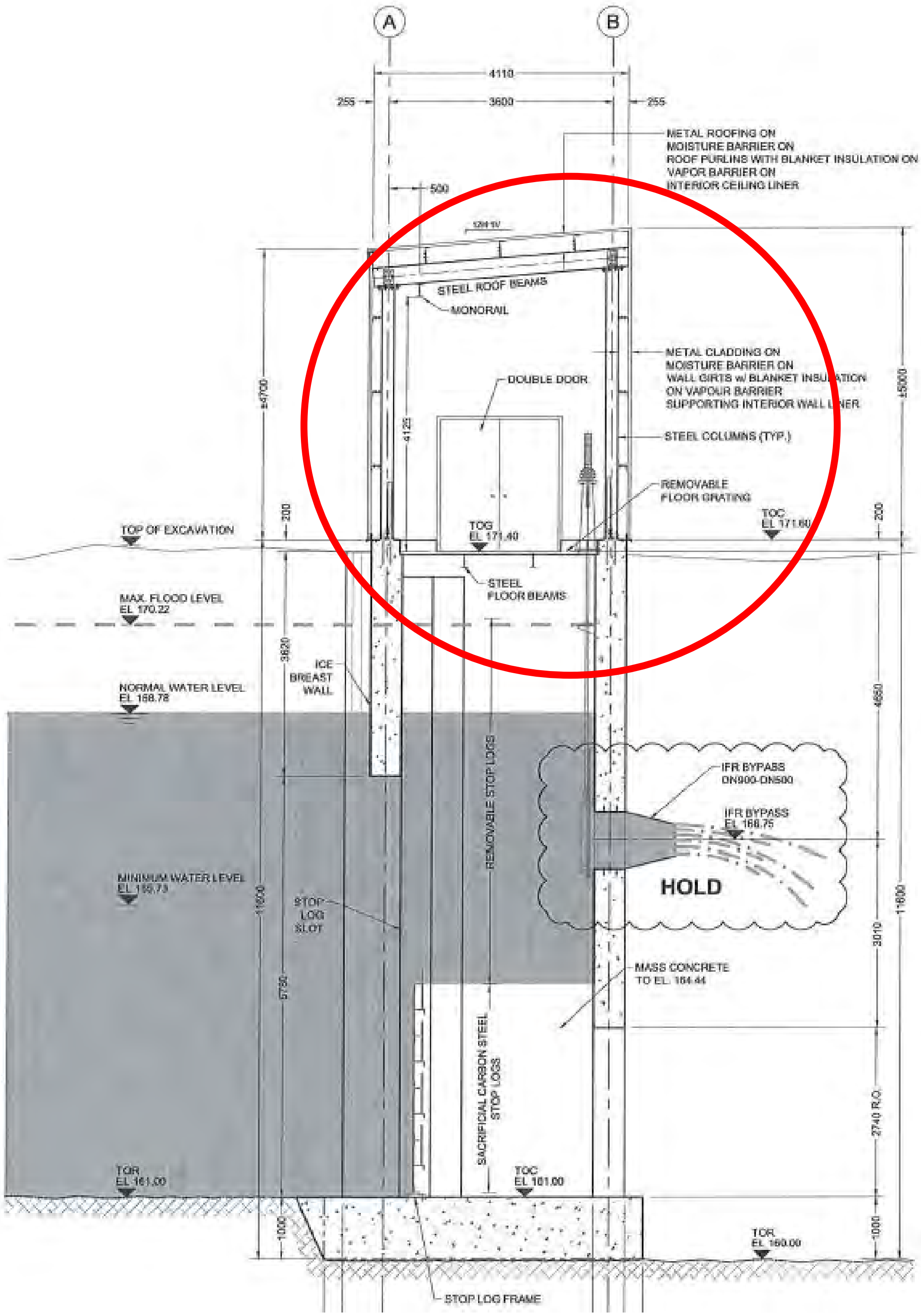


Figure 3.14 Bottom-outlet structure section through the IFR gate (building circled in red not constructed in 2012).



Equipment

The IFR gate is operated using an electric multi-turn actuator manufactured by Auma Actuators Inc. (Auma). The actuator is Auma's model number SA 10.1, and is constructed of stainless-steel. The operator's manual for the actuator is included in Appendix VII. The actuator is located at the top of the bottom-outlet structure, as shown in Figure 3.7 in Section 3.3.9. Figure 3.15 and Figure 3.16 show the actuator used to operate the IFR gate.

Figure 3.15 Auma actuator used to lift the IFR gate

Figure 3.16 Identification information for the IFR gate actuator

Operation

The IFR gate in the bottom-outlet structure is open at all times as per the DFO (2016) directive. The IFR should be operated to allow for the minimum passage of 0.75 m^3/s. The IFR gate can be closed or opened using the actuator described in the previous section. The actuator can be operated using portable generators, or by manually turning a hand wheel on the actuator in the event the generators are not available. Figure 3.10 in Section 3.3.9 shows the power supply for the IFR gate. Figure 3.11 in Section 3.3.9 shows the connection for the generator to the actuators. Auma indicated (personal communication), a portable air-pack with a 2-inch adaptor can be used to turn the actuator to open or close the gate.

Prior to operating the IFR gate, the following equipment must be on site:

- keys for the storage facility;
- a Wacker G25 20kW portable generator with the required power adaptor;
- fuel to power the portable generator during operation;
- portable light plants (if required); and
- depending on the time of year, a grader or loader may be required to clear snow to access the hoist.

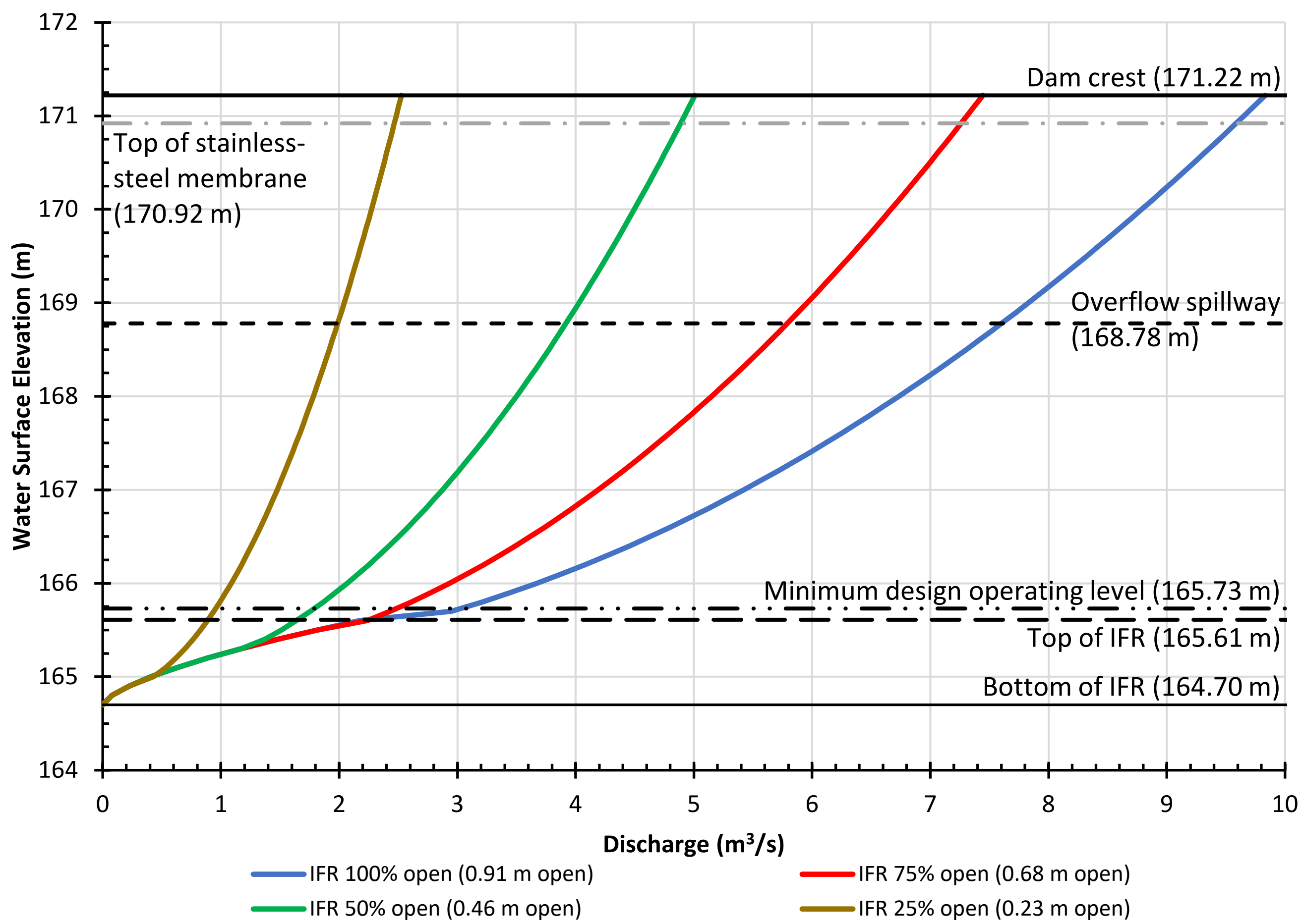
Before and during operation of the IFR gate, observe the areas upstream and downstream of the bottom-outlet structure. Prior to operation, check to see if the reservoir is ice-covered and if ice pans are floating near the bottom-outlet structure and overflow spillway. The IFR gate should not be closed unless it is required for safety reasons (e.g., work being completed upstream of the bottom-outlet structure). In the event the IFR gate is to be closed, NTPC may require a temporary water license variance.

The operators should monitor the reservoir surface upstream of the gate for vortices. Vortices can occur at large gate openings and can create unpredictable vibrations in the gate and hoist system. Open gates are required to prevent vibrations. Observations of vortices should be reported to NTPC's EoR.

Operating Rating Curve

Figure 3.17 shows the rating curve for the IFR gate, assuming the bottom-outlet gate is closed.

Figure 3.17 IFR gate rating curve



3.3.11 Stop Log Hoist

General

Metal stop logs measuring 1 m high by 3 m wide can be used to isolate the intake area for the bottom-outlet structure. As per the design drawings (drawing S401, included in Appendix II), the stop logs are Series 95 stainless-steel manufactured by Fontaine Aquanox. The 1 m high by 3 m wide stop logs are placed in the stop log slot, as shown in Figure 3.18, which was taken from the IFC drawings. An electric chain hoist (hoist) manufactured by Kito Corp (Kito) is used to lift the stop logs and place them in the stop log slot, near the upstream side of the bottom-outlet structure. Figure 3.19 shows the hoist on the top of the bottom-outlet structure.

Figure 3.18 Location of hoist and stop log slot (image taken from IFC drawing S804)

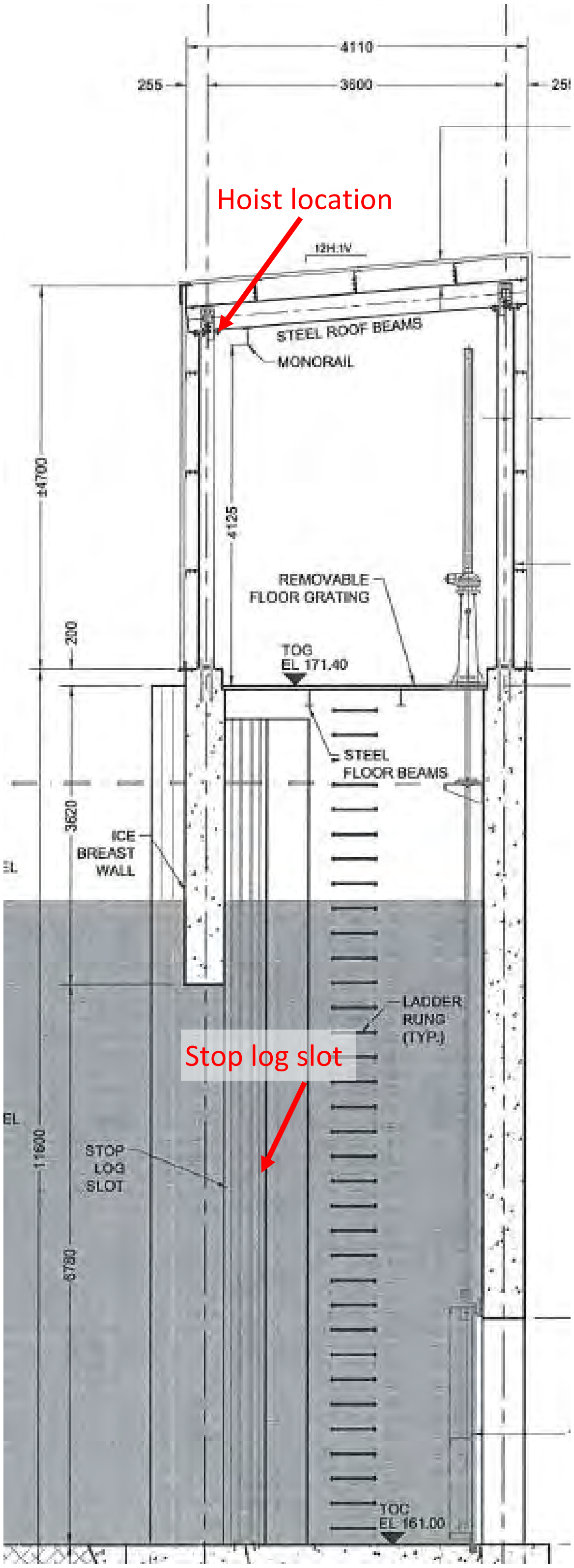


Figure 3.19 The hoist used to place stop logs at the top of the bottom-outlet structure

Equipment

The stop logs, which are shown in Figure 3.20, are stored between the dam and bottom-outlet structure. A Kito 500 kg electric chain hoist, which is shown in Figure 3.21 is used to place the stop logs. The operator's manual for the hoist is included in Appendix IX. A spreader bar (shown in Figure 3.22), which is stored on the operating deck below the hoist, is provided to assist in handling the stop logs.

Figure 3.20 Stop log panels stored on site between the dam and overflow spillway

Figure 3.21 Kito 500-kg electric chain hoist used to raise and lower stop logs

Figure 3.22 The spreader bar used in handling the stop logs

Operation

The stop logs need to be transported by a loader, or an alternative method depending on availability of the loader, to the operating deck of the bottom-outlet structure. After being brought to the operating deck, the stop logs are placed on the operating deck using a Kito 500 kg electric chain hoist, with assistance from a spreader bar. The loader should not drive onto the operating deck of the bottom-outlet structure. The panels are then lowered into place using the electric chain hoist. All gates should be closed when the stop logs are being lowered into place to prevent binding of the stop logs in the stop log slots. Once the stop logs are installed, the area between the gates and stop logs is dewatered by opening the bottom-outlet gate. The gates can then be exercised, tested or have maintenance work conducted on them. When work on the gates is completed, the gates are closed and the area between the gates and stop log panels is filled with water with a pump and hose to equalize the hydrostatic pressure on either side of the stop logs. The stop logs are then removed and stockpiled in a reverse manner as they were installed.

NTPC have not operated or completed maintenance on the stop log hoist system since completion of construction in 2012.

3.4 Unusual and Emergency Operations

3.4.1 General

The term "Unusual operations" is an umbrella term used to describe operations that are out of the norm and require adaptation by operations staff at NTPC. Depending on the severity of the possible consequences, unusual operations may also constitute emergency operations as described in Section 3.4.8. Unusual operations may require or include:

- temporary changes to the reservoir level, which may be required if:
  - maintenance to structures that are adjoining to the reservoir is required;
  - a sharp increase in local inflow has been identified; or
  - damage has been identified for water retaining structures (e.g., the stainless-steel membrane) or to the adjoining structures.
- manual operation of flow control equipment;
- operating flow control equipment on an alternative power sources;
- flow-control equipment inoperability due to:
  - planned maintenance or other activity;
  - power loss;
  - failure to operate;
  - equipment failure or breakdown;
  - unplanned events, such as a frozen gate; or
  - blockage due to ice or debris.
- loss of control systems or control of flow control equipment;
- wind storms;
- ice jams at the overflow spillway or bottom-outlet structure (severe ice conditions may require specific measures as discussed in Section 4.3.2 if operation is required;
- floating debris affecting operation of the flow control structures; and
- local inflow approaching the IDF Flood frequency estimates as provided in Section 3.4.4.

3.4.2 Drought Operations

NTPC have had low water level conditions in Bluefish Lake since the construction of Bluefish Dam was completed. To retain as much storage in Bluefish Lake as possible for power production, NTPC should only release the minimum discharge (6 m^3/s) as required in the license agreement with MVLWB.

During drought conditions, an involuntary drop in reservoir level is expected to occur due to forced and natural losses and a lack of recharge from natural inflow. Under ideal conditions, the reservoir is preferably maintained as close to FSL as possible.

The critical reservoir levels are as follows:

- normal operating level (or FSL) – El. 168.78 m;
- minimum design operating level – El. 165.73 m; and
- if the reservoir level drops below the minimum design operating level, power generation at Bluefish may be interrupted.

3.4.3 Winter Operations

During winter months, ice forms on the reservoir. The reservoir level is typically maintained so ice is not a concern for the operation of the bottom-outlet gate. However, leakage through the gate could cause ice buildup on the downstream side of the gate and could limit operation of the gates during cold weather conditions. Prior to operation, gates should be inspected to determine whether they can be opened without damaging the gate or seals. Although not normally required during the winter months, if operation is planned, a ground heater in the Bluefish shop should be used to remove ice from the gates and unfreeze the seals, as required. Figure 3.23 shows a ground heater in the shop. The operation procedure is as follows:

- if required, melt ice off the gates on the downstream side;
- begin opening the bottom-outlet gate, while visually inspecting the gate to look for signs of water flowing;
- if the gate does not open, ensure the gate is in the “closed” position and replace the ground heater near the gate;
- after reheating the gate (if required), inspect other areas of the gates such as ensuring the gate alignment is correct, or that the actuator is working;
- open the gate further and, if no issues arise, continue to the next step;
- if issues arise, troubleshoot them prior to continuing operating the structure;
- failure of the actuator during gate lifting may cause the gate to be damaged so that it cannot be closed again, with subsequent uncontrolled release of the reservoir until stop logs can be placed;
- open the gate further to make sure no operational issues develop; and
- after completing the operations, close the gate completely until observations show no flow out of the gate.

Figure 3.23 Ground heater (red circle) in a shop at Bluefish site

3.4.4 Flood Operations

General

Flood operation will occur when the inflow rate to the reservoir is sufficient to warrant operation of the flow control facilities that control outflow from Bluefish Lake. Outflows can be handled in the following manner:

- for small outflows, if the power station is shut down, the required outflow of 6 m^3/s must be released from the overflow spillway;
- it is feasible to discharge 6 m^3/s from the IFR if the reservoir is near FSL;
- the overflow spillway has a capacity of 387 m^3/s at the maximum pool elevation of 170.22 m;
- opening the bottom-outlet gate can discharge approximately 40 m^3/s if the reservoir level is at an elevation of approximately 166 m (EBA 2011);
- protocols for communications, water storage, and discharge based on the water license from MVLWB are included in Appendix IV; and
- the overflow spillway is the primary structure that will discharge the IDF.

Inflow Flood Frequency Estimates

The IDF discharge (one-third between the 1:1,000-year flood event and the PMF) was estimated to be 387 m^3/s, and the PMF discharge in the Yellowknife River was estimated to be 662 m^3/s by EBA (2011).

Estimation of Flood Inflows

NTPC conducts snow surveys of the Bluefish catchment to assist with forecasting the magnitude of spring freshet run-off. NTPC uses an empirical method to relate snow survey data to estimate peak discharge during spring freshet. NTPC does not include Bluefish in the snow survey forecasting, although measurements are taken, using the Tube and Scale Method, to determine the snow water equivalent (SWE) for Bluefish.

3.4.5 Overflow Spillway Operation

The overflow spillway is not operated as it is an uncontrolled overflow spillway with no gates.
A detailed description for the overflow spillway operation procedure is provided in Section 3.3.8.

3.4.6 Reservoir Drawdown Procedures

Drawdown may also be necessitated due to emergency conditions where the integrity or safety of the dam is jeopardized. If reservoir drawdown is required in an emergency (i.e. dam integrity is threatened) the reservoir can be lowered to elevation 161.00 m, which is the bottom elevation of the bottom-outlet gate in 2.5 days (there is no drawdown information given in the design report (EBA 2011), but 2.5 days was indicated during the kick-off meeting minutes). During reservoir drawdown, the dam stability and reservoir slope stability are not a concern due to the upstream rock fill shell of the dam and the generally bedrock-controlled reservoir rim.

During periods when drawdown occurs for any reason, the opportunity to carry out inspection or maintenance for areas that are normally inundated should be evaluated and if deemed appropriate, conducted at that time as described in Section 6. During periods involving drawdown, additional instrumentation surveillance should also be performed.

3.4.7 Fisheries and Fish Salvage

A fish salvage operation is considered an unusual operation and is required in any area where fish may potentially be stranded resulting in potential mortality. NTPC do not foresee any requirement for fish salvage as part of operations. Activities requiring instream works should be scheduled to avoid the spawning and incubation periods of potentially occurring fish species, if feasible, as fish and deposited eggs have an increased sensitivity to disturbance during these periods. A total of fifteen fish species have been previously documented in Bluefish Lake including both spring and fall spawning species (Golder 2017). The Northwest Territories Restricted Activity Timing Windows for the Protection of Fish and Fish Habitat identified by DFO indicate that instream works should be avoided between August 15 and July 15. This means that works that have the potential to harm fish, eggs, or habitat frequented by fish should be scheduled to occur in the period between July 16 and August 14, if feasible. Any operation or maintenance activity involving instream work should be evaluated to determine the need for fish salvage. Activities requiring fish salvage may include the following occurrences:

- as part of a dewatering operation, if required in a proposed work area that is normally inundated and may contain fish; and
- areas requiring cofferdams where fish may be isolated from the reservoir.

After stoppage of each flow release in the overflow spillway or bottom-outlet structure, which may be conducted as part of normal, unusual, or emergency operations, the continuity of flow may only be provided by the IFR and fish passage channel in the bottom-outlet.

The need for a fish salvage should be reviewed on a case by case basis and is dependent on location, duration, as well as other factors. NTPC should consult with their environmental staff or biological consultants for guidance on when fish salvage may be required. If fish salvage is deemed necessary, the following activities are considered necessary, but may be modified to suit specific requirements:

- fish salvage operations shall be conducted pursuant to Ministry of Environment and Fisheries and Oceans Canada requirements;
- obtain all required permits and approvals prior to commencing work and coordinate these activities with the required environmental services specialist;
- employ a subcontractor experienced in fish salvage operations to carry out all work directly related to catching and releasing trapped fish;
- if a salvage is required in the downstream channels, ensure the bottom-outlet gates are close, and it is safe to complete the work (i.e. flow is not discharging through the overflow spillway);
- construct a small cofferdam, which can consist of stacked sandbags placed within an exterior sheet of plastic, an inflatable AquaDam, or another acceptable barrier, across the outlet channel where required;
- install dewatering pumps equipped with intake screens (for fish exclusion);
- submersible pumps installed on floating platforms may be required for dewatering;
- ensure the power source is safe (i.e. use GFCI outlets for the power sources if using electric pumps);
- commence pumping to lower the water level in the channel prior to beginning the fish salvage, do not pump during periods when the operation is unattended and not monitored for extended periods to ensure fish are not stranded due to excessive drawdown;
- throughout the water lowering process, conduct fish salvage operations with hip waders and use dip nets to retrieve fish;
- to assist with the fish salvage, utilize a crane to lift the tubs of water with retrieved fish and release the contents downstream of the dam;

- photograph and document all activities throughout the dewatering and fish salvage operations;
- record fish captured and released and note condition of all exposed infrastructure;
- after completion of fish salvage operations and any other maintenance, inspection or surveillance activities in the dewatered area, allow water to refill the dewatered area, either flowing from the reservoir, or use pumps if required (if pumping, ensure there are intake screens on the pumps);
- post salvage reporting will be necessary to forward the information related to the fish salvage operation to the regulators as required in the permits and authorizations obtained;
- prior to re-flooding the area, the following activities may also be conducted upon completion of the dewatering and fish salvage;
- excavate and remove sediment and debris (if required) that may have accumulated in, as discussed in Section 4.3.1; and
- carry out special inspections as discussed in 6.4.3 to determine the condition of the exposed concrete, joints, or rock wall.

3.4.8 Emergency Operation

Emergency operation is required whenever events occur that may jeopardize the integrity of the Bluefish Dam or ancillary structures and possibly lead to failure. Such events may include extreme floods, equipment failure, or failure of a dam or structure component. During such occurrence, emergency drawdown may be required as discussed in Section 3.4.6. The remoteness of the Bluefish site, both in distance from Yellowknife and distance from major centres will impede mobilizing specialized equipment and contractors to site if extreme measures are required, such as opening a damaged gate to release water from Bluefish Lake. Following any emergency that may impact the integrity of the Bluefish Dam or ancillary structures, a detailed inspection should be conducted as described in Section 6.

4 MAINTENANCE – GENERAL

4.1 Maintenance Objectives

The importance of a well-developed maintenance program cannot be over-emphasized. The best-constructed facilities will eventually fail if maintenance is neglected. Keeping maintenance activities current is the keystone of successful project operation. The objectives of the maintenance program are to:

- keep the facilities in top operating condition always through proper maintenance;
- obtain the longest life and greatest use of the facilities by providing adequate maintenance and replacements in a timely fashion
- achieve the foregoing at the lowest possible cost.;
- since all structures and facilities are subject to some sort of deterioration, ongoing vigilance is necessary to identify and correct potentially unsafe or unsatisfactory conditions as they develop;
- seepage, cracks in concrete, settlement of the dam or a structure, etc. can lead to major failures if not corrected or repaired without delay;
- problems such as these are serious and the cause of the problem generally must be determined from investigations conducted by qualified professional and technical personnel before remedial maintenance work can be defined;
- there are many other problems of a less serious nature that may develop with the various structures; and
- in this regard, the term maintenance refers to those preventative or corrective measures which are to be conducted on an ongoing basis as the minor problems arise; thereby ensuring the safe and efficient operation of the project facilities.

All maintenance work should be conducted according to NTPC safe work policies and OHS guidelines.

4.2 Maintenance Work Orders

NTPC management staff assign maintenance tasks through NTPC's Central Maintenance Management System (CMMS). CMMS is used by NTPC to schedule and track maintenance tasks. The tasks are input into the system and work orders are issued at different scheduled times. The work is then conducted by the assigned maintenance staff and records are documented in the database. Maintenance requirements identified during routine inspections are also entered into CMMS by NTPC. The following sections discuss maintenance issues that may arise either as routine requirements or special cases.

Maintenance or repair tasks that can be completed by NTPC personnel are either conducted by the operators, if they are qualified to complete the work safely, or assigned to the maintenance group which may assign the work to electricians, mechanics, or other trades.

A list of contractors that are available for hire for specific tasks is maintained as part of the EPRP (NTPC 2012b). The list of contractors is also provided in Appendix X.

4.3 Bluefish Dam Site

4.3.1 Debris

Floating debris should generally be removed from the reservoir areas adjacent to the dam and ancillary structures. Generally, debris have not typically caused a problem at the overflow spillway intake or main dam and would normally be more of an issue at the power station intake. However, during periods of prolonged normal water level or during flood events, the amount of debris originating from upstream areas could increase and result in debris accumulation or partial blockage of the overflow spillway. Monitoring of debris near the dam should be ongoing throughout all operations with vigilance exercised during large floods. NTPC should create and maintain debris accumulation records to assist with planning debris management during large flood events.

There are two booms that help prevent debris in the reservoir from reaching the dam:

- upstream of the dam in Bluefish Lake; and
- upstream of the inlet to the Bottom-Outlet Structure.

Figure 4.1 and Figure 4.2 show one of the booms. Booms are described in Section 4.3.5.

Figure 4.1 One of the booms in the reservoir upstream of Bluefish Dam

Figure 4.2 One of the booms (the same one as shown in Figure 4.1) in the reservoir upstream of Bluefish Dam

Accumulation of debris could overstress safety booms and possibly result in failure if left unattended. The presence of debris accumulating against the boom should be monitored. If debris accumulation occurs, additional measures should be undertaken to protect the boom's integrity. If debris can not be removed, it may be necessary to remove or release one end of the boom to avoid failure of the boom and allow the debris to float to shoreline where it can be removed with an excavator or tow cables. Precautions should be taken when releasing one end of the boom to ensure it does not float into the overflow spillway and/or IFR structure and affect operations.

Debris is not typically a problem at the bottom-outlet and IFR structure. However, wood debris is sometimes noted in the bottom-outlet and IFR structure, as shown in Figure 4.3, which is looking down into the bottom outlet structure through the floor grate from the top deck. NTPC's procedure for removal involves a crew in a boat with hooks to manually move debris. The bottom-outlet and IFR gates should be closed during this period for safety. Lockout is required for the gates while the boat is working upstream. All safe work practices are to be followed while removing debris.

Figure 4.3 Wood debris in the bottom-outlet and IFR structure (looking down through the floor grating from the top deck of the bottom outlet structure)

4.3.2 Ice

Ice forms on the reservoir during the winter months, however, NTPC reports that ice build up has not been a significant concern for operating Bluefish Dam.

Gates are normally submerged and not exposed to ice buildup. If water levels are extremely low this could be a concern but Bluefish is normally operated at high water levels during the winter to maintain the RFC. If necessary, a Wacker Neuson E1100 diesel powered ground heater with 500 ft (152.4 m) of hose is available in the shop for thawing ice. If ice accumulation occurs upstream of the gates and stresses on the gate are considered by NTPC or their consultants to be excessive, the ice can be broken using a crane with a weight or other equipment NTPC and their consultants believe to be appropriate. A list of available contractors that can perform de-icing or ice removal services is provided in Appendix X. The suitability and availability of equipment for ice removal should be confirmed on an annual basis prior to the onset of cold weather.

4.3.3 Sediment

NTPC reports that sediment deposition has not been a historic operation problem at the Bluefish site. Some sediment buildup could occur upstream of the large gate which is not normally operated. However, Bluefish Lake at the outlet of the Yellowknife River will tend to cause sediments to settle further upstream, and the presence of the decommissioned dam will also promote sediment deposition in the original Bluefish Lake.

Long term sediment accumulation may have occurred within the reservoir resulting from submerged deltaic-type deposits at the upstream end of the reservoir as sediment is deposited in the low velocity environment of the reservoir. Bluefish Lake has been controlled with a dam since the 1940s so a submerged deltaic-type deposit may already exist at the upper end of Bluefish Lake, although a review of bathymetric data does not show a submerged deltaic-type deposit. Although sediment accumulation could take decades to occur such that it becomes a significant problem with loss of reservoir storage, monitoring should be undertaken by bathymetric survey at 5-year intervals to check the extent of sediment deposition. Records should be maintained for subsequent comparison to allow assessment of long term storage effects.

4.3.4 Signage

Warning signs are placed at various locations adjacent to the reservoir, overflow spillway, and bottom-outlet structure. As part of the routine inspections, NTPC should check signage for damage and weathering to ensure legibility. Signs may be damaged during severe weather such as high winds and should be checked regularly after such events. Long term exposure to weather effects may also affect the legibility of signs due to fading or loss of paint and should be checked at least annually. An inventory of signs should be prepared for use in future inspections.

4.3.5 Floating Booms

Floating safety booms are provided in the reservoir and downstream channel. Figure 4.2 (in Section 4.3.1) shows a floating safety boom in the reservoir upstream of the dam. A floating safety boom is provided downstream of the dam, as shown in Figure 4.4. Safety booms require regular inspection and repairs, as they are susceptible to damage caused by ice. Damage and repairs are an annual occurrence.

As a precaution, against ice damage, floating booms can be removed at the end of the open water season and installed at the beginning of the open water season. The need for removal of the safety booms should be assessed by NTPC with consideration of the time and cost to repair booms if ice damage occurs. Damage may also occur during large floods when high flows are discharged by the overflow spillway. The extent of any damages incurred by the floating booms should be assessed as soon as possible after occurrence of a flood event. If damage occurs to a boom, the boom should either be repaired, or, in the case of the boom upstream of the bottom-outlet structure that could impair overflow spillway or IFR operation, be removed and repaired as soon as possible to limit the potential for the damaged boom to interfere with the bottom-outlet and IFR operation. The overflow spillway, bottom-outlet gate, and IFR must not be in operation (i.e. passing flows) during installation/removal of the floating booms unless NTPC assesses that the work can be conducted safely. All safe work procedures are to be followed when installing and removing the floating booms. Details related to debris accumulation and removal adjacent the floating boom are described in Section 4.3.1.

Periodic inspection and maintenance should be provided for the safety booms when required. As a minimum, the safety boom should be inspected annually and any required maintenance work be conducted as soon as possible.

Figure 4.4 Floating safety boom downstream of the dam

4.4 Bluefish Dam

4.4.1 General

The following maintenance activities for Bluefish Dam include:

- snow removal from crest-access road to bottom-outlet structure and from access road to outlet of the overflow spillway and access road on top of toe berm;
- routine grading of the dam crest and access roadways;
- repairs to gravel-surfaced crest-access road;
- repairs to the riprap;
- trimming and cutting vegetation, as required; and
- repairs to fencing, road barriers, and signs, as required.

NTPC has various equipment on site for operation and maintenance tasks, including a front-end loader (scoop tram), pick-up trucks, one ground heater, two frost fighters (heaters), compressors, one light plant, and generators are stored on site in various shelters.

Some activities such as road maintenance activities are considered routine, and are conducted at regular intervals. However, other maintenance activities could be performed on an as-required basis as identified during routine inspections (see Section 6.4.2) and should be noted in monthly-maintenance records.

Maintenance of performance-monitoring instrumentation installed in Bluefish Dam is discussed in Section 7.

4.4.2 Dam Crest and Berm Roadways

Maintenance activities along the dam crest are conducted as required and directed by NTPC management. The only maintenance work on Bluefish Dam conducted to date by NTPC is snow removal and minor grading of the gravel-surfaced access roads.

As described in Section 2.9, the access roads are constructed of 50-mm-minus road topping overtop of 1.0 m minus rockfill. However, it is possible for ruts or low areas to form from vehicle traffic or snow-removal activities that could cause ponded water on the crest of the dam. NTPC should maintain the crest of the dam with grading and gravel placement to allow water to drain off the crest of the dam. Care should be taken to ensure that the geotechnical instruments and survey monitoring points along the dam crest are not damaged during snow-removal and grading activities.

4.4.3 Riprap Protection

Wave action during severe wind storms, or ice action during the winter may cause movement and dislocation of riprap on the upstream face of the Bluefish Dam. Due to its location, downstream of the former outlet of Bluefish Lake, Bluefish Dam is partially sheltered from wave action occurring in Bluefish Lake.

Settlement in riprap areas on the dam slope could indicate shallow upstream slope movement. Large depressions in the riprap may also indicate sink holes resulting from internal erosion. For areas with damage to the riprap, the required remedial action generally consists of one of the following actions:

- In cases where riprap is simply dislodged or removed due to wave erosion, or ice action, the riprap can be replaced in deficient areas and the slope re-graded to its former condition. If the affected area is large in area or depth, then further inspection and review may be required by NTPC engineering staff and/or a consultant to assess the cause of dislodgement, if the riprap protection is adequate, and if upgrading of the riprap protection is required.
- Areas of slope instability on the dam will require further investigation and assessment by NTPC engineering staff and a consultant before repairs are conducted. Placement of riprap on areas where slope failures have occurred sometimes results in additional weight causing more slope movements, therefore, riprap placement should be delayed until a more extensive remedial work plan has been identified.

4.4.4 Dam Crest Erosion

Surface runoff flows that are shed from the dam crest will tend to concentrate along localized depressions and in some cases, may be sufficient to initiate erosion of the gravel surfacing. The upstream slope is protected with riprap armouring and downstream slope consists of 1.0 m minus rockfill. Erosion from runoff from the crest of the dam is unlikely. The erosion will likely start as small erosion rills. If erosion is not addressed, the small rills can become larger erosion gullies that will require repair. Riprap or gravel from the stockpiles on site should be used to repair erosion rills or gullies as need.

The gravel surfacing on the crest of the dam may fall into voids of the underlying coarse rockfill and may appear to be sinkholes. NTPC should assess if large voids are present below minor sinkholes before backfilling the small sinkholes with 50-mm-minus gravel. Large voids beneath the crest could indicate that seepage erosion is occurring in the dam fill. Large voids should be assessed by NTPC engineering staff and a consultant.

4.4.5 Drainage Ditches

Drainage ditches are not located at the dam site. Drainage from the access road to the dam should be diverted into the lake through a channel and culvert before surface water runoff reaches the dam.

4.4.6 Vegetation

Vegetation is currently not a significant problem, but growth will occur over time. Trimming and cutting of vegetation is scheduled through the CMMS.

4.4.7 Animal Activity

Burrowing animals are not a problem at the dam due to the coarse nature of the rock fill.

Bears are a concern for the safety of site personnel and authorized visitors. Bear-safety and awareness training is provided to their field staff by NTPC. NTPC holds a business-firearms license and has a firearm on site for site personnel use. NTPC has an incinerator-operation procedure that includes burning all garbage and food waste with removal of ashes from site to limit the potential of bears being attracted to the site.

4.4.8 Geohazard Repairs

In the event of actual or potential damages to the dam resulting from a geohazard event such as a failure or ravelling of rock cuts, sinkhole formation, or new seepage occurrence, site personnel should contact their supervisor and NTPC engineering staff. The south rock-cut slope of the IFR discharge channel is cut into the right abutment of the dam. The stability of the south rock-cut slope is maintained with rock anchors installed during construction. Maintenance of the rock cuts for the overflow spillway and bottom-outlet structure is described further in Section 4.5. Geohazard repairs will involve specific procedures or specialty contractors as well as the services or a consultant.

4.5 Concrete Structure and Rock Cut Channels

The bottom-outlet structure and reconstitutive sill are the only concrete structures at Bluefish Dam.

Rock cuts were constructed with drill-and-blast methods for the IFR and bottom-outlet structure. Unstable areas were secured using rock bolts, as shown in Figure 4.5. The walls of the overflow spillway channel are rock cuts with an approximately 0.25H:1V slope. The maintenance required for the rock bolts will be based on the inspections as described in Section 6.4.3. Response to rock bolt failure or rock slope failure or rock fall may require the services of a rockwork consultant to aid in assessment and design of repairs.

Figure 4.5 Rock bolts on side slopes in the rock cuts downstream (south) of the bottom-outlet and IFR structure

The stability of the rock cuts needs to be maintained through inspection of the rock cuts and rock bolts, as described in Section 6.4.3, and removal of rock fall debris from the overflow spillway.

Any debris within the overflow spillway or bottom-outlet structure must be removed as part of routine maintenance, or as required. This is required to prevent damage to the reconstitutive sill and overflow spillway. Access for debris removal will be through the outlet of the spillway.

Minor repairs to the bottom-outlet structure or IFR structure may be undertaken, but major repairs should be referred by NTPC to a specialist consultant and contractor.

5 MAINTENANCE – FLOW CONTROL AND SUPPORT EQUIPMENT

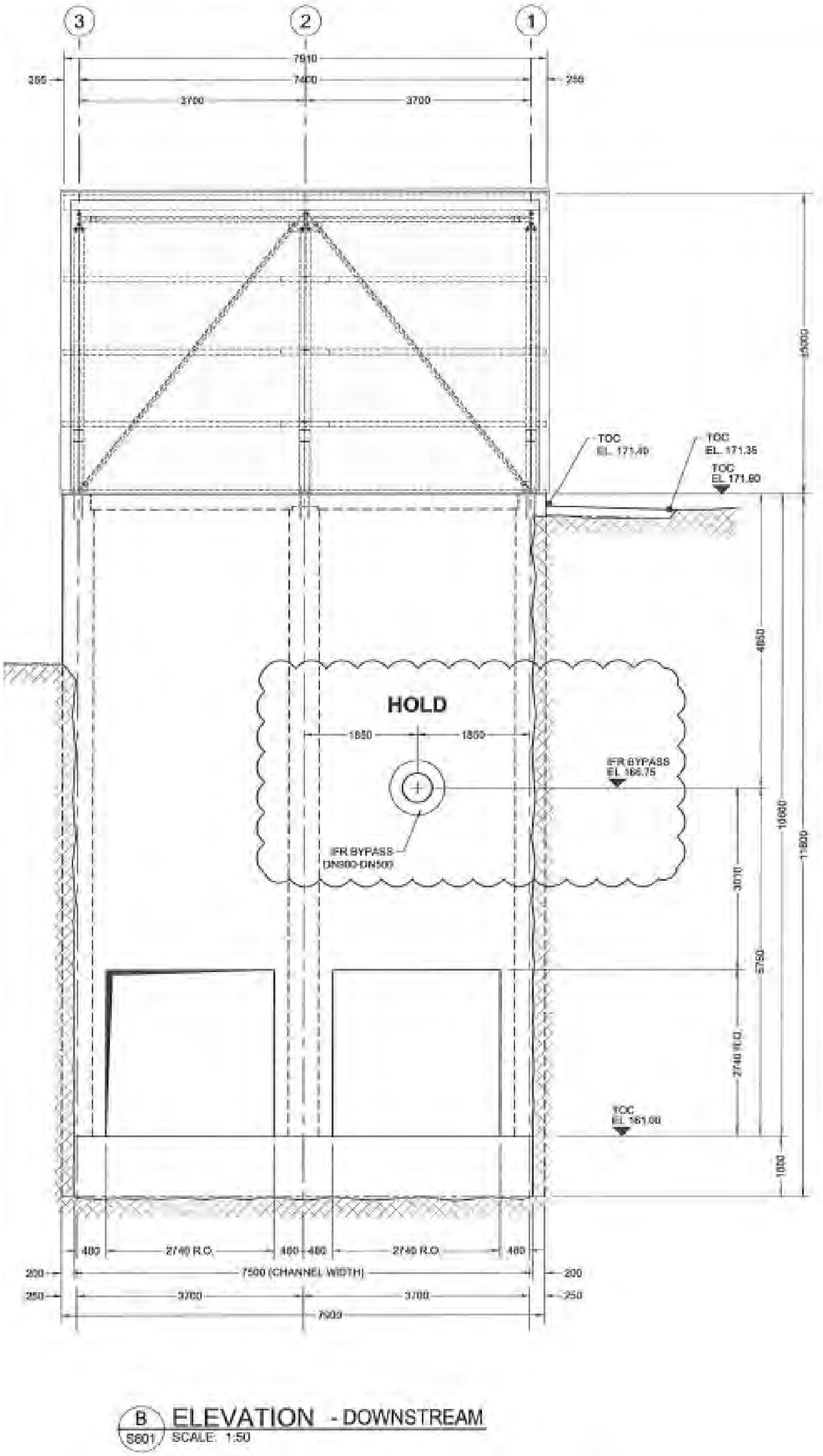
5.1 General

NTPC have two flow-control appurtenances at Bluefish Dam; the bottom-outlet gate and the IFR gate, which are shown in Figure 5.1, Figure 5.2 and Figure 5.3. All maintenance work should be conducted according to NTPC safe work policies and OHS guidelines.

Figure 5.1 Looking upstream (north) at the bottom-outlet gate and IFR gate

Figure 5.2 Looking down from the operating deck at the location of the bottom-outlet and IFR gates

Figure 5.3 Section view of the bottom-outlet and IFR gates



Electric actuators, shown in Figure 5.4 and Figure 5.5 are used to control the bottom-outlet and IFR gates, respectively. The actuators are located on a platform above the bottom-outlet structure and IFR gate as shown in Figure 5.6.

Figure 5.4 The actuator used to lift the bottom-outlet gate

Figure 5.5 The actuator used to lift the IFR gate

Figure 5.6 The platform the actuators are located on above the bottom-outlet and IFR gates

Maintenance and testing of flow-control equipment for the dam and reservoir is critical to dam safety. The bottom-outlet gate and the IFR gate are not critical to passage of floods but loss of reservoir water could occur if the gates cannot be closed. Preventative maintenance ensures that the equipment is inspected regularly and the potential for problems is minimized before use of the gate equipment is required. Gate testing should be conducted on a regular basis to maintain site personnel familiarity with how to operate the equipment, and that the equipment will be operational as designed. Local staff duties and tasks, as well as engineering inspections, either by NTPC engineering staff or consultants, inspections are discussed in this section.

NTPC should conduct periodic maintenance of the overflow spillway and bottom-outlet structure, to maintain functionality. Major maintenance issues such as major repairs required to the concrete structures will be identified through the inspections outlined in Section 6. The procedures for major maintenance works are specialized and dependant upon the nature of the required repair. Therefore, these procedures are not discussed in this manual. Any maintenance performed on the overflow spillway, bottom-outlet structure, gates, IFR or hoist should be recorded in maintenance and inspection reports.

5.2 Flow-Control Equipment Testing

5.2.1 General

Testing is required on all mechanical and electrical equipment used for flow control, including the bottom-outlet and IFR gates and actuators, stop logs and hoists, auxiliary equipment to support gate operation, and generators. Regular testing of flow-control structures and equipment is required to ensure that the equipment will safely operate when needed and to ensure that operators are familiar with the equipment and their operation. Testing may be achieved as part of normal operations, however, if the gates and components are not used during normal facility operations, specific gate testing is recommended. Whenever normal operations are required for passage of flows, the gate operations should be conducted in a manner that achieves the recommended testing requirements. To minimize water loss during gate testing, NTPC should consider conducting other gate-maintenance activities in conjunction with gate testing.

Full range testing of the gates is normally conducted in conjunction with Dam Safety Reviews or Audits but can be done during other periods if deemed appropriate.

Operational testing of the equipment is intended to check the movement of components under controlled circumstances. The testing can be done under hydrostatic load (wet testing) or with the stop logs in place and the water drained between the stop logs and the gates (dry testing). Both wet and dry testing are required to complete gate testing. All testing activities must be documented on an operations log. Recommendations for flow control equipment testing are provided in Sections 5.2.2 and 5.2.3. Recommended intervals for testing are summarized in Table 5.1.

Table 5.1 Recommended frequency for flow control equipment testing

Flow Control Equipment	Testing Details	Testing Frequency
Bottom outlet gate	Partial opening – open the gate using the actuator on site and normal power.	Annually
	Partial opening – open the gate manually.	Annually
	Full opening – function testing with normal power.	2 times/5 years
IFR gate	Wet test (partial opening) – open the gate using normal power.	Annually
	Full opening – function testing with normal power.	2 times/5 years

Sediments could be deposited over time upstream of the bottom-outlet structure, which is not normally operated. However, annual exercising of this gate to check its functionality would facilitate some flushing of any sediment. There may be some concern related to rocks falling into the upstream bottom-outlet gate area from the adjacent rock cut slopes which could impact operations by impeding gate operating during opening or closing. Underwater inspections conducted for the power station facilities should include the upstream area of the bottom-outlet gate. The IFR would have to be closed for a short period to facilitate the dive inspection. Lockout is required for the gates while divers are working in the area.

5.2.2 Bottom-Outlet Gate Testing

Before proceeding with testing of the bottom-outlet gate, a visual inspection shall be completed to confirm the bottom-outlet gate, actuator, and operating equipment are in good condition and that scheduled-maintenance work (e.g., lubrication) has been completed.

The gate should be operated annually as per testing requirements indicated in Table 5.1. During wet testing of the gate, NTPC personnel should conduct inspections of the various components and any unusual vibration, high loads (checked using motor amperage or speed of operation), noise, misalignments, or distortions/uneven movement should be noted, recorded and investigated. Dry testing of the gate (with the stop logs in place) should also be conducted after wet testing to allow inspection of all gate components during testing.

The basic functionality of the bottom-outlet gate shall be tested annually under reservoir head to ensure the gate can be opened under pressure. If the gate has not been used in the previous year, the gate shall be partially opened approximately 10% (approximately 275 mm). Before using powered gate operators, the gate should also be manually opened (i.e., with the hand wheel) a minimum of 25 mm from the closed position to verify it can be opened in the event of a loss of power.

Once every two and a half years (or twice within a five-year period), in conjunction with other flow control testing, the bottom-outlet gate shall be tested throughout the full range of operation as follows:

- fully open and close the bottom-outlet gate;
- address any operational issues with the gate that may occur; and
- document the gate test in the operations log.

Routine maintenance of the bottom-outlet gate and actuator should be completed according to the manufacturer's requirements, as discussed in Section 5.3.2.

5.2.3 IFR Gate Testing

As per the water license, the IFR gate is to remain open always.

Before proceeding with the testing of the IFR gate, a visual inspection shall be completed to confirm the IFR gate, actuator, and operating equipment are in good condition and that scheduled-maintenance work (e.g., lubrication) has been completed.

The IFR gate should be operated annually as per the testing requirements indicated in Table 5.1, During this operation, personnel should conduct inspections of the various components and any unusual vibration, high loads (checked using motor amperage or speed of operation), noise, misalignments, or distortions should be noted, recorded and investigated. Dry testing of the gate (with the stop logs in place) should also be conducted after wet testing to allow inspection of all gate components during testing.

The basic functionality of the IFR gate shall be tested annually under reservoir head to ensure the IFR valve can be opened and closed under pressure. Before using powered gate operators, the IFR gate should also be manually closed (i.e., with the hand wheel) a minimum of 25 mm from the normal open operation position.

Once every two and a half years (or twice within a five-year period), in conjunction with the bottom-outlet structure gate testing, the IFR valve shall be tested throughout the full range of operation as follows:

- fully open and close the IFR gate;
- address any operational issued with the IFR gate that may occur;
- document the IFR-gate test in the operations log; and
- routine maintenance of the IFR gate and actuator should be completed according to the manufacturer's requirements, as discussed in Section 5.3.3

5.2.4 Stop Log Hoist

The design load, described as the Bottom-outlet Control House Hoist permissible load, of the headframe for the hoist is 5 tonnes, and is given on IFC drawing S401, which is included in Appendix II. Maintenance of the Kito 500 kg electric chain hoist should be completed according to the manufacturer's requirements, as discussed in Section 5.3.4.

Routine maintenance of the stop log hoist should be completed according to the manufacturer's requirements. The routine maintenance includes:

- lubricating the chain;
- cleaning and lubricating bearings at least once per year;
- checking the oil level in the gear box;
- checking the motor break; and
- covering the hoist when not in use.

5.3 Maintenance of Bottom-Outlet Gate, IFR Gate, and Supporting Equipment

5.3.1 General

Maintenance required for each flow control equipment system, the frequency of maintenance, and staff responsibility of maintenance are described in this section.

Detailed records of all inspections and maintenance activities must be kept by NTPC. These records should include details of any components replaced and any deficiencies or areas of potential concern noted. Any changes to the components should be recorded, along with detailed descriptions including dimensions and photographs. If a decision is made to monitor a concern rather than repair it, change or lack of change in the condition of the component being monitored from one inspection to the next should be recorded on monthly inspection reports as described in Section 6.

Inspection and testing of the flow-control equipment are part of flow-control equipment maintenance activities. Visual inspections should always be done first. Any defects that could cause problems during operation should be noted and repaired before the equipment is moved. Testing of flow-control equipment is discussed in Section 5.2.

When lubricating or inspecting flow-control equipment that is being operated, follow all NTPC safety procedures to ensure that there is no hazard to personnel or the environment during these activities.

5.3.2 Bottom-Outlet Structure Gate

The bottom-outlet and IFR structure are to be routinely inspected and have the required maintenance completed.

Inspection and lubrication of components for the bottom-outlet structure and actuator is required on a regular frequency. Maintenance of the actuator should be completed as per the manufacturer's specifications, which are included in Appendix VII. Maintenance, including lubrication of the actuator is critical as high friction in the bearings can cause failure of the gate structure during operation. Maintenance tasks for the bottom-outlet structure gate and actuator are identified in Table 5.2.

Table 5.2 Bottom-Outlet Structure and actuator maintenance tasks

Component	Task	Frequency	Responsibility
Gate structure	Visual inspection – check for cracking, chipping, damage, and wear.	Every 5 years, annually if operated under load	Site with support from Dam Safety Department
Sacrificial stop logs	Visual inspection – check for cracking, chipping, damage, and wear.	Every 5 years, annually if operated under load	Site
Removable stop logs	Visual inspection – check for cracking, chipping, damage, and wear.	Every 5 years, annually if operated under load	Site
Stop log guides	Visual inspection – check for cracking, chipping, damage, wear, and deformations.	Every 5 years, annually if operated under load	Site
Actuator	Visual inspection – check for cracking, damage, and wear. Manufacturer's specified maintenance (i.e. lubrication, check seals, paint finish, etc.).	Annually; As per manufacturer's specification	Site

5.3.3 IFR Gate

Inspection and lubrication of components for the IFR gate and actuator is required on a regular frequency. Maintenance of the actuator should be completed as per the manufacturer's specifications, which are included in Appendix VII. Maintenance, including lubrication of the hoist, is critical as high friction in the bearings can cause failure of the hoist during operation. Maintenance tasks for the IFR valve and hoist are identified in Table 5.3.

Table 5.3 IFR gate and hoist maintenance tasks

Component	Task	Frequency	Responsibility
IFR Gate	Visual inspection – check for cracking, chipping, damage, and wear.	Every 5 years, annually if operated under load	Site with support from Dam Safety Department
IFR Gate	Visual inspection – check for cracking, chipping, damage, and wear.	Every 5 years, annually if operated under load	Site
IFR Gate guide	Visual inspection – check for cracking, chipping, damage, wear, and deformations.	Every 5 years, annually if operated under load	Site
Hoist	Visual inspection – check for cracking, damage, and wear. Manufacturer's specified maintenance (i.e. lubrication, check seals, paint finish, etc.).	Annually; As per manufacturer's specification	Site

5.3.4 Stop Logs

Maintenance outlined in the operation instructions and manuals for the Kito 500 kg electric chain hoist should be followed. The operating manuals for the Kito 500 kg electric chain hoist are included in Appendix IX.

Series 95 stainless-steel stop logs, manufactured by Fontaine Aquanox (shown in Figure 5.7), can be placed upstream of both gates to permit inspection and testing of both gates in dry conditions.

Figure 5.7 Stop logs that can be placed upstream of the bottom-outlet and IFR gates

.

A hoist and spreader bar which are shown in Figure 5.8 and Figure 5.9 are used to place the stop logs. The operation and procedure used to place the stop logs is described in Section 3.3.11.

Figure 5.8 The hoist used to place stop logs

Figure 5.9 The spreader bar used to place the stop logs

5.4 Overflow Spillway

5.4.1 General

The overflow spillway structure consists of rock cuts to create a spillway channel, as shown in Figure 5.10 and Figure 5.11. A reconstitutive sill was constructed to maintain the design reservoir level (at FSL). Figure 5.12 shows the reconstitutive sill. The overflow spillway structure and its components, which are shown in Figure 5.11 and Figure 5.12, should be routinely inspected and maintenance work should be completed as required. The chain-link fence around the overflow spillway and bottom-outlet structure should be kept in good condition, and repaired as required.

Figure 5.10 Looking upstream (north) at the overflow spillway

Figure 5.11 Looking downstream (south) at the overflow spillway from the bottom-outlet and IFR structure

Figure 5.12 The reconstitutive sill of the overflow spillway

5.4.2 Reconstitutive Sill

The reconstitutive sill is a reinforced concrete sill that is constructed on a bedrock surface exposed by drill-and-blast excavation. The excavation resulted in a final bedrock surface that was below design elevation and required a reconstitutive sill to be constructed to maintain reservoir level at FSL. Freezing could cause frost-lifting of the concrete from the bedrock surface, with increased leakage at the concrete bedrock contact. Maintenance work such as grouting or crack sealing may be required to seal seepage paths between the concrete and the bedrock, or to seal seepage paths through the shear zone. A shear zone crosses the overflow spillway diagonally between Sta. 0+010 and Sta. 0+015 m along the spillway channel, and passes beneath the reconstitutive sill (Sta. 0+000 is about 15 m upstream (into the reservoir) of the reconstitutive sill). IFC drawing C301 in Appendix II shows the stationing along the spillway channel.

The reconstitutive sill should be inspected as outlined in the routine inspections discussed in Section 6. All damages to the sill (e.g., cracking, chipping, etc.) should be reported and repaired as required. Repairs may include sealing leaks or cracks, or may require additional work.

5.4.3 Riprap Apron at Outlet of Overflow Spillway

There is a riprap apron at the outlet of the overflow spillway where it discharges into a lower pool of the Yellowknife River. The riprap is placed over alluvial sediments that were partially excavated during construction. The riprap was placed on geogrid and non-woven geotextile as a filtering layer. The riprap is displaced and partially eroded, with geogrid and nonwoven geotextile exposed (see Figure 5.13). The riprap was designed for low to moderate flows, and will be eroded during a large overflow spillway discharge event. The riprap was placed at the downstream end of the overflow spillway to address concerns about erosion of the riprap during low flow events.

Figure 5.13 Displaced riprap at the bottom of the overflow spillway with exposed geogrid

6 INSPECTION

6.1 Inspection Objectives

A planned inspection program is required to ensure the dam and structures (overflow spillway channel, bottom-outlet structure, gates, etc.) are in a condition to function safely and in the manner intended by the design. Bluefish Dam, the overflow spillway, and the bottom-outlet and IFR structure should be inspected with the following objectives in mind:

- to verify the physical condition and apparent safety of the structures and facilities;
- to determine the adequacy of the structures and facilities in serving the purpose for which they were designed and are being used; and
- to note any deteriorations as a basis for planning maintenance and repair work.

The success of the inspection program and optimum benefit derived from it depends upon NTPC's attention to detail, reporting, recording of information, and NTPC's response to recommended improvements. The inspection program includes:

- visual inspection of the dam and structures;
- monitoring the performance of the dam and structures; and
- a system of recording and reporting information, reviews, and recommendations for improvement.

Inspecting the dam and structures regularly is necessary for early detection of any signs of change, such as structural distress or seepage. The inspections should be conducted using a detailed checklist to ensure all critical areas of the dam and structures are checked. Performing inspections on a regular, consistent basis provides the earliest possible indication of potential problems.

6.2 Types of Inspections

Inspection is essentially a visual activity, although unusual occurrences or specific problem areas will often require investigative techniques or measurements to identify causes and define solutions. There are five types or categories of inspection:

- **Initial Inspections –** conducted by a team made up of representatives from the design, construction management and operating groups. This is a formal inspection of all work, to identify any deficiencies or uncompleted work and set forth the timetable and responsibilities for rectification or completion.
- **Routine Inspections –** conducted by on-site operating staff on a daily, weekly or monthly scheduled basis to provide for an early identification of any problems requiring remedial action. Routine inspections include a general inspection of the reservoir, dam, overflow spillway, bottom-outlet structure, and instrumentation.

- **Special Inspections –** conducted during and after special events such as storms, heavy rain, winters with severe ice action, earthquakes, significant spring freshets, discovery of unusual conditions at either Bluefish Dam or Duncan Dam, new developments downstream of the dam, new knowledge of safety analysis, new standards of safety, or any other unusual operating condition. Special inspections also include underwater and rock-bolt inspections.
- **Annual Inspections (or Annual Performance Reviews) –** conducted by a consultant experienced in the design and construction of dams and hydraulic structures and/or NTPC's EoR on an annual basis to verify that the structures are functioning in the intended manner and to detect any progressing deterioration due to physical wear or due to exposure to the environment.
- **Dam Safety Reviews or Audits –** According to EBA's (2011) design report and the Stantec (2017) dam safety review, Bluefish Dam has a "High" consequence classification, therefore, dam safety reviews should be conducted by registered professional engineers experienced in the design of dams and hydraulic structures every seven years as per CDA Guidelines 2013. Dam safety reviews or audits include the following tasks:
  - visually inspect all project components;
  - review and analyze the results of the ongoing instrumentation monitoring program;
  - conduct or recommend any supplemental investigations required to define specific potential problems;
  - report on the safety and stability of the various structures; and
  - and develop programs for any remedial action needed.

Inspections should be conducted according to NTPC safe work policies and OHS guidelines.

6.3 Frequency of Inspection

The different types of inspections outlined in Section 6.2, the frequency of each inspection type, and who the inspections are to be conducted by are outlined in Table 6.1 below.

Table 6.1 Types of inspections, required inspection frequency, and inspectors

Type of Inspection	Inspection Frequency	Inspection Completed By
Initial Inspections	After the completion of the dam construction, or any construction modifications to the original dam design; also includes a 1-year review conducted after first filling.	The first filling inspection was completed by Mr. Chris Gräpel, P.Eng. of KCB and NTPC representatives on October 31, 2012. Initial inspections should also be completed after any construction modification.
Routine Inspection	Daily, weekly, and/or monthly.	NTPC operating staff.
Special Inspection	After special events such as storms, heavy rain, winters with severe ice action, earthquakes, significant spring freshets, discovery of unusual conditions, new dams on the river system, new developments downstream of the dam, new knowledge of safety analysis, new standards of safety, or any other unusual operating condition.	NTPC operating staff and engineering staff as required.
Annual Inspection	Annually.	Consultant and/or NTPC's dam safety group.
Dam Safety Review or Audit	Every seven (7) years as per CDA Dam Safety Guidelines for a "High" consequence classification dam (EBA 2011 and Stantec 2017).	Registered professional engineer or multidisciplinary team of engineers

6.4 Inspection Procedures

The inspection procedure varies depending on the type of inspection. An inspection report must be completed when any inspection or review is completed.

6.4.1 Initial Inspection

The initial inspection is typically conducted once on a project – after completion of the dam. Additional initial inspections may be required if there is additional construction or modification made to the original dam design. Initial inspections include, but are not limited to the following:

- review the scope of work included in the construction contract;
- visually inspect all the various project components covered by the contract to identify any obvious deficiencies;
- review the final (or latest) progress claim to define deficiencies or discrepancies;
- prepare a list of deficiencies or repair work needed;
- establish a timetable and responsibilities for completion of all deficiencies and repairs; and
- prepare recommendations for issuance of Certificates of Substantial Performance and Total Performance.

For Bluefish Dam and ancillary structures, in the future, an initial inspection report would only be required for new projects modifying or affecting the original dam design.

6.4.2 Routine Inspection

Routine inspections are part of the duties of NTPC's operating staff and are to be conducted on a daily, weekly, or monthly basis as appropriate for the item being inspected. Routine inspections are to be based on, and follow a standard inspection form, will be provided in Appendix XI. Upon completion of the routine inspections, completed forms are to be filed in NTPC's database. Data, observations, and any issues or concerns are to be evaluated by NTPC management staff to confirm structural and operational safety and to identify areas requiring deficiency investigations. Action requests may be included on the inspection forms to ensure the appropriate action will be taken, depending on the severity of the observed deficiency.

If debris is passed downstream naturally, or flushed on purpose by opening the gates, the downstream section of the overflow spillway and bottom-outlet should be monitored for any impacts or damage to the structure. If debris is passed through the bottom-outlet structure, a detailed inspection of the bottom-outlet structure should be conducted by NTPC to check for any damage.

In preparation for operating the bottom-outlet gate, the bottom-outlet structure and gate should be inspected for visible signs of damage or distress. Before operating, ensure the areas immediately downstream of the outlet are clear of personnel and/or any equipment or materials that may be damaged during the spilling process.

The following is a guide and an outline of activities and items to be inspected when completing the routine inspection reports.

General

- report number;
- date and time;
- weather conditions;
- site conditions;
- inspector; and
- inflow (if available) and outlet discharges.

Reservoir

- reservoir level;
- condition of safety advisory/warning signs;
- floating debris;
- safety boom condition;
- ice accumulation;
- stability of reservoir slopes;
- leakage from the reservoir; and
- condition of chain-link fence.

Bluefish Dam

- upstream slope:
  - riprap;
  - slope stability;
  - wave action;
  - ice action; and
  - debris accumulation.
- downstream slope:
  - rock fill (Zone A – 1.0 m minus);
  - slope stability
  - signs of steam rising from voids in the 1.0-m-minus rockfill near the crest of the dam (steam was observed by NTPC in late fall of 2012 and 2013, and by KCB in 2013, the source of the steam was not known as discussed in KCB 2013); and
  - seepage.
- dam crest:
  - access roads and traffic;
  - rutting of the dam crest or road surface;
  - signs of frost action;
  - surface cracking;
  - settlement;
  - sinkholes; and
  - ponded water.
- overflow spillway:
  - condition of reconstitutive concrete sill;
  - condition of the concrete – check for cracking, chipping, or damage;
  - seepage through cracks in the concrete reconstitutive sill, at the concrete-bedrock contact below the reconstitutive sill, and through bedrock fractures and/or faults below the reconstitutive sill (ice build up could indicate seepage during winter months);
  - condition of stepped overflow spillway (rockfall, widened bedrock joints, debris accumulation);
  - condition of riprap at outlet of the overflow spillway (particle displacement, riprap thickness, etc.);

  - condition of chain-link fence;
  - condition of safety advisory/warning signs;
  - ice action or accumulation;
  - sediment accumulation; and
  - debris accumulation.
- bottom-outlet structure:
  - condition of concrete (cracking, etc.);
  - condition of grout;
  - condition of gates and stop logs;
  - mechanical and electrical condition of gate actuator and hoist;
  - condition of ladder, rungs, and fall protection apparatus in the bottom-outlet structure;
  - condition of IFR bypass;
  - condition of chain-link fence;
  - condition of safety advisory/warning signs;
  - observation of vortices (whirlpools) during operation of bottom-outlet structure;
  - condition of riprap at the bottom of the spillway channel (displacement, riprap thickness, etc.);
  - seepage;
  - ice action or accumulation;
  - sediment accumulation; and
  - debris accumulation.
- downstream slope and toe of natural ridge to northwest of overflow spillway;
- instrumentation:
  - condition of readout boxes, head boxes/protective casings, standpipe piezometers, ground temperature cables, corrosion monitoring instruments, and survey monitoring points; and
  - functionality of instruments will be reported as part of the scheduled readings.

6.4.3 Special Inspections

Special inspections are to be completed after special events such as storms, heavy rain, winters with severe ice action, earthquakes, significant spring freshets, discovery of unusual conditions at either Bluefish Dam, new developments downstream of the dam, new knowledge of safety analysis, new standards of safety, or any other unusual operating condition. Special inspections are to be completed by NTPC operations staff and engineering staff as required.

Following a flood event and discharge from the bottom-outlet gate, downstream of the bottom-outlet gate should be checked for erosion, the condition of the rock wall side slopes, and rock bolts. Observations should be recorded and any issues should be reported to NTPC's EoR.

Underwater and rock-bolt inspections are also included as special inspections and are discussed further below.

Trained and competent site staff, consultants, and the EoR are responsible to undertake or coordinate special inspections to ensure timely inspection of all structures during or after all potentially damaging events. Site staff should be aware of such opportunities for special inspections and advise dam safety personnel. Inspection reports are to be filed in NTPC's database for review by the NTPC engineers and consultants. The EoR is responsible for evaluating data and observations gathered during each special inspection. The requirements for these inspections are like the requirements for the routine inspections.

Underwater Inspections

Underwater inspections should be conducted and coordinated with special opportunities to observe facilities that are normally submerged. This may include periods when the overflow spillway channel is dewatered, the reservoir is significantly drawn down, or with divers.

Underwater inspections should include an inspection of the upstream side of the dam that is normally submerged and the upstream side of the reconstitutive concrete sill. Both should be checked for signs of deterioration or cracking. Underwater inspections would be conducted to assess the existence or potential of rockfall debris accumulating in front of the bottom-outlet and IFR structure.

Rock-Slope and Rock-Bolt Inspections

Regular inspections of rock slopes in the overflow spillway and IFR channel are required to confirm the stability of the rock slopes. The rock slope surfaces and area behind the crest of the rock slope should be inspected for cracking and weathering. Monitoring should be conducted to assess if seepage from the reservoir is exiting on the IFR channel rock slope. According to the As-built report (EBA 2013), there is deep weathering of the joints (in some cases greater than 5 m depth) along the west wall and the grout curtain between the dam and the bottom-outlet structure did not penetrate below the base of the IFR channel. If the visual inspection indicates that the rock slope stability is compromised, rock slope mitigation should be planned.

Rock bolts were used to stabilize rock slopes excavated for the overflow spillway and bottom-outlet structure where localized reinforcement was required. Some of the rock bolts installed in the rock slopes are shown in Figure 4.5 (in Section 4.5). The as-built report (EBA 2013) reports that the rock bolts were tensioned between 100 kN and 150 kN.

NTPC annually brings a rockwork consultant to inspect the power tunnel between the intake structure and the penstock. The overflow spillway rock-cut slopes and rock bolts should be inspected by the rockwork consultant when they are on site.

At least once a year, and when safe to do so, the rock bolts should be visually inspected looking for indication the bolts are structurally compromised. Inspections of the rock slopes can be conducted when the IFR is operating. Access for rock bolt inspections can be gained from the downstream end (outlet) of the spillway. A limited number of rock bolts can be viewed from the bottom-outlet structure. NTPC should develop a safe work plan for inspecting the rock slopes in the spillway.

Visual inspection of rock bolts should include, but not be limited to:

- condition of the rock bolts (collars tight with rock surface, signs of rock deterioration or loss of rock around the rock bolt);
- comparison of condition and stability of the cut slopes in areas with or without rock bolts;
- assessing if the bolts are being affected by ice jacking (discontinuity dilation, spalling, fresh surfaces, broken bolt head, raveling);
- signs of corrosion (rust, rust staining);
- assessing if repairs or additional rock-bolts are required (crack dilation, spalling, fresh surfaces, broken bolt head, raveling); and
- photographs of the rock slopes from various perspectives and prepare an annotated photo log for year to year comparison.

If the visual inspection concludes that the integrity of bolts is suspect, a pull-out testing program should be considered. The testing procedure and sampling percentage should be determined by the rockwork engineer hired by NTPC and the testing should be performed by a qualified testing company. Additional rock bolts may need to be installed if the tension testing indicates that anchors are failing. Notwithstanding this, the rock bolts should be subjected to a pull-out testing program before a minimum period of 25 years.

6.4.4 Annual Inspections

Annual inspections are more detailed than routine inspections. Annual inspections should be conducted once a year when the dam and overflow spillway is not covered with snow or ice. If possible, annual inspections should be completed over the range of operating conditions including minimum and maximum reservoir level as well as minimum and maximum inflow and outflow. Annual inspections should be completed by professional engineers, who are not part of the day-to-day operating personnel, such as an consultant who is experienced in the design and construction of dams, overflow spillways, and flow-control structures. NTPC’s engineers and senior operations personnel should also participate in the annual inspections.

Annual inspections are intended to be a more formal inspection and may include witnessing of testing of electrical and mechanical components to ensure they will function as required to pass the inflow design flood. Deficiencies disclosed during routine inspections are to be inspected in detail during annual inspections. Annual inspections include the review of instrumentation data related to performance monitoring.

A report should be completed by the engineer (or engineers) who completed the annual inspection. Annual inspection reports are to be submitted to NTPC's engineers and copies are to be filed in NTPC's database.

6.4.5 Dam Safety Review or Audit

Dam safety reviews should be completed every 7 years in accordance with CDA Guidelines (2013) by a registered professional engineer or multidisciplinary team of engineers. The engineer (or engineers) should be qualified by their background and experience in the design, performance evaluation, and operation of dams. The primary reviewer or head of the review team should not be a person who participated in the design or construction of the dam, or is normally involved in the routine inspection of the dam.

The dam safety review or audit is the systematic evaluation of the safety of the dam by means of:

- a comprehensive inspection of the structures;
- an assessment of the dam's performance;
- a review of design and construction records to ensure they meet current criteria and standards;
- a review of the OMS Manual and EPRP; and
- other activities as required by the specific Terms of Reference.

The review shall determine whether the dam, discharge facilities and reservoir slopes meet all currently applicable safety requirements. The review shall include the following:

- a review of dam classification;
- a site inspection;
- a review of design and construction records;
- a review of operations, including:
  - operating procedures;
  - testing of equipment required to operate discharge facilities; and
  - review of adequacy of ice and debris control procedures.
- a review of maintenance;

- a review of surveillance and monitoring methods for adequacy in detecting unsafe conditions in a timely manner, including:
  - monitoring program methods and frequency; and
  - frequency of data analysis.
- a review of emergency preparedness, including:
  - the EPRP for applicability;
  - warning systems; and
  - training.
- a review of compliance with previous reviews.

A dam safety report covering all aspects of the dam's safety is required, documenting the dam safety review. The report shall identify any additional steps that are required for the safe operation, maintenance and adequate surveillance of the dam. If the dam fails to meet the safety requirements, the report will include recommendations for safety improvements, as appropriate, including:

- safety improvements to the physical facilities;
- non-structural improvements; and
- overcoming any deficiencies in operation, inspection, maintenance, or surveillance of the dam, or emergency preparedness of its operators.

6.5 Reporting and Tracking

Reports should be issued to NTPC's EoR for Bluefish Dam for distribution to operations and engineering managers responsible for Bluefish Dam.

6.6 Inspection Forms

A copy of NTPC's inspection form is included in Appendix XI.

7 INSTRUMENTATION – DAM

7.1 General

Monitoring of performance is necessary to establish records of normal behavior. The establishment of records of normal readings by means of regular monitoring could help NTPC detect abnormal conditions through comparison to historical data. IFC drawings C209, C210, and C211 (in Appendix II) show the plan and section views of the design instrumentation locations. The performance monitoring instrumentation at the Bluefish Dam, which is shown on drawing C209 in Appendix II, was designed to include:

- standpipe piezometers to monitor groundwater levels downstream of the stainless-steel membrane, key trench, and grout curtain;
- ground-temperature cables to assess the depth of frost penetration downstream of the stainless-steel membrane;
- corrosion monitoring instruments to assess if corrosion of the stainless-steel membrane is occurring; and
- survey monitoring points to assess any settlements and lateral movement of the embankment throughout its operating life.

The standpipe piezometers, ground temperature cables, survey monitoring points and most of the corrosion-monitoring-instrument components were installed as part of the original dam construction in 2012. The performance monitoring instrumentation was intended to be read regularly with data processing and review conducted regularly so that NTPC could conduct systematic surveillance of the performance of Bluefish Dam. The surveillance and monitoring information gathered from these instruments facilitates measuring the performance of the dam and stainless-steel membrane and allows comparison against design parameters. Guideline values have been assigned for the primary design parameters and for the corrosion of the stainless-steel membrane, so comparisons can be made between the monitoring data and the design guideline values (i.e. caution values).

Standpipe piezometers, ground temperature cables, corrosion monitoring instruments, and survey monitoring points are located along the crest of the dam. Standpipe piezometers are also located on the access road on the lower downstream slope of the dam.

Although the site is remote, and access is restricted to authorized personnel, NTPC should lock the instrument headboxes to prevent potential damage caused by vandalism. The condition of the headboxes and instruments should be checked on a regular basis while reading instruments.

Instrumentation details are provided in the following sections. Summaries of instrument types and locations are shown in the corresponding tables in each section.

Caution values are presented for each instrument type based on design guidelines and technical performance requirements. If caution values are exceeded, instrument readings or survey measurements should be checked for accuracy by the personnel taking the readings. If errors are suspected or significant variations are observed, the instruments should then be re-checked or re-measured. If the readings are deemed to be accurate, additional checks should be conducted to determine if the instrument is damaged, which may affect the measurement. If unusual measurements are deemed accurate, the monitor's supervisor and NTPC's EoR should be advised to determine which additional precautionary measures should be implemented (i.e. additional monitoring requirements, change in operations, etc.). In cases where instruments are damaged or are not functioning properly, replacement may be required.

Standard operating procedures established for the instrument monitoring should be followed by all NTPC staff monitoring the instruments. The RST readout device operating procedures are included in Appendices XII (water-level meter manual) and XIII (ground temperature cable readout box manual). All instrumentation readings should be entered into a database for review by NTPC's EoR.

7.2 Standpipe Piezometers

7.2.1 Description and Location

Standpipe piezometers consist of a vertical pipe that usually includes an upper solid casing down to the depth of interest and a slotted or screened casing within the zone where the water pressure is being measured.

A total of ten pairs of nested piezometers were installed on the downstream crest and toe of the dam. The nested piezometers included one 50-mm diameter standpipe piezometer and one 25-mm diameter standpipe piezometer. The standpipes installed during construction are 50-mm diameter with 1500 mm long by 0.25 mm slotted (screened) sections. The standpipe piezometers are installed approximately 1 m into bedrock. The Casagrande standpipe piezometers extend 5 m below the bottom of the key trench, except SP01, which is located at Sta. 0+005 (as shown on IFC drawing C209 in Appendix II) near the crest of the bottom-outlet channel excavation. The SP01 Casagrande standpipe piezometer extends to a depth of 2 m below the elevation of the bottom-outlet channel. The standpipe piezometers installed have protective instrument covers that extend above the ground surface. Bentonite pellets were used to backfill between the piezometer tips. Quickset grout was used to backfill the top of the holes. Sand was used to backfill the 50-mm standpipe due to difficulties during construction.

Typical installation design details for the standpipe piezometers are shown in Figure 7.1. For convenience, a list of the active standpipe piezometers (based on IFC drawing C209) is included in Table 7.1. The location of the instruments, including standpipe piezometers is shown on the As-built drawing C209 included in Appendix V. During installation, SP-09A pulled up approximately 1.5 m (EBA 2013). The ground surface and piezometer tip elevations, are presented in Table 7.1.

Figure 7.1 Typical installation for the 25-mm-diameter and 50-mm-diameter standpipe piezometers

Table 7.1 Bluefish Dam piezometer locations, elevations, typical ranges, and caution values

Piezometer	Station	Offset (m)	Surface Elevation (m) [1]	Tip Elevation (m) [1]	Typical Water Level Elevation Range (m) [2]	Caution Value (m)
SP-01A	0+005	3.5	174.00	168.63	N/A [3]	160.76
SP-01B (deep)	0+005	3.5	174.00	157.47	N/A [3]	160.76
SP-02A [4]	0+030	3.5	171.22	164.67	164.67 to 165.36	167.77
SP-02B (deep)	0+030	3.5	171.22	158.38	162.52 to 164.21	165.21
SP-03A [4]	0+030	11.3	169.00	165.33	165.33 to 166.56	166.86
SP-03B (deep)	0+030	11.3	169.00	157.76	160.32 to 163.73	164.73
SP-04A	0+080	3.5	171.22	160.58	161.95 to 163.05	162.32
SP-04B (deep) [4]	0+080	3.5	171.22	153.28	153.28 to 163.51	164.51
SP-05A	0+080	21.4	163.50	157.28	158.92 to 159.03	159.59
SP-05B (deep) [4]	0+080	21.4	163.50	152.33	152.33 to 152.37	153.37
SP-06A	0+180	3.5	171.22	159.59	160.31 to 162.89	161.86
SP-06B (deep)	0+180	3.5	171.22	152.64	159.92 to 162.89	163.89
SP-07A	0+180	24.0	163.00	157.00	158.33 to 159.58	157.77
SP-07B (deep)	0+180	24.0	163.00	151.16	157.65 to 159.49	160.49
SP-08A	0+200	3.5	171.22	156.23	157.72 to 161.66	157.77
SP-08B (deep)	0+200	3.5	171.22	149.88	160.38 to 162.43	163.43
SP-09A [4, 5]	0+200	26.1	162.50	156.10	156.10 to 160.43	155.95
SP-09B (deep)	0+200	26.1	162.50	149.40	156.88 to 160.06	161.06
SP-10A	0+260	3.5	171.22	168.08	168.10 to 168.38	170.05
SP-10B (deep) [4]	0+260	3.5	171.22	161.59	161.59 to 166.15	167.15

[1] Ground surface and piezometer tip elevations provided by EBA.
[2] Typical range between March 8, 2013 and September 14, 2017.
[3] Only one reading has been taken since March 2013, so a typical range is not available.
[4] These piezometers had reported water elevation readings below the tip of the piezometer, which is not possible, so the lower limit in the range is taken as the piezometer tip.
[5] During installation, SP-09A pulled up approximately 1.5 m.

The typical range presented in Table 7.1 is based on readings taken between March 8, 2013 and September 14, 2017. There are some instances where the ground water elevation was reported to be lower than the piezometer tip elevation, which is not possible as standpipe piezometers cannot report water levels below its tip. Therefore, these elevations were removed from the “typical range” because they are believed to be errors.

The caution values were chosen based on the piezometer. For the shallow (50 mm diameter) standpipe piezometers, the caution value was 0.5 m above the top of the bedrock elevation taken from IFC drawing C211, which is included in Appendix II. The caution value for the deep (25 mm diameter) standpipe piezometers, the caution value was taken as a rise in piezometer levels to 1 m above the maximum historical water level for each piezometer to date.

7.2.2 Operating Procedure

Measurements of standpipe piezometers are conducted using a battery-operated water-level meter, similar to the one shown in Figure 7.2 below. The operating instructions for the water level meter are included in Appendix XII. The standard battery-operated water-level meter consists of a metal probe at the end of a permanently marked, flat polyethylene measuring tape. There are two stranded stainless-steel conductors within the polyethylene tape that terminate in the probe where an insulating gap is located around a central stainless-steel electrode.

Figure 7.2 A typical water-level meter, similar to the one used for measurements of standpipe piezometers at Bluefish Dam

The probe is lowered down the opening of the standpipe piezometer casing to the water level. When the probe contacts the water in the standpipe piezometer, the circuit is completed, sending a signal to the cable drum, causing a light and audible buzzer to be activated. The water level in the standpipe piezometer is then determined by recording a reading off the flat polyethylene measuring tape at the top of the standpipe (water level reading below top of PVC standpipe casing, not the steel protective headbox). The probe can be lifted and lowered several times to accurately check the depth at which the probe begins to sense the water surface. The standpipe piezometer stickup should be recorded by measuring from the ground surface to the top of the standpipe stickup. Both the water level below the top of PVC standpipe casing and the stickup should be recorded during each reading to ensure accurate ground water levels are measured, as it is possible for the stickup to change because of fill or ground settlement or damage to the standpipe. The depth of the water level is determined by subtracting the stickup from the water level reading, which gives the depth of water below the fill or ground surface. The elevation of the ground water is determined by subtracting the depth of water below the ground surface from the ground or fill surface elevation. It is important to reference the depth of the ground water to a common point, such as the ground surface.

Two sources of error when reading standpipe piezometers can be caused by water with very high conductivities and wells with a lot of moisture on the sides of the casing, which could give false signals. Care needs to be taken to ensure a steady and solid signal. The probe also needs to be kept very clean. The water level readout instrument should be maintained according to the manufacturer's specifications. Calibration is not required for the water level recorder.

Water in the 50-mm-diameter standpipes should be sampled for testing. The water samples should be tested for pH and chlorides. The type of water testing may be revised when the corrosion-monitoring instruments are commissioned, as discussed in Section 7.4.

Two companies located in Yellowknife that offer water testing are

- ALS Environmental (1-867-873-5593; https://www.alsglobal.com/ca/locations/americas/north-america/canada/northwest-territories/yellowknife-environmental); and
- Taiga Environmental Laboratory (1-867-767-9235 ext. 53151; http://www.enr.gov.nt.ca/en/services/taiga-environmental-laboratory).

7.2.3 Maintenance

The PVC standpipe stickup above the ground should be kept within a protective casing. Dependent on the nature of the standpipe installation and the materials in which the standpipe is installed, sediment may accumulate in the bottom of the standpipe due to groundwater inflow. The depth to bottom of standpipe should be measured during the original installation and can be checked periodically by sounding to the bottom of pipe.

7.2.4 Reading Frequency

Standpipe piezometers should be read monthly as recommended by KCB's 2013 inspection report. Following the occurrence of significant events, such as a significant storm or rainfall, where flooding or slope movements have occurred, additional readings may be required.

7.2.5 Data Presentation

Water levels in the standpipe piezometers are measured as a depth below the ground surface. The piezometric elevations of each instrument should be presented graphically. The graph should have the piezometric water elevation on the y-axis and the date on the x-axis, so changes in the water elevation can be observed over time, and to show variations or trends. For comparison, the corresponding reservoir elevation should also be plotted and presented on each piezometer plot.

7.2.6 Caution Values

Caution values for standpipe piezometers are selected based on historical performance as well as consideration of downstream slope stability. Tail water flooding should be noted as it could result in variations in readings. A summary of the standpipe piezometer data and recommended caution values is summarized on Table 7.1. Caution values should be reviewed periodically and updated if necessary.

The caution values for the deeper 25-mm diameter standpipe piezometers is related to water level increasing in the foundation due to increased seepage. The caution value is a rise in piezometer levels to 1 m above the maximum historical water level for each piezometer to date.

The caution values for the shallower 50-mm diameter standpipe piezometers is related to water level increasing in the rockfill due to increased seepage. The caution value is a rise in piezometer levels to 1.0 m above the maximum historical water level. The caution levels should initiate NTPC assessing the reason for the change in water level and initiate inspections of the downstream toe of the dam on a weekly basis for seepage. NTPC may involve third-party consultants to assist them in their assessments.

The caution value for SP-01A was chosen based on the bottom-outlet spillway elevation because SP-01A is located between the dam and the bottom-outlet spillway. The caution value for SP-01 is an elevation of 160.76, which is 1.0 m above the bottom-outlet spillway elevation.

7.3 Ground Temperature Cables

7.3.1 Description and Location

Ground temperature cables consist of a cable with digital thermal data acquisition nodes (nodes) spaced along the cable, typically at uniform spacing. The ground temperature cables have protective instrument covers that extend above the ground surface. The end of each ground temperature cable is an amphenol connector, which has several pairs of wires soldered to it to permit one connection to read multiple thermistors beads on the ground temperature cable. The ground temperature cables allow monitoring of the ground temperature at several depths within the dam fill and underlying bedrock, which permits assessment of the depth of seasonal frost penetration.

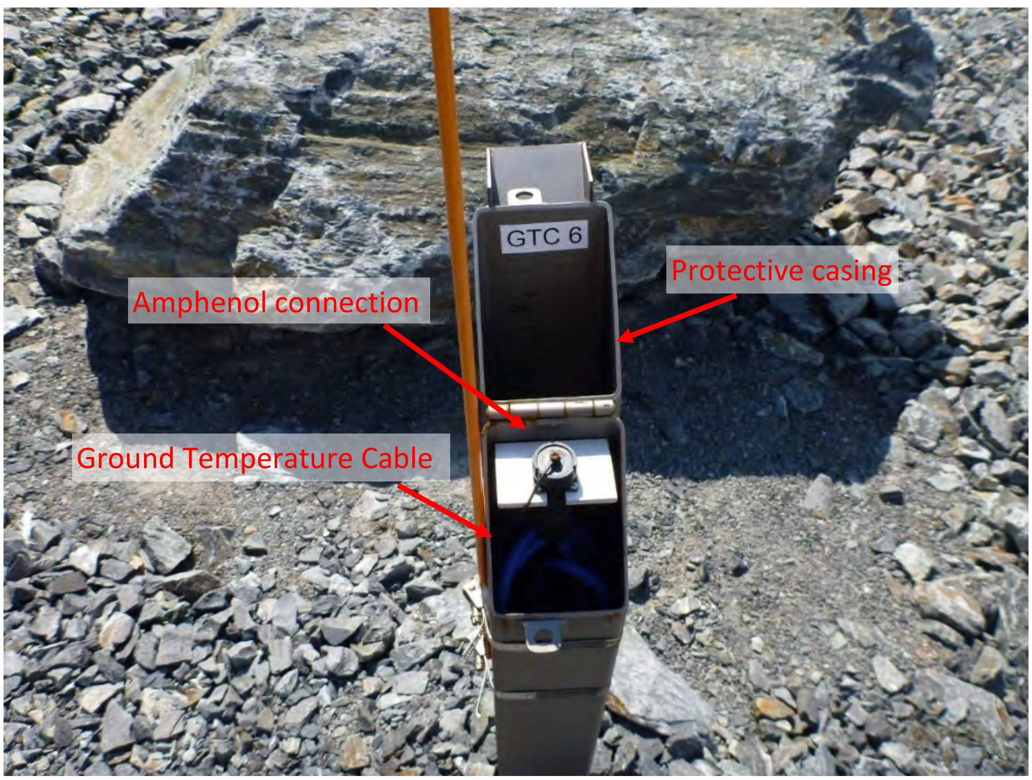
Six ground temperature cables were installed during construction. Table 7.2 shows the ground temperature cable locations, number of nodes, node spacing, and the top and bottom node elevations. The ground temperature cable wire sheets showing the which wires correspond to each node, and the calibration sheets are included in Appendix XIII.

Table 7.2 Bluefish Dam ground temperature cables locations, number of nodes, node spacing, top and bottom node elevations

Ground Temperature Cable	Serial Number	Station	Offset (m)	Number of Nodes	Node Spacing (m)	Elevation of Top Node (m)	Elevation of Bottom Node (m)
GTC-1	3420	0+005	2.0	7	1.0	165.29	159.29
GTC-2	3419	0+029	2.0	14	1.0	167.95	154.95
GTC-3	3418	0+079	2.0	14	1.0	166.25	153.25
GTC-4	3417	0+140	2.0	15	1.0	168.09	154.09
GTC-5	3416	0+229	2.0	10	1.0	163.45	154.45
GTC-6	3415	0+259	2.0	10	1.0	170.63	161.63

The location of the instruments, including ground temperature cables is shown on as-built construction drawings C209 included in Appendix V. Typical installation details for the ground temperature cables are shown in Figure 7.3.

Figure 7.3 Typical installation for ground temperature cables



7.3.2 Operating Procedure

Measurements of ground temperature cables are conducted using a battery-operated thermistor string readout box (RST TH2016B), as shown in Figure 7.4. The RST readout instruction manual is included in Appendix XIV. The thermistor string readout box connects to the ground temperature cable via a port on the readout box. The ground temperature at each node is saved in the readout box. The data can be transferred to a computer via USB connection in a compatible file format for Microsoft Excel and other spreadsheets.

Figure 7.4 Readout box used for reading ground temperature cables at Bluefish Dam

It is important to download the ground temperature data to a computer after the readings are completed. This will reduce the risk of losing data because the readout box has limited memory. Calibration of the readout box is required and can be completed by the manufacturer, RST Instruments Ltd. in Coquitlam, BC.

7.3.3 Maintenance

Maintenance is not required for the ground temperature cables. The cable that is above the ground surface should be kept within the protective headbox casing.

The amphenol connector is a slip connection that allows the connector to be paired with the read-out box. The cable should not be rotated when connecting the cable to the read-out box. Rotation of the cable will shear the soldered cable connections and will require re-soldering in the field according to the manufacturer's guidelines. The top of the ground temperature cable should be covered with its protective cap after readings are complete to ensure the cable can be connected to the readout box without issue the next time readings are scheduled. The read-out box should be calibrated and maintained as per the manufacturer's specifications.

7.3.4 Reading Frequency

Ground temperature cables should be read monthly, as recommended by KCB's 2013 inspection report. Caution values for the ground temperature cables are based on the depth of freezing observed. If freezing temperatures are recorded near the key trench concrete, the frequency of readings should be increased based on the depth of freezing as stated in Section 7.3.6.

7.3.5 Data Presentation

The ground temperate profile should be plotted based on the depth below the ground surface. The ground temperature recorded at each node should be presented graphically. The graph should have the depth below the ground surface of each node on the y-axis and the temperature on the x-axis, so variation in the ground temperature with depth can be observed. For comparison, the daily air temperature data, based on a thermometer at site, should be plotted and presented on a separate plot.

7.3.6 Caution Values

Caution values for ground temperature cables are selected based on depth of freezing as well as consideration of stability. The ground temperature cables extend below the bottom of the key trench concrete. NTPC should start reading the ground temperature cables every two weeks when a ground temperature of 0°C reaches the elevation of the top of the concrete key trench in any of the ground-temperature cables. If freezing temperatures are recorded below the bottom of the concrete, frost jacking of the key trench concrete could be of concern. NTPC should read ground temperature cables weekly and start weekly inspections of the toe of the dam to monitor for seepage if a ground temperature of 0°C reaches the elevation of the bottom of the concrete key trench in any of the ground-temperature cables.

7.4 Corrosion Monitoring Instruments

7.4.1 Description and Location

Corrosion monitoring instruments were installed in Bluefish Dam to monitor for potential corrosion of the stainless-steel membrane. NTPC was required to install these instruments in response to regulatory review recommendations made during the permitting phase of the project. The corrosion monitoring instruments were fabricated using extra pieces of stainless-steel membrane (coupons). Two types of corrosion monitoring instruments were used – non-retrievable corrosion monitoring points and retrievable corrosion monitoring points.

The following corrosion monitoring instruments and components were installed in 2012 during construction:

- three non-retrievable corrosion monitoring points were installed upstream of the stainless-steel membrane; and
- three retrievable corrosion monitoring points were installed inside 75 mm diameter PVC pipe downstream of the stainless-steel membrane with buried pull pits (although the pull pits were noted by EBA to have seized bolts holding the lid onto the pull pit).

Three retrievable corrosion monitoring points on the upstream side of the stainless-steel membrane were not installed as the leads were not available during construction. Only the 75 mm diameter PVC casings were installed.

During a site visit on June 27, 2017, KCB found four corrosion monitoring coupons in a cardboard box in the old construction camp building. Figure 7.5 shows the corrosion monitoring coupons found by KCB and NTPC staff.

Figure 7.5 Corrosion monitoring coupons

As per KCB's letter to NTPC dated September 7, 2017, the installation of the corrosion monitoring instruments is incomplete. The reference electrode that is required to read the corrosion monitoring instruments was not installed in 2012 at the end of the construction period. Without the reference electrode installed, NTPC can not read the corrosion monitoring instruments.

Figure 7.6 shows the IonX reference electrode that was supposed to be buried below the frost line on the upstream side of the dam.

Figure 7.6 IonX40 reference electrode that was supposed to be buried below the frost line on the upstream side of the dam

7.4.2 Operating Procedure

The retrievable corrosion-monitoring coupons installed in pull pits downstream of the stainless-steel membrane should be inspected once a year to assess if the stainless-steel coupon is experiencing corrosion. The thickness of each coupon should be read with calipers in eight locations around the perimeter of the coupon and at the center of the coupon to assess if the thickness of the coupons are changing with time.

7.4.3 Maintenance

The seized bolts that are holding the lids on the pull pits should be loosened, removed, and replaced to allow for consistent monitoring of the corrosion coupons.

7.4.4 Reading Frequency

The initial plan was to monitor the corrosion coupons daily when first installed (prior to saturation) to establish a baseline. After the first filling against the dam, monitoring was to be done on a weekly basis for one month, and then monthly for the first year. However, this has not occurred because the corrosion monitoring instrumentation was not completed in 2012.

The corrosion monitoring instruments should be read twice per year as a minimum, or whatever frequency is recommended when the corrosion-monitoring instruments are commissioned.

7.4.5 Data Presentation

Initial readings were not recorded for the corrosion monitoring installations. Therefore, the first readings completed should be taken as a baseline.

7.4.6 Caution Values

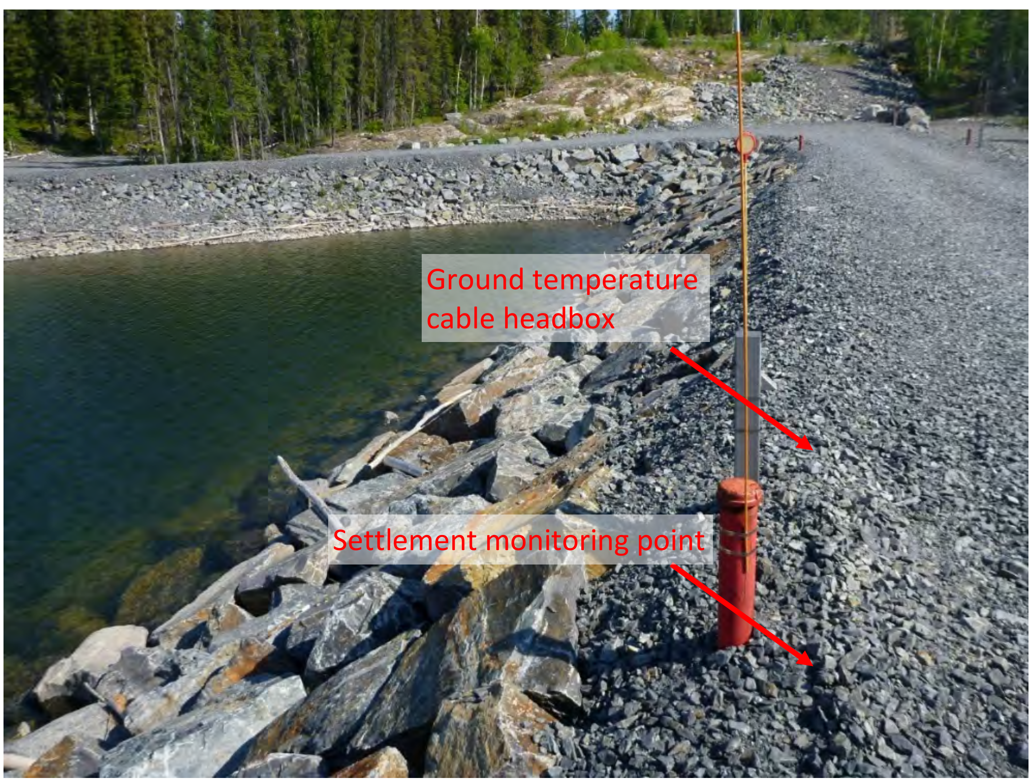
Currently, there are no established caution values for the corrosion monitoring instruments. The procedure for interpreting corrosion monitoring instrumentation readings will be prepared when the corrosion-monitoring instruments are commissioned.

7.5 Survey Monitoring Points

7.5.1 Description and Location

Monitoring of vertical movements is conducted at the Bluefish Dam site using survey monitoring points. A total of 18 survey monitoring points were installed on the downstream crest of the dam. All survey monitoring points were comprised of 1.5 m long, 30M rebar welded to a 500-mm-square steel plate. The survey monitoring points were installed on a 300-mm thick layer of Zone C material, and compaction of 95% was achieved using standard effort. A red protective casing pipe with a whip marker was placed over the rebar and backfilled using Zone C fill material. The protective casing and whip marker are to avoid damage during winter snow periods. A typical survey-monitoring point is shown in Figure 7.7.

Figure 7.7 Settlement monitoring point and a ground temperature cable headbox behind it



The survey monitoring points were surveyed after installation, and the northings, eastings, and elevations are used as the baseline which all subsequent surveys will be compared against. The survey monitoring points should be referenced to NAD 83 UTM Zone 11 geodetic elevation.

The survey monitoring points are listed in Table 7.3. The survey monitoring points are shown on the instrumentation plan on As-built drawing C209, included in Appendix V.

Table 7.3 Settlement monitoring points

Settlement Monitoring Point	Station	Offset (m)	Northing	Easting
M2-D	0+030	2.74	6952659.4	639792.4
M2-U	0+030	-2.74	6952655.7	639788.9
M3-D	0+060	2.74	6952639.1	639814.4
M3-U	0+060	-2.74	6952635.3	639810.9
M4-D	0+080	2.74	6952625.5	639829.1
M4-U	0+080	-2.74	6952621.7	639825.6
M5-D	0+100	2.74	6952611.9	639843.8
M5-U	0+100	-2.74	6952608.1	639840.3
M6-D	0+120	2.74	6952598.4	639858.5
M6-U	0+120	-2.74	6952594.6	639855.0
M7-D	0+150	2.74	6952578.0	639880.5
M7-U	0+150	-2.74	6952574.2	639877.0
M8-D	0+180	2.74	6952557.6	639902.5
M8-U	0+180	-2.74	6952553.8	639899.0
M9-D	0+200	2.74	6952544.0	639917.2
M9-U	0+200	-2.74	6952540.3	639913.7
M10-D	0+230	2.74	6952523.7	639939.2
M10-U	0+230	-2.74	6952519.9	639935.7

Note: survey monitoring points should be referenced to Miramar Datum at Bluefish Lake Dam as per the water licence from MVLWB included in Appendix IV.

7.5.2 Operating Procedure

NTPC does not have a procedure for surveying the settlement-monitoring points by a contract surveying company. Surveys of the settlement monitoring points are to be conducted at the designated frequency as outlined in Section 7.5.4. A baseline survey was completed after the installation of the settlement monitoring points, which all future surveys will be compared against.

The benchmark and data need to be kept constant. Survey monitoring points should be referenced to NAD 83 UTM Zone 11 and geodetic elevation. As stated in Section 3.3.3, all design coordinates used are referenced to NAD 83 UTM Zone 11 and geodetic elevation (EBA 2011). However, EBA (2011) also references the “old datum”, which is shifted from the geodetic datum by adding 17.15 m.

7.5.3 Maintenance

No specific maintenance is required other than ensuring the settlement monitoring points are accessible and clearly marked by a protective casing and whip marker so they will not be damaged by vehicle traffic, operations, or other maintenance activities on the access roads. Erosion, slope movements or other deterioration may occur near the slope monitoring points which will require periodic maintenance if survey measurement is affected.

7.5.4 Reading Frequency

Survey measurements should be conducted annually, until the next dam safety review, unless special events justify additional surveys. Following the next dam safety review, the monitoring points should be surveyed as part of each dam safety review.

7.5.5 Data Presentation

Elevations for each of the settlement monitoring points are to be compared to the baseline readings to determine incremental movements. KCB will begin a comparison of the survey data to the baseline readings after receiving the information. The readings should be presented on graphical plots showing the movement on the y-axis and the date on the x-axis, so movements can be observed over time, and to show variations or trends.

7.5.6 Caution Values

Vertical movements are expected to occur gradually with time and small settlements of the dam embankment may be observed. Incremental settlements exceeding 25 mm in one year should be reported to NTPC’s EoR for further assessment. Small heaving caused by frost action is not expected. Heaving may be indicated due to measurements being within the tolerance of survey error. In cases where heave exceeds 10 mm, NTPC should re-check the survey measurement for accuracy and notify NTPC’s EoR. Areas with suspected excessive movements should be inspected for other performance indicators such as cracking, settlement, damage to monitoring points, etc.

8 SUPPLEMENTARY DOCUMENTS

The following supplementary documents are included in appendices:

- existing Bluefish Dam decommissioning plan figure (Appendix III); and
- as-built construction drawings and figures (Appendix V).

9 REFERENCE DRAWINGS

The following reference drawings are included in appendices:

- design/IFC drawings (Appendix II);
- original Bluefish Dam decommissioning figure (Appendix III); and
- as-built construction drawings and figures (Appendix V).

REFERENCES

Alberta Chamber of Resources, Dam Integrity Advisory Committee, Engineer of Record Subcommittee 2017. Roles and Accountabilities for Dam Safety Management in Alberta.

Canadian Dam Association, 2007, revised 2013. Dam Safety Guidelines 2007 (revised 2013).

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Stantec Consulting Ltd., 2017. Bluefish Hydro Comprehensive Dam Safety Review.

APPENDIX I

NTCP Organizational Chart

Hydro Operations

41.5 perm positions
4.75 term* positions

NORTHWEST TERRITORIES POWER CORPORATION
Empowering Communities

Jay Pickett
Director, Hydro Operations
PC4102

Reporting to Director:

- **Nihal Costa** – Hydro Electrical Field EIT – PC4115
- **Lina Tao** – Hydro Mechanical Technologist* – PC4043
- **Gamini Hettiarachchige** – Civil Engineer (Hydro) – PC4050
- **Drew Farmer** – Manager, Finance, Generation – PC4107
- **Lal Jayatilleka** – Specialist Hydro Mechanical Field Engineer – PC4038

Ken Bell – Manager, Operations & Maintenance SS – PC4137

- **Shirley King** – Plant Supt (P/T) FortResolution – PC4132
- **John Cazon** – Hydro Plant Operator – PC4142
- **Clément Longpré** – Lead Hand Electrician/Operator – PC4144
- **John Davenport** – Hydro Plant Operator – PC4147
- **Vacant** – Electrician/Operator – PC4148
- **Neil Andersen*** – Apprentice Electrician – PC4196

Sergio Catlyn – Manager, Mechanical Services – PC4145

- **Martin Steedley** – Diesel Mechanic – PC4113
- **Stuart Robinson** – Maintenance Planner & Special Projects – PC4129
- **Craig Janz** – Diesel Mechanic – PC4133
- **Roger Cater** – Millwright – PC4134
- **JP Landry** – Diesel Mechanic – PC4163
- **Mike Mahussier** – Diesel Mechanic* – PC4183

Rob Sunderland – Manager, Plant Operations – PC4104

- **Norm McBride** – Plant Prcedures & Trning Offcr – PC4118
- **Blake Noksana** – Hydro Plant Operator – PC4180
- **Wayne Mercredi** – Hydro Plant Operator – PC4125
- **Vacant** – Hydro Plant Operator – PC4187
- **Gerry Jonasson** – Plant Supt Lutsel K'e – PC4136
- **Charlie Simpson** – Plant Supt Wha Ti – PC4188
- **Garry Wedawin** – Plant Supt (P/T) Behchoko* – PC4146
- **Joanna Chocolate** – Plant Supt. (P/T) Gameti – PC4191
- **François D'Avignon** – Hydro Plant Operator – PC4178
- **Ryan Sutherland** – Hydro Plant Operator – PC4195
- **Robbie MacIntosh** – Hydro Plant Operator – PC4179
- **Clayton Welna** – Hydro Plant Operator* – PC4948

Colin Steed – Manager, System Control – PC4108

- **Richard Taggart** – System Operator II – PC4123
- **Kevin Dunn** – System Operator II – PC4124
- **Douglas Sanders** – System Operator – PC4128
- **Steve James** – System Operator II – PC4130
- **Joe St.Croix** – System Operator – PC4330
- **Anthony Watler** – System Operator – PC4121

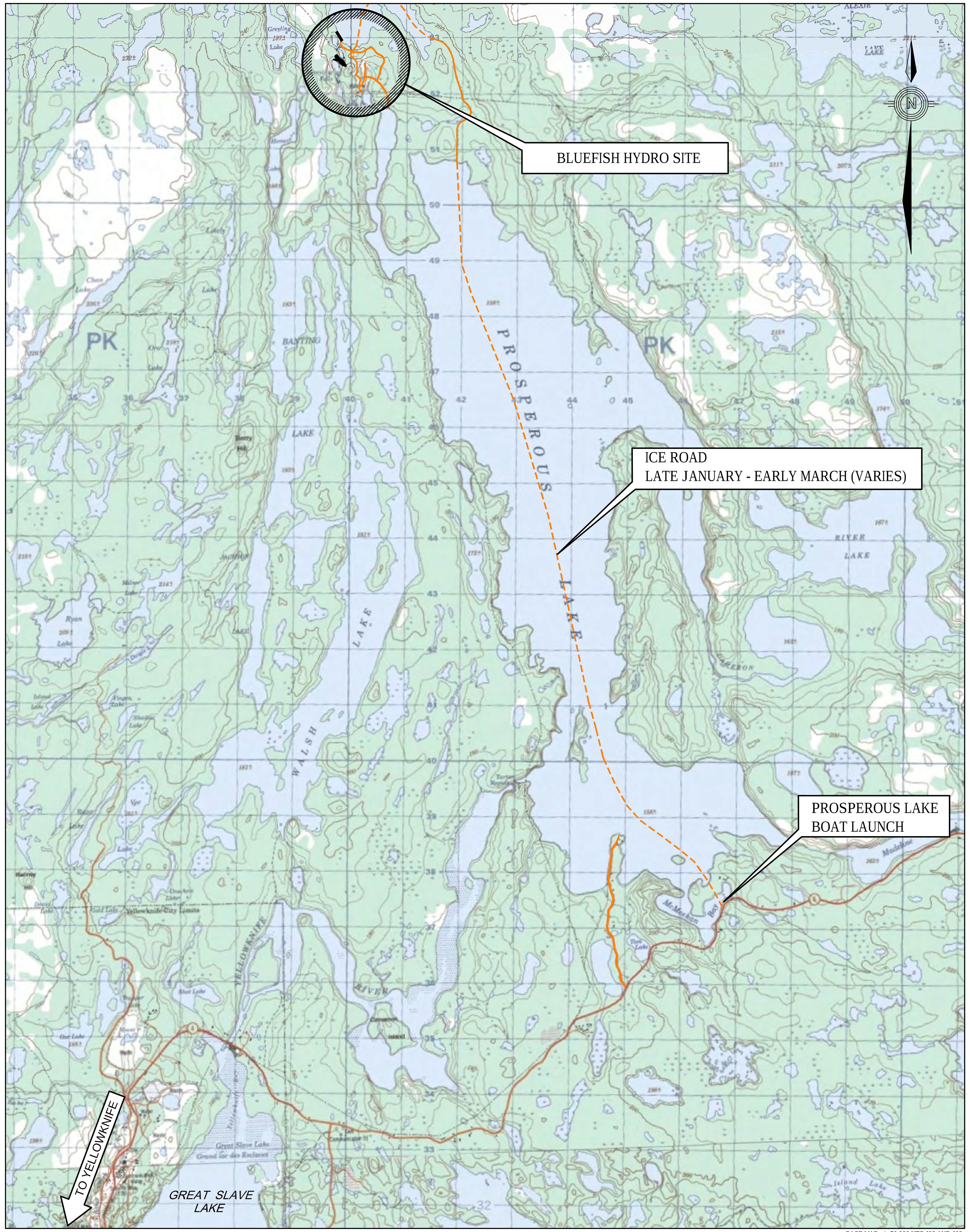
Robert Burgin – Manager, Electrical Services – PC4952

- **Kells Bissell/Mark Plotner** – Stockkeeper – PC4103
- **Morris Callahan** – Diesel Maint. Planner – PC4112
- **Mervin Penney** – Electrical Technologist – PC4116
- **Dennis Bourke** – Electrician – PC4120
- **Vacant** – Apprentice Power Systems Electrician – PC4184
- **Bob Norton** – Electrician – PC4316

June 2017

APPENDIX II

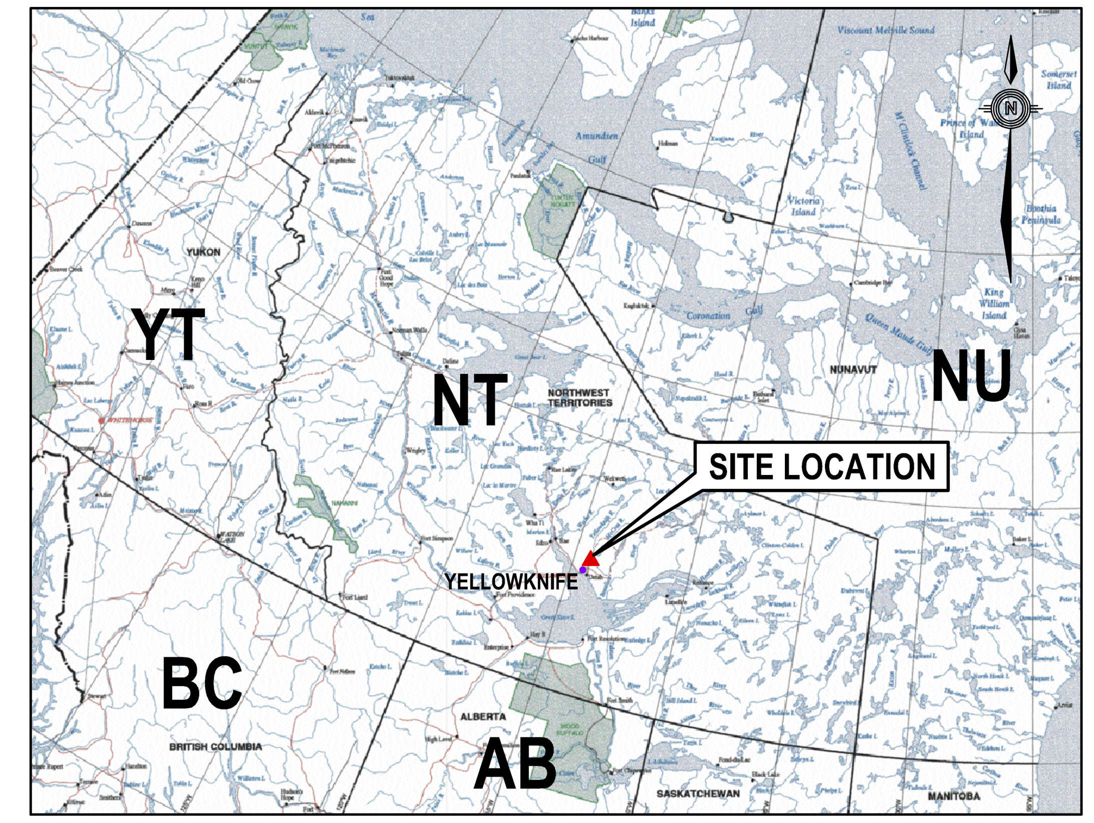
Selected IFC Drawings



BASE MAP: 1: 50 000 NTS J08 AND J09

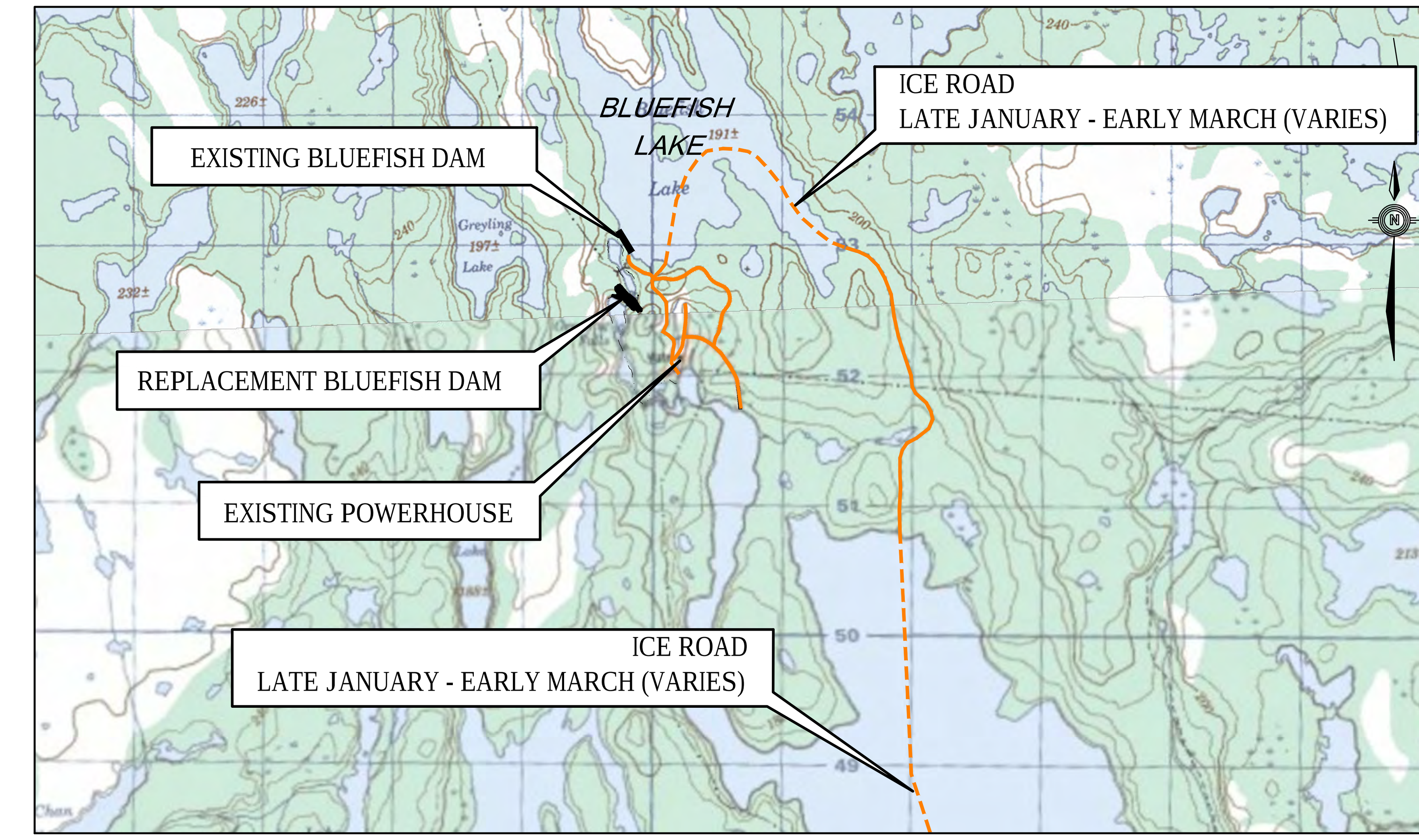
0 2 500
Scale: 1: 50 000 (metres)

SITE LOCATION MAP - ROUTE



GENERAL LOCATION MAP

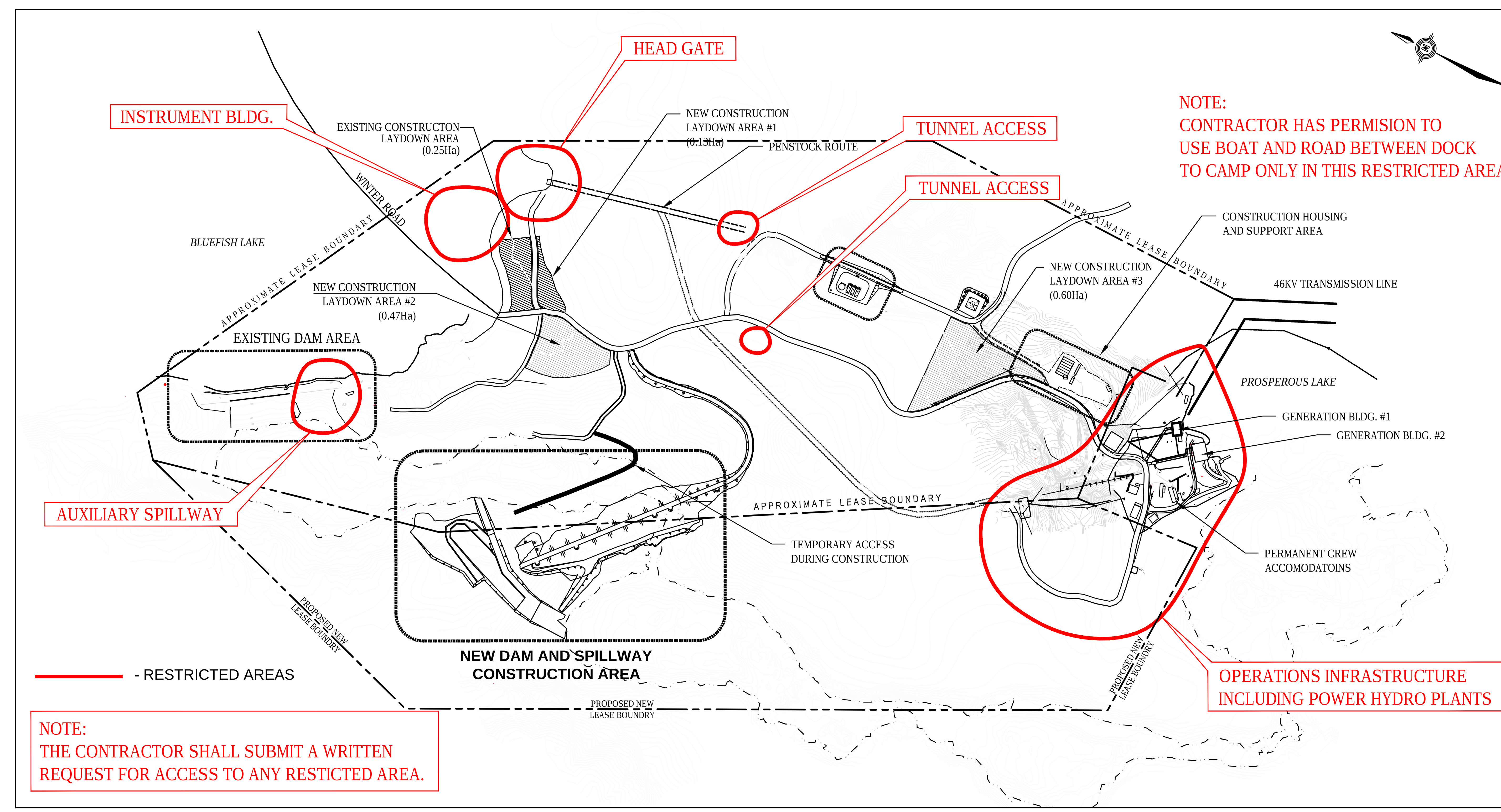
SCALE: NTS



0 2 000
Scale: 1: 40 000 (metres)

SITE LOCATION MAP

BASE MAP: 1: 50 000 NTS J08 AND J09



0 200
Scale: 1: 4 000 (metres)

GENERAL SITE ARRANGEMENT

ISSUED FOR CONSTRUCTION

LEGEND:

- - - - - ICE ROAD ACCESS ROUTE
——— - OVERLAND ACCESS ROUTE

NUM	DATE	DWN	CKD	APR	DESCRIPTION
2	FEB 17/12	DRG	CKG	CKG	Spillway Footprint Update
1	MAY 26/11	DRG	CKG	CKG	New Dam and Access Road Footprints

REVISIONS

NUM	DATE	APR	DESCRIPTION
12	FEB 17/12	CKG	RE-ISSUED FOR CONSTRUCTION
11	MAY 26/11	CKG	RE-ISSUED FOR CONSTRUCTION
10	OCT 29/10	CKG	ISSUED FOR CONSTRUCTION
F	MAR 11/10	CKG	RE-ISSUED FOR TENDER
E	FEB 9/10	CKG	ISSUED FOR DISCUSSION
D	NOV 16/09	CKG	ISSUED FOR TENDER
C	OCT 21/09	EH	ISSUED FOR REVIEW
B	OCT 13/09	EH	ISSUED FOR REVIEW
A	SEPT 23/09	EH	ISSUED FOR REVIEW

DRAWING STATUS

PERMIT TO PRACTICE
EBA ENGINEERING CONSULTANTS LTD.
Signature
Date Feb. 17, 2012
PERMIT NUMBER: P 018
NWT/NU Association of Professional Engineers and Geoscientists

PERMIT

REGISTERED PROFESSIONAL ENGINEER
C.K. GRAPEL
LICENSEE
NWT/NU
February 17, 2012

PROFESSIONAL SEAL

CLIENT

NORTHWEST TERRITORIES POWER CORPORATION

EBA Engineering Consultants Ltd.

REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

(GENERAL SITE)
SITE LOCATION AND IDENTIFICATION
OF MAJOR SITE FEATURES

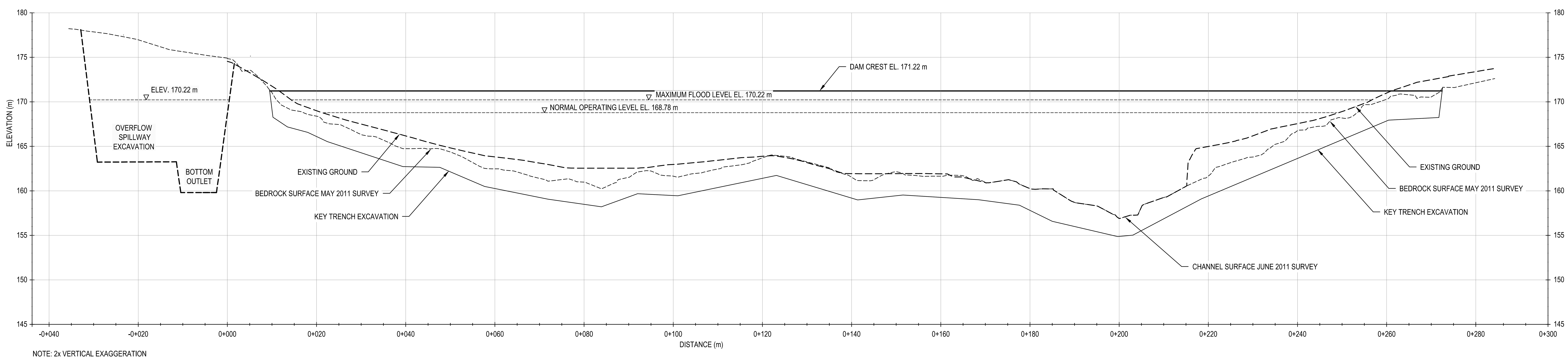
PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.004	EDM	CKG	KWJ	2	C101
DATE: February 2012	SHEET No. 1 of 6	DWN DRG	APP CKG	STATUS 12	

DAM ALIGNMENT CENTERLINE LAYOUT

STATION	NORTHING	EASTING
0+000	6952677.9	639768.7
0+020	6952664.5	639783.2
0+040	6952650.3	639798.5
0+060	6952637.1	639812.8
0+080	6952623.7	639827.3
0+100	6952610.0	639842.1
0+120	6952596.6	639856.6
0+140	6952583.2	639871.1
0+160	6952569.2	639886.3
0+180	6952555.6	639900.9
0+200	6952542.4	639915.3
0+220	6952528.5	639930.3
0+240	6952515.0	639944.8
0+260	6952501.1	639960.0
0+274	6952492.0	639969.7

PLAN - DAM

SCALE: 1:500



NOTE: 2x VERTICAL EXAGGERATION

PROFILE - DAM

SCALE: 1:500

ISSUED FOR CONSTRUCTION

NOTES:

1. DATUM: UTM ZONE 11 NAD 83, METRE; CENTRAL MERIDIAN 117d W
   ELEVATIONS ARE GEODETIC. CONVERSION TO PREVIOUS DATUM: GEODETIC + 17.15 m

2. SURVEY DATA PROVIDED BY SUB-ARCTIC SURVEYS LTD.
   BASE SURVEY PLAN PROVIDED JULY 30, 2008 AND FEBRUARY 2009; FILE NO.: 08-092-NT.
   ADDITIONAL BATHYMETRY AND TOPOGRAPHY SURVEY PROVIDED OCT. 19, 2009;
   FILE NO.: 09-012-04-NT-COMPILED. DETAILED SURVEY WITHIN DAM FOOTPRINT AND
   COFFERDAM LOCATION PROVIDED OCT. 30, 2009; FILE NO.: 09-012-04-DAMSITE.
   ADDITIONAL RIVER BOTTOM SURVEY JUNE 4, 2010, FILE NO.:09-012-06-compiled-NORTH.
   ADDITIONAL RIVER CHANNEL SURVEY JUNE 20, 2011, FILE NO.:Z-SECTIONS CLOUDED AREA.

3. 1.0 m CONTOUR INTERVAL

REVISIONS

NUM	DATE	DWN	CKD	APR	DESCRIPTION
2	FEB 17/12	DRG	CKG	CKG	Spillway footprint update, Hold removed and Key trench revised in channel area
1	MAY 26/11	DRG	CKG	CKG	Dam Alignment Rotated, Access Road changed

DRAWING STATUS

NUM	DATE	APR	DESCRIPTION
12	FEB 17/12	CKG	RE-ISSUED FOR CONSTRUCTION
11	MAY 26/11	CKG	RE-ISSUED FOR CONSTRUCTION
10	OCT 29/10	CKG	ISSUED FOR CONSTRUCTION
F	MAR 11/10	CKG	RE-ISSUED FOR TENDER
E	FEB 9/10	CKG	ISSUED FOR DISCUSSION
D	NOV 16/09	CKG	ISSUED FOR TENDER
C	OCT 21/09	EH	ISSUED FOR REVIEW
B	OCT 13/09	EH	ISSUED FOR REVIEW
A	SEPT 23/09	EH	ISSUED FOR REVIEW

PERMIT

PERMIT TO PRACTICE
EBA ENGINEERING CONSULTANTS LTD.
Signature
Date Feb. 17, 2012
PERMIT NUMBER: P 018
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PROFESSIONAL SEAL

REGISTERED PROFESSIONAL ENGINEER
C.K. GRAPEL
LICENSEE
NWT/NU
February 17, 2012

CLIENT

NORTHWEST TERRITORIES POWER CORPORATION

EBA Engineering Consultants Ltd.

REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

DAM - PLAN AND PROFILES

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.004	EDM	CKG	KWJ	2	C201
DATE: February 2012	SHEET No. 1 of 13	DWN DRG	APP CKG	STATUS 12	

FILL MATERIALS

- (A) ROCK FILL 1.0 m MINUS
- (A1) RIP-RAP 0.5 TO 1.0 m
- (B) TRANSITION 200 mm MINUS
- (C) BEDDING 20 mm MINUS
- (D) CONCRETE, KEY TRENCH BACKFILL

TYPICAL SECTION

SCALE: 1:100

ISSUED FOR CONSTRUCTION

NOTE:
TOP OF BEDROCK NOT SHOWN.

BASED ON EXISTING BOREHOLE DATA, DEPTH OF OVERBURDEN UNKNOWN BEYOND VICINITYOF DAM CENTERLINE.

ACTUAL OVERBURDEN QUANTITY TO BE DETERMINED AND COMPENSATED FOR THROUGH SURVEY DURING CONSTRUCTION.

Scale: 1: 100 (metres) 0 5

REVISIONS

NUM	DATE	DWN	CKD	APR	DESCRIPTION
1	MAY 26/11	DRG	CKG	CKG	Addition of Normal Operating Level, Grout hole length (varies)

DRAWING STATUS

NUM	DATE	APR	DESCRIPTION
11	MAY 26/11	CKG	RE-ISSUED FOR CONSTRUCTION
10	OCT 29/10	CKG	ISSUED FOR CONSTRUCTION
F	MAR 11/10	CKG	RE-ISSUED FOR TENDER
E	FEB 9/10	CKG	ISSUED FOR DISCUSSION
D	NOV 16/09	CKG	ISSUED FOR TENDER
C	OCT 21/09	EH	ISSUED FOR REVIEW
B	OCT 13/09	EH	ISSUED FOR REVIEW
A	SEPT 23/09	EH	ISSUED FOR REVIEW

PERMIT TO PRACTICE
EBA ENGINEERING CONSULTANTS LTD.
Signature
Date MAY 26, 2011
PERMIT NUMBER: P 018
NWT/NU Association of Professional Engineers and Geoscientists

PERMIT

C.K. GRAPEL LICENSEE
NWT/NU
May 26, 2011

PROFESSIONAL SEAL

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NORTHWEST TERRITORIES POWER CORPORATION

EBA Engineering Consultants Ltd.

REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

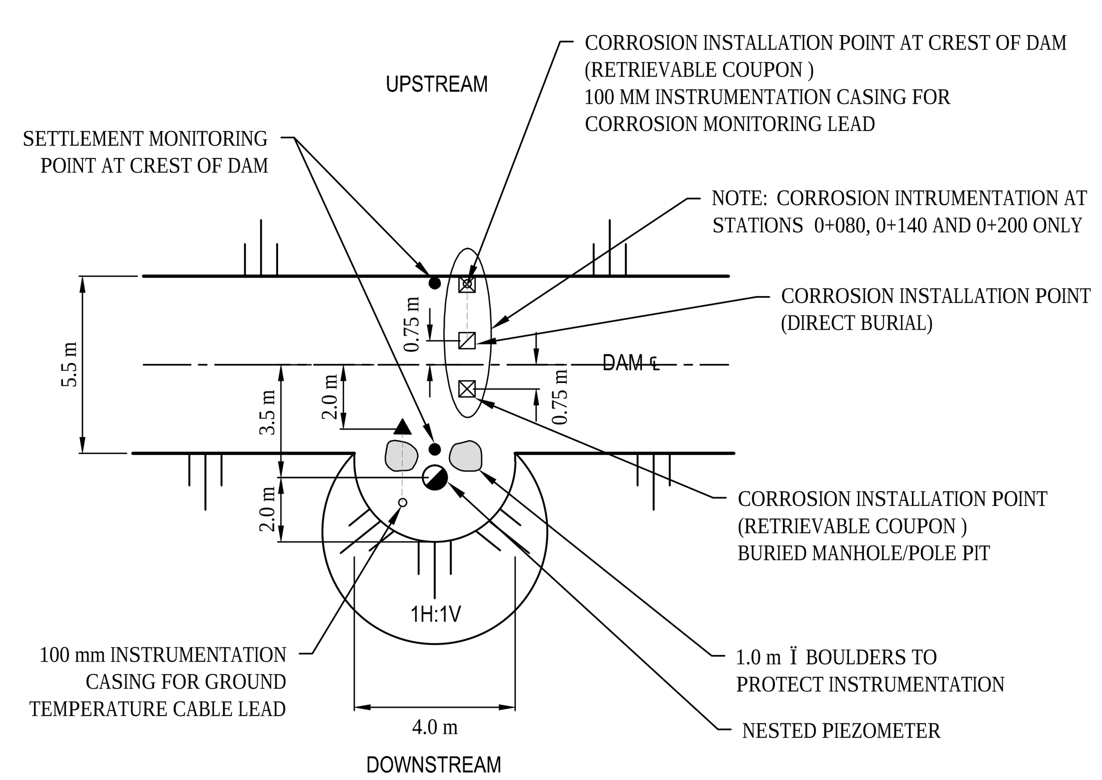
DAM - TYPICAL SECTION

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.004	EDM	CKG	KWJ	1	C202
DATE: April 2011	SHEET No. 2 of 11	DWN DRG	APP CKG	STATUS 11	

INSTRUMENTATION PLAN

SCALE: 1:400

Scale: 1: 400 (metres)



TYPICAL DETAIL - INSTRUMENTATION PAD

SCALE: 1:200

PIEZOMETER LAYOUT

PIEZOMETER	STATION	OFFSET	SURFACE ELEV.	TIP ELEV.	NORTHING	EASTING
SP-01A*	0+005	3.5 m	174.0	166.5	6952672.0	639769.9
SP-01B*	0+005	3.5 m	174.0	154.5	6952672.0	639769.9
SP-02A	0+030	3.5 m	171.2	165.5	6952655.0	639788.3
SP-02B	0+030	3.5 m	171.2	159	6952655.0	639788.3
SP-03A	0+030	11.3 m	169.0	165.5	6952649.3	639783.0
SP-03B	0+030	11.3 m	169.0	158	6952649.3	639783.0
SP-04A	0+080	3.5 m	171.2	160.5	6952621.1	639825.0
SP-04B	0+080	3.5 m	171.2	153.5	6952621.1	639825.0
SP-05A	0+080	21.4 m	163.5	158.5	6952607.9	639812.9
SP-05B	0+080	21.4 m	163.5	152.5	6952607.9	639812.9
SP-06A	0+180	3.5 m	171.2	160	6952553.2	639898.4
SP-06B	0+180	3.5 m	171.2	152.8	6952553.2	639898.4
SP-07A	0+180	24.0 m	163.0	156	6952538.1	639884.5
SP-07B	0+180	24.0 m	163.0	150.5	6952538.1	639884.5
SP-08A	0+200	3.5 m	171.2	156	6952539.6	639913.1
SP-08B	0+200	3.5 m	171.2	149.9	6952539.6	639913.1
SP-09A	0+200	26.1 m	162.0	154.5	6952523.0	639897.7
SP-09B	0+200	26.1 m	162.0	149.5	6952523.0	639897.7
SP-10A	0+260	3.5 m	176.5	168.5	6952499.0	639957.3
SP-10B	0+260	3.5 m	176.5	162.5	6952499.0	639957.3

* LOCATION TO BE DETERMINED BY ENGINEER DURING CONSTRUCTION

SETTLEMENT MONITORING POINT LAYOUT

SETTLEMENT POINT	STATION	OFFSET	NORTHING	EASTING
M1*	0+005	0.0 m	6952674.6	639772.3
M2-D	0+030	2.74 m	6952659.4	639792.4
M2-U	0+030	-2.74 m	6952655.7	639788.9
M3-D	0+060	2.74 m	6952639.1	639814.4
M3-U	0+060	-2.74 m	6952635.3	639810.9
M4-D	0+080	2.74 m	6952625.5	639829.1
M4-U	0+080	-2.74 m	6952621.7	639825.6
M5-D	0+100	2.74 m	6952611.9	639843.8
M5-U	0+100	-2.74 m	6952608.1	639840.3
M6-D	0+120	2.74 m	6952598.4	639858.5
M6-U	0+120	-2.74 m	6952594.6	639855.0
M7-D	0+150	2.74 m	6952578.0	639880.5
M7-U	0+150	-2.74 m	6952574.2	639877.0
M8-D	0+180	2.74 m	6952557.6	639902.5
M8-U	0+180	-2.74 m	6952553.8	639899.0
M9-D	0+200	2.74 m	6952544.0	639917.2
M9-U	0+200	-2.74 m	6952540.3	639913.7
M10-D	0+230	2.74 m	6952523.7	639939.2
M10-U	0+230	-2.74 m	6952519.9	639935.7
M11-D	0+250	2.74 m	6952510.1	639953.9
M11-U	0+250	-2.74 m	6952506.3	639950.4

* LOCATION TO BE DETERMINED BY ENGINEER DURING CONSTRUCTION

CORROSION MONITORING POINT LAYOUT

POINT NUMBER	STATION	OFFSET	NORTHING	EASTING	COUPON ELEVATION		
					A	B	C
C1	0+080	-2.6 m	6952624.85	639829.81	160.2 m	--	--
C2	0+080	-0.75 m	6952623.51	639828.61	168.0 m	165.0 m	162.0 m
C3**	0+080	0.75 m	6952622.40	639827.59	TOP OF KEYTRENCH		
C4	0+140	-2.6 m	6952584.79	639873.14	161.7 m	--	--
C5	0+140	-0.75 m	6952583.45	639871.94	168.0 m	165.0 m	162.0 m
C6**	0+140	0.75 m	6952582.34	639870.93	TOP OF KEYTRENCH		
C7	0+200	-2.6 m	6952543.79	639917.52	157.2 m	--	--
C8	0+200	-0.75 m	6952542.73	639915.99	168.0 m	165.0 m	162.0 m
C9**	0+200	0.75 m	6952541.62	639914.98	TOP OF KEYTRENCH		

** AS-BUILT ELEVATIONS OF TOP OF KEYTRENCH CONCRETE WILL BE REVIEWED AS INTRUMENTS ARE INSTALLED

GROUND TEMPERATURE CABLE LAYOUT

GTC POINT	STATION	OFFSET	NORTHING	EASTING	BEAD LAYOUT
GTC-1*	0+005	2.0 m	6952673.04	639770.99	1.2 m intervals until elevation 154.8 m
GTC-2	0+029	2.0 m	6952656.78	639788.56	168.78m, 1.0 m intervals until 5.0 m below keytrench
GTC-3	0+079	2.0 m	6952622.84	639825.28	168.78m, 1.0 m intervals until 5.0 m below keytrench
GTC-4	0+140	2.0 m	6952581.39	639870.02	168.78m, 1.0 m intervals until 5.0 m below keytrench
GTC-5	0+229	2.0 m	6952521.02	639935.42	168.78m, 1.0 m intervals until 5.0 m below keytrench
GTC-6	0+259	2.0 m	6952500.66	639957.45	168.78m, 1.0 m intervals until 5.0 m below keytrench

* LOCATION TO BE DETERMINED BY ENGINEER DURING CONSTRUCTION

ISSUED FOR CONSTRUCTION

LEGEND:

- SP-03 NESTED PIEZOMETER LOCATION
- M2-U SETTLEMENT MONITORING POINT LOCATION
- GTC-1 GROUND TEMPERATURE INSTALLATION POINT
- C2 CORROSION MONITORING INSTALLATION POINT (DIRECT BURIAL)
- C1 CORROSION MONITORING INSTALLATION POINT (RETRIEVABLE COUPON)
- INSTRUMENTATION CASING LOCATION

NOTES:

1. DATUM: UTM ZONE 11 NAD 83, METRE; CENTRAL MERIDIAN 117d W
   ELEVATIONS ARE GEODETIC. CONVERSION TO PREVIOUS DATUM: GEODETIC + 17.15 m
2. SURVEY DATA PROVIDED BY SUB-ARCTIC SURVEYS LTD.
   BASE SURVEY PLAN PROVIDED JULY 30, 2008 AND FEBRUARY 2009; FILE NO.: 08-092-NT.
   ADDITIONAL BATHYMETRY AND TOPOGRAPHY SURVEY PROVIDED OCT. 19, 2009;
   FILE NO.: 09-012-04-NT-COMPILED. DETAILED SURVEY WITHIN DAM FOOTPRINT AND
   COFFERDAM LOCATION PROVIDED OCT. 30, 2009; FILE NO.: 09-012-04-DAMSITE.
   ADDITIONAL RIVER BOTTOM SURVEY JUNE 4, 2010, FILE NO.:09-012-06-compiled-NORTH.
   ADDITIONAL BEDROCK SURVEY MAY 11, 2011. ADDITIONAL RIVER CHANNEL SURVEY JUNE 20,
   2011, FILE NO.:Z-SECTIONS CLOUDED AREA.
3. 1.0 m CONTOUR INTERVAL

REVISIONS

NUM	DATE	DWN	CKD	APR	DESCRIPTION
3	APR 23/12				Revise Corrosion and GTC Layout
2	FEB 8/12	DRG	CKG	CKG	Addtional Instrumentation added, Updated Channel Survey
1	JUNE 26/11	DRG	CKG	CKG	Dam Alignment Rotated, Addition of GTC Instrumentation

DRAWING STATUS

NUM	DATE	APR	DESCRIPTION
13	JULY 25/12	CKG	RE-ISSUED FOR CONSTRUCTION
12	FEB 17/12	CKG	RE-ISSUED FOR CONSTRUCTION
11	JUNE 26/11	CKG	RE-ISSUED FOR CONSTRUCTION
10	OCT 29/10	CKG	ISSUED FOR CONSTRUCTION
F	MAR 11/10	CKG	RE-ISSUED FOR TENDER

PERMIT TO PRACTICE
EBA ENGINEERING CONSULTANTS LTD.
Signature
Date JULY 25, 2012
PERMIT NUMBER: P 018
NWT/NU Association of Professional Engineers and Geoscientists

PERMIT

REGISTERED PROFESSIONAL ENGINEER
C.K. GRAPEL
LICENSEE
NWT/NU
July 24, 2012

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NORTHWEST TERRITORIES POWER CORPORATION

EBA Engineering Consultants Ltd.

REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

INSTRUMENTATION - PLAN

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.004	EDM	CKG	KWJ	3	C209
DATE:	SHEET No.	DWN	APP	STATUS	
February 2012	9 of 13	DRG	CKG	13	

TYPICAL SECTION - INSTRUMENTATION

SCALE: 1:150

NOTES:

STANDPIPE/CASAGRANDE PIEZOMETER

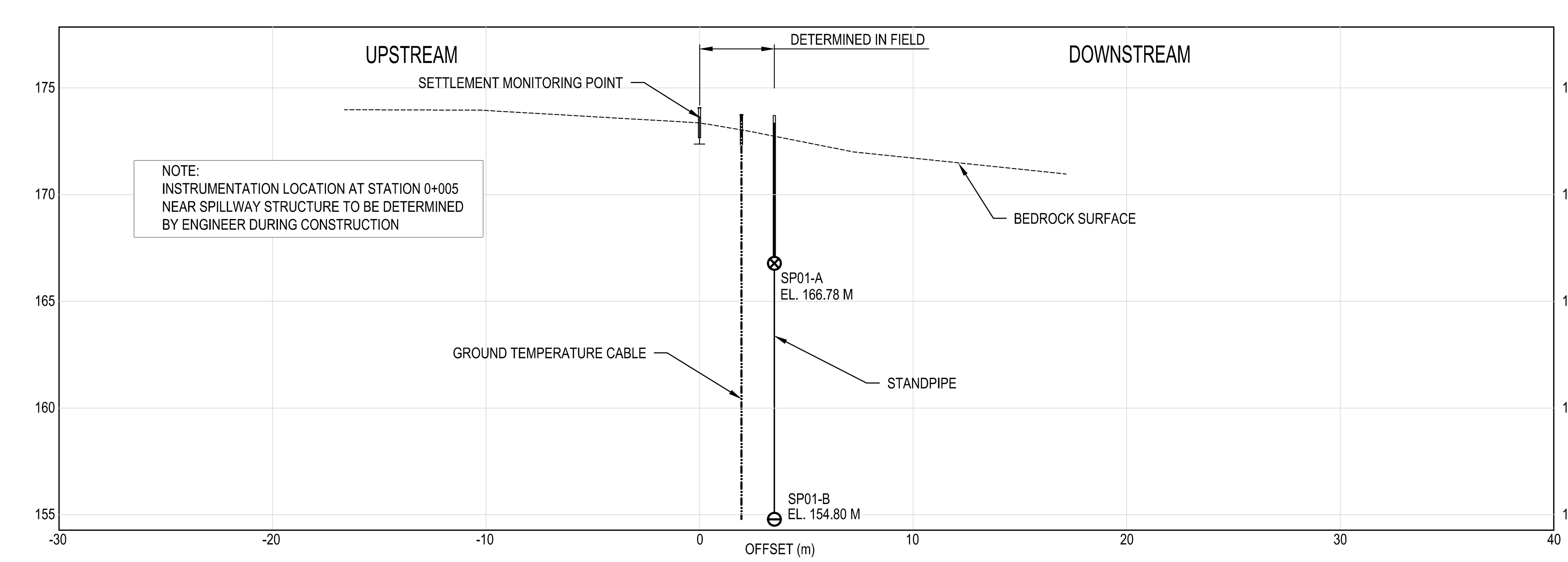
1. STANDPIPE PIEZOMETER SHALL BE 50 MM DIAMETER WITH 1500 MM LONG X 0.25 MM (.010") SLOTTED (SCREENED) SECTION.
2. CASAGRANDE AT STATION 0+005 SHALL EXTEND TO A DEPTH 2 METRES BELOW ELEVATION OF BOTTOM OF OUTLET CHANNEL.
3. STEEL PIPE PROTECTOR COVERS SHALL HAVE A MINIMUM EMBEDMENT LENGTH OF 600 MM. CONCRETE PLUG AT GROUND SURFACE
4. CLEAN, DRY SAND SHALL BE USED TO BACKFILL ANNULAR SPACE WITHIN THE STEEL PIPE PROTECTIVE COVER.

GROUND TEMPERATURE CABLE

1. GROUND TEMPERATURE CABLES SHALL BE INSTALLED WITHIN A CAPPED25 MM DIAMETER PVC PIPE, THREADED, GLUED AND TAPED JOINTS.
2. ALL HORIZONTAL CABLE LEADS FOR GROUND TEMPERATURE CABLES SHALL BE BURIED WITH A MINIMUM OF 700 MM COVER.
3. WHERE GROUND TEMPERATURE CABLE LEADS DAYLIGHT FROM HORIZONTAL TO VERTICAL; SHALL BE PROTECTED INSIDE 25 MM DIAMETER PVC RISER PIPE FROM THE TRENCH LOCATION INTO THE PROTECTIVE STEEL COVER PIPE.
4. GROUND TEMPERATURE CABLES SHALL TARGET A BOTTOM DEPTH OF 5 METRES BELOW KEY TRENCH. AT STATION 0+005 GROUND TEMPERATURE CABLE SHALL EXTEND TO A 10 METRE DEPTH BELOW BOTTOM OF OUTLET CHANNEL.
5. LOCATION OF GROUND TEMPERATURE CABLES SHALL BE OFFSET DOWNSTREAM OF MEMBRANE SUFFICIENT SO AS TO AVOID DRILLING THROUGH REINFORCED CONCRETE KEY TRENCH BACKFILL.
6. STEEL PIPE PROTECTOR COVERS SHALL HAVE A MINIMUM EMBEDMENT LENGTH OF 600 MM. CONCRETE PLUG AT GROUND SURFACE OF STEEL PIPE.
7. CLEAN, DRY SAND SHALL BE USED TO BACKFILL ANNULAR SPACE WITHIN THE STEEL PIPE PROTECTIVE COVER.

CORROSION MONITORING

1. CABLE LEADS SHALL EXTEND HORIZONTAL TO THE CREST OF THE DAM WITH A MINIMUM OF 700 MM COVER. WHERE CORROSION CABLE LEADS DAYLIGHT FROM HORIZONTAL TO VERTICAL; SHALL BE PROTECTED INSIDE 25 MM DIAMETER PVC RISER PIPE FROM THE TRENCH LOCATION INTO THE PROTECTIVE STEEL COVER PIPE.
2. STEEL PIPE PROTECTOR COVERS SHALL HAVE A MINIMUM EMBEDMENT LENGTH OF 600 MM. CONCRETE PLUG AT GROUND SURFACE OF STEEL PIPE PROTECTIVE COVERS SHALL BE A MINIMUM OF 600 MM THICK.
3. CLEAN, DRY SAND SHALL BE USED TO BACKFILL ANNULAR SPACE WITHIN THE STEEL PIPE PROTECTIVE COVER.



STATION 0+005

A / C209

SCALE: 1:200

LEGEND:

⊖ - CASAGRANDE STANDPIPE PIEZOMETER

⊗ - STANDPIPE

ISSUED FOR CONSTRUCTION

REVISIONS

NUM	DATE	DWN	CKD	APR	DESCRIPTION
1	APR 23/12	DRG	CKG	CKG	Revise Corrosion and GTC Layout

DRAWING STATUS

NUM	DATE	APR	DESCRIPTION
13	JULY 25/12	CKG	RE-ISSUED FOR CONSTRUCTION
12	FEB 17/12	CKG	RE-ISSUED FOR CONSTRUCTION
11	JUNE 26/11	CKG	RE-ISSUED FOR CONSTRUCTION
10	OCT 29/10	CKG	ISSUED FOR CONSTRUCTION
F	MAR 11/10	CKG	RE-ISSUED FOR TENDER

PERMIT TO PRACTICE
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Signature
Date JULY 25, 2012.
PERMIT NUMBER: P 018
NWT/NU Association of Professional Engineers and Geoscientists

PERMIT

REGISTERED PROFESSIONAL ENGINEER
C.K. GRAPEL
LICENSEE
NWT/NU
July 24, 2012

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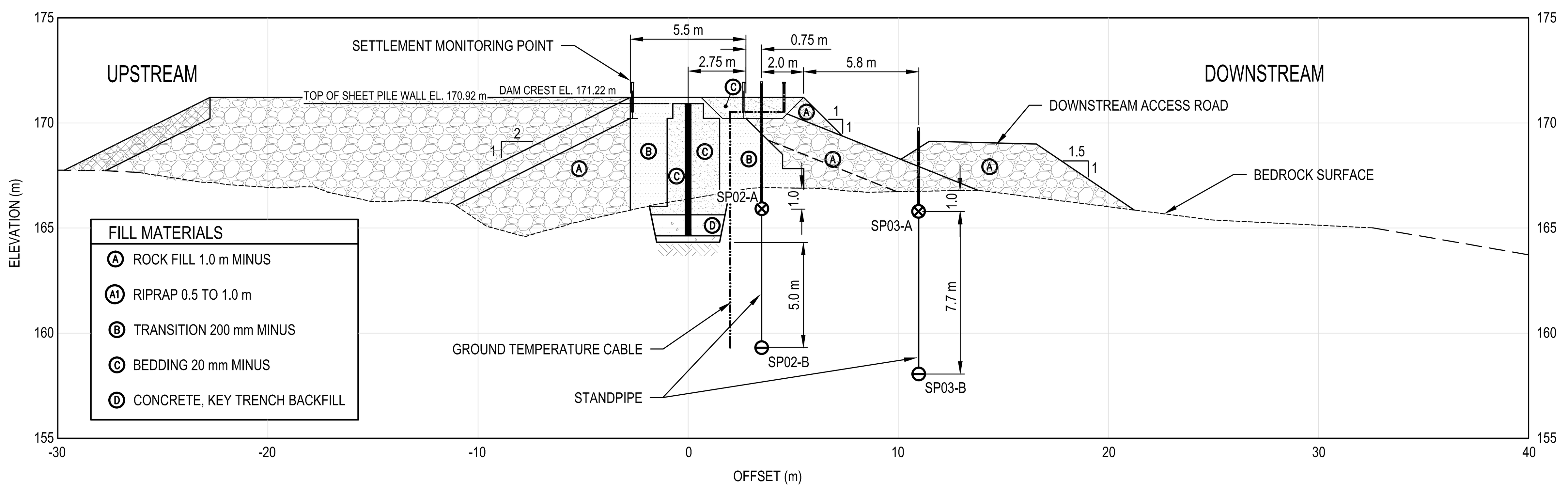
NORTHWEST TERRITORIES POWER CORPORATION

EBA Engineering Consultants Ltd.

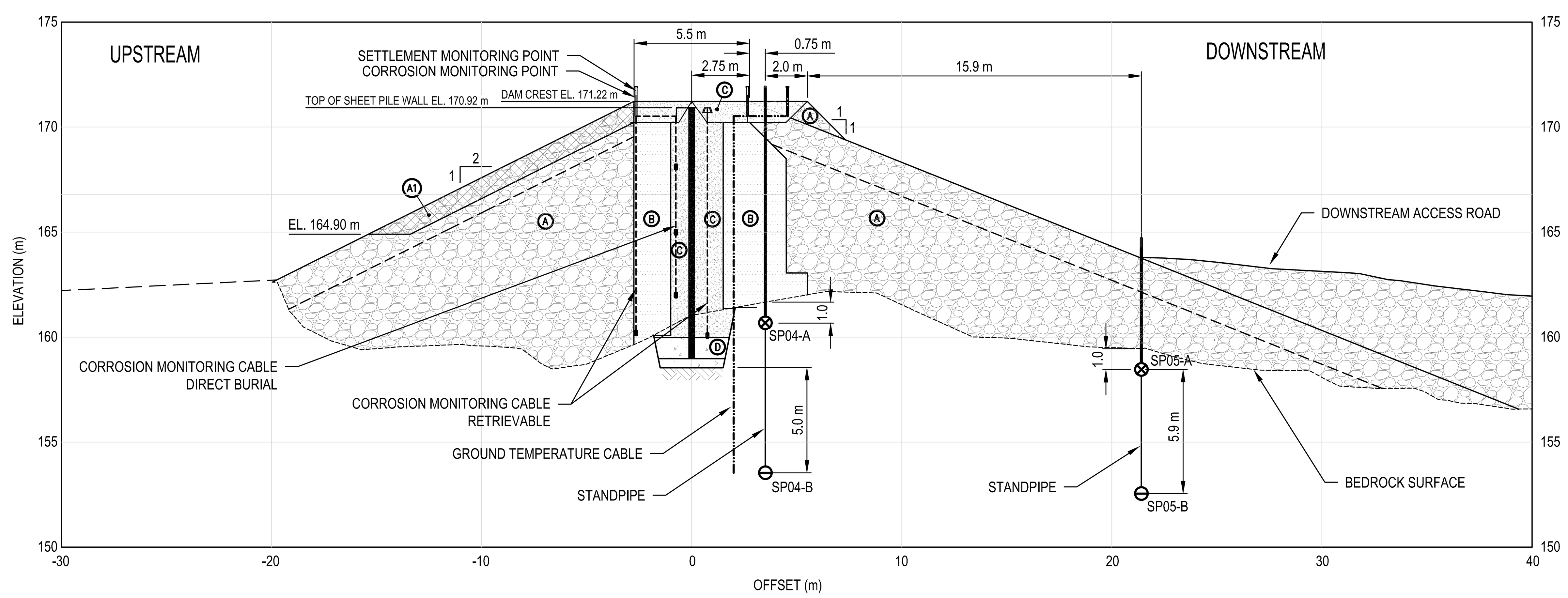
REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

INSTRUMENTATION - TYPICAL SECTION

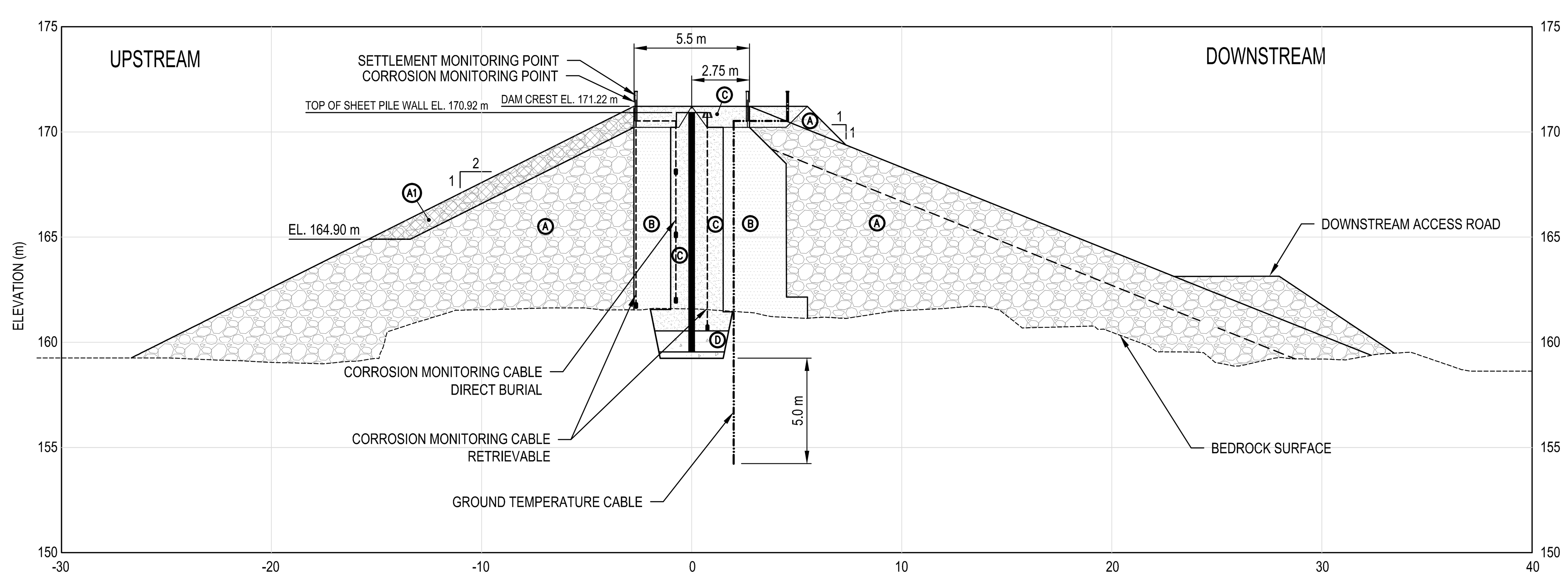
PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.004	EDM	CKG	KWJ	1	C210
DATE: February 2012	SHEET No. 10 of 13	DWN DRG	APP CKG	STATUS 13	



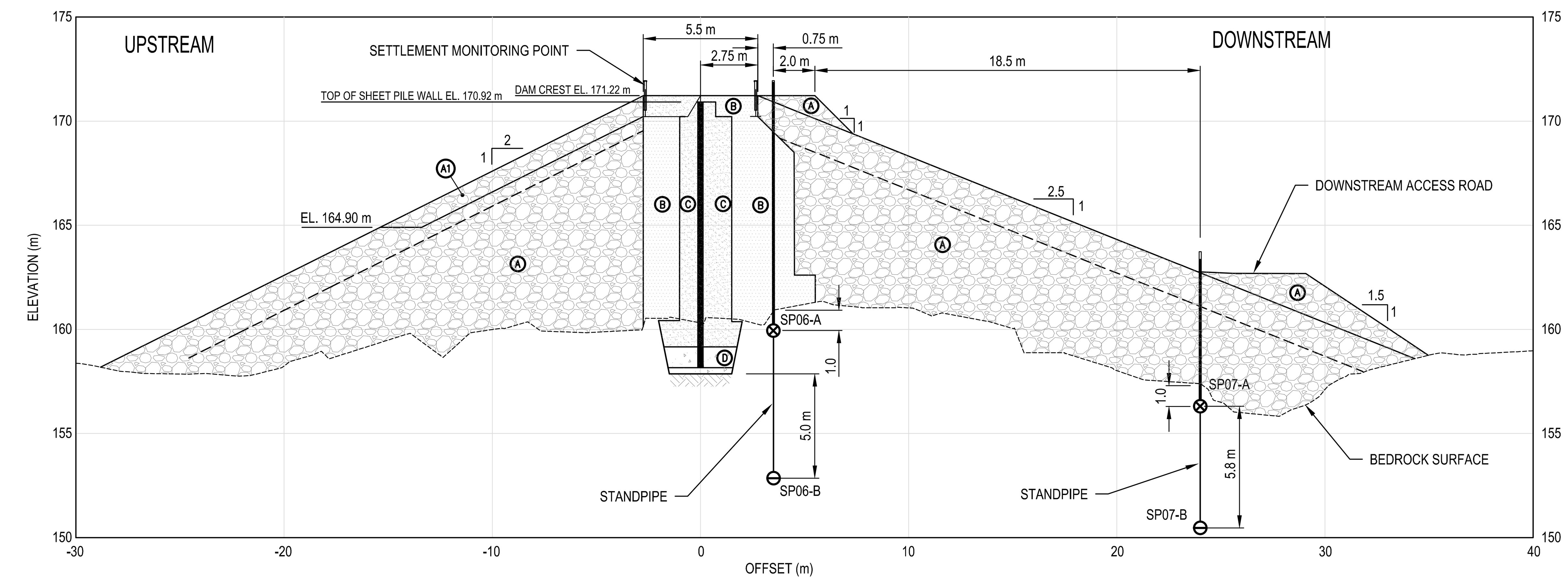
STATION 0+030 (B / C209)
SCALE: 1:200



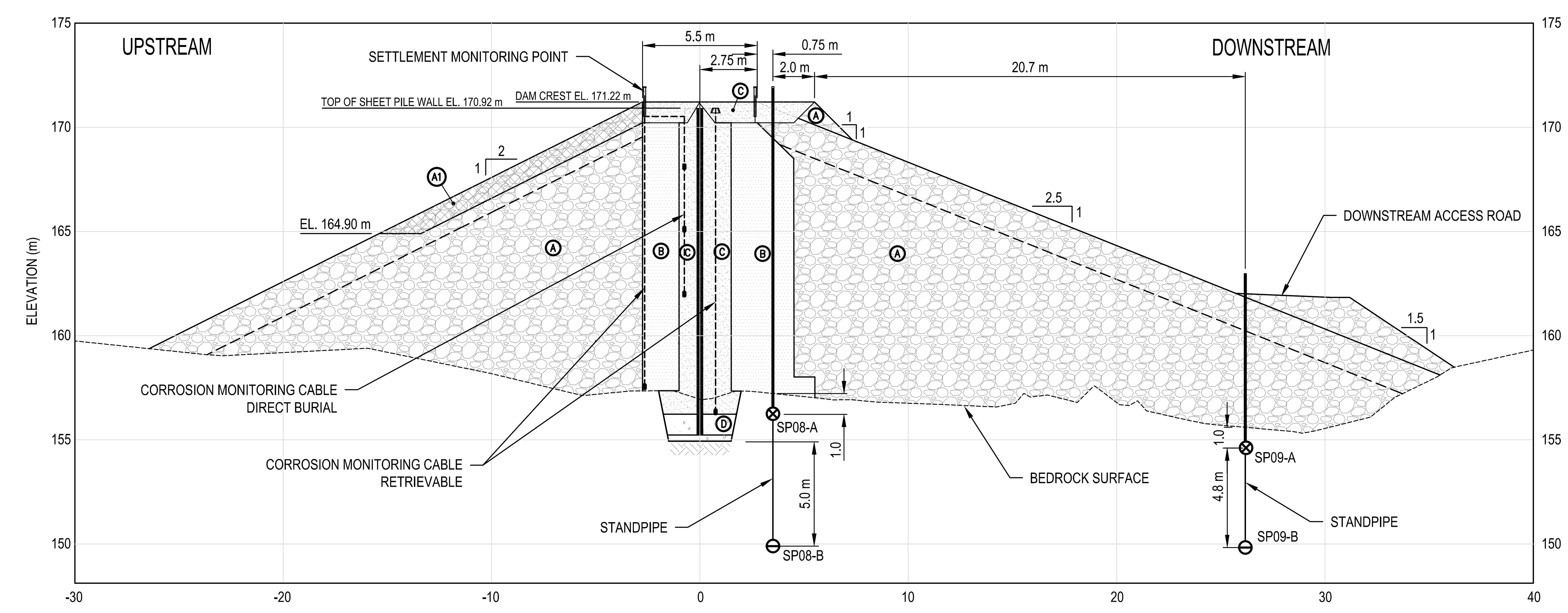
STATION 0+080 (C / C209)
SCALE: 1:200



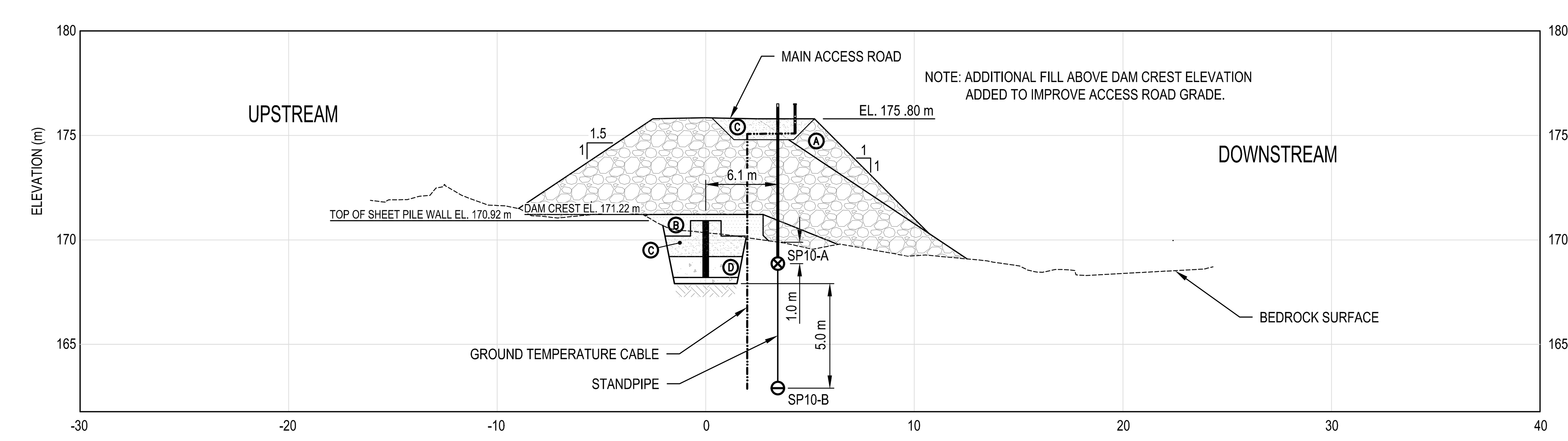
STATION 0+140 (D / C209)
SCALE: 1:200



STATION 0+180 (E / C209)
SCALE: 1:200



STATION 0+200 (F / C209)
SCALE: 1:200



STATION 0+260 (G / C209)
SCALE: 1:200

ISSUED FOR CONSTRUCTION

LEGEND:

⊖ - CASAGRANDE STANDPIPE PIEZOMETER

⊗ - STANDPIPE

REVISIONS

NUM	DATE	DWN	CKD	APR	DESCRIPTION
3	APR 23/12				Revise Corrosion and GTC Layout
2	FEB 8/12	DRG	CKG	CKG	Addtional Instrumentation added, Updated Channel Survey
1	JUNE 26/11	DRG	CKG	CKG	Dam Alignment Rotated, Addition of GTC Instrumentation

DRAWING STATUS

NUM	DATE	APR	DESCRIPTION
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10	OCT 29/10	CKG	ISSUED FOR CONSTRUCTION
F	MAR 11/10	CKG	RE-ISSUED FOR TENDER

PERMIT TO PRACTICE
EBA ENGINEERING CONSULTANTS LTD.
Signature
Date July 25, 2012.
PERMIT NUMBER: P 018
NWT/NU Association of Professional Engineers and Geoscientists

PERMIT

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July 24, 2012

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NORTHWEST TERRITORIES POWER CORPORATION

EBA Engineering Consultants Ltd.

REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

INSTRUMENTATION - SECTIONS

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.004	EDM	CKG	KWJ	3	C211
DATE: February 2012	SHEET No. 11 of 13	DWN DRG	APP CKG	STATUS 13	

FISH PASSAGE CHANNEL:
FOLLOWING BLASTING, A CHANNEL CONNECTING LOW AREAS IN THE BEDROCK SURFACE AT THE BASE OF THE SPILLWAY SHALL BE CREATED USING POT BLASTING TECHNIQUES TO CONNECT THE BOTTOM OUTLET PLUNGE POOL AND THE LOWER STEP PLUNGE POOL. A CHANNEL OF SIMILAR DIMENSIONS SHALL ALSO BE CREATED FROM THE LOWER STEP PLUNGE POOL TO THE NATURAL RIVER POOL DOWNSTREAM OF THE DAM. THE ACTUAL LOCATION OF THE FISH PASSAGE CHANNEL WILL BE A FIELD FIT DEPENDING ON THE LOCATIONS OF ANY LOW AREAS AT THE BASE OF THE SPILLWAY UPON BLASTING.

TYPICAL CHANNEL SECTION

LOWER STEP PLUNGE POOL:
UPON COMPLETION OF SPILLWAY PRODUCTION BLASTING, A LOCALIZED 1.0 M DEPRESSION AT THE BOTTOM OF THE LOWER STEP SHALL BE CREATED WITH SHALLOW BLAST EXCAVATION TECHNIQUES.

CONTROL LINES

POINT #	NORTHING	EASTING	DESCRIPTION
101	6952780.2	639792.4	OVERFLOW SPILLWAY
102	6952651.6	639739.8	OVERFLOW SPILLWAY
103	6952632.1	639735.3	OVERFLOW SPILLWAY
104	6952582.1	639732.4	OVERFLOW SPILLWAY
105	6952754.9	639831.5	BOTTOM OUTLET
106	6952684.7	639762.8	BOTTOM OUTLET
107	6952631.7	639741.1	BOTTOM OUTLET
108	6952581.9	639738.8	BOTTOM OUTLET

SPILLWAY AND BOTTOM OUTLET LAYOUT POINTS

POINT #	NORTHING	EASTING	ELEVATION
50	6952755.0	639826.4	161.0
51	6952747.5	639829.5	161.1
52	6952725.4	639797.1	161.0
53	6952719.9	639802.7	161.0
54	6952725.4	639797.1	161.0
55	6952725.1	639796.8	160.0
56	6952719.9	639802.7	161.0
57	6952719.6	639802.4	160.0
58	6952715.9	639798.9	160.0
59	6952721.4	639793.2	173.2
60	6952714.3	639786.3	160.0
61	6952708.8	639791.9	160.0

SPILLWAY AND BOTTOM OUTLET LAYOUT POINTS

POINT #	NORTHING	EASTING	ELEVATION
62	6952682.6	639766.0	159.8
63	6952686.8	639759.6	159.8
64	6952648.8	639752.1	159.6
65	6952650.4	639744.7	159.6
66	6952631.3	639748.0	159.6
67	6952631.3	639748.0	156.6
68	6952598.6	639745.9	156.6
69	6952587.7	639720.2	156.6
70	6952632.8	639722.7	156.6
71	6952632.8	639722.7	159.6
72	6952654.4	639727.4	159.6
73	6952654.4	639727.4	162.6

SPILLWAY AND BOTTOM OUTLET LAYOUT POINTS

POINT #	NORTHING	EASTING	ELEVATION
74	6952722.5	639755.3	164.0
75	6952760.3	639772.2	164.8
76	6952763.9	639780.9	165.0
77	6952760.5	639789.2	165.0
78	6952751.9	639792.9	164.8
79	6952703.4	639774.5	163.8
80	6952720.3	639792.0	168.8
81	6952742.5	639799.3	168.8
82	6952753.3	639798.1	168.8
83	6952762.6	639792.6	168.8
84	6952770.1	639780.8	168.8
85	6952766.4	639772.1	168.8

SPILLWAY AND BOTTOM OUTLET LAYOUT POINTS

POINT #	NORTHING	EASTING	ELEVATION
86	6952760.7	639765.9	168.8
87	6952709.2	639738.1	168.8
88	6952704.6	639746.5	168.8
89	6952712.1	639732.8	168.8
90	6952728.9	639741.9	168.8
91	6952769.9	639742.9	168.8
92	6952806.2	639757.7	168.8
93	6952761.0	639771.5	168.8
94	6952764.9	639780.9	168.8
95	6952761.2	639789.9	168.8
96	6952751.9	639793.8	168.8

LEGEND / RIPRAP PROTECTION NOTES:

RIPRAP IS NOT REQUIRED AT THE FISH PLUNGE POOL, WHICH IS TO BE EXCAVATED IN ROCK, OR ANY OTHER AREAS WHERE BEDROCK IS EXPOSED.

RIPRAP PROTECTION ZONE

FROM STATION 0+185 TO THE DOWNSTREAM POND (AS FAR AS POSSIBLE)

NON-WOVEN GEOTEXTILE SHOULD BE NILEX 4516 OR EQUIVALENT.

FOR GEOTEXTILE ROLL WIDTH OF 4.57 m, A MINIMUM OVERLAP OF 1.0 m IS REQUIRED.

Scale: 1: 400 (metres)

PLAN

SCALE: 1:400

ISSUED FOR CONSTRUCTION

LEGEND:

- BOREHOLE LOCATION (REFER TO EBA GEOTECHNICAL REPORT DATED: SEPTEMBER 2009)

- EDGE OF WATER

NOTES:

1. DATUM: UTM ZONE 11 NAD 83, METRE; CENTRAL MERIDIAN 117d W
   ELEVATIONS ARE GEODETIC. CONVERSION TO PREVIOUS DATUM: GEODETIC + 17.15 m

2. SURVEY DATA PROVIDED BY SUB-ARCTIC SURVEYS LTD.
   BASE SURVEY PLAN PROVIDED JULY 30, 2008 AND FEBRUARY 2009; FILE NO.: 08-092-NT.
   ADDITIONAL BATHYMETRY AND TOPOGRAPHY SURVEY PROVIDED OCT. 19, 2009;
   FILE NO.: 09-012-04-NT-COMPILED. DETAILED SURVEY WITHIN DAM FOOTPRINT AND
   COFFERDAM LOCATION PROVIDED OCT. 30, 2009; FILE NO.: 09-012-04-DAMSITE.
   ADDITIONAL RIVER BOTTOM SURVEY JUNE 4, 2010, FILE NO.:09-012-06-compiled-NORTH.

3. 1.0 m CONTOUR INTERVAL

REVISIONS

NUM	DATE	DWN	CKD	APR	DESCRIPTION
3	MAR 29/12	DRG	CKG	AC	Addition of Outlet Rip rap Protection
2	FEB 3/12	DRG	CKG	AC	Plunge pool, Fish Passage approved, Reconstitutive Sill Updated
1	May 26/11	DRG	CKG	AC	New Dam Footprint, Add Plunge Pools, Fish Passage Channel and Note

DRAWING STATUS

NUM	DATE	APR	DESCRIPTION
13	MAR 29/12	AC	RE-ISSUED FOR CONSTRUCTION
12	FEB 3/12	AC	RE-ISSUED FOR CONSTRUCTION
11	MAY 26/11	AC	RE-ISSUED FOR CONSTRUCTION
10	OCT 29/10	RJW	ISSUED FOR CONSTRUCTION
G	MAR 11/10	RJW	RE-ISSUED FOR TENDER
F	FEB 9/10	RJW	ISSUED FOR DISCUSSION
E	DEC 23/09	RJW	ISSUED FOR TENDER

PERMIT TO PRACTICE
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Date MARCH 29, 2012
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REGISTERED PROFESSIONAL ENGINEER
A.G. CHANTLER
LICENSEE
NWT/NU
2012 Mar 28

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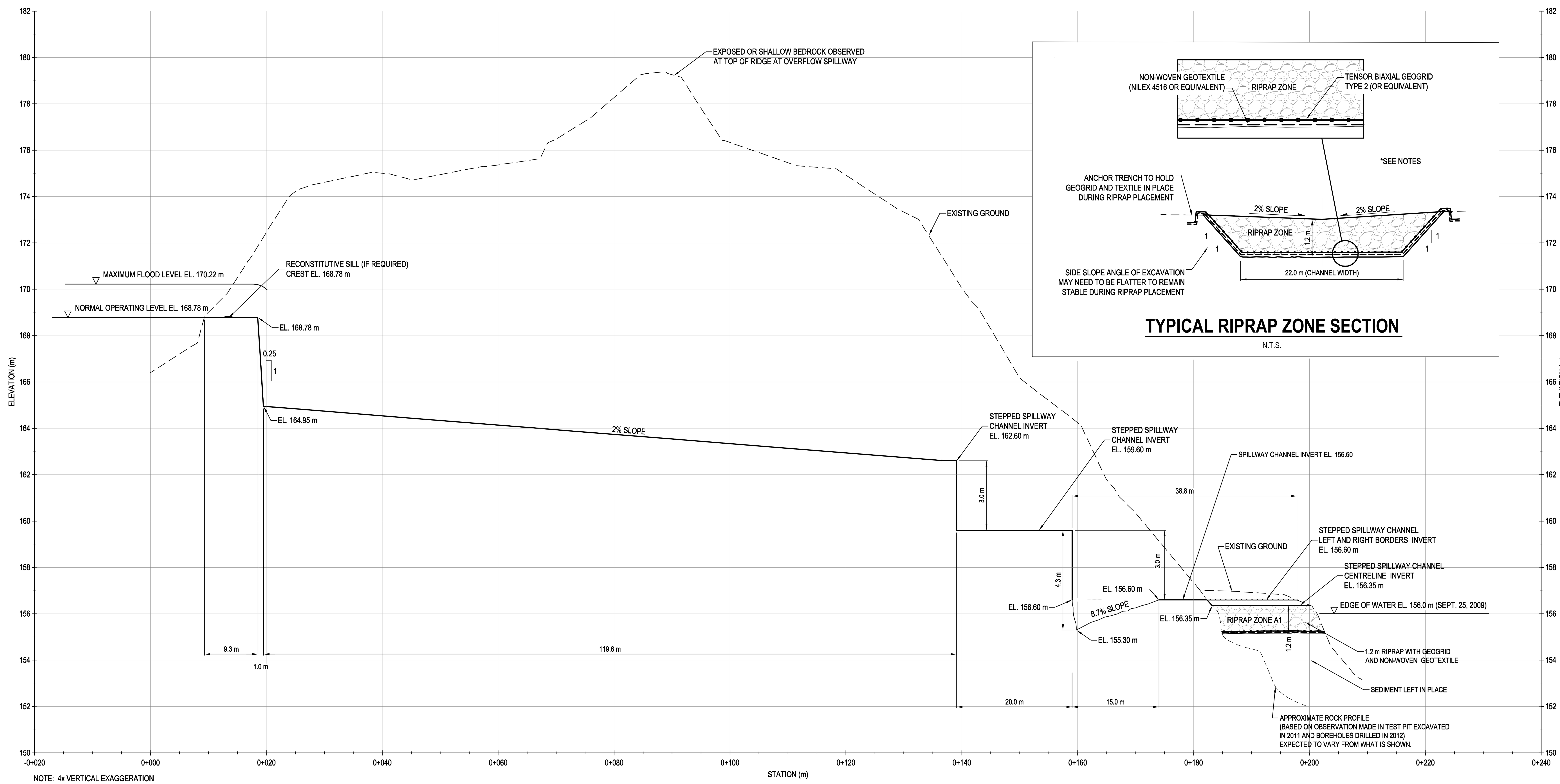
NORTHWEST TERRITORIES POWER CORPORATION

EBA Engineering Consultants Ltd.

REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

PLAN OF OVERFLOW SPILLWAY AND BOTTOM OUTLET

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.004	EDM	CH/RJW	CKG	3	C301
DATE:	SHEET No.	DWN	APP	STATUS	
February 2012	1 of 8	JAB/DG	CH/AC	13	



OVERFLOW SPILLWAY PROFILE

SCALE: 1:400

0 20
Scale: 1: 400 (metres)

ISSUED FOR CONSTRUCTION

NOTES:

1. TENSOR BIAXIAL GEOGRID TO BE PLACED ON TOP OF NON-WOVEN GEOTEXTILE AND OVERLAPPED TO MANUFACTURERS SPECIFICATION.
2. NON-WOVEN GEOTEXTILE TO BE SEWN OR OVERLAPPED TO MANUFACTURERS SPECIFICATION OR MINIMUM 1.0 m OVERLAP, WHICHEVER IS GREATER.
3. NON-WOVEN GEOTEXTILE TO BE INSTALLED WITH "SHINGLE STYLE" OVERLAPS. SEAMS TO BE PERPENDICULAR TO WATER FLOW.

REVISIONS

NUM	DATE	DWN	CKD	APR	DESCRIPTION
1	MAR 29/12	DRG	CKG	AC	Addition of Outlet Rip rap Protection

DRAWING STATUS

NUM	DATE	APR	DESCRIPTION
12	MAR 29/12	AC	RE-ISSUED FOR CONSTRUCTION
11	MAY 26/11	AC	RE-ISSUED FOR CONSTRUCTION
10	OCT 29/10	RJW	ISSUED FOR CONSTRUCTION
G	MAR 11/10	RJW	RE-ISSUED FOR TENDER
F	FEB 9/10	RJW	ISSUED FOR DISCUSSION
E	DEC 23/09	RJW	ISSUED FOR TENDER

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NWT/NU
2012 Mar 28

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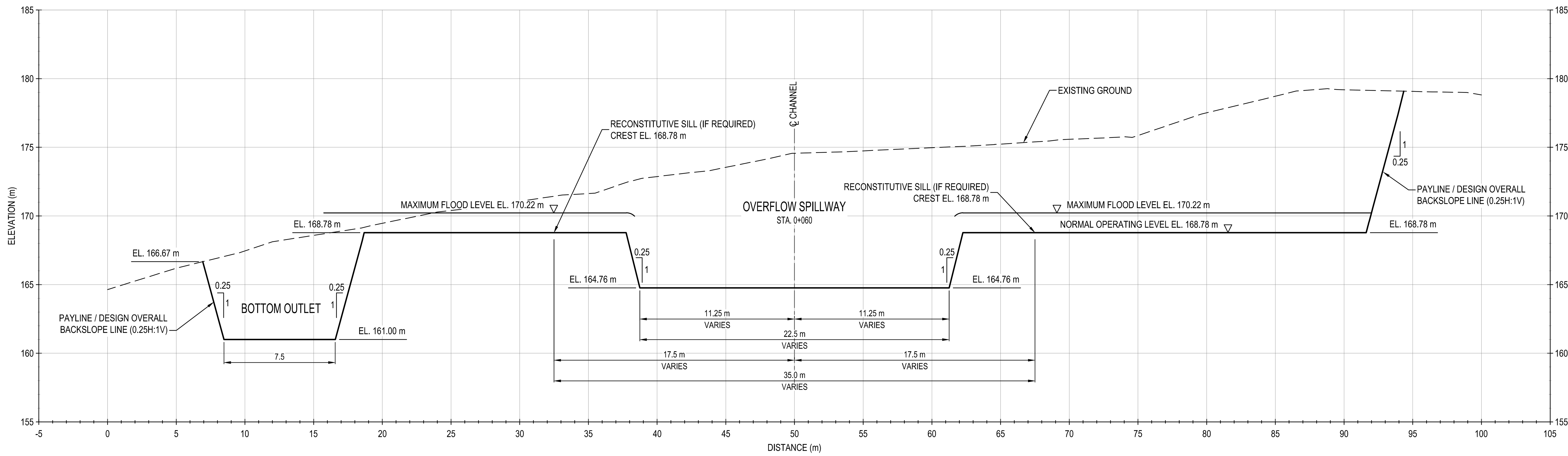
EBA Engineering Consultants Ltd.

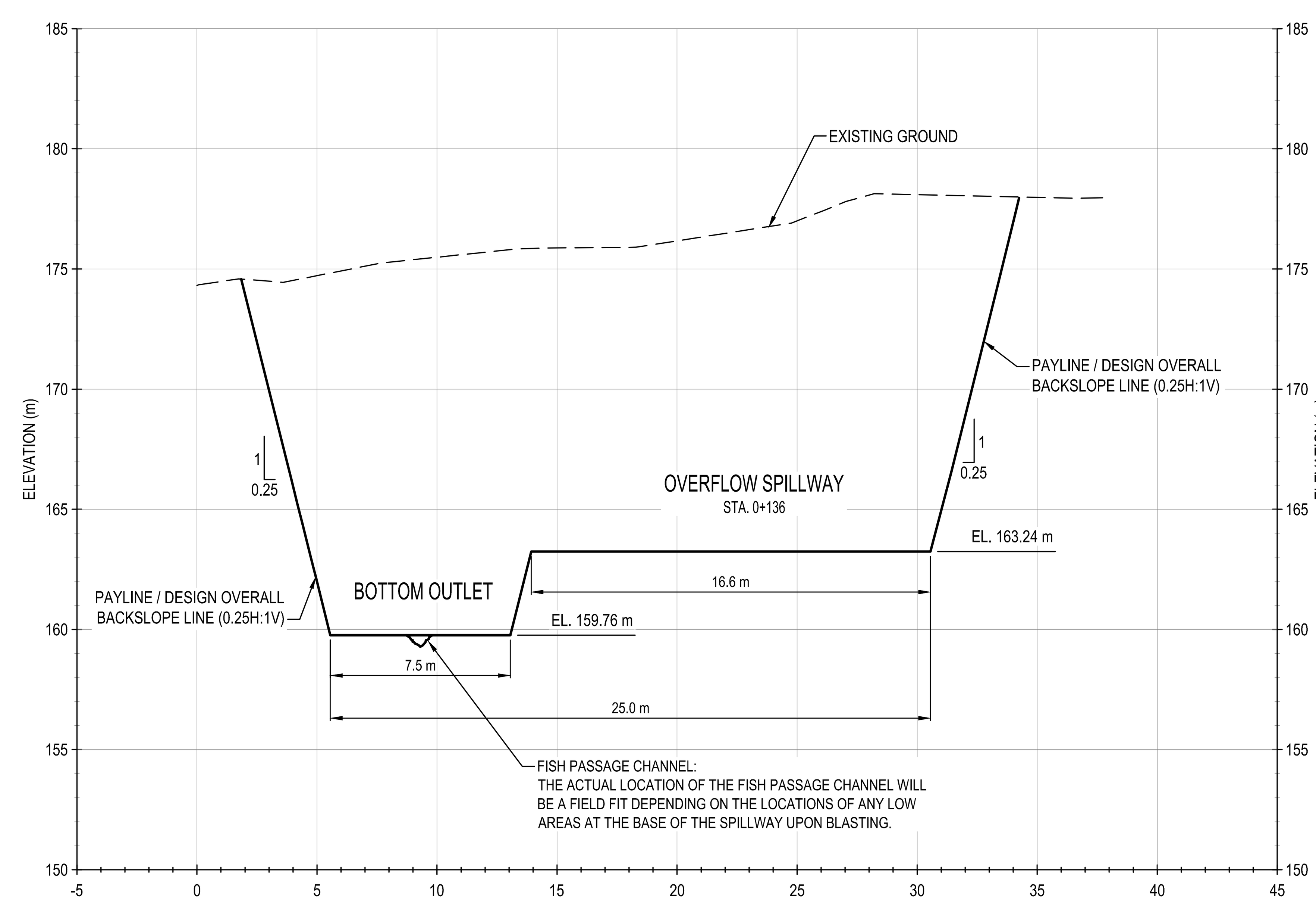
REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

PROFILE OF OVERFLOW SPILLWAY

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.004	EDM	CC/RJW	CKG	1	C302
DATE:	SHEET No.	DWN	APP	STATUS	
October 2010	2 of 8	JAB/DG	CC/AC	12	



SECTION A / C301
SCALE: 1:200



SECTION B / C301
SCALE: 1:200

0 10
Scale: 1: 200 (metres)

ISSUED FOR CONSTRUCTION

NOTES:

1. EXCEPT AS OTHERWISE SPECIFIED OR APPROVED IN WRITING BY THE ENGINEER, EACH LIFT OF EXCAVATION IN ROCK SHOULD NOT EXCEED 8.0m.

2. WHEN THE HEIGHT REQUIRES MORE THAN ONE LIFT, THE BOTTOM OF EACH LIFT SHALL BE AT THE DESIGN OVERALL SLOPE LINE (PAYLINE) OR AT THE BACK OF THIS LINE. UNLESS OTHERWISE SPECIFIED OR APPROVED BY THE ENGINEER, THE OFFSETS BETWEEN LIFTS SHALL BE AS FOLLOWS:

   a. IF THE BOTTOM OF THE FIRST LIFT IS AT THE DESIGN OVERALL SLOPE LINE, A MAXIMUM HORIZONTAL DISTANCE OF 0.5m OFFSET BETWEEN LIFTS IS PERMITTED.

   b. IF THE BOTTOM OF THE FIRST LIFT IS BEHIND THE BACK OF THE DESIGN OVERALL SLOPE LINE, THE OFFSET BETWEEN LIFTS SHALL BE EQUAL OR LESS THAN TWO TIMES THE HORIZONTAL DISTANCE BETWEEN THE OVERALL DESIGN SLOPE LINE AND THE ACTUAL BOTTOM OF THE FIRST LIFT.

REVISIONS

NUM	DATE	DWN	CKD	APR	DESCRIPTION
2	FEB 3/12	DRG	CKG	AC	Fish Passage Channel Approved
1	MAY 26/11	DRG	CKG	AC	Add Fish Passage Channel and Note

DRAWING STATUS

NUM	DATE	APR	DESCRIPTION
12	FEB 3/12	AC	RE-ISSUED FOR CONSTRUCTION
11	MAY 26/11	AC	RE-ISSUED FOR CONSTRUCTION
10	OCT 29/10	RJW	ISSUED FOR CONSTRUCTION
G	MAR 11/10	RJW	RE-ISSUED FOR TENDER
F	FEB 9/10	RJW	ISSUED FOR DISCUSSION
E	DEC 23/09	RJW	ISSUED FOR TENDER
D	NOV 16/09	CH/RJW	ISSUED FOR TENDER
C	OCT 21/09	RJW	ISSUED FOR REVIEW
B	OCT 13/09	RJW	ISSUED FOR REVIEW
A	SEPT 23/09	RJW	ISSUED FOR REVIEW

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A.G. CHANTLER
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NWT/NU
Feb 3, 2012

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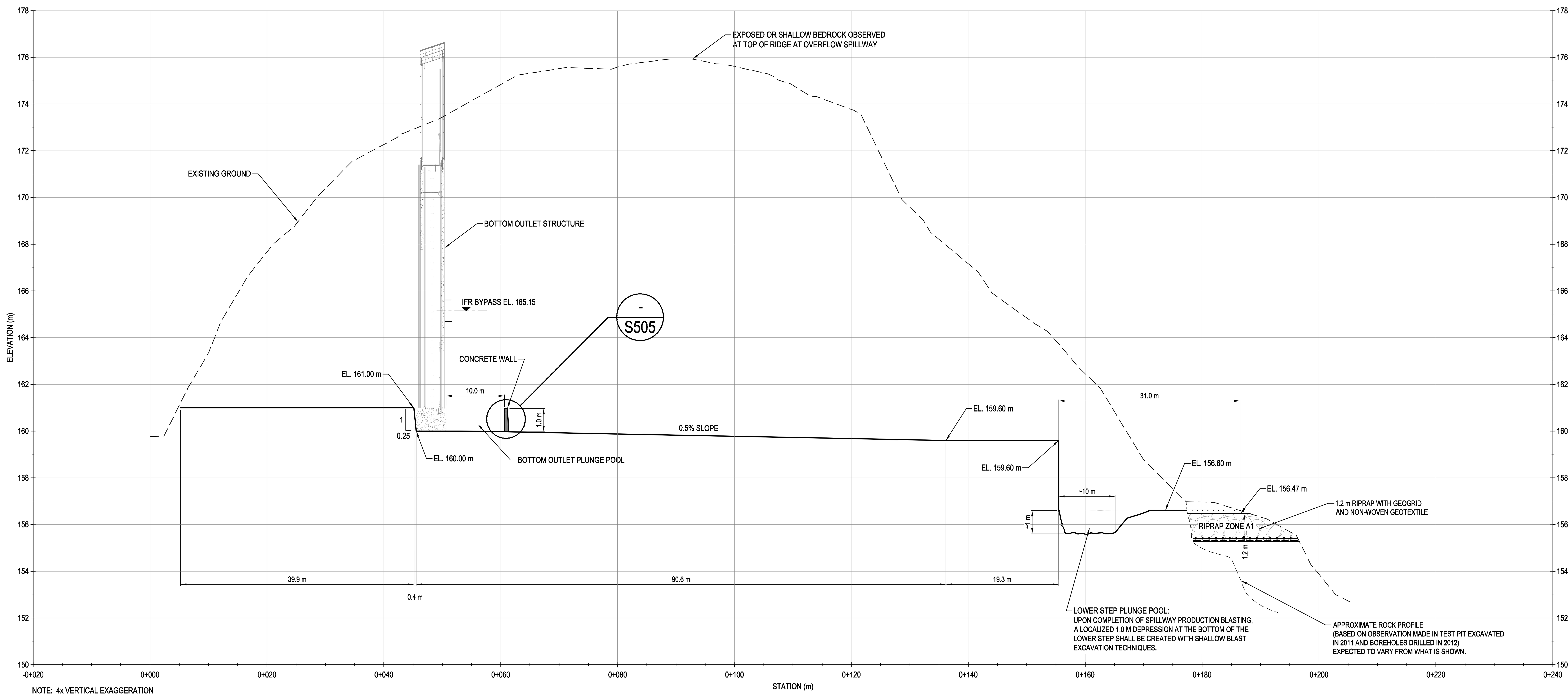
EBA Engineering Consultants Ltd.

REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

TYPICAL SECTIONS FOR SPILLWAY AND BOTTOM OUTLET

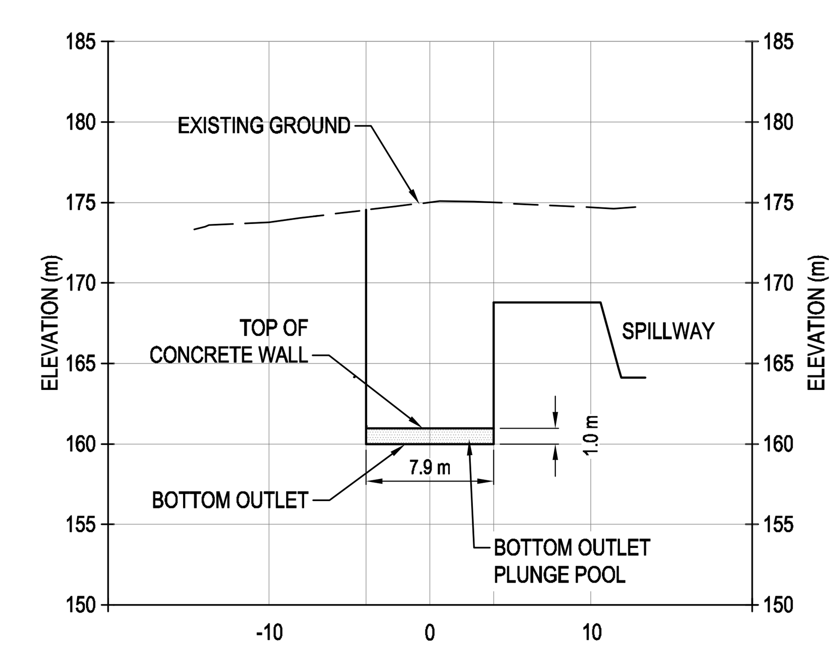
PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.004	EDM	CC/RJW	CKG	2	C303
DATE:	SHEET No.	DWN	APP	STATUS	
February 2012	3 of 8	DRG	CC/AC	12	



NOTE: 4x VERTICAL EXAGGERATION

BOTTOM OUTLET PROFILE

SCALE: 1:400



BOTTOM OUTLET PLUNGE POOL SECTION 0+060

SCALE: 1:400

0 20
Scale: 1: 400 (metres)

ISSUED FOR CONSTRUCTION

NUM	DATE	DWN	CKD	APR	DESCRIPTION
3	MAR 29/12	DRG	CKG	AC	Addition of Outlet Rip rap Protection
2	FEB 3/12	DRG	CKG	AC	Plunge Pools Approved, Bottom Outlet Structure moved upstream
1	MAY 26/11	DRG	CKG	AC	Addition of Bottom Outlet and Lower Step Plunge Pools

REVISIONS

NUM	DATE	APR	DESCRIPTION
13	MAR 29/12	AC	RE-ISSUED FOR CONSTRUCTION
12	FEB 3/12	AC	RE-ISSUED FOR CONSTRUCTION
11	MAY 26/11	AC	RE-ISSUED FOR CONSTRUCTION
10	OCT 29/10	RJW	ISSUED FOR CONSTRUCTION

DRAWING STATUS

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A.G. CHANTLER
LICENSEE
NWT/NU
2012 Mar 28

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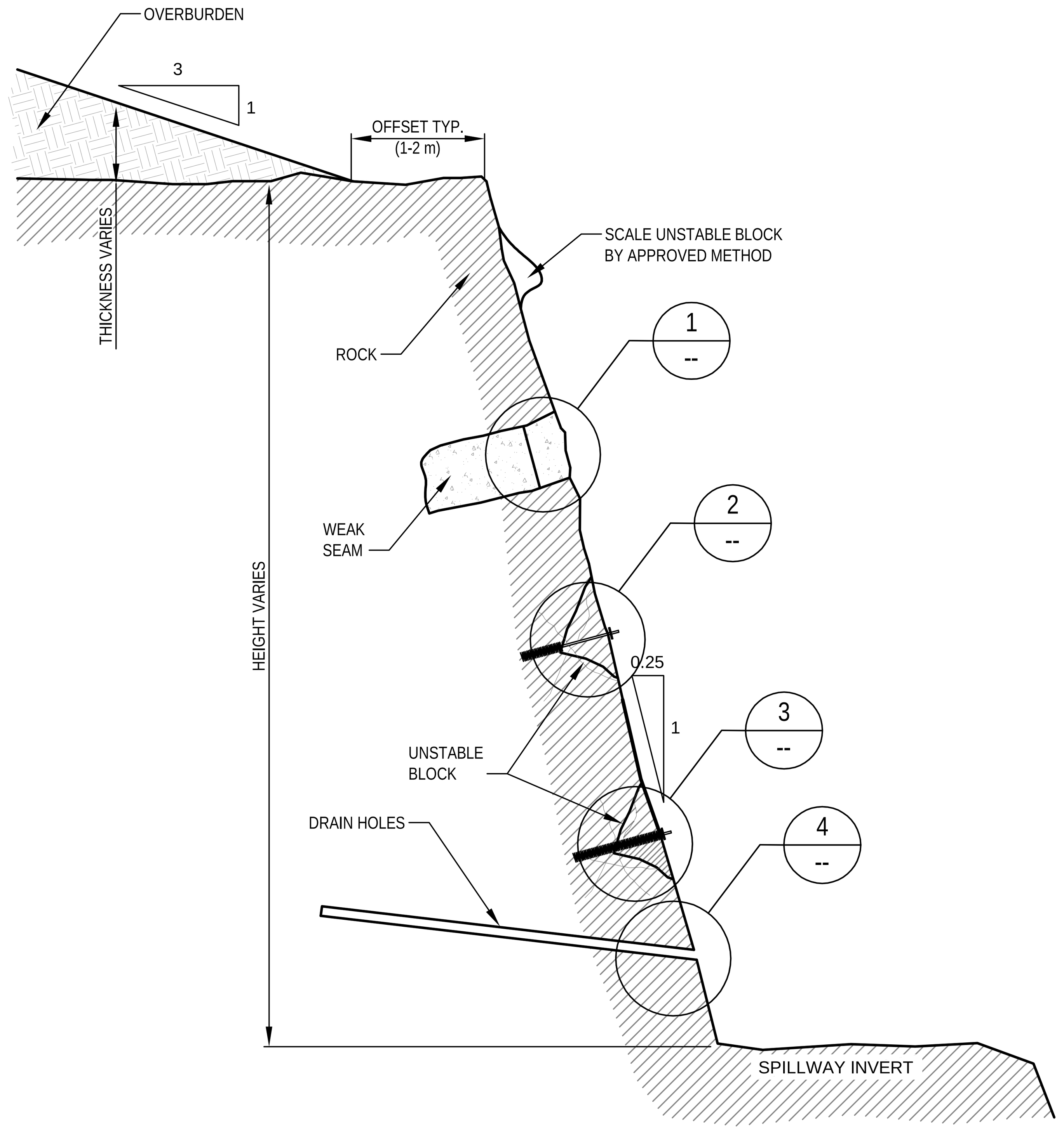
EBA Engineering Consultants Ltd.

REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

PROFILE OF BOTTOM OUTLET

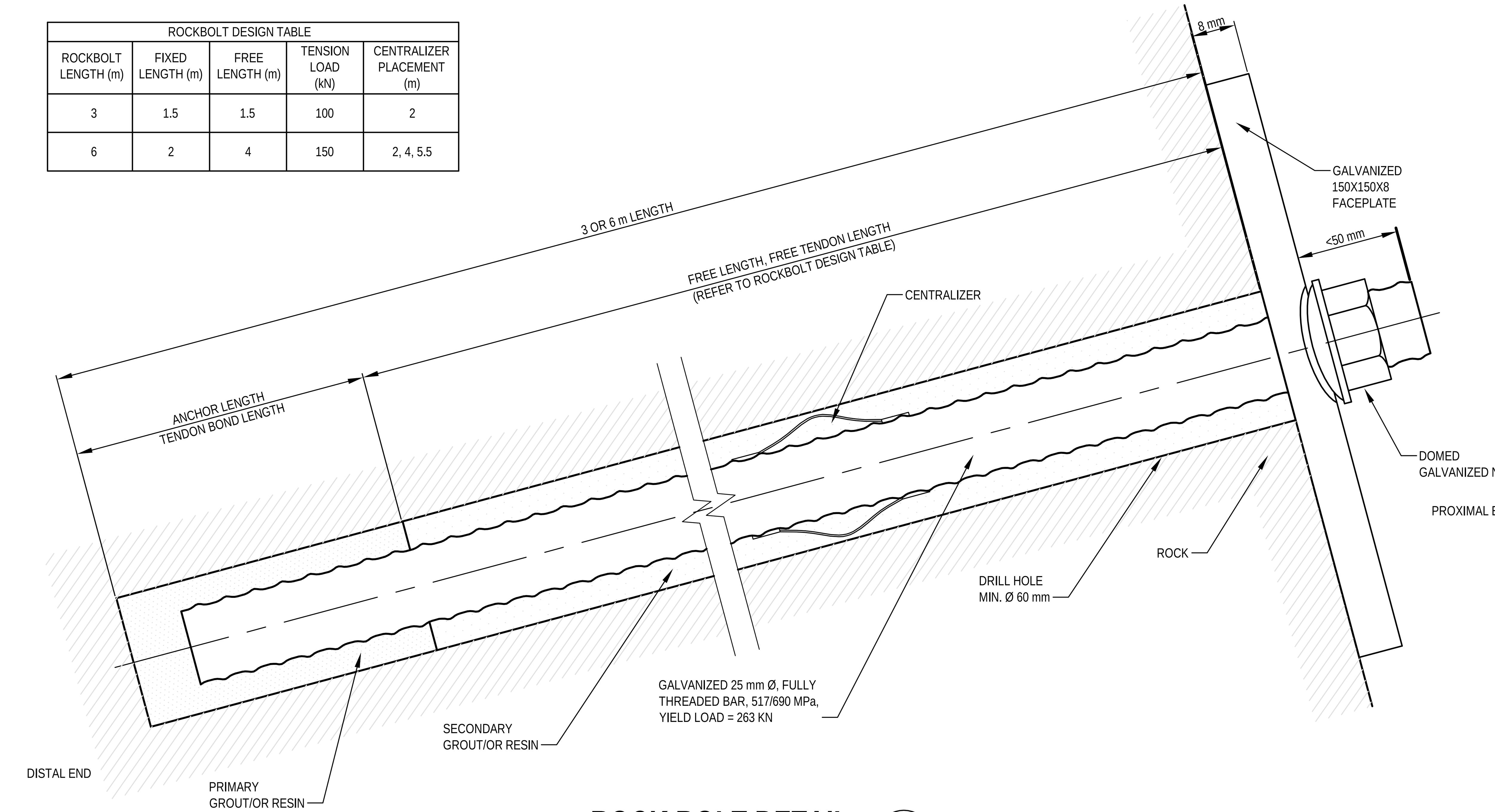
PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.004	EDM	CC/RJW	CKG	3	C305
DATE:	SHEET No.	DWN	APP	STATUS	
March 2012	5 of 8	JAB/DG	CC/AC	13	



GENERAL CROSS SECTION

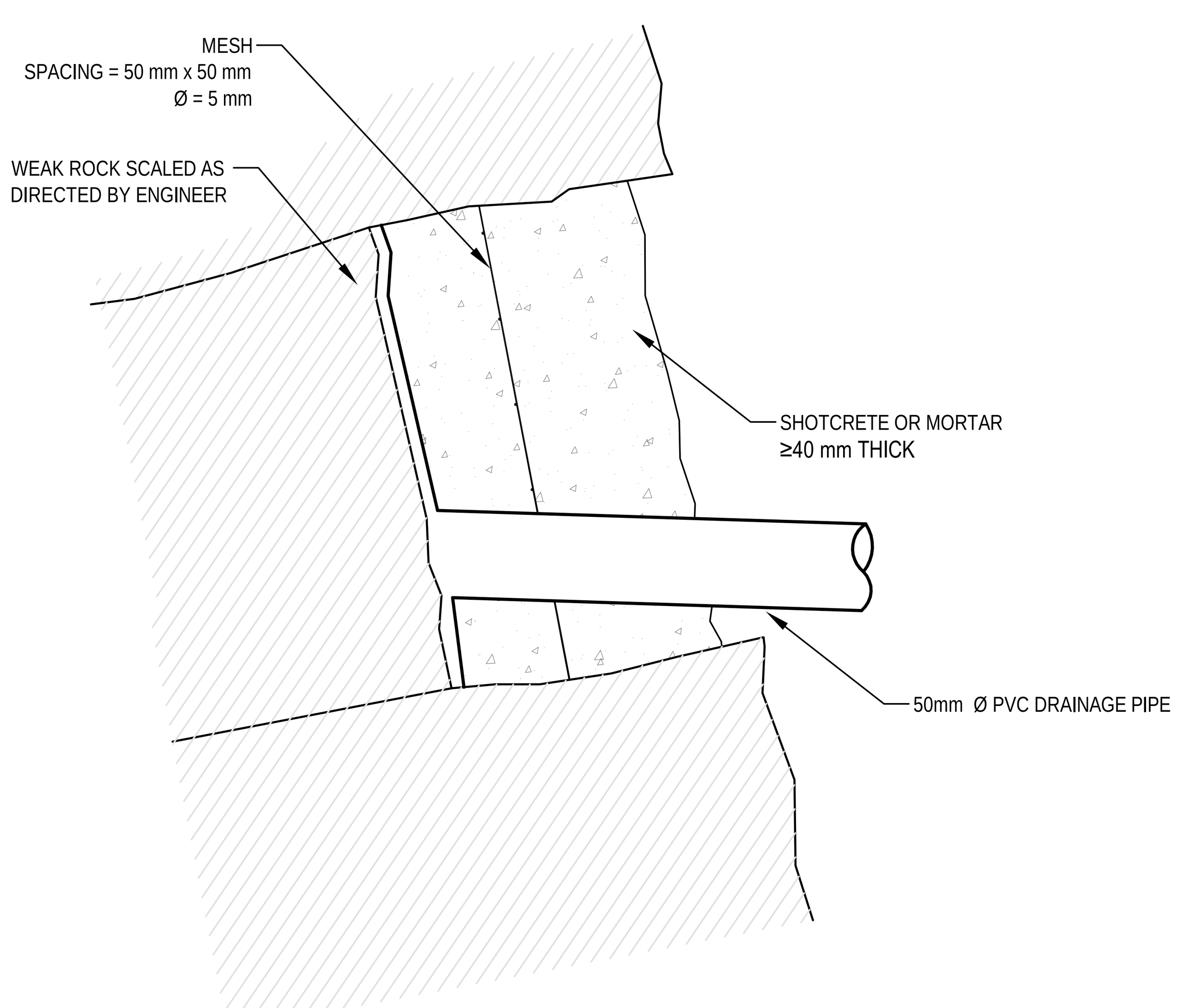
0 2.5
Scale: 1: 75 (metres)

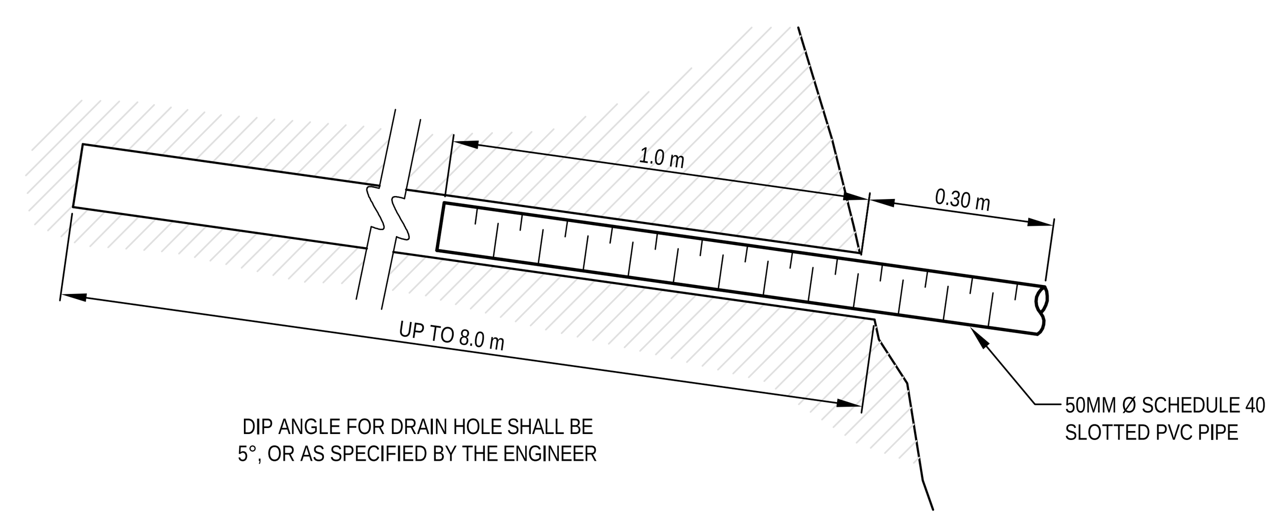
ROCKBOLT DESIGN TABLE				
ROCKBOLT LENGTH (m)	FIXED LENGTH (m)	FREE LENGTH (m)	TENSION LOAD (kN)	CENTRALIZER PLACEMENT (m)
3	1.5	1.5	100	2
6	2	4	150	2, 4, 5.5



ROCK BOLT DETAIL (2 / --)

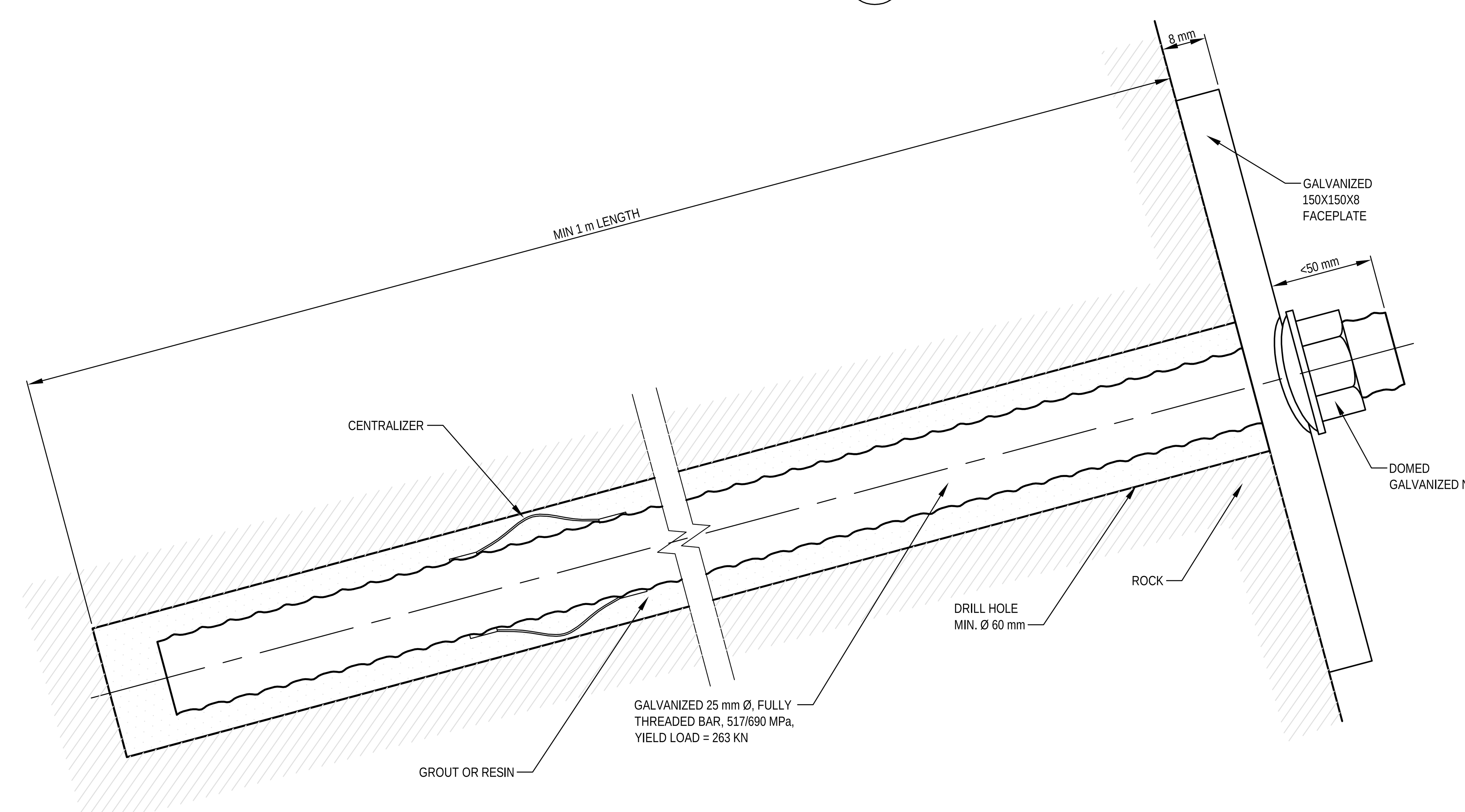
N.T.S.





DRAIN HOLE DETAIL (4 / --)

N.T.S.



DENTITION DETAIL (1 / --)

N.T.S.

DOWEL DETAIL (3 / --)

N.T.S.

ISSUED FOR CONSTRUCTION

NOTES:

1. ACTUAL NUMBER, LENGTH AND LOCATION OF ROCK BOLTS (TENSIONED OR UNTENSIONED) AND DRAIN HOLES TO BE INSTALLED ON THE PERMANENT SIDE WALLS OF THE SPILLWAY AND ON THE BLOCK BETWEEN THE SPILLWAYS ARE TO BE DECIDED DURING CONSTRUCTION. HOWEVER, FOR BIDDING PURPOSES 116 - 3 m AND 40 - 6 m LONG ROCK BOLTS (FOR A TOTAL LENGTH OF 588 m), AND 30 8-m LONG DRAIN HOLES ARE ESTIMATED. NOTWITHSTANDING THESE NUMBERS OF BOLTS, ROCK BOLT BARS SHALL BE DELIVERED TO THE SITE IN MILL LENGTHS OF 12.9 m (40 ft) THAT SHALL BE FIELD CUT TO THE REQUIRED LENGTHS.

2. ACTUAL AREA OF PERMANENT SIDE WALLS OF THE SPILLWAY WHERE DENTITION IS REQUIRED IS TO BE DECIDED DURING CONSTRUCTION. HOWEVER, FOR BIDDING PURPOSES 50 m² OF DENTITION IS ESTIMATED.

NUM	DATE	DWN	CKD	APR	DESCRIPTION

REVISIONS

NUM	DATE	APR	DESCRIPTION
11	MAY 26/11	CH/CKG	RE-ISSUED FOR CONSTRUCTION
10	OCT 29/10	CC	ISSUED FOR CONSTRUCTION
G	MAR 5/10	CC	RE-ISSUED FOR TENDER
F	FEB 9/10	CC	ISSUED FOR DISCUSSION
E	DEC 23/09	CC	ISSUED FOR TENDER
D	NOV 16/09	CH/RJW	ISSUED FOR TENDER
C	OCT 21/09	RJW	ISSUED FOR REVIEW
B	OCT 13/09	RJW	ISSUED FOR REVIEW
A	SEPT 23/09	RJW	ISSUED FOR REVIEW

DRAWING STATUS

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Date MAY 26, 2011
PERMIT NUMBER: P 018
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REGISTERED PROFESSIONAL ENGINEER
C.H.E. HUNT
LICENSEE
NWT/NU
26th May 2011

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NORTHWEST TERRITORIES POWER CORPORATION

EBA Engineering Consultants Ltd.

REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

ROCK STABILIZATION DETAILS

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.004	EDM	SF	CKG	0	C308
DATE:	SHEET No.	DWN	APP	STATUS	
October 2010	8 of 8	JAB/DG	CH	11	

C:\HOME WORK\Bluefish\IFC DRAWINGS REVISED 2011\Y14101066.027_C301-C306_R0_IFC.dwg [C308] May 27, 2011

1.0 GENERAL

1.1 In the case of conflict between information presented on this drawing and the information presented in the Technical Specifications, the Technical Specifications shall take precedence.

1.2 SI units are used throughout these drawings. All dimensions are in millimeters and all levels are in meters unless specifically noted otherwise.

1.3 Check all dimensions prior to commencing work and notify the Engineer of any conflicting or erroneous information.

1.4 All elevations are in meters(m), all dimensions are in millimeters(mm).

1.5 Do not scale dimensions from the drawings.

1.6 Opening dimensions are rough dimensions.

1.7 Definitions:

-TOR	Top of Rock	-TOS	Top of Steel	-TOC	Top of Concrete
-TOG	Top of Ground	-BOS	Bottom of Steel	-NTS	Not to Scale
-c/w	Complete with	-EA	Each	-o/c	On Center

2.0 DESIGN CRITERIA

2.1 Codes and Standards

(Do work in accordance with the current revision of the following standards except where specified otherwise.)

-National Building Code of Canada
-CSA A23.3 Design of Concrete Structures
-CSA S16 Limit States Design of Steel Structures

2.2 Design Loads

2.2.1 Live Loads:

2.2.1(b) Permissible usage loads due to human, moving equipment and laydown of parts:

-Bottom Outlet Control House Main Level	10 kPa
-Bottom Outlet Control House Roof Area	2 kPa
-Bottom Outlet Control House Hoist	5 tonne
-Railings & Partitions (Greater of)	2 kPa or 1.5kN/m

2.2.2 Seismic Loads:

-Peak ground acceleration	PGA = 0.059 g
-Importance factor	Ie = 1.5
-Site Classification	Site class B (Rock)

-Spectral parameters

Period, T	0.2s	0.5s	1.0s	2.0s
S(T)	0.116	0.056	0.023	0.006

2.2.3 Wind Loads:

-Design primary structural members	q10 = 0.34 kPa
-Design secondary members	q50 = 0.47 kPa
-Importance factor	Iw = 1.25

2.2.4 Snow and Rain Loads:

-Ground snow load	S_s = 2.2 kPa
-Associated rain load	S_r = 0.1 kPa
-Importance factor	Is = 1.25

2.2.5 Ice Loads:
-Distributed over the top 500mm of water   Ice=150 kN/m

2.2.6 Hydraulic Loads:

-Maximum flood water level	EL 170.22 m
-Normal operating water level	EL 168.78 m
-Minimum operating water level	EL 165.73 m

3.0 FORMWORK AND FINISHES

3.1 Design formwork and falsework to comply with CAN/CSA S269.1 and CAN/CSA S269.3

3.2 Formed Finishes

Finish F1: Forms built of standard formply with a minimum of refinement.

Finish F2: Forms for general application for surfaces exposed to view without stringent aesthetic requirements; of plywood, steel or form liner of pre-approved material.

Finish F4: Severe tolerance limit; of smooth sanded unlined and uncoated plywood.

3.3 Unformed Finishes

Finish U3: Steel troweled finish.

Finish U4: Hard, steel troweled finish; burnished.

Finish U5: Broom finish.

3.4 Form all exposed concrete corners and edges with 20 mm chamfers.

4.0 REINFORCEMENT

4.1 Materials

4.1.1 Reinforcement for structural concrete and rock dowels:
-Deformed bar reinforcement to CSA G30.18, Grade 400W
-Minimum yield strengths for deformed reinforcement   fy = 400 MPa
-Rock dowels galvanized to CSA G164

4.1.2 Dywidag Threadbar for rock bolts:
-Rock bolts to ASTM A722, Grade 835/1030
-Minimum yield strength for rock bolts   fy = 835 MPa
-Galvanized to CSA G164
-Prestressed load range   Pd = 0 kN

4.1.3 Dywidag Threadbar for DCP rock anchors:
-Rock Anchors to ASTM A722, Grade 835/1030
-Minimum yield strength for rock anchors   fy = 835 MPa
-Double corrosion protection   DCP
-Prestressed load range   Pd = 500 kN to 5000kN

4.2 Definitions

-E.F. Each Face	-N.F. Near Face	-F.F. Far Face
-D.B. Dowel Bar	-H1E Hook One End	-H2E Hook Two Ends

4.3 Minimum Concrete Cover:

-Cast Against Soil	-75mm
-Contact with Water	-60mm
-Contact with Air or Soil	-50mm

4.4 Tolerances On Concrete Cover:

-On cover	-0 mm, +10 mm
-On effective depth(from face opposite to rebar)	-10 mm, +10 mm
-On embedment and lap lengths	-0 mm, NO UPPER LIMIT
-On standard hook dimensions	-0 mm, NO UPPER LIMIT

4.5 Splices

4.5.1 All splice lengths not explicitly indicated on drawings are Type B, as defined by Clause 12.15.1 of CSA A23.3. Unless noted otherwise, minimum splice lengths are:

Bar Diameter(mm)	Top Bar(mm)	Other(mm)
10M	450	350
15M	700	550
20M	900	700
25M	1400	1100

Top bars have 300 mm or more of concrete cast below them.

4.5.2 Locate reinforcement splices only where shown on the drawings. No additional splices are allowed without the prior written approval of the Engineer.

4.6 Do not weld or tack-weld reinforcement.

4.7 Only vertical column and pedestal dowel bars may be cranked at lap locations by 1:6.

4.8 Fabricate bends and hooks of bars to Clause 12.2 of A23.1 unless otherwise dimensioned on the drawings.

4.9 Bend all steel reinforcement cold.

4.10 Spacing limits for reinforcement

4.10.1 Clear distance between parallel bars in a layer not less than 1.4 times the bar diameter, not less than 1.4 times the nominal maximum size of the coarse aggregate, and not less than 30 mm.

4.10.2 Where parallel reinforcement is placed in two or more layers, place bars in the upper layers directly above bars in the lowest layer.

4.11 Drawing Symbols

-Standard 90° hook
Elevation   Plan

-Standard 180° hook

-Lapped splice   OR   OR

-Bottom or far face bars

-Top or near face bars

5.0 CONCRETE

5.1 Materials

5.1.1 Concrete
-Cement: To CSA A3000 Type GU.
-Aggregates: To CSA A23.1 Maximum size of course aggregate is 20mm.
-Admixtures: CSA A3000, ASTM C260, ASTM C494 and ASTM C1017. Calcium chloride admixtures not permitted.
-Exposure Class: CSA A23.1, F-1(Exposed to Freeze-Thaw, no chlorides)

5.1.2 Concrete Mixes:
1) Structural Reinforced Concrete
-Mix   C30
-Specified 28 day compressive strength   f'c = 30 MPa

2) Bonding Layer Concrete
-Mix   C30B
-Specified 28 day compressive strength   f'c = 30 MPa

5.1.3 Non-Shrink Grouts:
-Cementicious pre-mixed grout
-Specified 28 day compressive strength   f'c = 40 MPa

5.1.4 Concrete Bonding Agent:
-Daraweld-C or pre-approved alternate.

5.1.5 Waterstops:
-Greenstreak Type 679 Ribbed PVC Extruded Waterstop.
-Voclay RX-101T Waterstop with WB-Adhesive.

5.2 Do not add additional water to the concrete after batching and mixing in accordance with the mix design. The Engineer may reject any concrete to which additional water was added without further cause.

5.3 Do not place concrete without prior inspection and approval by the Engineer.

5.4 Locate construction joints as shown on the drawings. Do not make additional construction joints without the prior written approval of the Engineer.

5.5 Do not remove forms before the concrete achieves a cylinder strength of at least 70% of the specified compressive strength or twice the maximum stress present in the concrete after form removal.

5.6 Commence with curing of all surfaces immediately after stripping of forms.

5.7. Roughen all vertical and horizontal construction joints to minimum 5 mm amplitude by means of air/water jet blasting or bush-hamering to remove laitance and expose coarse aggregate. Simple roughening of freshly cast surface is not adequate.

5.8 Drawing Symbols

Construction joints:

6.0 EMBEDMENTS

6.1 Anchor Rods

6.1.1 Cast-in-Place Anchors:
a) Carbon Steel (Galvanized) -Plate to CSA G40.21M Grade 300W
-Rod to CSA G40.21M Grade 300W

b) Stainless Steel -Plate to ASTM A666, Type AISI 304
-Rod to ASTM A276, Type AISI 304

6.1.2 Post-Installed Anchors:
a) Adhesive -Hilti HIT-HY150 Max or Hilti HIT-ICE as detailed

b) Carbon Steel (Galvanized) -Plate to CSA G40.21M Grade 300W
-Threaded Rod to Hilti HAS-E-STD ISO 898 Class 5.8 or to ASTM F1554 Grade A36 as specified on the drawings.

c) Stainless Steel -Plate to ASTM A666, Type AISI 304
-Threaded Rod to Hilti HAS-SS AISI 304/316 SS
-Expansion Ancors to HILTI KWIK Bolt 3 AISI 304/316 SS

6.2 Verification of Embeddments

6.2.1 Ensure that required structural, mechanical, electrical or other embeddments are accurately placed prior to concreting.

6.2.2 Do not place additional embeddments for construction purposes without the prior written approval of the engineer.

6.3 Protect exposed ends of anchor bolts embedded in concrete from damage during and after concrete placement.

7.0 STRUCTURAL STEEL

7.1 Materials: to CSA G40.21M (Galvanized)

Shapes	Grade	Yield Stress
W, L, and C Shapes	350W	350 MPa
HSS Shapes	350W(Class C)	350 MPa
Plate	300W	300 MPa
Bar	300W	300 MPa

7.2 Materials: to ASTM A653/A653M (Galvanized)

Shapes	Grade	Yield stress
Roof and Wall Cladding	33	230 MPa
Cold Formed Sections	50	345 MPa

7.3 Stainless Steel Membrane: to ASTM A320, Type 304   Fy = 205 MPa

7.4 Stainless Steel Structural Sections: to ASTM A276, Type 304   Fy = 205 MPa

7.5 Bolted Connections

7.5.1 Materials
(a)Primary Structural Carbon Steel (Galvanized):
Bolts: to ASTM A325
Nuts: to ASTM A563M
Washers: to ASTM F436M Type I.

(b)Cold Formed Carbon Steel (Galvanized):
Bolts: to ASTM A307
Nuts: to ASTM A563A
Washers: to ASTM F844

(c)Stainless Steel:
Bolts: to ASTM A320 Type 304-B8 Class 2
Nuts: to ASTM A194M Type 304N Grade 8
Washers: to ASTM A666M Type 304N.

7.5.2 Install bolts by the turn-of-nut method in accordance with CAN/CSA S16.1.

7.6 Welds (for structural and miscellaneous steel items):

7.6.1 Welding: to CSA W59 E49XX and ASME BPVC Section IX unless noted otherwise.

7.6.2 Perform all welding using welders certified in accordance with the requirements of CSA W47.1.

7.6.3 Unless noted otherwise, welds are 6 mm continuous fillet welds.

7.7 Unless shown otherwise, all gusset plates are 10 mm thick.

7.8 Unless noted otherwise, seal the ends of all tubular and hollow-section members with 6 mm thick plates and continuous fillet welds. Provide ventilation holes at both ends of completely sealed tubular and hollow-section members to avoid welding blow-out.

8.0 NON-STRUCTURAL COMPONENTS

8.1 Flashing and Trim
-For flashing and trim see specification 07620.
-All galvanized steel flashing and trim are to be a mimimum 24 gauge (0.61mm).
-Fasteners: Install all flashing, trim and other various sheet metals with galvanized screws or rivets.

8.2 For weather barriers see specification 07210.

8.3 Roof Cladding
-Mercury Metals 22ga. CL-912 R roof cladding or pre-approved equivalent.

8.4 Wall Cladding
-Mercury Metals 22ga. CL-912 wall cladding or pre-approved equivalent.

8.5 Insulation

8.4.1 Ceiling and Wall Insulation for the Gate Control House:
-Ceiling rating of R28
-Wall rating of R20.

9.0 FOUNDATIONS

9.1 Benched excavations are shown for illustrative purposes only. All concrete, backfill and stabilization measures behind the payline will be at the contractor's cost.

9.2 Backfill all excavations with clean, frost-stable 50mm granular select structural fill compacted in 300mm lifts compacted to 95% SPDD.

9.3 The foundation levels given on the drawings are anticipated levels.The final foundation levels will determined by the Engineer based on actual site conditions.

9.4 Prior to placing concrete, remove and replace all areas of loose or soft material or compact subgrade soils as directed by the Engineer.

9.5 Keep excavations free of standing water at all times.

10.0 TEMPORARY STRUCTURES

10.1 Design and detail all temporary structures, in particular the excavation support system. Submit the design and drawings for such structures to the Engineer for approval prior to construction.

10.2 Maintain all structures in a stable condition during construction and ensure at all times that no part of the structure is overstressed due to the construction activities.

11.0 EQUIPMENT

11.1 Slide Gates
-Series 20 Stainless Steel Fabricated Slide Gates manufactured by Fontaine or pre-approved alternate.
-For Slide Gate see Technical Specification 11405.

11.2 Stop Logs
-Series 95 Stainless Steel Fabricated Stop Log manufactured by Fontaine or pre-approved alternate.
-For Stop Log see Technical Specification 11630.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER
P 334
GYGAX ENGINEERING ASSOCIATES LTD.

10	ISSUED FOR CONSTRUCTION	28 OCT 2010
REVISION		DATE

Northwest Territories Power Corporation
BLUEFISH SPILLWAY REPLACEMENT PROJECT

TITLE:
STRUCTURAL NOTES

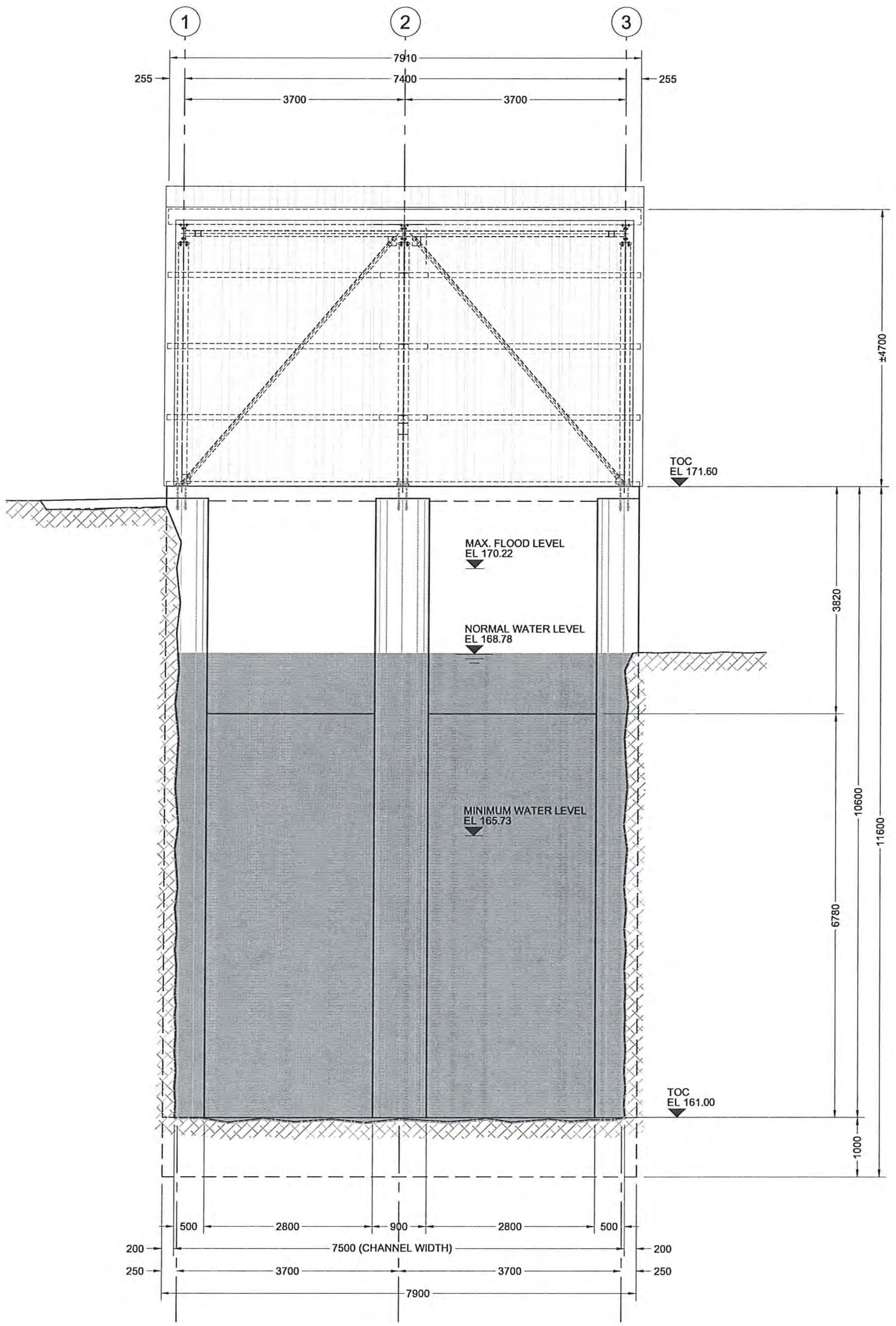
GEA Gygax Engineering Associates Ltd.
103-1718 Commercial Drive
Vancouver, B.C., Canada V5N 4A3
Tel: (1 604) 254 3914 Fax: (1 604) 254 3928
E-mail: mail@gea.ca

eba EBA Engineering Consultants Ltd.
PO Box 2244 201 - 4916 49th Street
Yellowknife, NT, Canada X1A 2P7
Tel: (1 867) 920 2287
Fax: (1 867) 873 3324

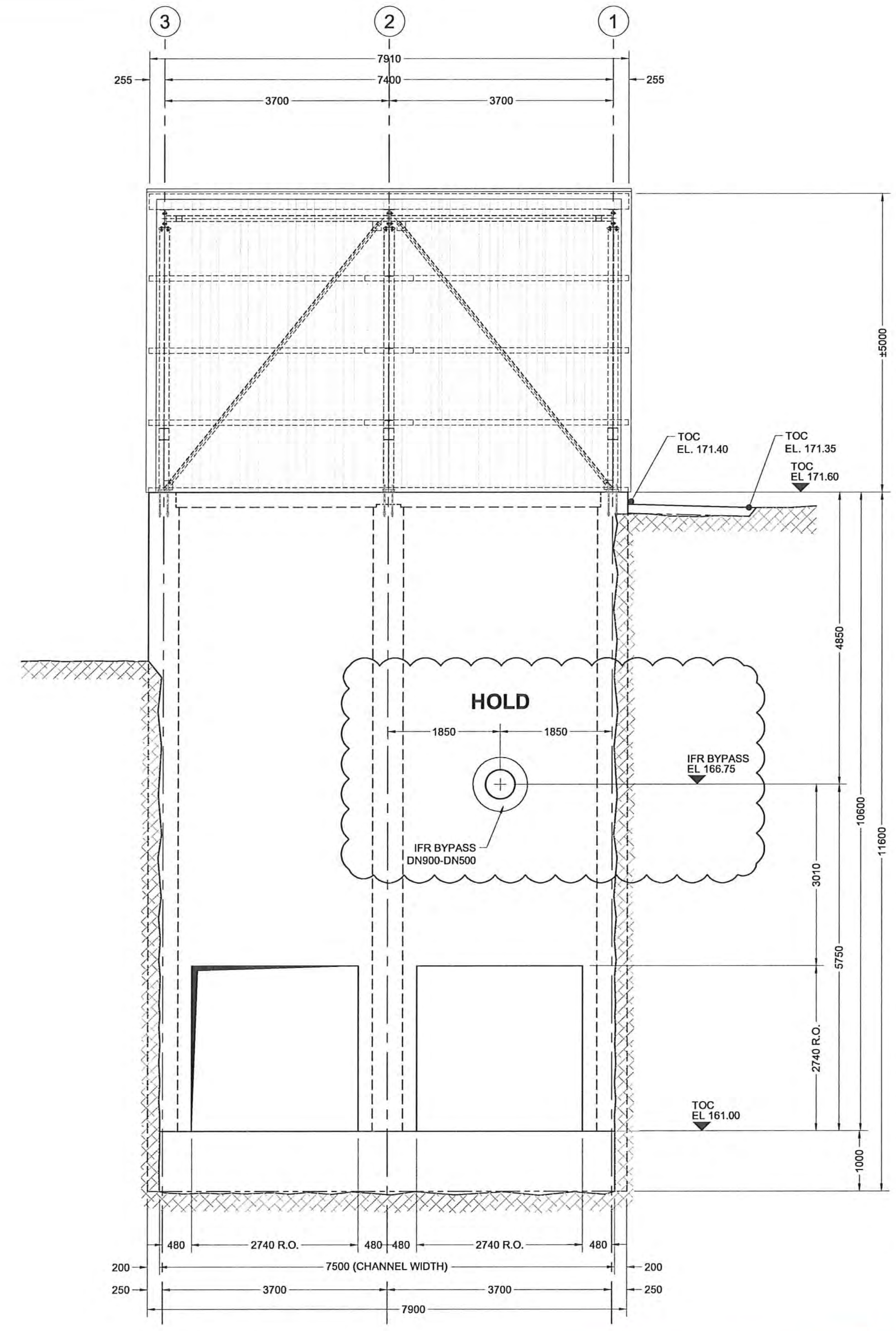
REGISTERED PROFESSIONAL ENGINEER
OCT 2 8 2010
K.A. GYGAX
LICENSEE
N.W.T.

SCALE:

DRAWN:	A. ORTIZ	DATE:	13 NOV 2009
CHECKED:	T. LOVRIC	DATE:	16 NOV 2009
APPROVED:	A. GYGAX	DATE:	16 NOV 2009
DRAWING NO:	09012.621- S401		10



A ELEVATION - UPSTREAM
S801 SCALE: 1:50



B ELEVATION - DOWNSTREAM
S801 SCALE: 1:50

NOTES:

1. REFER TO DRAWING S401 FOR COMPLETE STRUCTURAL NOTES.

REVISION		DATE
10	ISSUED FOR CONSTRUCTION	28 OCT 2010

Northwest Territories Power Corporation
BLUEFISH SPILLWAY REPLACEMENT PROJECT

TITLE:
BOTTOM OUTLET GENERAL ARRANGEMENT
ELEVATIONS

GEA Gygax Engineering Associates Ltd.
103-1718 Commercial Drive
Vancouver, B.C., Canada V5N 4A3
Tel: (1 604) 254 3914 Fax: (1 604) 254 3928
E-mail: mail@gea.ca

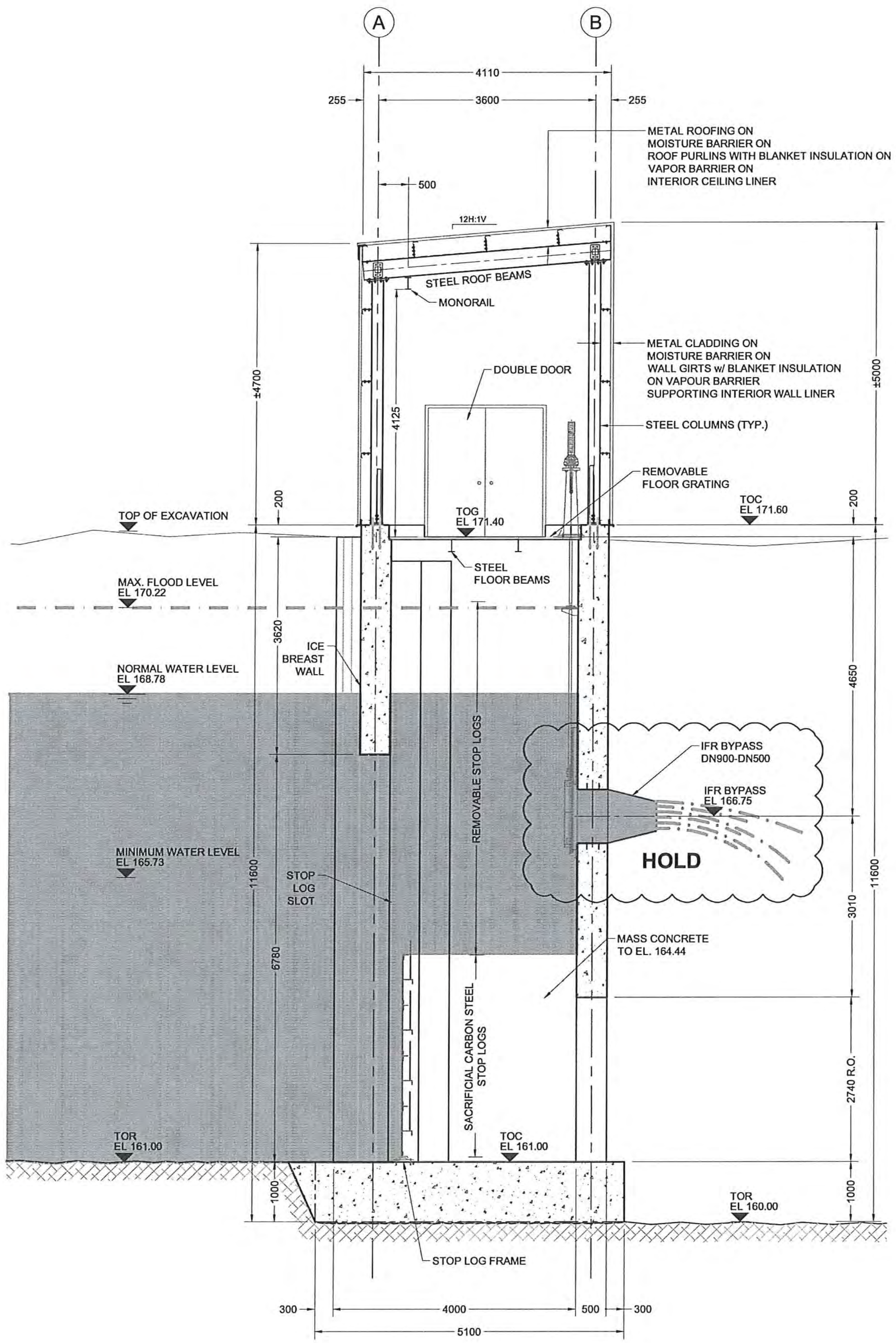
eba EBA Engineering Consultants Ltd.
PO Box 2244 201 - 4916 49th Street
Yellowknife, NT, Canada X1A 2P7
Tel: (1 867) 920 2287
Fax: (1 867) 873 3324

SCALE: 1:50 0 4.0 m

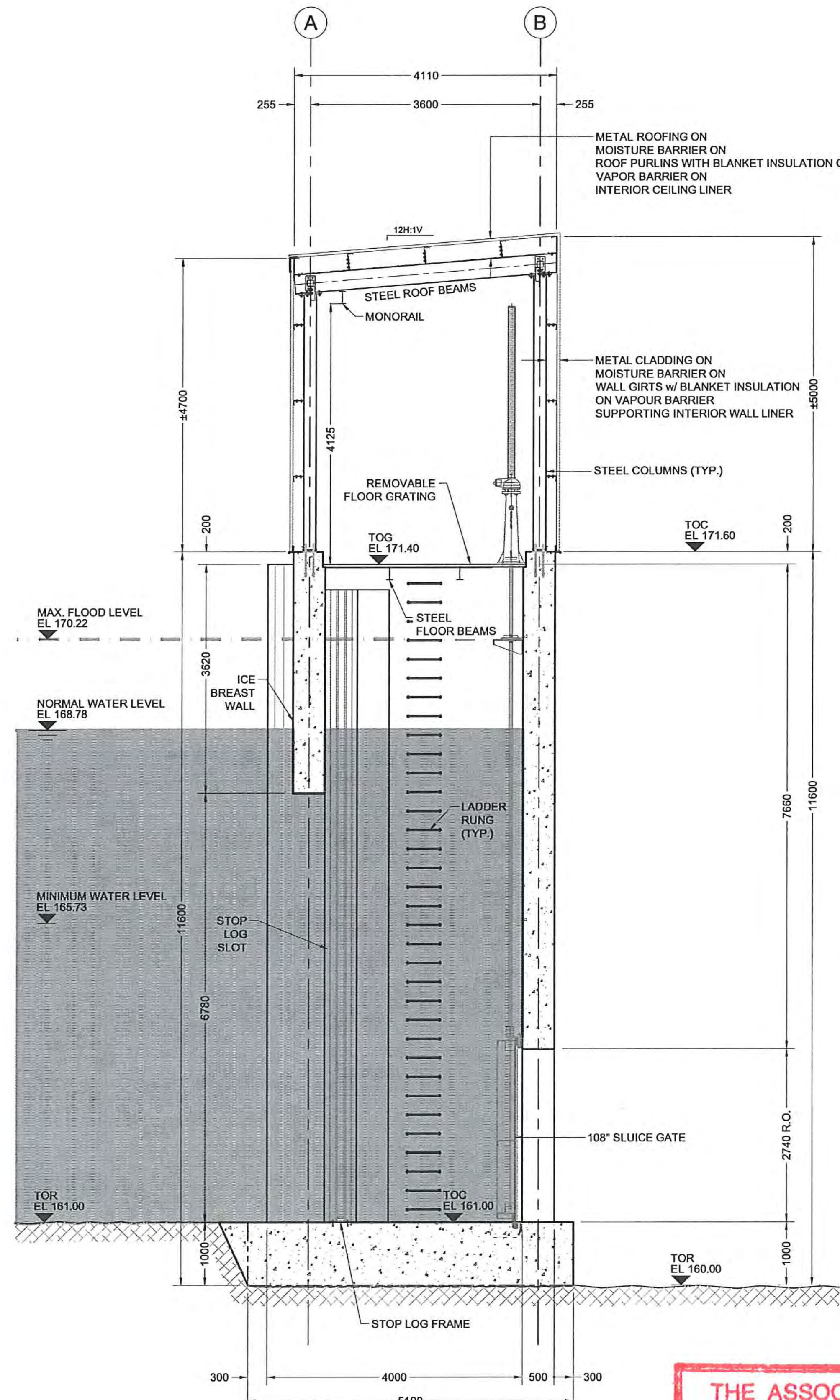
DRAWN:	T. LOVRIC	DATE:	23 AUG 2010
CHECKED:	A. GYGAX	DATE:	23 AUG 2010
APPROVED:	A. GYGAX	DATE:	27 OCT 2010
DRAWING NO:	09012.621-S803		10

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 334
GYGAX ENGINEERING ASSOCIATES LTD.

REGISTERED PROFESSIONAL ENGINEER
OCT 28 2010
K. A. GYGAX
LICENSEE
N.W.T.



C SECTION
S801 SCALE: 1:50



D SECTION
S801 SCALE: 1:50

NOTES:

1. REFER TO DRAWING S401 FOR COMPLETE STRUCTURAL NOTES.

REVISION		DATE
10	ISSUED FOR CONSTRUCTION	28 OCT 2010

Northwest Territories Power Corporation

BLUEFISH SPILLWAY REPLACEMENT PROJECT

TITLE:

BOTTOM OUTLET GENERAL ARRANGEMENT
SECTIONS

GEA Gygax Engineering Associates Ltd.
103-1718 Commercial Drive
Vancouver, B.C., Canada V5N 4A3
Tel: (1 604) 254 3914 Fax: (1 604) 254 3928
E-mail: mail@gea.ca

eba EBA Engineering Consultants Ltd.
PO Box 2244 201 - 4916 49th Street
Yellowknife, NT, Canada X1A 2P7
Tel: (1 867) 920 2287
Fax: (1 867) 873 3324

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER
P 334
GYGAX ENGINEERING ASSOCIATES LTD.

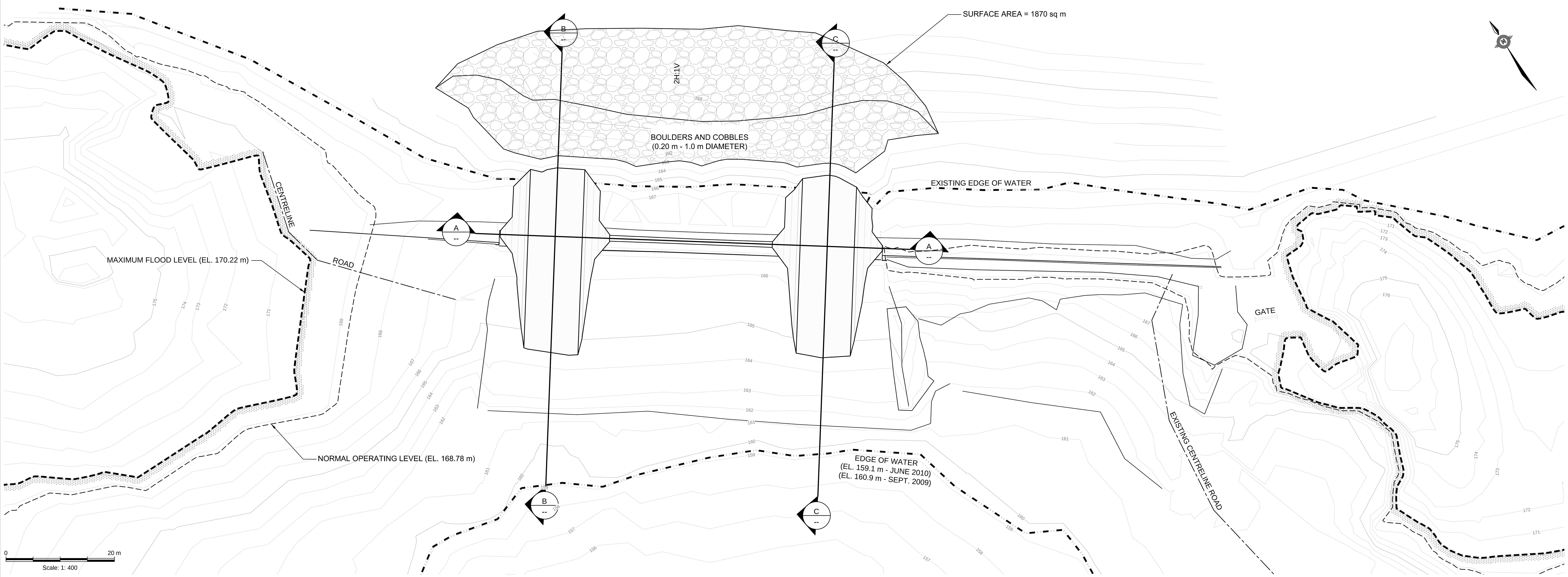
REGISTERED PROFESSIONAL ENGINEER
OCT 28 2010
K. A. GYGAX
LICENSEE
N.W.T.

SCALE: 1:50 (0 – 4.0 m)

DRAWN:	T. LOVRIC	DATE:	23 AUG 2010
CHECKED:	A. GYGAX	DATE:	23 AUG 2010
APPROVED:	A. GYGAX	DATE:	27 OCT 2010
DRAWING NO:	09012.621-S804		10

APPENDIX III

Original Bluefish Dam Decommissioning Plan Figure



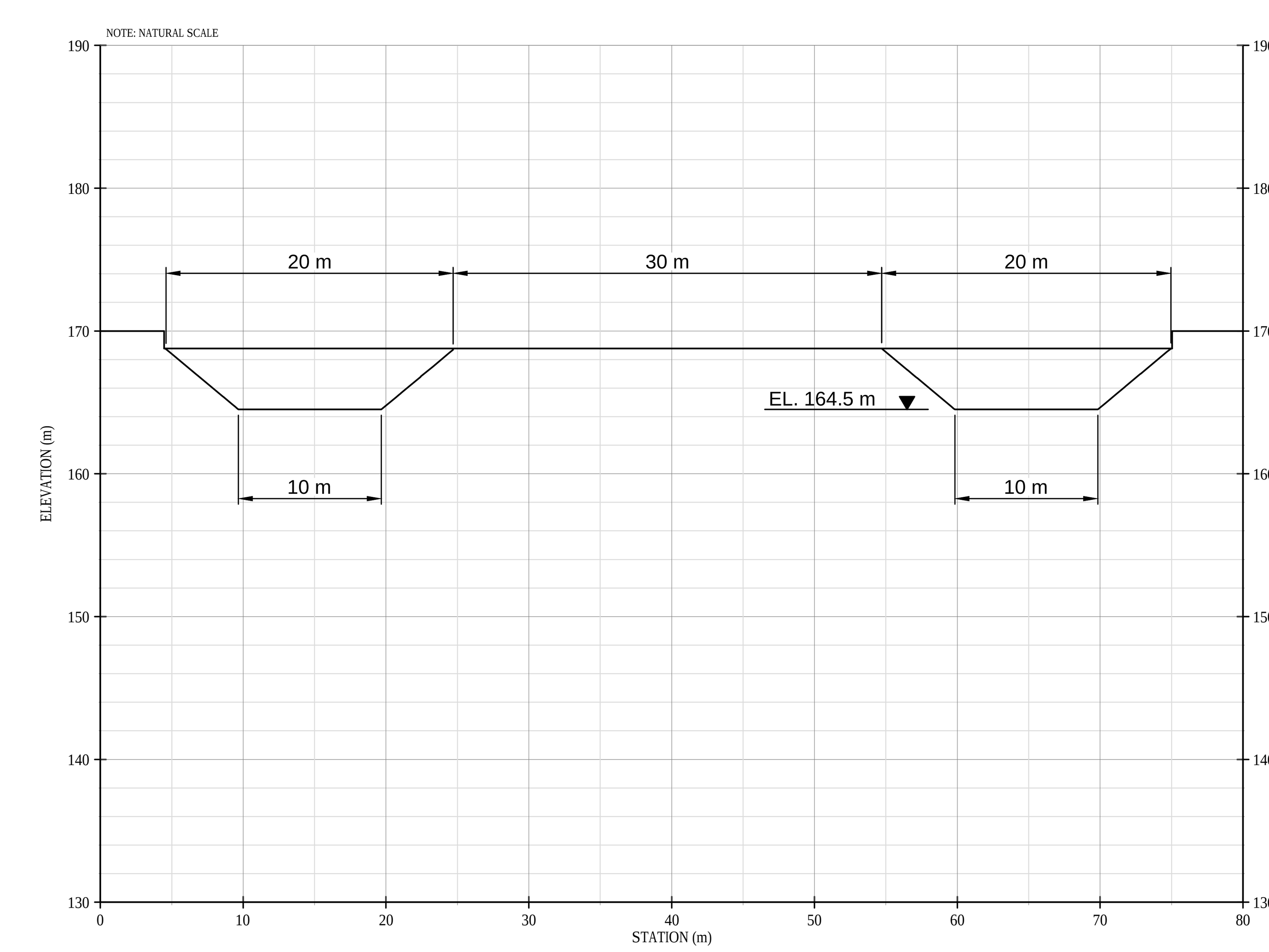
NOTES
DATUM: UTM ZONE 11 NAD 83, METRE; CENTRAL MERIDIAN 117d W

ELEVATIONS ARE GEODETIC. CONVERSION TO PREVIOUS DATUM: GEODETIC + 17.15 m

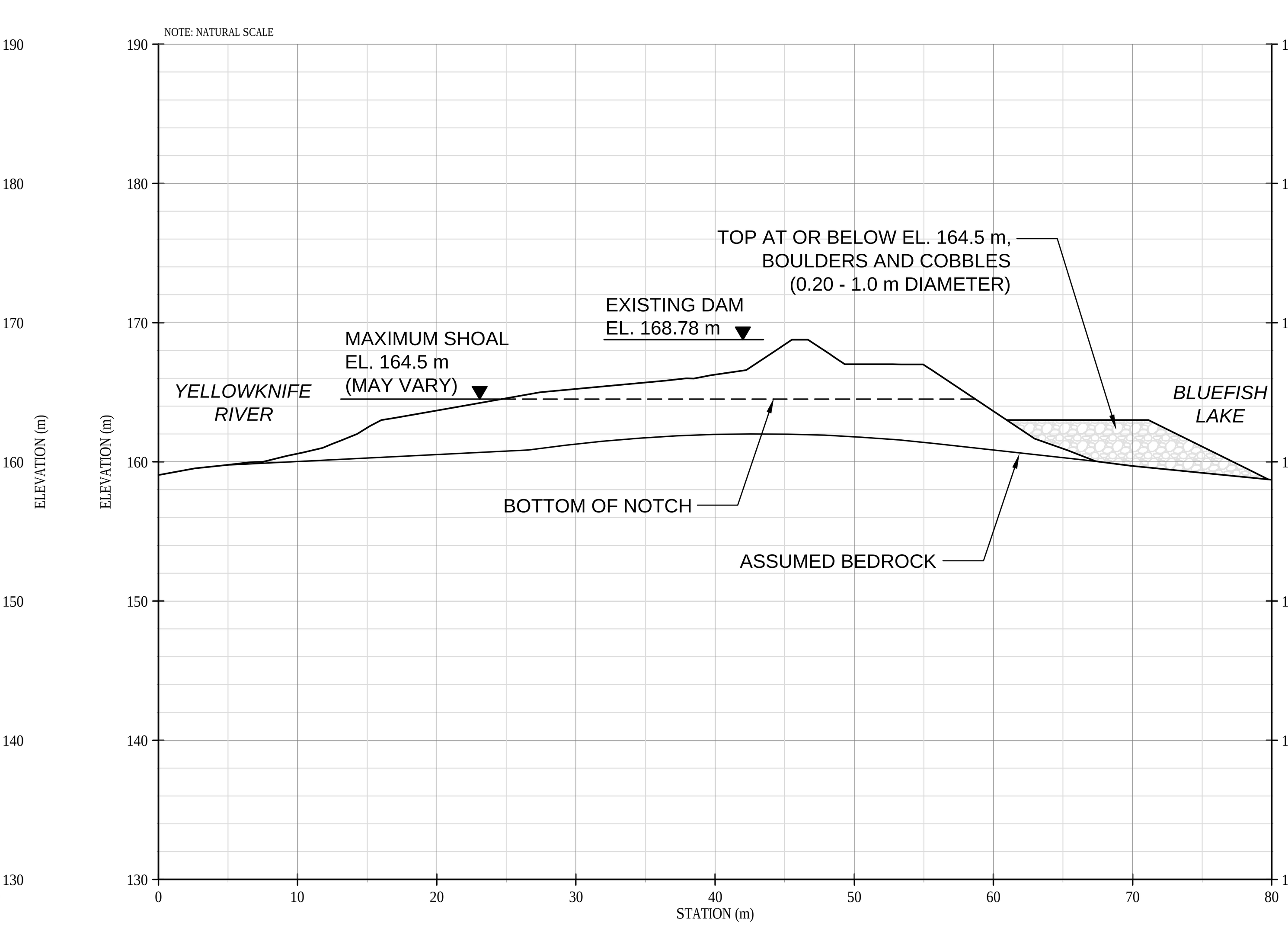
SURVEY DATA PROVIDED BY SUB-ARCTIC SURVEYS LTD.

1.0 m CONTOUR INTERVAL

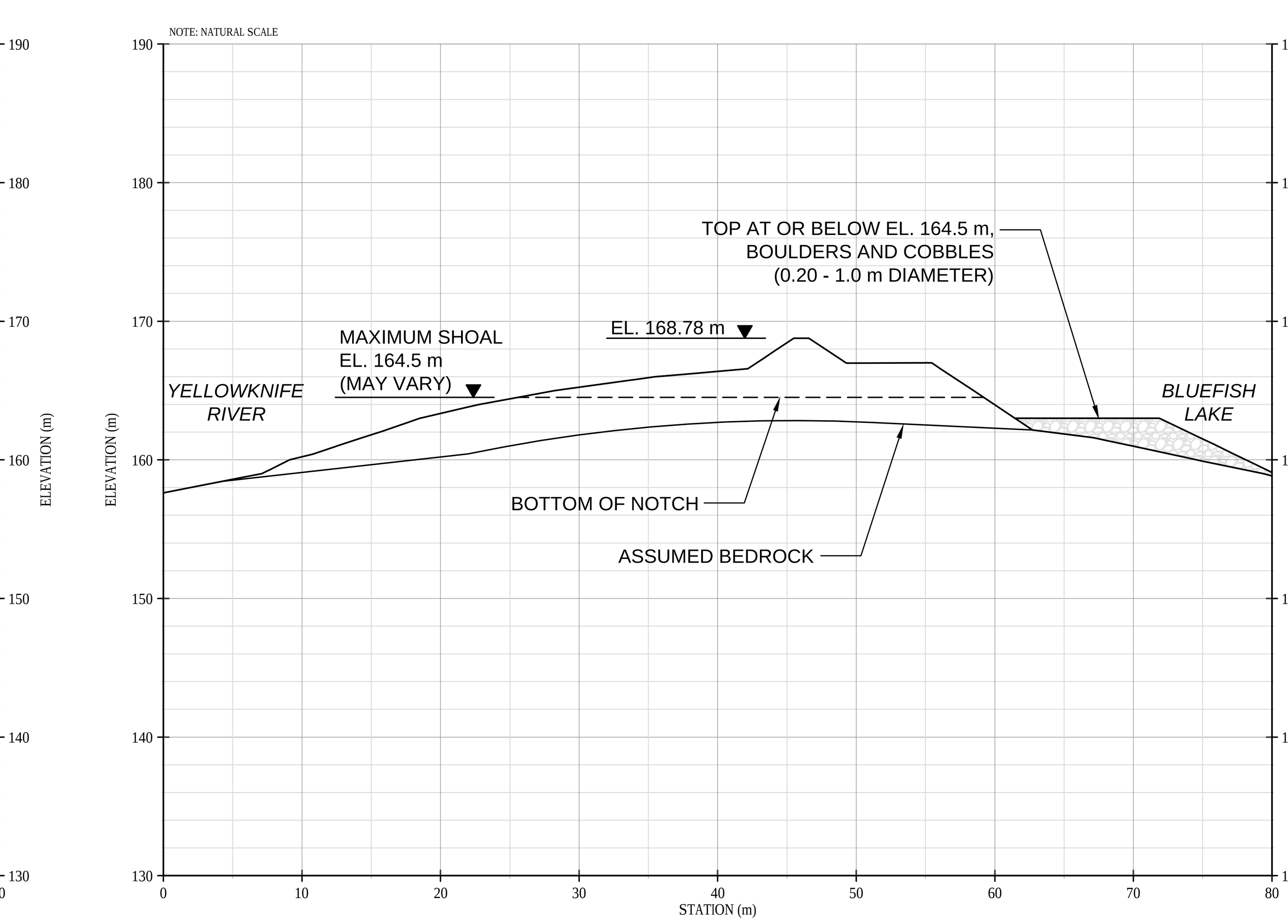
BATHYMETRY BASED ON DATA COPIED/SCANNED FROM ARCHIVED ACRES INTERNATIONAL DRAWINGS FOR EARLY 1980's REHABILITATION OF EXISTING DAM



SECTION A
1:400



SECTION B
1:400



SECTION C
1:400

NUM	DATE	APR	DESCRIPTION

REVISIONS

NUM	DATE	APR	DESCRIPTION
A	07-12-2011	'	50% complete drawing

DRAWING STATUS

PERMIT

PROFESSIONAL SEAL

CLIENT

NORTHWEST TERRITORIES POWER CORPORATION

eba A TETRA TECH COMPANY

EXISTING DAM AND SPILLWAY DECOMMISSIONING
BLUEFISH HYDRO, NT

NTPC BLUEFISH HYDRO
BLUEFISH LAKE FISH COMMUNITY
HABITAT INSTALLATION

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.004	EDM	RR/CKG	CKG	0	FIGURE 1
DATE:	SHEET No.	DWN	APP	STATUS	
July 12, 2011	1 of 2	EL	CKG	A	

APPENDIX IV

MVLWB Water License

Mackenzie Valley Land and Water Board
7th Floor - 4910 50th Avenue • P.O. Box 2130
YELLOWKNIFE, NT X1A 2P6
Phone (867) 669-0506 • FAX (867) 873-6610

June 26, 2006

File: MV2005L4-0008

Ms. Myra Berrub
Coordinator, Business and Energy Development
Northwest Territories Power Corporation
4 Capital Drive
HAY RIVER, NT X0E 1G2

FAX: (867) 874-5229

Dear Ms. Berrub:

ISSUANCE OF A TYPE "A" WATER LICENCE

Attached is Water Licence MV2005L4-0008 granted by the Mackenzie Valley Land and Water Board (MVLWB) in accordance with the *Northwest Territories Waters Act*. A copy of this Licence has been filed in the Public Registry at the office of the MVLWB. The MVLWB approved Water Licence MV2005L4-0008 for a period of fifteen (15) years commencing immediately and expiring April 2, 2021.

Attached are general procedures for the administration of licences in the Northwest Territories. The MVLWB requests that you review these and address any questions to the Board's office.

Please be advised that this letter, with attached procedures, all inspection reports, and correspondence related thereto, are part of the Public Registry, and are intended to keep all interested parties informed of the manner in which the Licence requirements are being met. All Public Registry material will be considered if an amendment to the Licence is requested.

The full cooperation of the Northwest Territories Power Corporation is anticipated and appreciated.

Yours sincerely,

V Blondin

Violet Camsell-Blondin
Chair, Bluefish Water Licence Tribunal

Attachments

Copied to: North Slave Region Distribution List

MACKENZIE VALLEY LAND AND WATER BOARD
WATER LICENCE

Pursuant to the *Mackenzie Valley Resource Management Act* and Regulations, the Mackenzie Valley Land and Water Board, hereinafter referred to as the Board, hereby grants to:

Northwest Territories Power Corporation
(Licensee)

of 4 Capital Drive, Hay River, NT X0E 1G2
(Mailing Address)

Hereinafter called the Licensee, the right to alter, divert or otherwise use water subject to the restrictions and conditions contained in the *Northwest Territories Waters Act* and Regulations made thereunder and subject to and in accordance with the conditions specified in this Licence.

Licence Number:	MV2005L4-0008 (RENEWAL OF N1L4-0735)
Licence Type:	A
Water Management Area:	NORTHWEST TERRITORIES 01
Location:	BLUEFISH POWER GENERATION FACILITIES, NT
Purpose:	STORAGE AND DIVERSION OF WATER FOR A HYDROELECTRIC POWER UNDERTAKING AND ASSOCIATED USES
Description:	CLASS II HYDROPOWER GENERATION
Effective Date of Licence:	APRIL 3, 2006
Expiry Date of Licence:	APRIL 2, 2021

This Licence issued and recorded at Yellowknife includes and is subject to the annexed conditions.

MACKENZIE VALLEY LAND AND WATER BOARD

Witness

Chair,
Bluefish Water Licence Tribunal

APPROVED BY

Minister of Indian and Northern Affairs Canada

PART A: SCOPE AND DEFINITIONS

1. Scope

a) This Licence entitles the Northwest Territories Power Corporation (the **Licensee**) to use, divert and store water from the McCrea River and the Yellowknife River to the Duncan and Bluefish Lakes respectively for the Class II hydroelectric power undertaking and associated uses related to the Bluefish **Power Generation Facilities**, Northwest Territories (62° 40' North and 114° 15' West);

b) This Licence is issued subject to the terms and conditions contained herein with respect to the use of water. Whenever new **Regulations** are made or existing **Regulations** are amended by the Governor in Council under the *Northwest Territories Waters Act*, or other statutes imposing more stringent conditions relating to the quantity of water which may be used, this Licence shall be deemed, upon promulgation of such **Regulations**, to be automatically amended to conform with such **Regulations**; and

c) Compliance with the terms and conditions of this Licence does not relieve the **Licensee** from responsibility for compliance with the requirements of any applicable Federal, Territorial and Municipal legislation.

2. Definitions

In this Licence: MV2005L4-0008

"*Act*" means the *Northwest Territories Waters Act*;

"Board" means the Mackenzie Valley Land and Water Board established under part 4 of the *Mackenzie Valley Resource Management Act*;

"Inspector" means an **Inspector** designated by the **Minister** under section 35(1) of the *Northwest Territories Waters Act*;

"Licensee" means the holder of this Licence;

"Minister" means the **Minister** of Indian and Northern Affairs Canada;

"NTPC Datum at Bluefish Lake Dam" means the Water Survey of Canada benchmark elevation of 194.388 metres (637.756 feet), which is the top of the drill steel cemented in bedrock, top of the hill on the south end of the dam. This was formerly known as Miramar Datum at Bluefish Lake Dam;

"NTPC Datum at Duncan Lake" means the Water Survey of Canada benchmark elevation of 214.605 metres (704.085 feet), which is the brass cap in bedrock (marked by iron pipe) 23.3 metres northwest of shelter, 21.2 metres north of BM 88-2, and 19.5 metres northwest of BM 88-1. This was formerly known as Miramar Datum at Duncan Lake;

"Power Generation Facilities" means the Duncan Lake Reservoir and control structure, McCrea River, Yellowknife River, Bluefish Lake Reservoir and spillway dam, and the Bluefish forebay, penstock, intake, powerhouses and tailraces as indicated on Drawing Numbers YH-61-1, dated February 25, 1972, YH-63-2 dated August 23, 1973 and the Bluefish Topographical dated October 18, 1995;

"Regulations" means **Regulations** proclaimed pursuant to section 33 of the *Northwest Territories Waters Act*; and

"Waste" means **Waste** as defined by section 2 of the *Northwest Territories Waters Act*.

PART B: GENERAL CONDITIONS

1. The water use fee shall be paid annually in advance of any water use.

2. The **Licensee** shall maintain the current security deposit of $50,000 pursuant to section 17(1) of the ***Act*** and section 12 of the **Regulations**. The **Licensee** shall also post any further amounts required by the **Board** during the term of this Licence. The security deposit shall be maintained until such time as it is fully or in part refunded by the **Minister** pursuant to section 17 of the ***Act***. This clause shall survive the expiry or renewal of this Licence.

3. The **Licensee** shall be liable for any and all costs related to the abandonment and restoration of the **Power Generation Facilities** over and above the total amount of the security deposit posted under part B, item 2.

4. The **Licensee** shall file an Annual Report with the **Board** not later than March 31 of the year following the calendar year reported which shall contain the following information:

   a) a listing of the recorded daily and monthly water levels in metres (**NTPC Datum at Bluefish Lake Dam** and **NTPC Datum at Duncan Lake**) at Bluefish and Duncan Lakes Dam Reservoirs;

   b) a listing of the computed daily and monthly mean water flows in cubic metres per second passing through the Bluefish Powerhouses;

   c) a listing of the computed daily and monthly mean water flow rates in cubic metres per second in the Yellowknife River at the inlet of Prosperous Lake;

   d) a detailed record of modifications and major maintenance work carried out on the **Power Generation Facilities**;

   e) revisions to the contingency plans required under part F, items 1, 2 and 6 and the abandonment and restoration plans required under part J, items 1 and 3;

f) tabular summaries of all data generated under the *Surveillance Network Program* annexed to this Licence;

g) a list of all unauthorized discharges; and

h) any other details on water use or operating procedures requested by the **Board** on or before November 1 of the year being reported.

5. Meters and devices used for measuring water levels and water flows shall be installed, operated and maintained by the **Licensee** to the satisfaction of an **Inspector**.

6. The **Licensee** shall comply with the *Surveillance Network Program* annexed to this Licence, and any amendment to the said *Surveillance Network Program* as may be made from time to time, pursuant to the conditions of this Licence.

7. The attached *Surveillance Network Program* and compliance dates specified in the Licence may be amended at the discretion of the **Board**.

8. The **Licensee** shall post and maintain signs to identify the stations listed in the attached *Surveillance Network Program*. All postings shall be located and maintained to the satisfaction of an **Inspector**.

9. The **Licensee** shall ensure a copy of this Licence is maintained at the **Power Generation Facilities** at all times.

PART C: CONDITIONS APPLYING TO STUDIES

1. The **Licensee** shall submit to the **Board** for approval Terms of Reference for any studies deemed necessary by the **Board** during the term of this Licence.

2. The **Licensee** shall carry out any studies required by the **Board** according to the Terms of Reference referred to in part C, item 1 as and when approved by the **Board**.

PART D: CONDITIONS APPLYING TO OPERATION

1. The **Licensee** may store and divert water to generate electrical power from the **Power Generation Facilities** or as modified by part E, item 1.

2. The **Licensee** shall operate the **Power Generation Facilities** in a manner such that:

   a) the Bluefish Lake Reservoir water level does not fall below 182.88 metres (**NTPC Datum at Bluefish Lake**); and

   b) the **Power Generation Facilities** are maintained to the satisfaction of an **Inspector**.

3. A minimum flow of six (6) cubic metres per second shall be maintained in the Yellowknife River below the Bluefish Powerhouses and above the inlet to Prosperous Lake.

4. The **Licensee** shall install and maintain a guard on all water intakes to prevent entrainment of fish in accordance with the *Fisheries Act* and any other applicable legislation.

5. The **Licensee** shall submit to the **Board**, prior to June 1 and December 1 of each year, a Reservoirs Operation Plan for the next six (6) month period. These plans shall show the forecasted monthly average river inflow and outflow values in cubic metres per second and subsequent reservoir levels above mean sea level.

6. The **Licensee** shall have detailed geotechnical inspections of all **Power Generation Facilities** undertaken by a qualified geotechnical engineer registered in the Northwest Territories. These inspections shall take place every four (4) years starting in 2009 when the annual water level in the Yellowknife River is high. The engineer's report shall be submitted to the **Board** no later than sixty (60) days after the inspection, and shall include a covering letter from the **Licensee** outlining an implementation plan to respond to any recommendations made by the engineer.

PART E: CONDITIONS APPLYING TO MODIFICATIONS

1. The **Licensee** may, without written approval from the **Board**, carry out modifications to the **Power Generation Facilities** provided that such modifications are consistent with the terms of this Licence and the following requirements are met:

   a) the **Licensee** has notified the **Board** in writing of such proposed modifications at least sixty (60) days prior to beginning the modifications;

   b) such modifications do not place the **Licensee** in contravention of either the Licence or the ***Act***;

   c) the **Board** has not, during the sixty (60) days following notification of the proposed modifications, informed the **Licensee** that review of the proposal will require more than sixty (60) days; and

   d) the **Board** has not rejected the proposed modifications.

2. Modifications for which all of the conditions referred to in part E, item 1 have not been met may be carried out only with written approval from the **Board**.

3. The **Licensee** shall provide to the **Board** any applicable as-built plans and drawings of the modifications referred to in part E, items 1 and 2 of this Licence within ninety (90) days of completion of the modifications.

PART F: CONDITIONS APPLYING TO CONTINGENCY PLANNING

1. The **Licensee** shall submit to the **Board** for approval an updated General Contingency Plan within six (6) months following the issuance of this Licence. The General Contingency Plan shall be in accordance with the Canadian Dam Safety Association's "Dam Safety Guidelines".

2. The **Licensee** shall review the General Contingency Plan annually and, if necessary, revise the General Contingency Plan to reflect any changes in operation or technology. All revisions shall be in accordance with the Canadian Dam Safety Association's "Dam Safety Guidelines" and shall be submitted to the **Board** for approval.

3. The **Licensee** shall implement the General Contingency Plan identified in part F, items 1 and 2 and notify an **Inspector** immediately should a failure of any of the structures associated with the **Power Generation Facilities** occur, or seem likely to occur, which would result in an uncontrolled release of water.

4. If, during the period of this Licence, a failure to comply with part D, items 2 and 3 of this Licence occurs, or is foreseeable, the **Licensee** shall employ the General Contingency Plan referred to in part F, items 1 and 2 and shall notify an **Inspector** immediately.

5. The **Licensee** shall provide an **Inspector** with a detailed written report of each event referred to in part F, items 3 and 4. The written report shall be submitted to an **Inspector** not later than thirty (30) days after initially reporting the event to the **Inspector** as required under part F, items 3 and 4.

6. The **Licensee** shall review the Oil Pollution Emergency Plan annually and, if necessary, revise the Oil Pollution Emergency Plan to reflect any changes in operation or technology. All revisions shall be in accordance with the NWT Water Board's "Guidelines for Contingency Planning, January 1997", or any subsequent versions, and shall be submitted to the **Board** for approval.

7. The **Licensee** shall revise the plans referred to in part F, items 1, 2 and 6 if not approved by the **Board**. The revised Plans shall be submitted to the **Board** for approval within three (3) months of receiving notification of the **Board's** decision.

8. If, during the period of this Licence, an unauthorized discharge of **Waste** is foreseeable or if such a discharge of **Waste** occurs, the **Licensee** shall:

   a) implement the appropriate contingency plan referred to in either part F, items 1, 2 or 6;

   b) report the incident immediately via the 24 Hour Spill Reporting Line (867) 920-8130 in accordance with the instructions contained in the Spill Report Form NWT 1752/0593 or subsequent editions; and

3. A minimum flow of six (6) cubic metres per second shall be maintained in the Yellowknife River below the Bluefish Powerhouses and above the inlet to Prosperous Lake.

4. The **Licensee** shall install and maintain a guard on all water intakes to prevent entrainment of fish in accordance with the *Fisheries Act* and any other applicable legislation.

5. The **Licensee** shall submit to the **Board**, prior to June 1 and December 1 of each year, a Reservoirs Operation Plan for the next six (6) month period. These plans shall show the forecasted monthly average river inflow and outflow values in cubic metres per second and subsequent reservoir levels above mean sea level.

6. The **Licensee** shall have detailed geotechnical inspections of all **Power Generation Facilities** undertaken by a qualified geotechnical engineer registered in the Northwest Territories. These inspections shall take place every four (4) years starting in 2009 when the annual water level in the Yellowknife River is high. The engineer's report shall be submitted to the **Board** no later than sixty (60) days after the inspection, and shall include a covering letter from the **Licensee** outlining an implementation plan to respond to any recommendations made by the engineer.

PART E: CONDITIONS APPLYING TO MODIFICATIONS

1. The **Licensee** may, without written approval from the **Board**, carry out modifications to the **Power Generation Facilities** provided that such modifications are consistent with the terms of this Licence and the following requirements are met:

   a) the **Licensee** has notified the **Board** in writing of such proposed modifications at least sixty (60) days prior to beginning the modifications;

   b) such modifications do not place the **Licensee** in contravention of either the Licence or the ***Act***;

   c) the **Board** has not, during the sixty (60) days following notification of the proposed modifications, informed the **Licensee** that review of the proposal will require more than sixty (60) days; and

   d) the **Board** has not rejected the proposed modifications.

2. Modifications for which all of the conditions referred to in part E, item 1 have not been met may be carried out only with written approval from the **Board**.

3. The **Licensee** shall provide to the **Board** any applicable as-built plans and drawings of the modifications referred to in part E, items 1 and 2 of this Licence within ninety (90) days of completion of the modifications.

c) submit to an **Inspector** a detailed report on each occurrence not later than thirty (30) days after initially reporting the event.

9. All unauthorized discharges of **Waste** shall be reclaimed to the satisfaction of an **Inspector**.

PART J: CONDITIONS APPLYING TO ABANDONMENT AND RESTORATION

1. The **Licensee** shall review the approved Interim Abandonment and Restoration Plan annually, and, if necessary, shall revise the Plan to reflect any changes in operation or technology. All revisions to the Interim Abandonment and Restoration Plan shall be submitted to the **Board** for approval.

2. The **Licensee** shall revise the Conceptual Abandonment and Restoration Plan referred to in part G, item 1 if not approved by the **Board**. The revised Plan shall be submitted to the **Board** for approval within six (6) months of receiving notification of the **Board's** decision.

3. The **Licensee** shall submit to the **Board** for approval a Final Abandonment and Restoration Plan at least eighteen (18) months prior to abandoning the **Power Generation Facilities**.

4. The **Licensee** shall complete the restoration work within the time schedule specified in the Final Abandonment and Restoration Plan, or as subsequently approved by the **Board**.

MACKENZIE VALLEY LAND AND WATER BOARD

LICENSEE: Northwest Territories Power Corporation

LICENCE NUMBER: MV2005L4-0008
(Renewal of Water Licence N1L4-0154)

EFFECTIVE DATE OF LICENCE: April 3, 2006

SURVEILLANCE NETWORK PROGRAM

A. Location of Surveillance Network Stations

Station Number	Description
735-1	Old Bluefish Powerhouse meter.
735-2	New Bluefish Powerhouse meter.
735-3	Duncan Lake Reservoir level.
735-4	Bluefish Lake Reservoir water level.
735-5	Yellowknife River at inlet to Prosperous Lake.

B. Flow and Volume Measurement Requirements

1. Daily mean water flow rates at Station Numbers 735-1 and 735-2 shall be measured and recorded in cubic metres per second.
2. Daily mean water flow rates at Station Number 735-5 shall be computed from daily measured water levels and recorded in cubic metres per second.
3. Daily mean water levels at Station Numbers 735-3 and 735-4 shall be measured and recorded in metres above mean sea level.

C. Reports

1. The **Licensee** shall, within thirty (30) days of the end of each quarter being reported, submit to the **Board** a quarterly report including all the data and information required under the *Surveillance Network Program*.

Signed the 3rd Day of April 2006 on behalf of the Mackenzie Valley Land and Water Board

Witness

Chair
Bluefish Water Licence Tribunal

GENERAL PROCEDURES FOR THE ADMINISTRATION OF LICENCES ISSUED UNDER THE NORTHWEST TERRITORIES WATERS ACT IN THE NORTHWEST TERRITORIES

1. At the time of issuance, a copy of the Licence is placed on the Public Registry in the office of the Mackenzie Valley Land and Water Board in Yellowknife, and is then available to the public.

2. To enforce the terms and conditions of the Licence, the Minister of Indian and Northern Affairs Canada has appointed Inspectors in accordance with section 35(1) of the *Northwest Territories Waters Act*. The Inspectors coordinate their activities with staff of the Mackenzie Valley Land and Water Board. The Inspector responsible for Water Licence MV2005L4-0008 is located in the South Mackenzie District Office, Yellowknife, NT.

3. To keep the Mackenzie Valley Land and Water Board and members of the public informed of the Licensee's conformity to Licence conditions, the Inspectors prepare reports which detail observations on how each item in the Licence has been met. These reports are forwarded to the Licensee with a covering letter indicating what action, if any, should be taken. The inspection reports and covering letters are placed on the Public Registry, as are any responses received from the Licensee pertaining to the inspection reports. It is therefore of prime importance that you react in all areas of concern regarding all inspection reports so that these concerns may be clarified.

4. It is the responsibility of the Licensee to apply to the Mackenzie Valley Land and Water Board for a new licence. The past performance of the Licensee, new documentation and information, and points raised during a public hearing, if required, will be used to determine the terms and conditions of any new licence. Please note that if the Licence expires and another has not been issued, then water and waste disposal must cease, or you, the Licensee, would be in contravention of the *Northwest Territories Waters Act*. It is suggested that an application for a new licence be made at least eight (8) months in advance of the Licence expiry date.

5. If, for some reason, Water Licence MV2005L4-0008 requires amendment, then a public hearing is required. You are reminded that applications for amendments should be submitted as soon as possible to provide the Mackenzie Valley Land and Water Board with ample time to go through the amendment process. The process may take up to six (6) months or more depending on the scope of the amendment requested.

6. Specific clauses of your Licence make reference to the Board, Analyst or Inspector. The contact person, address, phone and fax number of each is:

Mackenzie Valley Land and Water Board (Board):

Public Registry Clerk
Mackenzie Valley Land and Mackenzie Valley Land and Water Board
P.O. Box 2130
4910 50th Avenue, 7th Floor
YELLOWKNIFE NT XIA 2P6
Phone No. (867) 669-0506
Fax No. (867) 873-6610

Analyst:

Analyst
Taiga Environmental Laboratory
Indian and Northern Affairs Canada
P.O. Box 1500
4601- 52nd Avenue
YELLOWKNIFE NT XIA 2R3
Phone No. (867) 669-2780
Fax No. (867) 669-2718

Inspector:

Inspector
South Mackenzie District Office
Indian and Northern Affairs Canada
140 Bristol Avenue
P.O. Box 1500
Yellowknife NT X1A 3T2
Phone No. (867) 669-2761
Fax No. (867) 669-2720

Mackenzie Valley Land and Water Board
7th Floor - 4910 50th Avenue
P.O. Box 2130
YELLOWKNIFE NT X1A 2P6
Phone (867) 669-0506
FAX (867) 873-6610

REASONS FOR DECISION

In the Matter of: Renewal of Water Licence N1L4-0735

File Number: Water Licence MV2005L4-0008, Type "A"

Licensee: Northwest Territories Power Corporation

Mackenzie Valley Land and Water Board

REASONS FOR DECISION

Issued pursuant to Section 26
of the *Northwest Territories Waters Act*, R.S.C. 1992, c.39

BACKGROUND AND REGULATORY HISTORY

On July 18, 2005, the Northwest Territories Power Corporation (NTPC or the Licensee) applied to the Mackenzie Valley Land and Water Board (MVLWB or the Board) to renew (the renewal application) Water Licence N1L4-0735 for the diversion and storage of water and associated activities at the Bluefish Hydroelectric Facilities (Bluefish) in the Northwest Territories. The initial renewal application was declared incomplete but following the receipt of NTPC's community engagement log, the renewal application was declared complete on August 31, 2005. The renewal application and the resulting Renewal Licence have been assigned file number MV2005L4-0008.

Although the renewal application had been received by the Board, the Board was concerned that Water Licence N1L4-0735 would expire before the renewal process could be completed. As a result, the Board initiated an extension proceeding and scheduled a public hearing on whether or not the term of Water Licence N1L4-0735 should be extended. Input into this matter was sought from first nations, governments and other stakeholders but only the Yellowknives Dene First Nation (YKDFN) and the North Slave Métis Alliance (NSMA) responded. These first nations indicated their support for a one year extension in their interventions for the public hearing in the extension proceeding. Since no interventions opposing the extension were received, and the applicant agreed, the Board cancelled the extension hearing and, on August 24, 2005, decided to extend the term of Water Licence N1L4-0735 for one year.

The renewal application was accompanied by a letter requesting that the Board exempt the renewal application from part 5 of the *Mackenzie Valley Resource Management Act*[1] (MVRMA) under the provisions of section 157.1 of the MVRMA. According to section 157.1, a licence related to an undertaking that is the subject of a licence issued before June 22, 1984 is exempt from part 5 of the MVRMA if the licence does not represent a significant alteration from the original undertaking or is not made for the abandonment and decommissioning of the undertaking.

Bluefish has continuously been the subject of a water licence since 1942. That licence was renewed in at least 1981 and 1996. Any repairs and upgrades to Bluefish since 1981 have been routine and have not required the licence to be amended. The current renewal application does not propose any alterations to or the decommissioning of Bluefish. Based on these facts, the Board, on September 7, 2005, decided that the renewal application is exempt from part 5 of the MVRMA.

Following the decision on exemption of the renewal application from part 5 of the MVRMA, the Board requested that reviewers submit preliminary comments on the renewal application by October 7, 2005 to assist in analyzing matters related to the storage and diversion of water associated with the renewal application. The Northwest Territory Métis Nation (NWTMN) requested and received an extension to the deadline for preliminary comments but no comments from the NWTMN were ever received.

The preliminary comments were forwarded to NTPC for a written response which was received on October 21, 2005. The preliminary comments and the Licensee's response were distributed on October 24, 2005 to assist the reviewers in writing their public hearing interventions.

Notice of the public hearing was provided in accordance with the requirements of the *Northwest Territories Waters Act*[2] (NWTWA) on October 10, 2005. The hearing was scheduled for December 13, 2005. The only hearing intervention received by the November 9, 2005 deadline was from the NSMA. It was forwarded to NTPC for a written response. Their response was received by the Board on November 29, 2005.

On December 9, 2005, the NSMA informed the Board that they might be unable to attend the public hearing due to the medical unavailability of one of their staff members and due to a scheduling conflict with other public sessions being held by the Board. The Board acknowledged these difficulties but decided that it was unfair to other parties to reschedule the public hearing at such a late date and on short notice.

The Board proceeded with the public hearing on December 13, 2005 as scheduled; however, it was adjourned early as no representative from the NSMA was available. The Board, with NTPC's support, provided the NSMA with the opportunity to make written submissions to the Board following the hearing. The NSMA's submission was received on January 20, 2006. The Board also received a letter from the YKDFN on December 19, 2006, after the hearing, even though that party had not provided a hearing intervention prior to the Board's deadline and had not received permission to file a late submission.

The NSMA and the YKDFN post hearing submissions asserted that they had not been consulted by NTPC or the Government of Canada regarding the implications of the renewal application on their rights protected by section 35 of the *Constitution Act*.

---

[1] S.C. 1998, c.25 as amended
[2] S.C.1992, c. 39.

The Board forwarded the submissions from the NSMA and YKDFN to Indian and Northern Affairs Canada (INAC) because under section 14(6)(a) of the NWTWA, the issuing authority or final decision maker for Type A water licences is the Minister of INAC. Furthermore, it is the Crown's duty to ensure that consultation with first nations or aboriginal persons adversely affected by the issuance of licences or permits are properly consulted.

Since the Board is not the issuing authority for Type A water licences, the Board proceeded with the renewal licensing process. The Board is of the view that any consultation concerns should be addressed by the Minister of INAC and that the Renewal Licence and these reasons may assist the Minister in discharging those responsibilities.

The NSMA's post hearing submissions were also forwarded to NTPC. NTPC, at the request of the Board, submitted their closing statements for the hearing on February 3, 2006. At that point, the Board declared the record closed for the renewal licensing process.

APPROACH TO THE DEVELOPMENT OF THE LICENCE

Section 18 of the NWTWA provides for the renewal of a water licence with or without changes to the conditions of the water licence. The Board made only those changes that were supported by evidence filed before the closing of the record.

BOARD DECISION

The Board decided to issue Water Licence MV2005L4-0008 subject to the terms and conditions set out therein. This Renewal Licence has been issued under separate cover. The Board's Reasons for Decision are elaborated below under the headings set out in the Renewal Licence.

The Renewal Licence includes the terms and conditions that the Board feels are necessary to protect the environment, conserve the water resources of the Yellowknife River and McCrea River watersheds and provide appropriate safeguards in respect of NTPC's storage and diversion of waters.

REQUIREMENTS OF SECTION 14 OF THE NWTWA

Existing Licensees

With respect to paragraph 14(4)(a) of the NWTWA, the Board is satisfied that granting the Renewal Licence to NTPC will not adversely affect, in a significant way, any existing licensee, providing the conditions of the Renewal Licence are met. There are no licensees with precedence.

Existing Water Users

Paragraph 14(4)(b) of the NWTWA prohibits the issuance of a licence unless the Board is satisfied that appropriate compensation has been or will be paid by the licensee to members of the classes of water users and persons listed in that paragraph who have claimed compensation within the period specified in the Notice of the application.

The only references to compensation were made by the NSMA in their post hearing submission to the Board on January 20, 2006. These references are listed below:

1. Page 1, paragraph 3: "*...NSMA requests that a study be completed by an independent specialist in human ecology, selected in Consultation with the NSMA, to evaluate the*

potential impacts of the project on the NSMA's interests, and to provide recommendations providing appropriate compensation."

2. Page 2, paragraph 2: "*The NSMA also represents the interests of NSMA members who are entitled to consultation and compensation prior to interference with their rights as "existing water users", under section 14 of the NWT Waters Act. NSMA members' existing water uses can be described as domestic, instream, owners of property, occupiers of property, and/or holders of outfitting concessions, registered traplines, and other rights of a similar nature.*"

3. Page 2, paragraph 3: "*The original Bluefish Hydro Project was constructed, without consultation, accommodation, or compensation, to support the Cominco Con Mine, which is now a contaminated site that promises to interfere with the rights of the North Slave Métis community for many more years to come. There has never been any cumulative effects assessment of how those related projects affected the North Slave Métis biophysical or socioeconomic environment. NSMA has no records that the North Slave Métis received a commensurate share of the benefits of that undertaking in compensation for their costs or damages.*"

It is not the Board's role to determine the effects that a licence renewal may have on a particular person or group of people on behalf of that particular person or people. Paragraph 14(4)(b) and subsection 14(5) of the NWTWA clearly require that a water user claiming compensation inform the Board of the provable or potential loss or damage a project may have on his or her rights and interests. The NSMA has not supplied any evidence of actual loss or damage. The question of Crown "consultation" is not directly related to compensation for damages arising because of a water licence.

Therefore, the Board cannot conclude that the NSMA will be adversely affected by the renewal of the Bluefish licence. Furthermore, as pointed out by NTPC, the NSMA missed the deadlines specified in paragraph 14(4)(b) and this may by itself be fatal to their compensation claim.

Considering the evidence adduced by the NSMA, the Board is of the opinion that compensation for the NSMA under section 14(4)(b) of the NWTWA is not warranted.

Financial Responsibility of the Licensee

The Board must satisfy itself of the financial responsibility of the licensee under paragraph 14(4)(d) of the NWTWA before it can issue a water licence. The Board is satisfied that NTPC is capable of meeting the obligations set out in the MVRMA, NWTWA, and the Renewal Licence. NTPC paid the security deposit of fifty thousand dollars ($50,000) required under Water Licence N1L4-0735 by certified cheque, which is the same requirement under the Renewal Licence. Paying by cheque eliminates the uncertainty surrounding financial instruments that require renewal on a regular basis. NTPC has also consistently maintained the security deposits required under their other licences for the Snare Hydro system.

REQUIREMENTS OF SUBSECTION 15(2) OF THE NWTWA

With respect to subsection 15(2) of the NWTWA, the Board must minimize any adverse effects the operation may have on other licensees, users, depositors, owners, occupiers, or other rights holders that have interests in the water management area in which the licensed operation is located. These parties are to have the opportunity to notify the Board regarding their concerns about the effects the development may have on them.

The regulatory process followed by the MVLWB during the development of the Renewal Licence provided interested parties with the opportunity to express their concerns and comments about the development through written submissions and during a public hearing. Those concerns and comments were reviewed carefully during the development of the terms and conditions of the Renewal Licence. The Board is satisfied that NTPC's adherence to the terms and conditions of the Renewal Licence will protect parties who have an interest in the Yellowknife River and McCrea River watersheds.

WATER LICENCE MV2005L4-008 TERMS AND CONDITIONS

Scope of the Licence

The scope in the Renewal Licence remains unchanged from the scope in the existing licence, Water Licence N1L4-0735, except for one administrative update. NTPC has replaced Con Exploration Ltd and Miramar Con Mine Ltd as the Licensee. No party provided evidence suggesting the need for any further changes to the scope.

Term of the Licence

The Board agreed with NTPC that a longer term for the Renewal Licence is appropriate as the liability associated with Bluefish can be considered low risk. The facility has remained unchanged except for routine repairs and upgrades since the 1940s and no changes associated with the storage and diversion of water are expected in the future. The electricity generated at Bluefish is also a necessary utility for the people of Yellowknife.

The Board is of the opinion that any uncertainties related to a longer licence term are reduced by the flexibility provided by the Renewal Licence. The Board can require the posting of further security deposits during the term of the Renewal Licence under part B, item 2. This ensures that any liability associated with the licensed activity at the site is fully secured. Under part C, the Board may require any predicted or observed environmental effects to be studied. These studies can, if necessary to reduce effects in water quality or quantity, result in changes to the Surveillance Network Program (SNP) or to conditions of the Renewal Licence.

However, the Board disagreed with NTPC that a twenty five (25) year term is appropriate because claims for compensation, although not proved, indicate that there is a certain level of concern amongst some parties. The Board has set a term of fifteen (15) years to the Renewal Licence in order to provide an earlier opportunity for these parties to discuss their concerns in a regulatory setting.

Part B: General Conditions

The general conditions set out the security requirements and assist in the appropriate administration of the Renewal Licence, including keeping the Board informed of activities on site through a requirement for annual reporting.

Conditions Applying to Security: Pursuant to subsection 17(1) of the NWTWA, the Board may require the Licensee to provide security to the Minister of INAC. Subsection 17(2) of the NWTWA specifies how much security may be applied, including the reimbursement of the Government of Canada for expenditures made during the course of remedial activities necessary under subsections 37(3) and 39(1) of the NWTWA.

Detailed reasons for individual conditions relating to security are provided below.

Part B, item 2: The Board requires that NTPC maintain the security deposit of fifty thousand dollars ($50,000) required under Water Licence N1L4-0735. No further amounts were required as none of the reviewers provided evidence indicating that this amount is inadequate or that the security requirements should be re-evaluated.

Furthermore, the Board is of the opinion that the risk associated with clean up liability at Bluefish is low considering that NTPC is a Crown corporation owned by the Government of the Northwest Territories.

To ensure that adequate security is in place throughout the term of the Renewal Licence, the Board has incorporated into part B, item 2, the sentence "The Licensee shall also post any further amounts required by the Board during the term of this Licence".

Part C: Conditions Applying to Studies

Under Water Licence N1L4-0735, the Licensee was required to submit for the Board's approval Terms of Reference for a fish and fish habitat study. This condition was satisfied and the study was carried out. No evidence that the results of this study needed to be re-evaluated was provided to the Board; therefore, these conditions were replaced by more generic conditions in the Renewal Licence.

The generic conditions require NTPC to submit for the Board's approval the Terms of Reference for any studies deemed necessary by the Board during the term of the Renewal Licence. These generic conditions will allow any predicted, perceived or observed environmental effect to be studied and evaluated. This information can then be used to modify the management of Bluefish or the conditions of the Renewal Licence to mitigate or reduce the identified environmental effects.

Part D: Conditions Applying to Operation

The conditions applying to operation provide limits for reservoir levels and flow rates for the Yellowknife River in order to protect the aquatic habitat in the water bodies associated with Bluefish. Reservoir Operation Plans and regular geotechnical inspections will also ensure that Bluefish is maintained and operated safely.

Part D, item 4: The Board agreed with the Department of Fisheries and Oceans (DFO) that water intakes should be guarded to prevent the entrainment of fish in accordance with the *Fisheries Act*. Part A, item 1(c) also requires NTPC to remain in compliance with all applicable legislation.

Part E: Conditions Applying to Modifications

The conditions applying to modifications serve two purposes. The first purpose is to provide a mechanism whereby NTPC has the flexibility to modify structures or methods without requiring Board approval if the modifications do not contravene the Renewal Licence, the MVRMA or the NWTWA. The second purpose of part E is to provide a mechanism whereby the Board and the Inspector remain informed of all modifications being carried out at Bluefish. No changes have been made to part E as no evidence suggesting otherwise was filed with the Board.

Part F: Conditions Applying to Contingency Planning

Appropriate contingency planning is needed to ensure that sudden, foreseen or unforeseen events can be dealt with in such a way that human safety is maximized and environmental impacts are minimized.

Part F, item 1: The Board requires NTPC to submit an updated General Contingency Plan (GCP) to the Board for approval because the GCP has not been updated since NTPC took over the operation of Bluefish in 2003. The Board notes that NTPC supports this requirement.

Part F, item 6: NTPC is only required to update the Oil Pollution Emergency Plan (OPEP) if there are changes in operation or technology because the Board approved the latest OPEP recently on June 22, 2005.

Environment Canada made a number of recommendations in their preliminary comments dated September 23, 2005 that relate to spills and spill contingency planning:

1. Fuels and wastes associated with the project shall not enter waters frequented by fish.
2. Sediment shall not be deposited into any water body.
3. All fuels must be stored a minimum of 30 metres from the normal high water mark of any water body and be stored such that no fuel can enter any water bodies.
4. Secondary containment with an impervious liner should be used for the storage of fuel, waste oil and batteries.
5. Fuel and hazardous waste storage sites should be inspected on a regular basis.
6. All hazardous wastes, including waste oil, must receive proper treatment and disposal at an approved facility.
7. Drip pans, or other similar preventative measures, should be used when refueling equipment/storage tanks on site.

The Board agreed with all of Environment Canada's recommendations and has addressed their points as follows: points 1 and 2 are regulated under the *Fisheries Act* and part A, item 1(c) of the Renewal Licence requires the proponent to comply with all applicable legislation; points 3-6 are addressed in the current OPEP; and point 7 is addressed through the Board's requirement that NTPC include the use of drip pans in the current OPEP.

Part J: Conditions Applying to Abandonment and Restoration

The Board has not made any significant changes to part J as no evidence was filed with the Board suggesting the need for changes.

Part J, item 1: The Board notes that the latest version of the Conceptual Abandonment and Restoration Plan (CARP) was approved on June 22, 2005. Since this approval occurred recently, the Board requires NTPC to submit a revised CARP only if there are changes in operation or technology.

OTHER RECOMMENDATIONS MADE BY REVIEWERS

The Water Resources Division of INAC and the City of Yellowknife, in their preliminary comments dated October 7, 2005 and October 21, 2005 respectively, indicated that they did not support NTPC's plans to eventually operate Bluefish remotely. These agencies are concerned that NTPC would not be able to respond to spills or other emergencies as quickly and as effectively as they do now with an on-site caretaker.

The Board acknowledges and understands this concern; however, requiring an on-site caretaker or prohibiting remote operation of the site may be outside the Board's jurisdiction. These concerns can be alleviated by requiring NTPC to fully plan responses to spills and emergencies through the submission of updated GCP and OPEP that reflect remote operation of Bluefish.

SURVEILLANCE NETWORK PROGRAM

The objective of the Surveillance Network Program (SNP) is to monitor the effects of the storage and diversion of water associated with NTPC's hydroelectric power undertakings at Bluefish. No evidence recommending changes to the SNP was filed; therefore, the Board did not modify the SNP.

CONCLUSION

Subject to the terms and conditions set out in the Renewal Licence, and for the reasons expressed herein, the MVLWB is of the opinion that Bluefish can be managed in such a way which will protect the water resources of the Yellowknife River and McCrea River watersheds from unacceptable impacts.

Signed the 3rd Day of April 2006 on behalf of the Mackenzie Valley Land and Water Board

Witness

Chair,
Bluefish Water Licence Tribunal

June 26, 2006

WL 2005L4-0008

DISTRIBUTION LIST by Fax

NORTH SLAVE REGION

FIRST NATIONS

Chief Peter Liske	Yellowknives Dene First Nation (Dettah)	29	873-5969
Chief Fred Sangris	Yellowknives Dene First Nation (Ndilo)	30	873-8545
Chief Adeline Jonasson	Lutselk'e Dene First Nation	34	867-370-3143

COMMUNITY

Mayor Gordon Van Tighem	City of Yellowknife	54	920-5649

ABORIGINAL ORGANIZATIONS

Chris Paci	Dene Nation	40	920-2254
Chairperson Robert Sayine	Akaitcho Territory Government	51	867-394-3413
Dora Enzoe	Akaitcho Pre-screening Board	52	867-370-3209
Ethel Liske	NWT Treaty 8 Tribal Corporation	56	873-8738
President Bill Enge	North Slave Metis Alliance		867-669-7442
Director	Tli Cho Lands Protection Department	22	867-392-6862
President North Douglas	Rae-Edzo Metis Local #64	26	**PREFERS EMAIL** rae_edzometisnation@theedge.ca 371-5406
President Robert Tordiff	Northwest Territory Metis Nation	45	867-872-2772

GOVERNMENT

Ed Hornby	South Mackenzie District Office	57	669-2720
Kathleen Racher	Water Resources Division		669-2716
Mark Davy	GNWT - MACA	62	920-6343
Jason McNeil	GNWT - ENR	63	873-4021
Michael Brown	GNWT - DOT	64	920-2565
Duane Fleming	GNWT - Health	65	669-7517
Greg Brady	GNWT – ITI		873-0645
Mike Fournier	Environment Canada	66	873-8185
Ernie Watson	DFO	68	669-4940

OTHERS

Vern Christensen	MVEIRB	50	766-7074

If there is an error in our contact, please notify our office.

Mackenzie Valley Land and Water Board
7th Floor - 4910 50th Avenue
P.O. Box 2130
YELLOWKNIFE NT X1A 2P6
Phone (867) 669-0506
FAX (867) 873-6610

FILE NUMBER: MV2005L4-0008

Date:	April 3, 2006
To:	Violet Camsell-Blondin, Chair
Organization:	MVLWB
Fax Number:	
From:	Bob Wooley, Executive Director MVLWB
Number of pages including cover	20

Remarks:

The attached Board Meeting items have been reviewed and are attached for your signature.

☐ Land Use Permit Type "A"
- Issuance Letter
- Land Use Permit Cover
- Preliminary Screening
- Conditions
- Distribution List

☒ Water License
- Cover Page
- General Procedures
- Scope and Definitions
- SNP

☒ Letter
Letter to Minister
☒ Reasons for Decision

☐ Final Clearance Letter

☐ Approval Letter for Reports/ Plans

☐ Approval Letter for Conditions

☒ Notification

☐ Enclosures
☐ As requested
☐ For your information
☐ For your comment
☐ For your approval
☒ For your action

Delivered by	**Date**
☐ E-Mail Out	
☐ Faxed Back	

Bob Wooley, Executive Director MVLWB

Date: April 3/06

Mackenzie Valley Land and Water Board
7th Floor - 4910 50th Avenue • P.O. Box 2130
YELLOWKNIFE, NT X1A 2P6
Phone (867) 669-0506 • FAX (867) 873-6610

April 3, 2006

File: MV2005L4-0008

The Honourable Jim Prentice
Minister Responsible for Indian and Northern Affairs Canada
Terrasses de la Chaudière
10 Wellington St.
GATINEAU, QUEBEC K1A 0H4

Dear Minister Prentice:

Issuance of a Type "A" Water Licence – Bluefish Hydro Facility

The Mackenzie Valley Land and Water Board (MVLWB) has completed its regulatory process for the application of the Northwest Territories Power Corporation for a hydroelectric power generation undertaking at the Bluefish Hydro Facility, NT. A motion was passed at the April 3, 2006 Board meeting to approve the attached licence. The Reasons for Decision are also attached for your review.

As it is a Type A water licence, it requires your signature as per section 81 of the *Mackenzie Valley Resource Management Act*. The MVLWB recommends your approval and signature.

Yours sincerely,

V CBlondin

Violet Camsell-Blondin
Chair, Bluefish Water Licence Tribunal

Attachments

Ministre des Affaires indiennes et
du Nord canadien et interlocuteur fédéral
auprès des Métis et des Indiens non inscrits

Minister of Indian Affairs and
Northern Development and Federal Interlocutor
for Métis and Non-Status Indians

Ottawa, Canada K1A 0H4

JUN JUIN 1 2 2006

Mackenzie Valley Land
& Water Board

File

JUN 19 2006

Application # MV2005L4-0008

Copied To SB / Reg

Ms. Violet Camsell-Blondin
Chair
Bluefish Water Licence Tribunal
Mackenzie Valley Land and Water Board
4910 - 50th Avenue, 7th Floor
PO Box 2130
YELLOWKNIFE NT X1A 2P6

Dear Ms. Camsell-Blondin:

Thank you for your letter of April 3, 2006, with attachments, regarding the completed regulatory process and Reasons for Decision for the application of the Northwest Territories Power Corporation for storage and diversion of water for a hydroelectric power undertaking and associated uses at the Bluefish Power Generation Facility, Northwest Territories, Licence Number: MV2005-L4-0008 (renewal of N1L4-0735).

I am pleased to inform you that I have approved the licence as recommended by the Mackenzie Valley Land and Water Board. The signed original is enclosed.

Sincerely,

The Honourable Jim Prentice, PC, QC, MP

Encl.

Canada

Confirmation Report – Memory Send

Page : 001
Date & Time: 27-Jun-2006 08:25
Line 1 : +8678736610
Line 2 :
Machine ID : MVLWB

Job number	:	785
Date	:	27-Jun 08:14
To	:	7667074
Number of pages	:	021
Start time	:	27-Jun 08:14
End time	:	27-Jun 08:25
Pages sent	:	021
Status	:	OK

Job number : 785 *** SEND SUCCESSFUL ***

Mackenzie Valley Land and Water Board
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YELLOWKNIFE NT X1A 2P6
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FAX (867) 873-6610

FILE NUMBER: MV2005L4-0008

Date:	June 26, 2006
To:	Vern Christensen, Executive Director
Company	Mackenzie Valley Environmental Impact Review Board
Fax Number:	766-7074 *(50)*
Copied To:	Ed Hornby, South Mackenzie District, DIAND
From:	Janna for Violet Camsell-Blondin, Chair, Bluefish Water License Tribunal
Number of pages including cover	21

Remarks:

Issuance of a Type "A" Water License – MV2005L4-0008 (renewal of N1L4-0735) attached for your review:

Water License Type "A"
- Issuance Letter
- WL Cover
- General Procedures
- Scope and Definitions
- Surveillance Network Program
- Reasons For Decision

☐ Enclosures
☐ As requested
☒ For your information
☐ For your comment
☒ For your approval

Delivered by		Date
☐	Mail	
☐	Courier	
☐	Hand Delivered	
☒	Fax	Jun 26/06

Mackenzie Valley Land and Water Board
7th Floor - 4910 50th Avenue
P.O. Box 2130
YELLOWKNIFE NT X1A 2P6
Phone (867) 669-0506
FAX (867) 873-6610

FILE NUMBER: MV2005L4-0008

Date:	June 26, 2006
To:	Vern Christensen, Executive Director
Company	Mackenzie Valley Environmental Impact Review Board
Fax Number:	766-7074 (50)
Copied To:	Ed Hornby, South Mackenzie District, DIAND
From:	Janna for Violet Camsell-Blondin, Chair, Bluefish Water License Tribunal
Number of pages including cover	21

Remarks:

Issuance of a Type "A" Water License – MV2005L4-0008 (renewal of N1L4-0735) attached for your review:

Water License Type "A"
- Issuance Letter
- WL Cover
- General Procedures
- Scope and Definitions
- Surveillance Network Program
- Reasons For Decision

- [ ] Enclosures
- [ ] As requested
- [x] For your information
- [ ] For your comment
- [x] For your approval

Delivered by	**Date**
[ ] Mail	
[ ] Courier	
[ ] Hand Delivered	
[x] Fax	Jun 26/06

Mackenzie Valley Land and Water Board
7th Floor - 4910 50th Avenue
P.O. Box 2130
YELLOWKNIFE NT X1A 2P6
Phone (867) 669-0506
FAX (867) 873-6610

FILE NUMBER: MV2005L4-0008

Date:	July 4, 2006
To:	Ms Myra Berrub Coordinator, Business and Energy Development
Organization:	Northwest Territories Power Corporation
Fax Number:	(867) 874-5229
Copied To:	
From:	Janna for Violet Camsell-Blondin, Chair, Bluefish Water License Tribunal
Number of pages including cover	9

Remarks:

Issuance of a Type "A" Water License

- ☐ Enclosures
- ☐ As requested
- ☐ For your information
- ☐ For your comment
- ☒ For your action
- ☐ For your approval

Delivered by		**Date**
☒	Mail	
☐	Courier	
☐	Hand Delivered	
☒	Fax	July 4/06

Confirmation Report – Memory Send

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Line 2 :
Machine ID : MVLWB

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To	: ☎18678745229
Number of pages	: 009
Start time	: 04-Jul 12:16
End time	: 04-Jul 12:19
Pages sent	: 009
Status	: OK

Job number : 863 *** SEND SUCCESSFUL ***

Mackenzie Valley Land and Water Board

Mackenzie Valley Land and Water Board
7th Floor - 4910 50th Avenue
P.O. Box 2130
YELLOWKNIFE NT X1A 2P6
Phone (867) 669-0506
FAX (867) 873-6610

FILE NUMBER: MV2005L4-0008

Date: July 4, 2006

To: Ms Myra Berrub
Coordinator, Business and Energy Development

Organization: Northwest Territories Power Corporation

Fax Number: (867) 874-5229

Copied To:

From: Janna for Violet Camsell-Blondin, Chair, Bluefish Water License Tribunal

Number of pages including cover 9

Remarks:

Issuance of a Type "A" Water License

- ☐ Enclosures
- ☐ As requested
- ☐ For your information
- ☐ For your comment
- ☒ For your action
- ☐ For your approval

Delivered by		**Date**
☒	Mail	
☐	Courier	
☐	Hand Delivered	
☒	Fax	July 4/06

Mackenzie Valley Land and Water Board
7th Floor - 4910 50th Avenue
P.O. Box 2130
YELLOWKNIFE NT X1A 2P6
Phone (867) 669-0506
FAX (867) 873-6610

FILE NUMBER: MV2005L4-0008

Date:	July 4, 2006
To:	Distribution List – attached
Organization:	Various
Fax Number:	Various
Copied To:	
From:	Janna for Violet Camsell-Blondin, Chair, Bluefish Water License Tribunal
Number of pages including cover	3

Remarks:

Issuance of a Type "A" Water License

- ☐ Enclosures
- ☐ As requested
- ☐ For your information
- ☐ For your comment
- ☒ For your action
- ☐ For your approval

Delivered by		Date
☒	Mail	
☐	Courier	
☐	Hand Delivered	
☒	Fax	July 4/06

Job number : 865

*** SEND SUCCESSFUL ***

Mackenzie Valley Land and Water Board
7th Floor - 4910 50th Avenue
P.O. Box 2130
YELLOWKNIFE NT X1A 2P6
Phone (867) 669-0506
FAX (867) 873-6610

FILE NUMBER: MV2005L4-0008

Date:	July 4, 2006
To:	Distribution List – attached
Organization:	Various
Fax Number:	Various
Copied To:	
From:	Janna for Violet Camsell-Blondin, Chair, Bluefish Water License Tribunal
Number of pages including cover	3

Remarks:

Issuance of a Type "A" Water License

- ☐ Enclosures
- ☐ As requested
- ☐ For your information
- ☐ For your comment
- ☒ For your action
- ☐ For your approval

Delivered by		Date
☒	Mail	
☐	Courier	
☐	Hand Delivered	
☒	Fax	July 4/06

Group Send Report

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Line 2 :
Machine ID : MVLWB

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Number of pages	: 003
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26	18673715406
45	18678722772
57	6692720
62	9206343
63	8734021
64	9202565
65	6697517
66	8738185
68	6694940
50	7667074

Fax numbers

☎6697442
☎6692716
☎8730645

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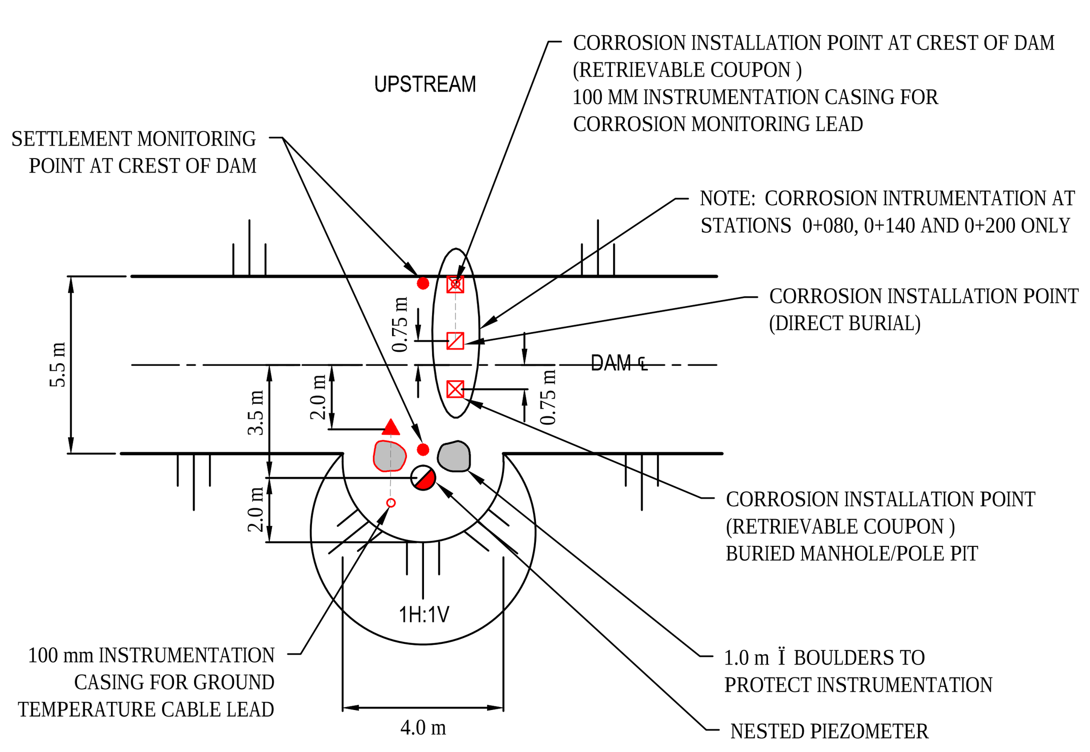
APPENDIX V

Selected As-Built Drawings and Figures

AS-BUILT INSTRUMENTATION PLAN

SCALE: 1:400



TYPICAL DETAIL - INSTRUMENTATION PAD

SCALE: 1:200

RECORD

LEGEND:

- SP-03 NESTED PIEZOMETER LOCATION
- M2-U SETTLEMENT MONITORING POINT LOCATION
- GTC-1 GROUND TEMPERATURE INSTALLATION POINT
- C2 CORROSION MONITORING INSTALLATION POINT (DIRECT BURIAL)
- C1 CORROSION MONITORING INSTALLATION POINT (RETRIEVABLE COUPON)
- INSTRUMENTATION CASING LOCATION

NOTES:

1. DATUM: UTM ZONE 11 NAD 83, METRE; CENTRAL MERIDIAN 117d W ELEVATIONS ARE GEODETIC. CONVERSION TO PREVIOUS DATUM: GEODETIC + 17.15 m
2. AS-BUILT SURVEY DATA PROVIDED BY SUB-ARCTIC SURVEYS LTD. BASE SURVEY PLAN PROVIDED JULY 30, 2008 AND FEBRUARY 2009; FILE NO.: 08-092-NT. ADDITIONAL BATHYMETRY AND TOPOGRAPHY SURVEY PROVIDED OCT. 19, 2009; FILE NO.: 09-012-04-NT-COMPILED. DAM FOOTPRINT AND LOCATION PROVIDED DEC. 18, 2012; FILE NO.: JOB 205 DAM FINAL ASBUILTS 2012. OVERFLOW SPILLWAY AND BOTTOM OUTLET LOCATIONS PROVIDED DEC. 18, 2012; FILE NO.: JOB 205 SPILLWAY AND OUTLET STRUCTURE FINAL ASBUILTS 2012.
3. 1.0 m CONTOUR INTERVAL

REVISIONS

NUM	DATE	DWN	CKD	APR	DESCRIPTION
4	MAR 12/13	SF	BC	BC	Updated drawing using As-Built data
3	APR 23/12	DRG	CKG	CKG	Revise Corrosion and GTC Layout
2	FEB 8/12	DRG	CKG	CKG	Addtional Instrumentation added, Updated Channel Survey
1	JUNE 26/11	DRG	CKG	CKG	Dam Alignment Rotated, Addition of GTC Instrumentation

DRAWING STATUS

NUM	DATE	APR	DESCRIPTION
14	MAR 12/13	BC	ISSUED FOR RECORD
13	JULY 25/12	CKG	RE-ISSUED FOR CONSTRUCTION
12	FEB 17/12	CKG	RE-ISSUED FOR CONSTRUCTION
11	JUNE 26/11	CKG	RE-ISSUED FOR CONSTRUCTION
10	OCT 29/10	CKG	ISSUED FOR CONSTRUCTION
F	MAR 11/10	CKG	RE-ISSUED FOR TENDER

PERMIT

PROFESSIONAL SEAL

CLIENT

NORTHWEST TERRITORIES POWER CORPORATION

EBA Engineering Consultants Ltd.

REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

AS-BUILT INSTRUMENTATION - PLAN

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.004	EDM	CKG	KWJ/BC	4	C209
DATE:	SHEET No.	DWN	APP	STATUS	
Marc 2013	6 of 12	DRG/SF	CKG/BC	14	

CONTROL LINES			
POINT #	NORTHING	EASTING	DESCRIPTION
104	6952582.1	639732.4	OVERFLOW SPILLWAY
105	6952754.9	639831.5	BOTTOM OUTLET
106	6952684.7	639762.8	BOTTOM OUTLET
107	6952631.7	639741.1	BOTTOM OUTLET
108	6952581.9	639738.8	BOTTOM OUTLET
101	6952780.2	639792.4	OVERFLOW SPILLWAY
102	6952651.6	639739.8	OVERFLOW SPILLWAY
103	6952632.1	639735.3	OVERFLOW SPILLWAY

AS-BUILT SPILLWAY AND BOTTOM OUTLET LAYOUT POINTS			
POINT #	NORTHING	EASTING	ELEVATION
50	6952751.7	639820.5	0.0
51	6952732.1	639821.4	0.0
52	6952725.8	639798.2	0.0
53	6952720.6	639802.1	0.0
54	6952725.5	639797.6	0.0
55	6952725.1	639796.8	160.0
56	6952719.5	639802.0	0.0
57	6952718.5	639801.2	0.0
58	6952715.9	639798.9	160.0
59	6952721.4	639793.2	173.2
60	6952714.3	639786.3	160.0

AS-BUILT SPILLWAY AND BOTTOM OUTLET LAYOUT POINTS			
POINT #	NORTHING	EASTING	ELEVATION
61	6952708.8	639791.9	160.0
62	6952682.6	639766.0	159.8
63	6952684.3	639756.5	0.0
64	6952646.4	639751.0	0.0
65	6952652.1	639745.7	0.0
66	6952632.0	639749.6	0.0
67	6952631.3	639748.0	156.6
68	6952598.6	639745.9	156.6
69	6952588.4	639720.3	0.0
70	6952630.9	639724.0	0.0
71	6952632.7	639723.8	0.0

AS-BUILT SPILLWAY AND BOTTOM OUTLET LAYOUT POINTS			
POINT #	NORTHING	EASTING	ELEVATION
72	6952650.6	639726.5	0.0
73	6952653.2	639726.8	0.0
74	6952719.6	639756.0	0.0
76	6952763.7	639780.8	0.0
77	6952759.2	639789.9	0.0
78	6952750.2	639790.5	0.0
79	6952701.9	639773.5	0.0
80	6952737.5	639796.2	168.8
81	6952745.4	639798.2	168.8
82	6952753.3	639798.1	168.8
83	6952762.6	639792.6	168.8

AS-BUILT SPILLWAY AND BOTTOM OUTLET LAYOUT POINTS			
POINT #	NORTHING	EASTING	ELEVATION
84	6952770.1	639780.8	168.8
85	6952766.4	639772.1	168.8
87	6952746.6	639742.4	0.0
88	6952702.3	639746.2	0.0
89	6952712.1	639732.8	168.8
90	6952728.7	639743.1	0.0
92	6952803.5	639759.2	0.0
95	6952761.2	639789.9	168.8
96	6952753.0	639793.3	0.0
109	6952729.2	639791.0	168.8

0 — 20
Scale: 1: 400 (metres)

AS-BUILT PLAN

SCALE: 1:400

RECORD

LEGEND:
- BOREHOLE LOCATION (REFER TO EBA GEOTECHNICAL REPORT DATED: SEPTEMBER 2009)
- EDGE OF WATER
- FISH CHANNEL
- AS-BUILT EXTENT OF RIPRAP

NOTES:
1. DATUM: UTM ZONE 11 NAD 83, METRE; CENTRAL MERIDIAN 117d W ELEVATIONS ARE GEODETIC. CONVERSION TO PREVIOUS DATUM: GEODETIC + 17.15 m
2. AS-BUILT SURVEY DATA PROVIDED BY SUB-ARCTIC SURVEYS LTD. BASE SURVEY PLAN PROVIDED JULY 30, 2008 AND FEBRUARY 2009; FILE NO.: 08-092-NT. ADDITIONAL BATHYMETRY AND TOPOGRAPHY SURVEY PROVIDED OCT. 19, 2009; FILE NO.: 09-012-04-NT-COMPILED. DAM FOOTPRINT AND LOCATION PROVIDED DEC. 18, 2012; FILE NO.: JOB 205 DAM FINAL ASBUILTS 2012. OVERFLOW SPILLWAY AND BOTTOM OUTLET LOCATIONS PROVIDED DEC. 18, 2012; FILE NO.: JOB 205 SPILLWAY AND OUTLET STRUCTURE FINAL ASBUILTS 2012.
3. 1.0 m CONTOUR INTERVAL FOR EXISTING GROUND & 10.0 m MAJOR AND 2.0 m MINOR CONTOUR INTERVAL FOR AS-BUILT OVERFLOW SPILLWAY AND BOTTOM OUTLET

REVISIONS

NUM	DATE	DWN	CKD	APR	DESCRIPTION
4	MAR 12/13	SF	BC	BC	Updated drawing using As-Built data
3	MAR 29/12	DRG	CKG	AC	Addition of Outlet Rip rap Protection
2	FEB 3/12	DRG	CKG	AC	Plunge pool, Fish Passage approved, Reconstitutive Sill Updated
1	May 26/11	DRG	CKG	AC	New Dam Footprint, Add Plunge Pools, Fish Passage Channel and Note

DRAWING STATUS

NUM	DATE	APR	DESCRIPTION
14	MAR 12/13	BC	ISSUE FOR RECORD
13	MAR 29/12	AC	RE-ISSUED FOR CONSTRUCTION
12	FEB 3/12	AC	RE-ISSUED FOR CONSTRUCTION
11	MAY 26/11	AC	RE-ISSUED FOR CONSTRUCTION
10	OCT 29/10	RJW	ISSUED FOR CONSTRUCTION
G	MAR 11/10	RJW	RE-ISSUED FOR TENDER
F	FEB 9/10	RJW	ISSUED FOR DISCUSSION
E	DEC 23/09	RJW	ISSUED FOR TENDER

PERMIT

PROFESSIONAL SEAL

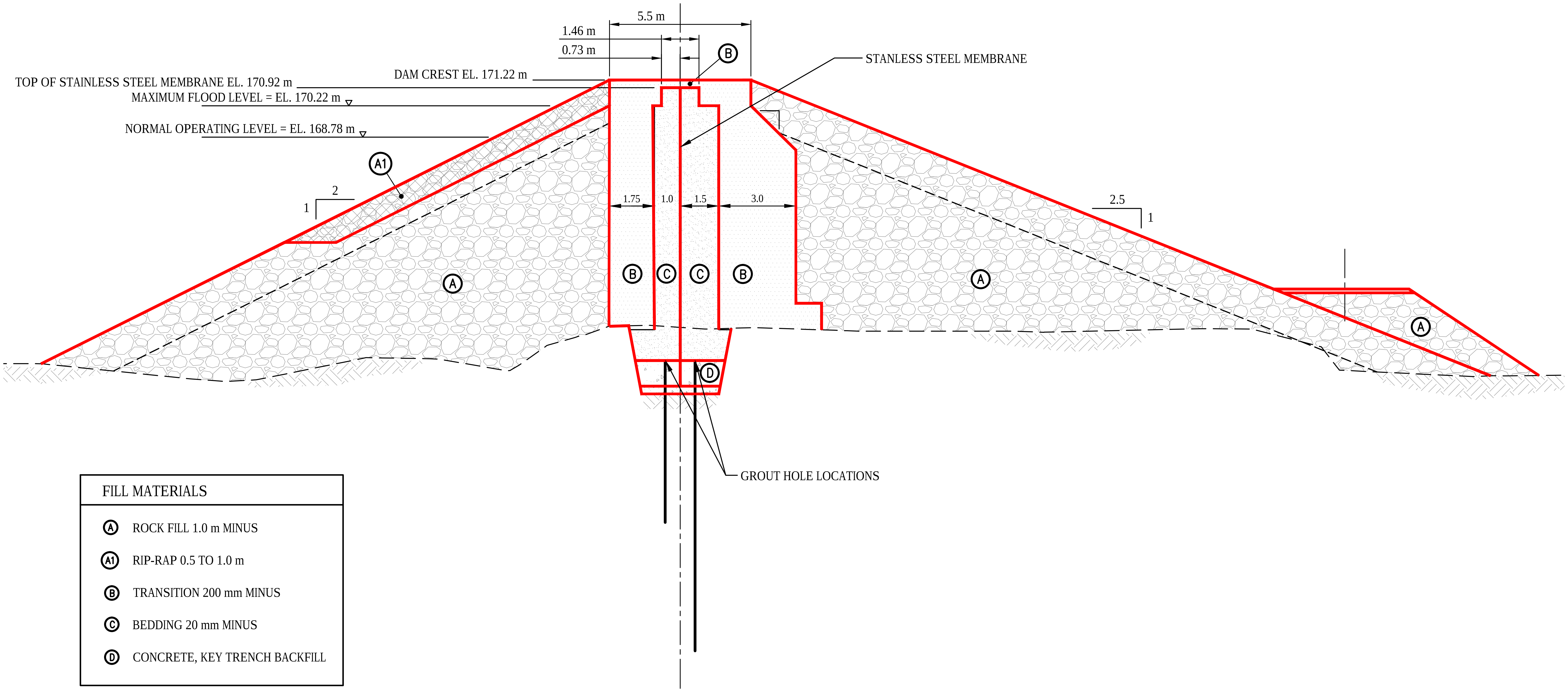
CLIENT
NORTHWEST TERRITORIES POWER CORPORATION

EBA Engineering Consultants Ltd.

REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

AS-BUILT PLAN OF OVERFLOW SPILLWAY AND BOTTOM OUTLET

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
E14101129.007	EDM	CH/RJW	CKG	4	C301
DATE: March 2013	SHEET No. 7 of 12	DWN DG/SF	APP CH/AC	STATUS 14	



LEGEND:

- CRITICAL MATERIAL INTERFACES TO BE SURVEYED TO PRODUCE ACCURATE RECORD DRAWINGS

0 5

Scale: 1: 150 (metres)

ISSUED FOR REVIEW

CLIENT

NORTHWEST TERRITORIES POWER CORPORATION

eba A TETRA TECH COMPANY

REPLACEMENT DAM AND SPILLWAY
BLUEFISH HYDRO, NT

TYPICAL SECTION SHOWING CRITICAL MATERIAL INTERFACES TO BE SURVEYED FOR ACCURATE RECORD DRAWING PRODUCTION

PROJECT NO.	DWN	CKD	REV
E14101129.004	DRG	CKG	0

OFFICE	DATE
EDM	November 21, 2011

Figure 5

APPENDIX VI

Emergency Preparedness and Response Plan

NORTHWEST TERRITORIES POWER CORPORATION

Empowering Communities

An NT Hydro Company

EMERGENCY PREPAREDNESS PLAN

BLUEFISH HYDROELECTRIC FACILITY
PLANT #122
BLUEFISH LAKE, NORTHWEST TERRITORIES

Issue Date: September 2010
Revised Date: February 2012

AUTHORIZATION			
Prepared by:	Golder	**Date:**	September 2010
Approved by:	Eddie Smith NTPC	**Date:**	October 2011

DOCUMENT HISTORY				
Revision #	**Revised Section(s)**	**Description of Revision**	**Prepared by**	**Issue Date**
1	Sections 3 and 4	Added reference to the proposed new Bluefish Lake Dam	Golder Associates Ltd.	November, 2010
2	Entire document	Formatting revisions	Golder Associates Ltd.	December, 2010
3	Emergency Contact Information	2011 Update	NTPC	October 2011
4	Emergency Contact Information	2012 Update	NTPC	February, 2012

TABLE OF CONTENTS

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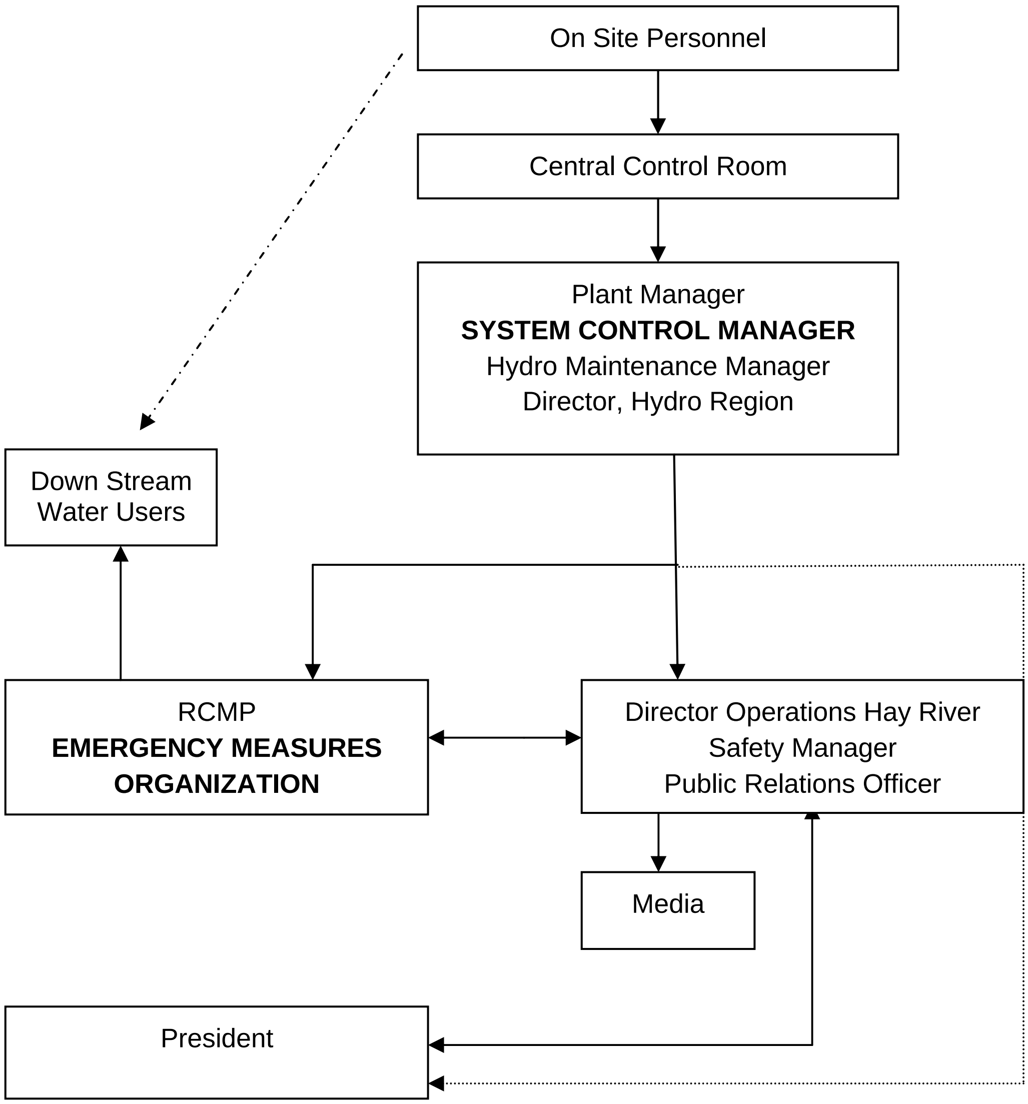
EMERGENCY NOTIFICATION FLOWCHART ORGANIZATIONAL COMMUNICATION PLAN



If any individual cannot contact the next person on the list that position should be skipped and immediately go to the next position.

Emergency Notification Information

Last updated Oct 2011

On Site Personnel / Control Center Operator shall report to:

Manager, YK Systems
Ken Dies
867-669-3327(O) 867-873-8094 (H) 867-445-6515 (cell)

Hydro Maintenance Manager
Aaron Martin
867-669-3326 (O) 867-766-3541 (H) 867-445-3389 (cell)

Operations Manager,
Colin Steed
867-669-3347 (O) 867-920-4574 (H) 867-446-4712 (cell)

Director, Hydro Region
Robert Schmidt
867-669-3301 (O) 867-669-0858 (H) 867-445-6525 (cell)

Assistant Director, Hydro Region
Randy Waddell
867-669-3306 (O) 867-873-4322 (H) 867-445-6514 (cell)

Regional Director shall report to the following:

President & CEO
Emanuel DaRosa
867-874-5276 (O) 867-875-7694 (cell)

Manager, Health, Safety & Environment
Edward Smith
867-874-5327 (O) 867-875-7737 (cell)

Director, Engineering
Daniel Roberts
867-874-5283 (O) 867-874-4025 (H) 867-875-7022 (cell)

Local agencies (Yellowknife):

Fire Department/Ambulance	867-873-2222
Hospital	867-669-4111
RCMP	867-669-1111
City Hall	867-920-5600
Public Works	867-920-5653
Public Works (After Hours Emergency)	867-920-5699

Downstream water users:

Cassidy Point Resident Association	
Yellowknife Dene First Nation (Dettah)	867-873-4307
Yellowknife Dene First Nation (N'Dilo)	867-873-8951
Dene Nation	867-873-4084
North Slave Métis Alliance	867-873-6762
Akaitcho Treaty #8 Tribal Corp	867-873-9282
City of Yellowknife	867-920-5600

Other important phone numbers:

GNWT Emergency Measure Organization	867-920-2303
Aboriginal Affairs and Northern Development Canada	867-669-2500
Fisheries and Oceans Canada	867-669-4900
24 Hour NWT Spill Report Line	867-920-8130

HEALTH & SOCIAL SERVICES
Primary Community Services
Health Planner - Health Emergency Management
(867) 920-8826

MUNICIPAL & COMMUNITY AFFAIRS
PUBLIC SAFETY
Emergency Management Intern
(867) 920-8066 (after hours – 873-7554)

MUNICIPAL & COMMUNITY AFFAIRS
PUBLIC SAFETY
24 Hour Emergency Contact Fire Marshal/Emerg. Measures
(867) 920-2303

PUBLIC WORKS & SERVICES
NORTH SLAVE REGIONAL OFFICE
Emergency Response Phone
(867) 920-2359

INDUSTRY, TOURISM & INVESTMENT
North Slave Region
Parks Enforcement-Emergency
(867) 920-3244

ENVIRONMENT & NATURAL RESOURCES
North Slave Region
Wildlife Emergency
(867) 873-7181

TRANSPORTATION
Programs & Standards
Operations Safety & Emergency Planning Officer
(867) 873-7752

TRANSPORTATION
Programs & Standards
Operations Safety & Emergency Planning Officer
(867) 920-6193

TRANSPORTATION
Programs & Standards
Operations Safety & Emergency Planning Officer
(867) 920-6957

STANTON TERRITORIAL HEALTH AUTHORITY
EMERGENCY UNIT
Emergency Unit
(867) 669-4100

STANTON TERRITORIAL HEALTH AUTHORITY
EMERGENCY UNIT
Manager Critical Care Services
(867) 669-4385

STANTON TERRITORIAL HEALTH AUTHORITY
EMERGENCY UNIT
Clinical Coordinator
(867) 669-4365

STANTON TERRITORIAL HEALTH AUTHORITY
EMERGENCY UNIT
Fax (867) 669-4171

1 INTRODUCTION

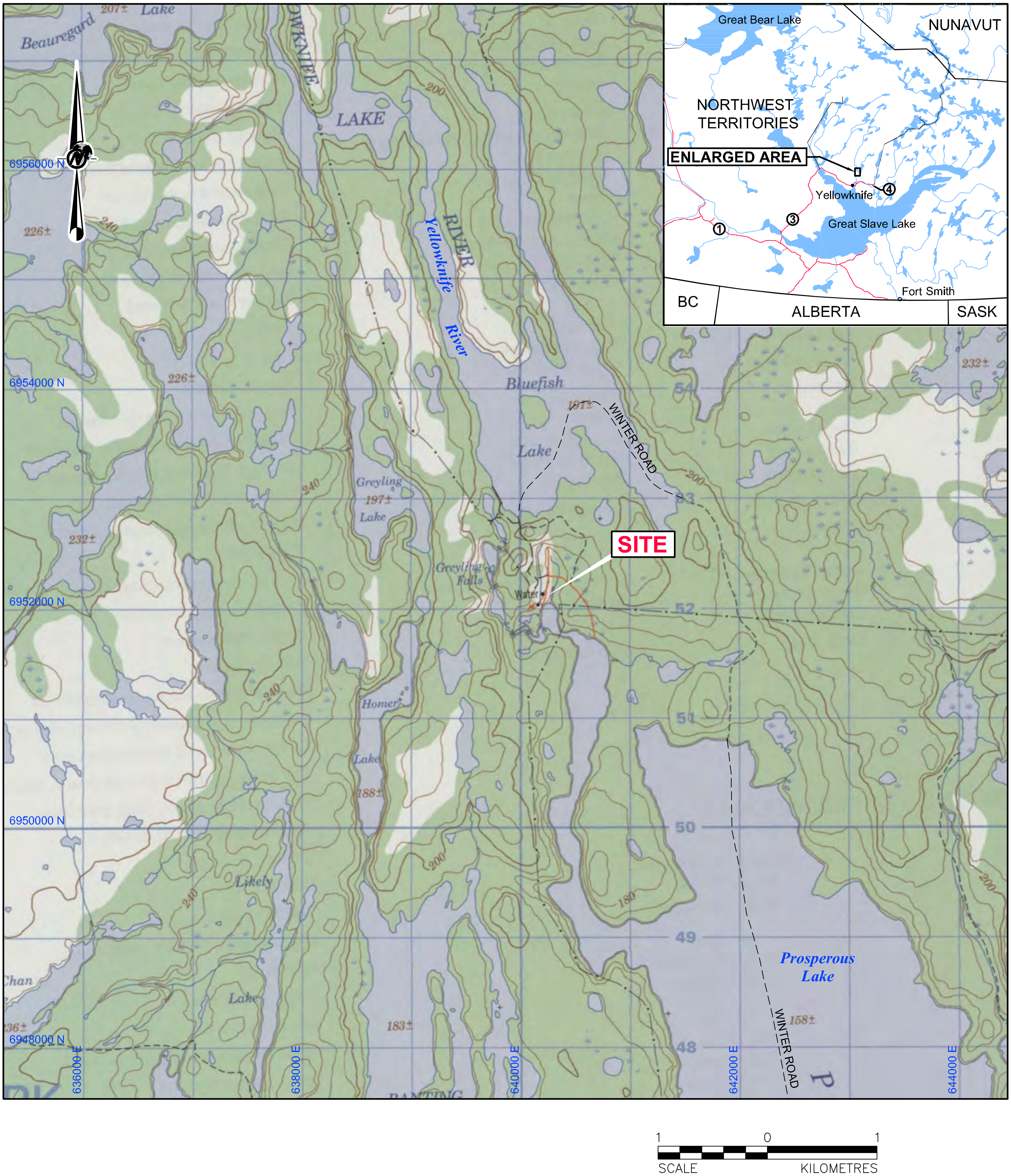
This plan is written to meet Northwest Territories Power Corporation (NTPC) requirements for a General Contingency Plan (GCP) for the Company's Bluefish Hydro generation plant. It covers the following key areas:

- NTPC policy statement;
- purpose and scope of the GCP;
- pre-emergency planning;
- emergency response;
- training and practice;
- plan evaluation; and
- plan updates.

1.1 FACILITY LOCATION

The Bluefish hydroelectric facility is located on Prosperous Lake, 39 km north of Yellowknife, NT, on the Yellowknife River system (Figure 1). The facility includes the following:

- Duncan Lake dam;
- Bluefish Lake dam;
- reservoir created by the Duncan Lake dam;
- reservoir created by the Bluefish Lake dam;
- old dam at outflow of Bluefish Lake;
- new dam, downstream of the old dam (expected to be operational in 2012);
- approximately 900 m long tunnel/penstock;
- old power plant;
- new power plant; and
- miscellaneous buildings and other appurtenances.



PROJECT

NWT POWER CORPORATION
BLUEFISH HYDRO
BLUEFISH LAKE, NWT

TITLE

BLUEFISH LAKE HYDROELECTRIC FACILITY LOCATION

NORTHWEST TERRITORIES POWER CORPORATION

PROJECT	10.1328.0030.5000	
DESIGN	DP	26/03/10
CADD	BSW	24/03/11
CHECK	GC	24/03/11
REVIEW	GC	24/03/11

FILE No.10132800305000B002

SCALE AS SHOWN REV. 0

FIGURE: 1.1

REFERENCE

TOPOGRAPHIC MAP 85J/09 OBTAINED FROM TOPOMAP.© 2002 HER MAJESTY THE QUEEN IN RIGHT OF CANADA. DEPARTMENT OF NATURAL RESOURCES.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD27 COORDINATE SYSTEM: UTM ZONE 11.

L:\2010\1328\10-1328-0030\5000\Report B\Fig 1.1 10132800305000B002 Facility Location.dwg Mar 24, 2011 - 2:20pm

1.2 OPERATION OVERVIEW

1.2.1 Operations Infrastructure

The Bluefish Hydro facility makes use of water from the Yellowknife River drainage basin. Prior to the damming of Bluefish Lake in 1940 and diverting of the Yellowknife River through the Bluefish facility, the Yellowknife River connecting Bluefish and Prosperous Lakes went over a waterfall at the outlet from Bluefish Lake. Prosperous Lake is approximately 38 m lower than Bluefish Lake.

In 1940 a dam was constructed at the outlet to Bluefish Lake to divert part of the flow of the Yellowknife River through a generator. The amount of water entering the generator is controlled by a large head gate. The intake leads to a 760 m long unlined rock tunnel. From the tunnel, a metal 3 m diameter, 150 m long metal penstock connects to two powerhouses. NTPC generally operates on the new plant most frequently, and utilizes the old plant as a variable flow unit when flows and electrical demand that exceed the requirement of the new unit. There are several additional buildings located near the powerhouses, including two trailers housing operations employees.

The main water storage area for the Bluefish Hydro Facility is at Duncan Lake, a large lake to the northeast of Bluefish Lake where the hydro facility primary dam is located. Water flows from Duncan Lake through the McCrea River to Neck Lake, then to Short Point and Angle Lake. Water from Angle Lake flows into Quyta Lake and then into Bluefish Lake where the Duncan River system joins the Yellowknife River system.

A control dam has been constructed near the south end of Duncan Lake which can vary the water level of the lake between 209.3 and 212.4 m (3.1 m). The 3.1 m of water in Duncan Lake represent a volume of 207,224,949 m^3.

The primary purpose of the Duncan Lake dam is to control water levels in Bluefish Lake. The Duncan Lake control dam was originally built in 1942, rebuilt in 1974 using concrete, and repaired in 1994 due to concrete erosion. The maximum draw down at the dam is to 209.45 m. The top of the spillway is at 212.49 m; the top of the dam is at 213.41 m.

The NTPC operator on duty at the Bluefish Hydro facility inspects the Bluefish Dam, Head Gate and the spillway twice a day during his daily routine. The Duncan Lake Dam is inspected at least four times a year.

1.2.2 Hydrology

The Yellowknife River System, at the Bluefish Hydro site, drains an area of approximately 11,655 km^2. Duncan Lake accounts for approximately 3,522 km^2. Mean annual rainfall (30 years) at the Bluefish Hydro site is 239 mm. The minimum historical Yellowknife River flow (50 year: 6.9 m^3/s mean monthly) occurred in April 1977; maximum flow (50 year: 152 m^3/s maximum monthly) occurred in July 1991. Plant flow capacity with both units operating at maximum output is about 28 m^3/s. Typically, maximum spillage over the Bluefish dam occurs during August and September. Water shortages occur during the second quarter of each year. Seepage at the Bluefish dam is estimated between 2.1 and 2.8 m^3/s when Bluefish Lake is at 186 m elevation.

1.3 NTPC STATEMENT OF CORPORATE COMMITMENT – ENVIRONMENT & SAFETY

- Conduct operations in an environmentally sound manner which ensures compliance with all applicable national and local regulations.
- Assign accountability and responsibility for implementation of the environmental policy and make environmental performance an important factor in the management review process.
- Provide adequate resources, personnel, and training so that all employees are aware of and able to carry out their responsibilities in accordance with the environmental policy.
- Communicate openly with employees, regulatory agencies, and the public on environmental issues and address concerns pertaining to potential hazards and impacts.
- Work in cooperation with industry, the public, and government toward the development of responsible environmental policies, laws, and regulations.
- In locations where environmental regulations are absent apply the best management practices to achieve environmental protection consistent with industry standards.
- Implement operating practices which incorporate the efficient use of energy and materials, and minimizes the use and production of hazardous substances.
- Establish and maintain appropriate emergency response plans for all activities and facilities.
- Maintain a self-monitoring program at each facility to ensure compliance.
- Conduct periodic environmental assessments at all NTPC facilities and develop and implement action plans to correct potential deficiencies in a timely manner.
- Encourage all employees to report to management any known or suspected departure from this policy or related procedures.

1.4 PURPOSE AND SCOPE OF THE EMERGENCY PREPAREDNESS PLAN

The purpose of this manual is to provide a practical source of information required to assess environmental risks, develop an effective contingency program, and respond in a safe and effective manner to environmental emergencies associated with power facility operation. The plan was specifically developed for operations at NTPC's Bluefish hydroelectric facility. Much of the material contained in the manual is in summary form for ease of use in emergency situations.

To meet Dam Safety Guidelines, the following procedures and information are required

- emergency identification and evaluation;
- preventative actions;
- notification procedure (See Section 5);
- communications system;
- access to the site;
- response during periods of darkness;
- response during periods of adverse weather;
- sources of equipment;
- stockpiling supplies and materials;
- emergency power sources;
- inundation maps; and
- warning systems, if used.

The level of detail required in the Emergency Preparedness Plan is dependent on the consequences of failure in terms of potential loss of life and property damage. An evaluation of these consequences for the Bluefish Hydro facility is provided in Section 2.0.

1.5 GENERAL CONTINGENCY PLAN USE AND DISTRIBUTION

The appropriate procedures in this plan are to be followed in the case of any environmental emergency other than spills (discussed in detail in a separate document, Bluefish Hydro Facility Spill Contingency Plan). The Hydro Maintenance Manager, Safety and Environment Manager, or Hydro Region Director will decide what further action is appropriate in each case.

All persons issued this manual must become familiar with its contents. Emergency response procedures are laid out in chart form for ease of reference. It is important to understand areas of responsibility and the appropriate actions to take in the case of an environmental emergency. Procedures that are not understood must be clarified with the Hydro Maintenance Manager.

1.6 UPDATE PROCEDURE AND SCHEDULE

This manual will be reviewed for accuracy and completeness annually by the Operations Director Hay River and the Hydro Region Director Yellowknife. Changes to procedures will be incorporated as amendments to the manual. The internal contacts list will be updated annually, and the date of update noted on the contact list.

1.7 REGULATORY FRAMEWORK AND PLAN REQUIREMENTS

Requirement for a GCP is set out in the Bluefish Water License MV2005L4-0008, issued April 3, 2006. Enabling legislation for the Water License is the Northwest Territories Water Act. The GCP must, as a minimum, meet the requirements of an Emergency Preparedness Plan (EPP) detailed in the Dam Safety Guidelines, published by the Canadian Dam Safety Association (1995). These require that the Operator:

- identify potential emergencies at the dam and evaluate the consequences of dam failure;
- prepare, test and maintain an emergency preparedness plan for any dam where failure may cause loss of life, or where advanced warning would reduce upstream and downstream damage;
- assess whether dam breach warnings should be issued directly to inhabitants in areas downstream of a dam, due to the short period of time before the anticipated arrival of a flood wave (not applicable for Bluefish);
- link appropriate dam surveillance with government emergency response procedures; and
- institute preventative actions as appropriate where available to prevent failure or to limit damages where failure is inevitable.

2 DAM FAILURE ANALYSIS

Consequences categories are based on the incremental losses which a failure might inflict on downstream or upstream areas or at the dam. Incremental losses are those over and above losses which might have occurred for the same natural event or conditions, had the dam not failed. Evaluation of potential losses, both with and without dam failure, must be based on inundation studies and must consider existing and anticipated future downstream development and land uses. The appropriate study level of inundation depends on the potential consequences of failure. Consequences analyses must be based on average discharge conditions and maximum normal operating levels.

The Dam Safety Guidelines (Canadian Dam Safety Association, 1995) provide four Consequence of Failure (COF) categories:

- Very high: large increases in loss of life; excessive increase in social, economic, and/or environmental losses;
- High: some increase in loss of life; substantial increase in social, economic, and/or environmental losses;
- Low: no increase in loss of life; low social, economic and/or environmental losses; and
- Very low: no increase in loss of life; small dams with minimal social, economic, and/or environmental losses; losses limited to owner's property.

The analysis of the reservoir and dam system used to generate hydropower at Bluefish in summary has the following key aspects:

- the drainage basin between Duncan and Bluefish lakes is uninhabited;
- there are few dwellings on Prosperous Lake; the only permanent dwellings are on Cassidy Point which is connected by road to Yellowknife and is a raised peninsula;
- most residences (permanent and cabins) are above probable maximum flood levels;
- the rate of rise of flood waters due to dam failure would be small;
- incremental risk to life is small;
- potential for economic loss is small; and
- the dams are in a zone of low earthquake potential.

Based on these considerations, the Consequences Classification for the Duncan and Bluefish dams is considered to be low. The basis for this classification is further evaluated in Section 3.0.

3 EMERGENCY IDENTIFICATION & EVALUATION

3.1 EMERGENCY IDENTIFICATION

The following emergencies at the Bluefish Hydro facility are considered in this plan:

- the probable maximum flood (PMF) for the Duncan Lake dam;
- the probable maximum flood (PMF) for the Bluefish Lake dam;
- maximum credible earthquake (MCE) event;
- failure of the Duncan Lake dam;
- failure of the Bluefish dam (either the new dam or the old dam, whichever is operational at the time);
- sequential failure of both Duncan and Bluefish lake dams with a PMF;
- rupture of the penstock; and
- fire at the old or new powerhouse.

3.2 EMERGENCY EVALUATION

3.2.1 Definition of the Probable Maximum Flood

The International Commission on Large Dams defines the Probable Maximum Flood (PMF) as follows (Canadian Dam Safety Association 1995):

“The PMF identifies estimates of hypothetical flood characteristics (e.g., peak discharge, volume and hydrograph shape) that are considered to be the most severe ‘reasonably possible’ at a particular location, based on relatively comprehensive hydrometeorological analysis of critical runoff-producing precipitation (including snowmelt, if pertinent), and hydrological factors favorable for maximum flood runoff.”

The PMF would result from a combination of the most critical input of water on the watershed and of an initial condition. The water input can be of the form of: a) the most reasonably severe rainstorm on the area, called the Probable Maximum Precipitation, or b) a combination of the most reasonably severe snow accumulation, called the Probable Maximum Snow Accumulation (PMSA), with a severe rainstorm and a severe temperature sequence.

The Probable Maximum Precipitation (PMP) is defined as “the greatest depth of precipitation for a given duration meteorologically possible for a given size storm at a particular location at a particular time of year, with no allowance made for long-term climatic trends" (Huschke, 1959). It is a description of an upper physical bound to precipitation that the atmosphere can produce.

3.2.2 Estimation of Probable Maximum Precipitation

A probable maximum flood event PMF has not been calculated by Water Survey of Canada for either the Duncan or Yellowknife River systems, and in general, the appropriate hydrometeorological data for evaluating PMFs (temperature, relative humidity, precipitation, streamflow, etc.) are not available for northern Canada. Therefore alternate methods must be considered for each project area on a case-by-case basis. In this case, the 2 x Q10000 was assumed to be equivalent to the PMF and to provide a reasonable estimate for evaluating potential dam-break scenarios.

Annual peak flow data are available for the Yellowknife River at the inlet to Prosperous Lake (drainage area = 11,260 km^2) for the period 1939 to 1994, with missing data for ten years. Using this data, the 10,000 year peak flows were estimated assuming normal, log-normal, lo-Pearson Type 111, and 3-parameter log-normal distribution. The resulting values are shown in Table 3-1.

Table 3-1. Summary of Estimation of Probable Maximum Flood (PMF) for the Yellowknife River at Prosperous Lake by Various Methods

Assumed Probability Distribution	Estimated 10,000 year Peak Flow (m^3/s)	2 x 10,000 year Peak Flow (m^3/s)
Normal	176.2	352.4
Log-normal	383.3	766.6
Log-Pearson Type III	279.5	559.0
3-Parameter Log-normal	323.5	647.1

The recorded annual peak flows at the inlet to Prosperous Lake may have been attenuated by upstream storages, and there is statistical inaccuracy in extrapolating 46 years of data to a return period of 10,000 years. To account for this, the PMF peak at the inlet to Prosperous Lake was taken to be 30% higher than the highest value shown in Table 3-1. The PMF peaks at the inlets to Duncan Lake and the Bluefish dam were then estimated by drainage area ratios. The resulting PMF peaks are shown in Table 3-2.

Table 3-2. Summary of Estimation of PMF for the inlets to Prosperous, Duncan, and Bluefish Lakes

Location	Drainage Area (km^2)	PMF Peak Flow (m^3/s)
Inlet to Prosperous Lake	11,260	1,000
Inlet to Duncan Lake	3,520	310
Yellowknife River at Bluefish Dam	7,740	689

The PMF hydrographs were conservatively assumed to have the peak flows listed in Table 3-2, a 24-hour base and a trapezoidal shape. In effect, the assumption of the 24-hour base (or the time period when flows have receded to approximately 5% of the peak flow) compresses the time to peak and the duration of flow, but does not change the volume of flow. In this case, the PMF hydrographs were routed through the system assuming that the Duncan Lake dam and the old Bluefish dams were full to the respective spillway crest elevations at the commencement of the respective PMF hydrographs.

Based on the hydrograph analyses, elevations were predicted for the PMF at the inlets and outlets for Duncan and Bluefish Lakes. These elevations were calculated assuming lake levels were at the spillway crest, and in essence yielded the largest possible change in stage height (for the given assumptions). These data are compared with the elevations of the spillway crest, top of dam and dam design heights (i.e., failure elevation) in Table 3-3. In both cases the predicted elevations for the PMFs at the dam outlets are less than the design heights. If the lake levels were greater than the spillway crest at the time of the PMF, then the stage at the time of the PMF would be greater than that given, but the amount of rise would be less (i.e., because the spillway width increases with depth at the dam cross section). For example, the predicted rise due to the PMF at Duncan dam is only 0.24 m (or from 212.60 to 212.84 m above mean sea level (amsl)). If the lake level was at the top of the dam (213.4 m), then the total rise due to the PMF would be somewhat less than 0.24 m. In any case for both dams, the PMF does not produce a water surface elevation equal to or greater than the design elevation.

Table 3-3. Comparison of Elevations of the Spillway Crest and Top of Dam with the Predicted PMF Elevations and the Failure Elevation

	PMF = 2 x Q10000			Spillway Crest	Top of Dam	Failure Elevation
	m^3/s	metres amsl	metres asc	metres amsl	metres amsl	metres amsl
Inflow to Duncan Lake	312	-	-	-	-	-
Duncan Dam	4	212.8	0.24	212.6	213.4	214.4
Inflow to Bluefish lake	689	-	-	-	-	-
Old Bluefish Dam	689	188.2	203?	185.9	187.1	188.6
New Bluefish Dam	TBD					

Amsl = above mean sea level; asc = above spillway crest; TBD = to be determined.

These results are based on the old Bluefish dam. Although the new Bluefish dam is anticipated to have a similar or greater failure elevation than the old Bluefish dam, the exact design specifications have not been finalized. This Plan will be updated when the failure elevation of the new dam has been calculated. Regardless, the above analyses indicate that the dams will not reach failure elevations from a hydrometeorological condition. However, dam failures due to other types of events (e.g., from piping, ruptures, or earthquakes) should be evaluated.

3.2.3 Maximum Credible Earthquake Event

The site is well away from seismic source zones and Geological Survey of Canada (GSC) has not specified a maximum earthquake for the region. We have therefore (on the advice of GSC) assumed a maximum credible event of magnitude 5.0. The nearest seismic source zone is several hundred km to the west in the McKenzie Mountains. National Building Code of Canada zoning for the Bluefish hydro facility area is ZA = 0; ZV = 1; V = 0.05 m/s; where ZA = acceleration zone, ZV = velocity zone, and V = velocity (or acceleration). These data indicate seismic risk is low and expected accelerations are also low (i.e., earthquakes are very unlikely to cause structural damage at the site).

3.2.4 Failure of Duncan Lake Control Dam

The Duncan Lake control dam is a concrete structure which in the past was subject to seepage. Repairs have resulted in reduction of seepage, as discussed previously. A reappearance of seepage from the dam would result in a reduction in effectiveness, but would not result in an emergency; the dam would be repaired as was previously done.

Based on the EBA Engineering (EBA) analysis (EBA, February 1998), the Duncan Lake control dam is postulated to fail when the spillway is overtopped by 1.8 m (no information is available on the original design flood for the Duncan or Bluefish dams, but EBA conducted a dam failure analysis which indicated failure heights of 1.8 m for the Duncan dam and 2.7 m for the Bluefish dam). Complete failure of the Duncan Lake control dam would result in the release of up to 245.5 million m^3 of water. The probability (based on statistically determined probable maximum flood event [see Section 3.221]) of attaining from natural hydrometeorological conditions a flood crest 1.8 m above the spillway crest are extremely unlikely and are estimated to have a return period on a geological time scale of tens of thousands of years.

Released water from Duncan Lake dam takes, on average, 15 days to reach Bluefish Lake (based on observations by the facility operator when stoplogs were added or removed) with flows at normal release levels. The total discharge from the dam would require a minimum of 14.6 days and approximately the same length of time for the flood peak to reach Bluefish Lake. Floodwaters from the Duncan Lake dam would flow into the Yellowknife River system and downstream to Prosperous Lake, or, under normal circumstances, through the penstocks and power generators at Bluefish and thence into Prosperous Lake. Flood effects in the Yellowknife River will be reduced due to the buffering and storage effects of the intermediate lakes between Duncan and Bluefish Lake (i.e., in downstream order, Neck Lake, Short Point Lake, Angle Lake and Quyta Lake) and the Bluefish dam, as well as the lag time caused by the transit distance of 34.5 km between Duncan and Bluefish Lakes. There are no permanent human habitations along the stretch of the Duncan River system between Duncan and Bluefish lakes. Damage would be limited to environmental damage, principally an increase in sediment loads and riparian area flooding. Once the crest of the flood passed, waters would recede, similar to a flood from natural causes.

3.2.5 Failure of Old Bluefish Lake Dam

Based on the EBA analysis (EBA, June 25th, 2009), the current situation at Bluefish Dam justifies reasonable apprehension of failure. The internal timbers have reached a state of deterioration that indicates they have reached the end of their service life. The rate of seepage has increased dramatically since an inspection in 2008, and piping has initiated. Continued piping and seepage could further deteriorate the dam. Finally, the spillway discharge is undersized and recent flood events had completely overtopped the dam. An emergency spillway was constructed as a result, which has corrected this issue.

3.2.6 Effect on Prosperous Lake

Bluefish Lake drains into the north end of Prosperous Lake through an approximately 1.7 km long reach of the Yellowknife River, and there are no intervening lakes to buffer flood flows. Thus, nearly all the water released from sudden dam failure at Bluefish Lake would flow quickly into Prosperous Lake. However, normal peak maximum flood events in the Yellowknife River are much larger and would nearly mask any effects of dam failure.

Bluefish Lake has approximately 2% the volume of Prosperous Lake (33.86 million m^3 vs. 1457 million m^3) and any release of water from the Bluefish Lake would have a similarly small effect on lake levels in Prosperous Lake.

3.2.7 Sequential Failure of Duncan and Bluefish Dams

The sequential failure of both the Duncan and Bluefish dams is an extremely low probability event. In the event of a sequential failure of both the Duncan and Bluefish dams, the Duncan River system between Duncan Lake and Bluefish Lake would not be affected any differently than from failure of the Duncan Lake control dam.

The greatest potential effects from failure of the two dams would be a failure of the Bluefish dam at the time the flood crest from the Duncan Lake control dam reached Bluefish dam. The effects of dam failure on Prosperous Lake would depend on the lake level. If the lake level were low, no flooding would occur. If the lake were already in flood, an incremental increase would result from dam failures. Long-term lake level records for Prosperous Lake indicate a maximum level in July 1991 of nearly 160.5 m.

A dry weather dam break analysis was completed to determine the incremental effects of Duncan and Bluefish Lake dam failures. The analysis, as summarized in Table 3-4, predicted a maximum 0.4 m rise in Prosperous Lake if both dams overtopped or failed.

Table 3-4. Comparison of Predicted Water Surface Elevations during Sequential Dam Failure with the Spillway Crest, Top of Dam, and Failure Elevations

	Both Dams Failing at Design Heights			Spillway Crest	Top of Dam	Failure Elevation
	m^3/s	metres amsl	metres asc	metres amsl	metres amsl	metres amsl
Inflow to Duncan Lake	2184	-	-	-	-	-
Duncan Dam	495	214.4	1.8	212.6	213.4	214.4
Inflow to Bluefish lake	573	-	-	-	-	-
Old Bluefish Dam	1221	188.6	2.7	185.9	187.1	188.6
New Bluefish Dam	TBD					
Prosperous Lake	603	153.6	0.4	153.2a	-	-

Amsl = above mean sea level; asc = above spillway crest; a = average lake level; TBD = to be determined

Depending on the water level of Prosperous Lake, some flooding of low lying structures including houses could result from dam failure and a rise of 0.4 m in addition to higher water caused by flood discharge from the Yellowknife River. Registered (i.e., known) property owners are almost entirely confined to Cassidy Point and could be readily notified from Yellowknife, since there is road access to properties.

3.2.8 Penstock Rupture

Penstock rupture will lead to loss of water flowing in the penstock until the intake (head) gate is closed. The rate of flow of water released due to a complete failure of the penstocks would depend on where the failure occurred. The penstock is connected to the head gate via a 3.6 x 3.6 m cross section tunnel. The penstock diameter is 3 m. A rupture at the top end of the penstock would result in water release being controlled by the tunnel; a rupture at the bottom, by the penstock. The worst-case scenario is a break at the pipe/tunnel interface. Flow rate calculations for this scenario were provided by Power Engineering Ltd., designers of the penstock system. They used the hydraulic modeling package, KYPIPE, and verified their results with hand calculations. The simulation estimated a maximum flow rate of 77.9 m^3/s. This assumed the break would be clean and that there would be no backpressure from anything downstream (worst case). Realistically, there would be some obstruction which would make the flow rate smaller. Bluefish is now equipped with a intake gate that can be dropped in an emergency from the plants or from the Yellowknife Control Center; smaller breaks or leaks may go undetected for some time, but would have no significant impact, as water would be captured by the trench below the penstock pipe.

A major break in the penstock would be noticed immediately at the powerhouse for obvious reasons; smaller leaks would be noted at the time of weekly visual inspection of the penstocks, or sooner, depending on the size of the leak. Any catastrophic break in the penstock system would illicit an immediate response from the operator to shut off flows at the intake gate.

A major discharge of water would flow down the channel where the penstocks are located and impinge on the new powerhouse wall. Water would likely have sufficient force to breach the wall, flow through and around the powerhouse and into Prosperous Lake. The erosive power of the water would likely result in entrainment of sediment until the soil overlying the bedrock at the site was washed away.

A sediment plume would be carried by the penstock water a variable distance down Prosperous Lake from the powerhouse, depending on the current velocity created in the lake and the particle size distribution of eroded sediment. Coarse materials (the bulk of the material from the sandy soil eroded) would settle quickly once the current dropped. Dissipation of energy and water resistance in Prosperous Lake would result in a rapid drop in current velocity. Fine particles (silt and clay) would remain suspended for several hours/days and could drift further down the lake before settling, if the wind direction were down-lake (southerly).

Fish spawning beds are located near the mouth of Bluefish Creek, the seepage discharge channel from the Bluefish dam. Depending on the flow from Bluefish Creek into Prosperous Lake, there is some potential for suspended sediment to back up into Bluefish Creek. This would presuppose little or no flow in Bluefish Creek, a condition that would contravene the Bluefish Water License. If lake levels are low, a hydraulic gradient will exist between the fish spawning beds and Prosperous Lake, and sediment will not reach the beds. Sedimentation of the fish spawning beds is a low probability event, even given a rupture of the penstocks because NTPC must keep a minimum flow of water in the channel continuously. Because of the steel construction of the penstock, a major rupture is a very low probability event. More minor leaks would have minimal or no environmental effects.

3.2.9 Fire at the Generator

Fire at either Generator 1 or 2 (Figure 1) could result in disruption of power production. Such an emergency would have consequences for staff at the Bluefish facility and NTPC customers, but would not affect any other people on Prosperous Lake directly. Bulk fuel is stored in two double-walled tanks; diesel near and gasoline well away from structures (Figure 1). Other flammable petroleum products are stored in a steel shed. The scenario of fire at the fuel farm is dealt with in a separate report, the Bluefish Hydro Facility Oil Pollution Emergency Plan. The new powerhouse has a nitrogen gas automated fire extinguishing system which is designed to extinguish fires quickly with a minimum of damage. Conventional smoke and fire detectors, carbon dioxide system for control panels and water deluge for the generator are in place at the old generator powerhouse. Fire extinguishers are located at both plants and in the residence trailers.

4 EMERGENCY SCENARIOS AND RESPONSES

4.1 FAILURE OF DUNCAN LAKE CONTROL DAM

Dam failure prevention consists of regular inspection and maintenance of the structure. Geotechnical engineers inspect the dams and provide a report every four years which is forwarded to the Water Board as per requirements of the Bluefish Water Licence. In the event of a failure other than the flood spillway, stop logs in the spillway would be removed if required to lower water levels and remove pressure from the dam. The decision to allow water over the flood spillway would be made by on-site personnel after consultation with the System Control & Hydro Planning Manager (where time permitted).

INAC in Yellowknife would be notified immediately that the System Control & Hydro Planning Manager became aware of an emergency situation. An increase in water released from Duncan Lake Dam would require up to 15 days to be reflected in Bluefish Lake levels. Increases that could credibly occur could be handled through increases in power output (and therefore water use in the power turbines) and by release through the Bluefish Dam sluiceway (the Yellowknife River).

Automated water level recorders with a satellite radio link to Yellowknife have been installed by WSC at Duncan and Bluefish lakes. Data are available to NTPC via the internet and checked daily. Water Survey of Canada checks the gauges on at least a quarterly basis, or more frequently if problems are evident unexpectedly high (or low) readings would be checked as soon as noted by WSC. Periodically gauge readings are checked against benchmarks located in bedrock by WSC.

4.2 FAILURE OF BLUEFISH LAKE DAM

This procedure relates to either the new or old Bluefish Dam, whichever is operational at the time of the failure. As with the Duncan Lake Dam, the Bluefish Dam and spillway are regularly inspected.

INAC in Yellowknife would be notified immediately that the Operator became aware of an emergency situation. The System Control & Hydro Planning Manager would also be notified immediately. At this point, if flood damage was estimated to be possible on Prosperous Lake, EMO and the RCMP in Yellowknife would be notified. As noted in Sections 1 and 3, because of the slow rise in water levels in Prosperous Lake due to dam failure, no immediate danger to life and property would result from failure.

The crest would result in a rise in Prosperous Lake over a period of hours, the extent of which would depend on the amount of water that was released from Bluefish Lake. Under any conditions but peak flood in the Yellowknife River, the flood crest would be well below maximum flood levels normally encountered on Prosperous Lake.

Notification procedures are discussed in Section 5.0.

4.3 SEQUENTIAL FAILURE OF DUNCAN AND BLUEFISH DAMS

Sequential failure of Duncan and Bluefish dams cannot occur from hydrometeorological causes. Earthquakes or sabotage at both dams would be possible causes of failure of both dams.

4.4 PENSTOCK RUPTURE

In the case of a large leak or failure of the penstock, The Bluefish Operator would immediately drop the intake gate from the closest plant and would notify the System Control & Hydro Planning Manager and the Environment, Health and Safety Manager. Either of these latter two people would notify INAC. The Operator would then deal with the emergency as appropriate. Since the general public would not be affected by a penstock rupture, there would be no other notifications with respect to public safety. Environmental or senior management staff at NTPC would notify Fisheries and Oceans and Environment Canada.

Depending on the nature of the rupture, water could he diverted from the powerhouse over the flood spillway until repairs were effected. Alternately, minor leaks could be repaired while maintaining flows in the penstocks. Depending on the extent of leakage, one of the following procedures would be followed:

- For small leaks not causing erosion, the foreman or the Environment, Health and Safety Manager would notify INAC of an unauthorized discharge; a log book of the incident would be started and kept by the System Control & Hydro Planning Manager; and the penstocks would be repaired during routine maintenance.
- For larger leaks less than rupture but of a nature to cause erosion the procedures would be as above, except that rip rap armor would be placed at the point of water impact to protect against soil erosion.
- For very large leaks, short of complete rupture, which impaired the operation of the powerhouse, threatened the integrity of the penstocks or posed a serious environmental threat, the procedures outlined in the first paragraph in this section would be followed.

In the event of environmental damage from penstock rupture, INAC, Environment Canada and Fisheries and Oceans would be notified, the damage would be assessed and a report prepared with mitigation actions proposed and implemented.

4.5 GENERATOR FIRE

The immediate concern for a generator house fire would be safety of site personnel, and then controlling the fire. Automated fire control devices would likely be deployed initially, except in the case of a small fire which would be controlled using fire extinguishers by site personnel. If the fire could not be contained by on-site fire fighting equipment or automated fire suppression devices (a very low probability event), evacuation procedures would be implemented, people moved by helicopter or boat (winter road in the winter) away from danger. The Yellowknife Fire Department and INAC would be notified, and NTPC's management would also be notified as described in Section 5.

4.6 MAINTENANCE AND TESTING OF THE EMERGENCY PROCEDURES

4.6.1 Plan Evaluation

Despite careful planning, it is highly probable that certain components of the General Contingency Plan (GCP) will need to be modified. Therefore the plan will be reviewed to pinpoint those components that need to be corrected, adjusted or upgraded. Emphasis will be for aspects of the plan affecting safety of employees of the facility and the general public. The operational aspects of the plan and any paperwork that deals with the plan will be reviewed as well.

Formal evaluations of the plan will be documented, deficiencies noted in the report and progress in addressing deficiencies tracked in writing. Responsibilities to address deficiencies and accountabilities will be assigned and deadlines for addressing required changes will be set. The Environment, Health and Safety Manager will assume overall responsibility for the process in close consultation with the System Control & Hydro Planning Manager; authorization for expenditures may be required from other management personnel.

4.6.2 Training

At least once every two years all NTPC employees potentially involved in a Bluefish Hydro facility emergency response will have a response drill conducted by the Environment, Health and Safety Manager. If a drill is too disruptive to operations because of clearing out the entire facility at one time, alternate practice drills will be arranged. Based upon notes taken by the Environment, Health and Safety Manager during the drill, a report will be prepared by the Environment, Health and Safety Manager concerning success of the drill. Suggestions will be made to decrease response time and increase overall control. Any special problems encountered will be noted along with corrective actions recommendations.

5 NOTIFICATION PROCEDURE

The first action of NTPC staff would be to control the emergency situation. Notification would follow control actions. In general, the following notification procedures will be required:

- All on site NTPC staff shall be notified, accounted for and mustered to a safe location.
- Notification of the System Control & Hydro Planning Manager.
- If danger to the public is a possibility, immediate notification (by NTPC personnel) of the Emergency Measures Organization and possibly the RCMP; subsequent notification the Cassidy Point Residents Association and other local land users.
- Notification by NTPC personnel of INAC Water Resources, Fisheries and Oceans, and Environment Canada, Yellowknife.
- Notification of the Environment, Health and Safety Manager.
- Notification of other agencies and the general public as appropriate.

Refer to the first page of this plan for a list of phone numbers. Emergency phone numbers are also posted in the powerhouses, maintenance garage and trailer. A notification flow chart for emergency scenarios is on the first page of this Plan.

6 COMMUNICATION SYSTEMS

Communications between the Bluefish hydro facility and others is by satellite telephone, which has proven to be very reliable. The satellite link provides one phone and one fax line (which can be used as a phone). A radio is also available to communicate with NTPC Control Center at Jackfish Lake. Internally, incidents are assessed by the Bluefish Hydro Operator on duty who makes a decision as to what further action is required to address the incident. The Bluefish Hydro Operator reports directly to the Plant Manager who reports to the Hydro Region Director, the senior company representative for the Northwest Territories Power Corporation in the Yellowknife area.

7 SITE ACCESS

Access to the site is by boat, float plane or helicopter from Yellowknife; 39 km to the south. Access by boat to the powerhouses is from the south end of Prosperous Lake. The dock at this end of the lake is connected by road to Yellowknife. Access to the Duncan Lake dam is by float plane or helicopter; typically a helicopter is used. In winter, a winter road is maintained up Prosperous Lake by NTPC, thus affording access to Bluefish Lake dam. Duncan Dam year-round access is by helicopter. At break up and freeze up, helicopter access is the only practical method of access to both dams.

8 RESPONSE DURING DARKNESS AND ADVERSE WEATHER

Normal access may be limited in adverse weather. During daylight hours, helicopters are available both summer and winter. In summer, if visibility limitations prevent air access: a boat can be used on Prosperous Lake. In winter, the ice road can be used at all times, except break up and freeze up. Under certain circumstances in adverse weather, it may he necessary to wait until daylight to provide outside assistance to Bluefish. Yellowknife-based charter aircraft & helicopter companies would be used: NTPC has a trailer-mounted boat for summer access available at the Jackfish Diesel Plant. Other than limitations on access, emergency response would not differ in adverse weather from that under more normal weather conditions.

9 EQUIPMENT, MATERIALS, AND EMERGENCY POWER

9.1 EQUIPMENT SOURCES

Dam repair equipment is not kept on site at the Bluefish hydro facility because of the low probability of dam failure. If routine maintenance and inspection indicates undue seepage from the dams, the necessary equipment will be trucked from Yellowknife or barged / air lifted to the dam site to effect repairs. The equipment available at site include a Cat 930 Loader, JS 200 Scoop Tram and a Ford F 150 Truck. Fire fighting equipment (detailed above) is kept at the powerhouses in case of a fire. As well as automatic fire suppression equipment, fire extinguishers are kept at strategic locations in both powerhouses, including near entrances and at locations likely to be occupied by operations personnel.

9.2 SUPPLIES AND MATERIALS STOCKPILES

Supplies and materials for dam repair are not kept at the Bluefish Hydro facility, other than rock which could be used on the Bluefish dam. For the Bluefish dam, rock might be required for repairs downstream of the dam face. For Duncan Dam and most repairs at Bluefish Dam, the most likely required material include cement, sand and gravel to make concrete, these materials would be transported from Yellowknife.

9.3 EMERGENCY POWER SOURCE

The powerhouse has an emergency standby diesel generator in case of power failures

10 INUNDATION MAP

Inundation is not a significant factor from dam failures based on the analyses provided in Section 3.0, and therefore an inundation map is not warranted and is not provided.

11 WARNING SYSTEM

Immediately upon major dam failure, the Bluefish Hydro Operator at the powerhouse would call the RCMP in Yellowknife at (867) 669-1111; the Operator will next immediately notify the System Control & Hydro Planning Manager who would notify the North Slave Director and the Environment, Health and Safety Manager.

Phone or personal contact would be used to warn residents on Prosperous Lake, should dam failure that could cause flooding occur. People with registered properties (owned) on Prosperous Lake would be contacted by phone or by vehicle from Yellowknife. Radio announcements would be made from Yellowknife. Air charter companies and tour operations would also be contacted. NTPC personnel would attempt to contact non-registered properties on Prosperous Lake by boat, and leave warning signs. Contact for natural flood events, e.g. a Probable Maximum Flood, is the responsibility of the RCMP or Civil Defense authorities (Emergency Measures Organization).

12 REFERENCES

Canadian Dam Safety Association. 1995. Dam Safety Guidelines. Edmonton, AB.

Huschke, R. E. 1959. Glossary of Meteorology. Editor. American Meteorological Society.

APPENDIX VII

Bottom-Outlet and IFR Gate Actuator Operating Manual

auma®

Electric multi-turn actuators

SA 07.1 – SA 16.1
with actuator controls
AMB 01.1/AMB 02.1

TÜV CERT
ISO 9001
ISO 14001
Certificate Registration No.
12 100 4269
12 104 4269

Operation instructions

Scope of these instructions:	These operation instructions are valid for multi-turn actuators of the type range SA 07.1 – SA 16.1 with controls AMB 01.1/AMB 02.1. These operation instructions are only valid for ”clockwise closing”, i.e. driven shaft turns clockwise to close the valve.

Table of Contents

1. Safety instructions

1.1 Range of application

AUMA actuators are designed for the operation of industrial valves, e.g. globe valves, gate valves, butterfly valves and ball valves.
For other applications, please consult us. The manufacturer is not liable for any possible damage resulting from use in other than the designated applications. Such risk lies entirely with the user.
Observance of these operation instructions is considered as part of the controls'/actuator's designated use.

1.2 Commissioning (electrical connection)

During electrical operation certain parts inevitably carry lethal voltages. Work on the electrical system or equipment must only be carried out by a skilled electrician himself or by specially instructed personnel under the control and supervision of such an electrician and in accordance with the applicable electrical engineering rules.

1.3 Maintenance

The maintenance instructions (refer to page 27) must be observed, otherwise a safe operation of the actuator is no longer guaranteed.

1.4 Warnings and notes

Non-observance of the warnings and notes may lead to serious injuries or damage. Qualified personnel must be thoroughly familiar with all warnings and notes in these operation instructions.
Correct transport, proper storage, mounting and installation, as well as careful commissioning are essential to ensure a trouble-free and safe operation.
The following references draw special attention to safety-relevant procedures in these operation instructions. Each is marked by the appropriate pictograph.

This pictograph means: Note!
“Note” marks activities or procedures which have major influence on the correct operation. Non-observance of these notes may lead to consequential damage.

This pictograph means: Electrostatically endangered parts!
If this pictograph is attached to a printed circuit board, it contains parts which may be damaged or destroyed by electrostatic discharges. If the boards need to be touched during setting, measurement or for exchange, it must be assured that immediately before a discharge through contact with an earthed metallic surface (e.g. the housing) has taken place.

This pictograph means: Warning!
“Warning” marks activities or procedures which, if not carried out correctly, can affect the safety of persons or material.

2. Short description

AUMA multi-turn actuators type SA 07.1 – SA 16.1 have a modular design. The actuators are driven by an electric motor and controlled with the electro-mechanical version of the controls AUMA MATIC BASIC AMB 01.1/AMB 02.1, which are included in the scope of supply.
The limitation of travel is realised via limit switches in both end positions. In end position CLOSED, tripping may be performed by torque switch. The type of seating is determined by the valve manufacturer.

3. Technical data

Table 1: Technical data multi-turn actuator SA 07.1 – SA 16.1

Features and functions	
Type of duty[1)]	Standard: Short-time duty S2 - 15 min. Option: Short-time duty S2 - 30 min.
Motors	3-ph AC asynchronous motor, type IM B9 according to IEC 34
Insulation class	F, tropicalized
Motor protection	Standard: Thermoswitches (NC)
Self-locking	yes (for output speeds from 4 to 90 rpm)
Limit switching	Counter gear mechanism for end positions CLOSED and OPEN for 1 to 500 turns per stroke (optional for 1 to 5,000 turns per stroke) Standard: Single switch (1 NC and 1 NO) for each end position: Options: Tandem switch (2 NC and 2 NO) for each end position, switches galvanically isolated Triple switch (3 NC and 3 NO) for each end position, switches galvanically isolated Intermediate position switch (DUO limit switching)
Torque switching	Adjustable torque switching for directions OPEN and CLOSE Standard: Single switch (1 NC and 1 NO) for each direction Options: Tandem switch (2 NC and 2 NO) for each direction, switches galvanically isolated
Position feedback signal, analogue (options)	Potentiometer or 0/4 – 20 mA For further details see separate data sheet
Mechanical position indicator (option)	Continuous indication, adjustable indicator disc with symbols OPEN and CLOSED
Running indication	Blinker transmitter
Heater in switch compartment	Standard: self-regulating PTC heater, 5 – 20 W, internally supplied
Manual operation	Manual drive for setting and emergency operation, handwheel does not rotate during electric operation Option: Handwheel lockable
Electrical connection to the controls	AUMA plug/ socket connector
Terminal plan	KMS TP 110/001 (basic version)
Output drive types	A, B1, B2, B3, B4 according to EN ISO 5210 A, B, D, E according to DIN 3210 C according to DIN 3338 Special output drives: AF, AK, AG, IB1, IB3
Service conditions	
Enclosure protection according to EN 60 529	Standard: IP 67 Options: IP 68 For both enclosure protections (IP 67 und IP 68) the terminal compartment ist additionally sealed against the interior - double sealed
Corrosion protection	Standard: KN Suitable for installation in industrial units, in water- or power plants with a low pollutant concentration[2)] Options: KS Suitable for installation in occasionally or permanently aggressive atmosphere with a moderate pollutant concentration (e.g. in waste-water treatment plants, chemical industry) KX Suitable for installation in extremely aggressive atmosphere with high humidity and high pollutant concentration KX-G same as KX, however aluminium-free version (outer parts)
Finish coating	Standard: two-component iron-mica combination
Standard colour	Standard: silver-grey (DB 701, similar to RAL 9007) Option: Other colours are possible on request
Ambient temperature	Standard: – 25 °C to + 70 °C Option: – 40 °C to + 70 °C
Vibration resistance according to EN 60068-2-6	1 g, from 10 Hz to 200 Hz
Lifetime	see table below

Type	Operating cycles (OPEN-CLOSED-OPEN) with 30 turns per stroke
SA 07.1 – SA 10.1	20,000
SA 14.1 – SA 16.1	15,000

1) Based on 20 °C ambient temperature and at an average load with running torque according to Technical data SA.
2) If occasionally or permanently exposed to aggressive substances, we recommend a higher corrosion protection KS or KX

Other information	
EC directives	Electromagnetic Compatibility (EMC): (89/336/EEC) Low Voltage Directive: (73/23/EEC) Machinery Directive: (98/37/EC)
Reference documents	Product description “Electric multi-turn actuators SA” Dimension sheets SA Electrical data sheets SA Technical data sheet SA

Table 2: Technical data actuator controls AMB 01.1/AMB 02.1

Supply voltage	Refer to name plate
Motor controls reversing contactors:	mechanical, electrically interlocked, max. 690 V AC, max. 7.5 kW
Control voltage	Standard: 230 V AC from internal power supply unit, also available for input signals OPEN-STOP-CLOSE/ OPEN-CLOSE and for external indication lights (P max = 2.5 W) Option: 115 V AC from internal power supply unit
Binary inputs (input signals) Nominal voltage:	Standard: OPEN-STOP-CLOSE, EMERGENCY-STOP Option: OPEN-CLOSE, EMERGENCY-STOP Standard: 230 – 240 V AC from internal power supply unit (non potential-free) Option: 24 V DC externally supplied (potential-free via relay)
Binary outputs	Standard: End position OPEN/ end position CLOSED (non potential-free) Option: End position OPEN / end position CLOSED (potential-free) in combination with tandem limit switches in multi-turn actuator. Selector switch LOCAL/ selector switch REMOTE (potential-free)
Relay outputs (potential-free)	Version B01: without relay board (see binary outputs)
	Version B02: Thermoswitch or overload relay tripped (NO contact) Signal: Torque switch tripped in mid-travel (change-over contact).
	Version B03: see binary outputs
	Version B04: Thermoswitch or overload relay tripped (NO contact) Signal: Torque switch tripped in mid-travel (change-over contact).
Local controls	Standard: Selector switch LOCAL-OFF-REMOTE, lockable Push-buttons OPEN-STOP-CLOSE Option: Push-buttons OPEN-CLOSE, EMERGENCY-STOP Indication lights end position OPEN, FAULT[1)], end position CLOSED
Enclosure protection	Same as actuator
Temperature range	Same as actuator
Electrical connection	Standard: AUMA plug/socket connector with screw type connection
Threads for cable glands	Standard: Metric thread Options: Pg thread, NPT thread, G thread

1) Only in conjunction with version BX02 and BX04

4. Additional information to the wiring diagram legend

Information A: Change-over switch S9 for changing the type of seating (see subclause 19.2, page 23).

Information B: Self-retaining in local operation can be cancelled by cutting the link B3 (see subclause 19.3, page 24).

Information C: Plug-in link for operation mode REMOTE (see subclause 19.4, page 24).

Information E: The control voltage is 115 V or 230 V AC (according to order) and must only be switched via potential-free contacts.
End position signal: 115 V or 230 V AC, max. 2.5 W.

Information F: Instead of a link, an EMERGENCY switch with NC contact can be used.

Connections XK 49 and XK 50 carry control voltage (115 or 230 V AC) and must only be opened via the potential-free contact.

Information G: (Versions B02 and B04 only)
Plug-in link for potential-free feedback (see subclause 19.6, page 25).

5. Transport and storage

- Transport to place of installation in sturdy packing.
- Do not attach ropes or hooks to the handwheel for the purpose of lifting by hoist.
- If multi-turn actuator is mounted on valve, attach ropes or hooks for the purpose of lifting by hoist to valve and not to multi-turn actuator.
- Store in well-ventilated, dry room.
- Protect against floor dampness by storage on a shelf or on a wooden pallet.
- Cover to protect against dust and dirt.
- Apply suitable corrosion protection agent to bright surfaces.

If multi-turn actuators are to be stored for a long time (more than 6 months), the following points must be observed additionally:

- Prior to storage: Protect bright surfaces, in particular the output drive parts and mounting surface, with long-term corrosion protection agent.
- Check for corrosion approximately every 6 months. If first signs of corrosion show, apply new corrosion protection.

After mounting, connect actuator immediately to electrical system, so that condensation is prevented by the heater.

6. Packaging

Our products are protected by special packaging for the transport ex works. The packaging consists of environmentally friendly materials which can easily be separated and recycled.
For the disposal of the packaging material we recommend recycling and collection centres.
We use the following packaging materials: wood, cardboard, paper and PE foil.

7. Mounting to valve/ gearbox

- **Prior to mounting the actuator must be checked for damage. Damaged parts must be replaced by original spare parts.**
- **After mounting to valve/ gearbox, touch up any possible damage to paint finish.**

Mounting is most easily done with the valve shaft/gearbox shaft pointing vertically upward. But mounting can be done in any other position as well. The multi-turn actuator leaves the factory in position CLOSED (limit switch CLOSED tripped).

- Check if mounting flange fits the valve/ gearbox.

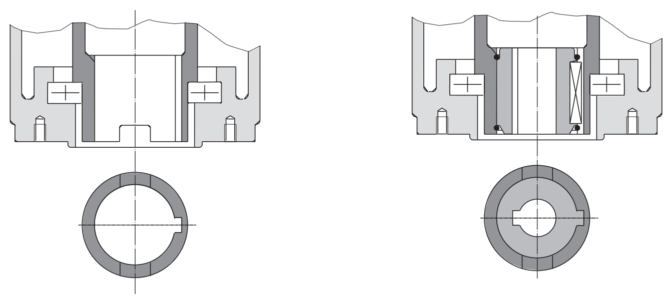
Spigot at flanges should be loose fit!

The output drive types B1, B2, B3 or B4 (figure A) are delivered with bore and keyway (usually according to ISO 5210).

Figure A

Output drive type B1/B2
Plug sleeve

Output drive type B3/B4
Bore with keyway



For output drive type A (figure B-1), the internal thread of the stem nut must match the thread of the valve stem. If not ordered explicitly with thread, the stem nut is unbored or with pilot bore when delivered. For finish machining of stem nut refer to next page.

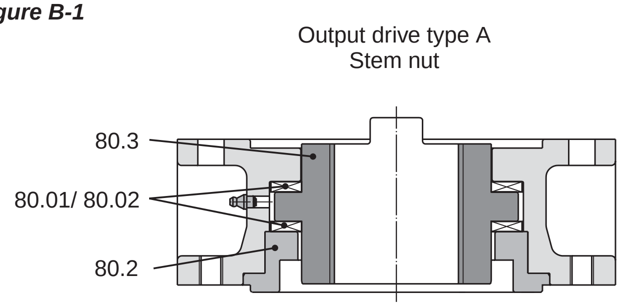
- Check whether bore and keyway match the input shaft of valve/gearbox.
- Thoroughly degrease mounting faces at multi-turn actuator and valve/ gearbox.
- Apply a small quantity of grease to input shaft of valve/gearbox.
- Place actuator on valve/ gearbox and fasten. Fasten bolts (at least quality 8.8, refer to table 3) evenly crosswise.

Table 3: Fastening torque for bolts

Strength class 8.8	T_A (Nm)
M 8	25
M 10	50
M 12	87
M 16	220
M 20	420

Finish machining of stem nut (output drive type A):

Figure B-1



The output drive flange does not have to be removed from the actuator.

- Remove spigot ring (80.2, figure B-1) from mounting flange.
- Take off stem nut (80.3) together with thrust bearing (80.01) and thrust bearing races (80.02).
- Remove thrust bearing and thrust bearing races from stem nut.
- Drill and bore stem nut and cut thread.
  When fixing in the chuck, make sure stem nut runs true!
- Clean the machined stem nut.
- Apply ball bearing grease to thrust bearing and races, then place them on stem nut.
- Re-insert stem nut with thrust bearings into the mounting flange. Ensure that dogs are placed correctly in the slots of the hollow shaft.
- Screw in spigot ring until it is firm against the shoulder.
- Press Lithium soap EP multi-purpose grease on mineral oil base, quantities see table, into the grease nipple with a grease gun:

Table 4: Grease quantities for output drive A

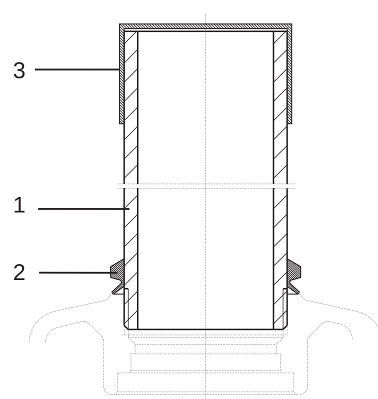
Output drive	A 07.2	A 10.2	A 14.2	A 16.2	A 25.2	A 30.2	A 35.2	A 40.2	A 48.2
Qty.[1]	1.5 g	2 g	3 g	5 g	10 g	14 g	20 g	25 g	30 g

1) For grease with a density ρ = 0.9 kg/dm³

Protection tube for rising valve stem

- Protection tubes may be supplied loose. Seal thread with hemp, Teflon tape or thread sealing material.
- Screw protection tube (1) into thread (figure B-2) and tighten it firmly.
- For corrosion protection KS/ KX, push down the seal (2) to the housing.
- Check, whether cap (3) is available and without damage.

Figure B-2: Protection tube for rising valve stem



8. Manual operation

The actuator may be operated manually for purposes of setting and commissioning, and in case of motor failure or power failure.
Manual operation is engaged by an internal change-over mechanism.

Engaging manual operation:

- Lift change-over lever in the centre of the handwheel up to approx. 85°, while slightly turning the handwheel back and forth until manual drive engages (figure C).

Figure C

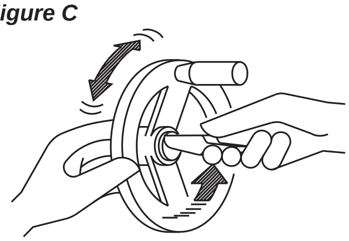
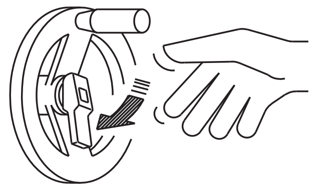


Figure D



Manual force is sufficient for operating the change-over lever. It is not necessary to use an extension. Excessive force may damage the change-over mechanism.

- Release change-over lever (should snap back into initial position by spring action, figure D), if necessary push it back manually.

Operating the change-over lever while the motor is running (figure E) can lead to increased wear at the change-over mechanism.

Figure E

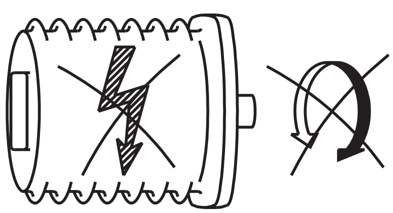
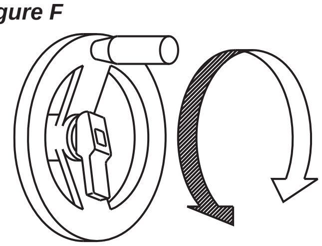


FIgure F



- Turn handwheel into desired direction (figure F).

Disengaging manual operation:

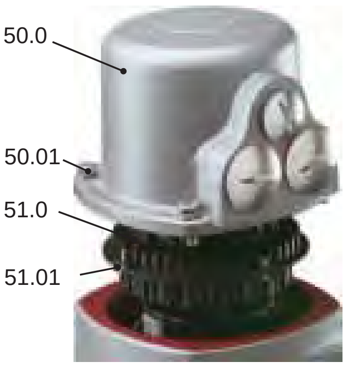
Manual operation is automatically disengaged when motor is started again.
The handwheel does not rotate during motor operation.

9. Electrical connection

Work on the electrical system or equipment must only be carried out by a skilled electrician himself or by specially instructed personnel under the control and supervision of such an electrician and in accordance with the applicable electrical engineering rules.

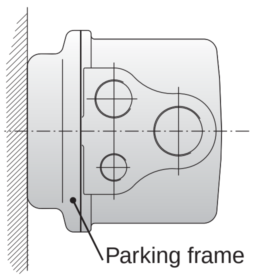
9.1 Connection with AUMA plug/ socket connector

Figure G-1: Connection



- Check whether type of current, supply voltage and frequency correspond to motor data (refer to name plate at motor).
- Loosen bolts (50.01) (figure G-1) and remove plug cover.
- Loosen screws (51.01) and remove socket carrier (51.0) from plug cover (50.0).
- Insert cable glands suitable for connecting cables.
  (The enclosure protection stated on the name plate is only ensured if suitable cable glands are used).
- Seal cable entries which are not used with suitable plugs.
- Connect cables according to order related wiring diagram.
  The wiring diagram applicable to the actuator is attached to the handwheel in a weather-proof bag, together with the operation instructions. In case the wiring diagram is not available, it can be obtained from AUMA (state commission no., refer to name plate) or downloaded directly from the Internet (www.auma.com).

Bild G-2: Parking frame (accessory)



A special parking frame (figure G-2) for protection against touching the bare contacts and against environmental influences is available.

Table 5: Technical data AUMA plug/socket connector

Technical data		Protective earth	Control pins
Contacts max.		1 (leading contact)	50 pins/sockets
Designation		according to VDE	1 to 50
Voltage max.		–	250 V
Current max.		–	16 A
Type of customer connection		Screw for ring lug	Screws
Cross section max.		6 mm^2	2.5 mm^2
Material:	Pin/socket carrier	Polyamide	Polyamide
	Contacts	Brass (Ms)	Brass, tin plated or gold plated (option)

9.2 Heater

AUMA multi-turn actuators have a heater installed as standard. To prevent condensation, the heater must be connected.

9.3 Motor protection

In order to protect against overheating and impermissibly high temperatures at the actuator, thermoswitches are embedded in the motor winding. The thermoswitch is tripped as soon as the max. permissible winding temperature has been reached.

9.4 Remote position transmitter

For the connection of remote position transmitters (potentiometer, RWG) screened cables must be used.

9.5 Fitting of the cover

After connection:

- After completion of the power supply connection, insert the socket carrier (51.0) into the plug cover (50.0) and fasten it with screws (51.01).
- Clean sealing faces at the plug cover and the housing.
- Check whether O-ring is in good condition.
- Apply a thin film of non-acidic grease (e.g. Vaseline) to the sealing faces.
- Replace plug cover (50.0) and fasten bolts evenly crosswise.
- Fasten cable glands with the specified torque to ensure the required enclosure protection.

10. Opening the switch compartment

To be able to make the following settings (clause 11. to 17.) the switch compartment must be opened and, if installed, the indicator disc must be removed.

These settings are only valid for “clockwise closing”, i.e. driven shaft turns clockwise to close the valve.

Work on the electrical system or equipment must only be carried out by a skilled electrician himself or by specially instructed personnel under the control and supervision of such an electrician and in accordance with the applicable electrical engineering rules.

10.1 Removal of the switch compartment cover

- Remove 4 bolts and take off the cover at the switch compartment (figure H) .

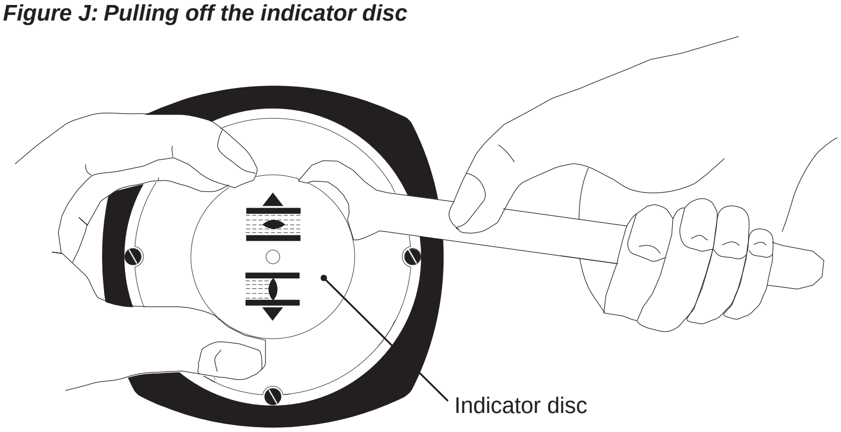
Figure H-1: Cover with indicator glass

Figure H-2: Cover without indicator glass

10.2 Pulling off the indicator disc (option)

- If installed, pull off indicator disc (figure J). Open end spanner (approx. 14 mm) may be used as lever.

Figure J: Pulling off the indicator disc

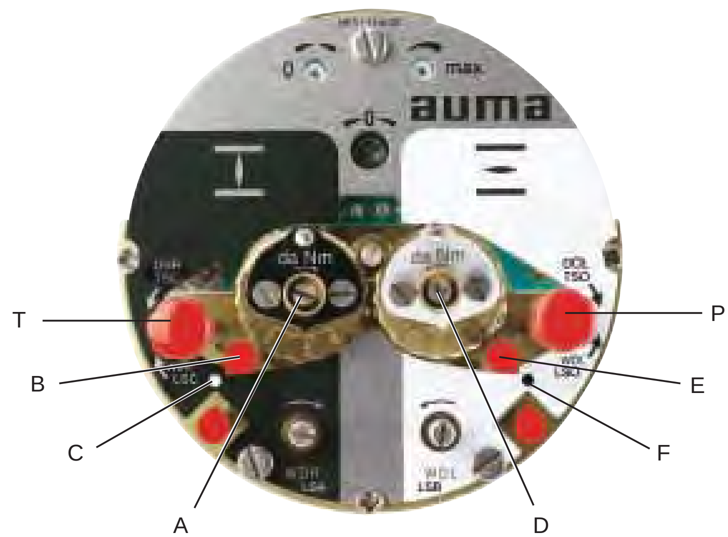


11. Setting of the limit switching

11.1 Setting for end position CLOSED (black section)

- Turn handwheel clockwise until valve is closed.
- After having reached the end position, turn back handwheel approximately 1/2 a turn (overrun). During test run (page 17) check overrun and, if necessary, correct setting of the limit switching.
- **Press down** and turn setting spindle A (figure K-1) with screw driver (5 mm) in direction of arrow, thereby observe pointer B.
  While a ratchet is felt and heard, the pointer B moves 90° every time. When pointer B is 90° from mark C, continue turning slowly. When pointer B has reached the mark C, stop turning and release setting spindle. If you override the tripping point inadvertently (ratchet is heard after the pointer has snapped), continue turning the setting spindle in the same direction and repeat setting process.

Figure K-1: Control unit



11.2 Setting for end position OPEN (white section)

- Turn handwheel counterclockwise until valve is open, then turn back approximately 1/2 a turn.
- **Press down** and turn setting spindle D (figure K-1) with screw driver (5 mm) in direction of arrow, thereby observe pointer E.
  While a ratchet is felt and heard, the pointer E moves 90° every time. When pointer E is 90° from mark F, continue turning slowly. When pointer E has reached the mark F, stop turning and release setting spindle. If you override the tripping point inadvertently (ratchet is heard after the pointer has snapped), continue turning the setting spindle in the same direction and repeat setting process.

11.3 Checking the switches

The red test buttons T and P (figure K-1) serve for operating the limit switches manually.

- Turning T in direction of the arrow LSC (WSR) triggers limit switch CLOSED.
- Turning P in direction of the arrow LSO (WÖL) triggers limit switch OPEN.

12. Setting of the DUO limit switching (option)

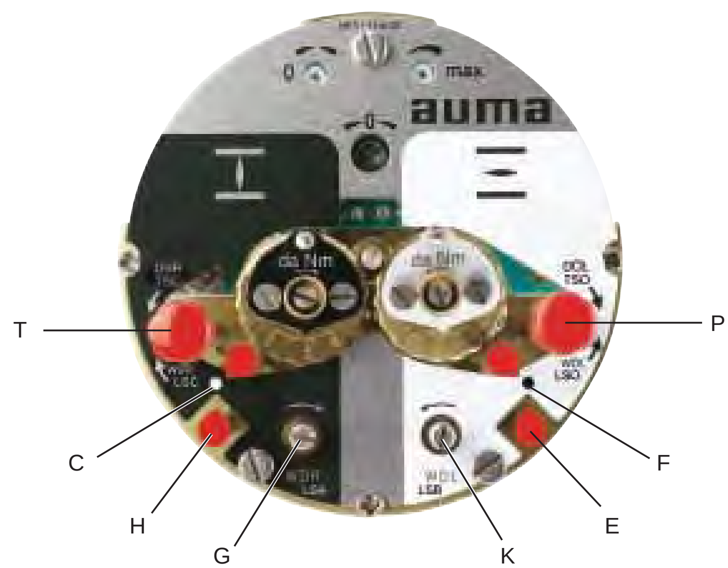
Any application can be switched on or off via the two intermediate position switches.

For setting, the switching point (intermediate position) must be approached from the same direction as afterwards in electrical operation.

12.1 Setting for direction CLOSE (black section)

- Move valve to desired intermediate position.
- **Press down** and turn setting spindle G (figure K-2) with screw driver (5 mm) in direction of arrow, thereby observe pointer H.
  While a ratchet is felt and heard, the pointer H moves 90° every time. When pointer H is 90° from mark C, continue turning slowly. When pointer H has reached the mark C, stop turning and release setting spindle. If you override the tripping point inadvertently (ratchet is heard after the pointer has snapped), continue turning the setting spindle in the same direction and repeat setting process.

Figure K-2: Control unit



12.2 Setting for direction OPEN (white section)

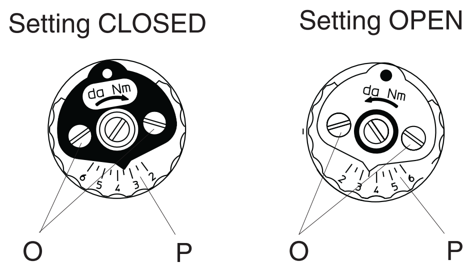
- Move valve to desired intermediate position.
- **Press down** and turn setting spindle K (figure K-2) with screw driver (5 mm) in direction of arrow, thereby observe pointer L.
  While a ratchet is felt and heard, the pointer L moves 90° every time. When pointer L is 90° from mark F, continue turning slowly. When pointer L has reached the mark F, stop turning and release setting spindle. If you override the tripping point inadvertently (ratchet is heard after the pointer has snapped), continue turning the setting spindle in the same direction and repeat setting process.

13. Setting of the torque switching

13.1 Setting

- **The set torque must suit the valve!**
- **This setting should only be changed with the consent of the valve manufacturer!**

Figure L: Torque switching heads



- Loosen both lock screws O at the torque dial (figure L).
- Turn torque dial P to set it to the required torque (1 da Nm = 10 Nm).
  Example:
  Figure J shows the following setting:
  3.5 da Nm = 35 Nm for direction CLOSE
  4.5 da Nm = 45 Nm for direction OPEN
- Tighten lock screws O again

- **The torque switches can also be operated in manual operation.**
- **The torque switching acts as overload protection over full travel, also when stopping in the end positions by limit switching.**

13.2 Checking the switches for torque and DUO limit switching

The red test buttons T and P (figure K-2) serve for operating the torque switches manually:

- Turning T in direction of the arrow TSC (DSR) triggers torque switch CLOSED.
- Turning P in direction of the arrow TSO (DÖL) triggers torque switch OPEN.
- If a DUO limit switching (optional) is installed in the actuator, the intermediate position switches will be operated at the same time.

14. Test run

14.1 Check direction of rotation

This check is only required for multi-turn actuators with 3-ph AC motor.

- If provided, place indicator disc on shaft.
  The direction of rotation of the indicator disc (figure M-1) indicates the direction of rotation of the output drive.
- If there is no indicator disc, the direction of rotation can also be observed on the hollow shaft. To this end, remove screw plug (no. 27) (figure M-2).

Figure M-1: Indicator disc

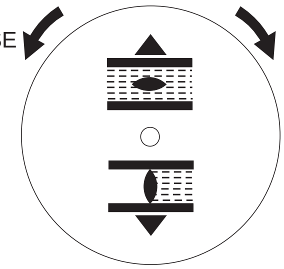
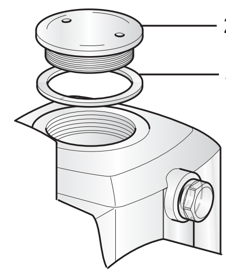


Figure M-2: Opening the hollow shaft



- Move actuator manually to intermediate position or to sufficient distance from end position.
- Set selector switch to local control (I)(figure M-3).

Figure M-3: Selector switch on local controls

- Switch on the voltage supply.
- Operate push-button CLOSE (figure M-4) and observe the direction of rotation:

Figure M-4 Push-button CLOSE

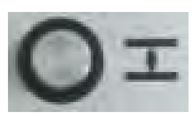
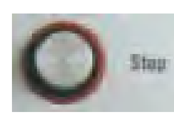


Figure M-5: Push-button STOP



If the direction of rotation is wrong switch off immediately with push-button “Stop” (figure M-5) or by turning **both** test buttons T and P (figure K-2) simultaneously in any direction. Correct phase sequence at motor connection. Repeat test run.

Table 6:

Direction of rotation of the indicator disc:	
counterclockwise	correct
Direction of rotation of the hollow shaft:	
clockwise	correct

14.2 Check the setting of the limit switching

- Move actuator manually into both end positions of the valve.
- Check whether limit switching is set correctly. Hereby observe that the appropriate switch is tripped in each end position and released again after the direction of rotation is changed. If this is not the case, the limit switching must first be set, as described from page 14.

14.3 Check whether type of seating is set correctly

The valve manufacturer states whether switching off in the end position CLOSED should be by limit seating or torque seating.
- Checking the setting: see page 23, clause 19.

If no other options (clauses 15. to 17.) require setting:
- Close switch compartment (see page 22, clause 18.).

15. Setting of the potentiometer (option)

– For remote indication –

- Move valve to end position CLOSED.
- If installed, pull off indicator disc.
- Turn potentiometer (E2) clockwise until stop is felt.
  End position CLOSED corresponds to 0 %, end position OPEN to 100 %.
- Turn potentiometer (E2) slightly back from the stop.

Due to the ratio of the reduction gearings for the position transmitter the complete resistance range is not always utilized for the whole travel. Therefore an external possibility for adjustment (setting potentiometer) must be provided.

- Perform fine-tuning of the zero point at external setting potentiometer (for remote indication).

Figure N: Control unit

16. Setting of electronic position transmitter RWG (option)

– For remote indication or external control –

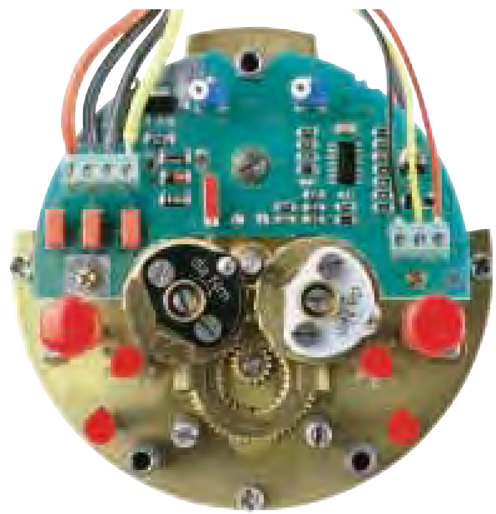
After mounting the multi-turn actuator to the valve, check setting by measuring the output current (see subclause 16.1 or 16.2) and re-adjust, if necessary.

Table 7: Technical data RWG 4020

Wiring diagrams		BSP. . . KMS TP_ _ 4 / _ _ _ 3-/ 4-wire system	BSP. . . KMS TP _ 4 _ / _ _ _ BSP. . . KMS TP _ 5 _ / _ _ _ 2-wire system
Output current	I_a	0 – 20 mA, 4 – 20 mA	4 – 20 mA
Power supply	U_v	24 V DC, ± 15 % smoothed	14 V DC + (I x R_B), max. 30 V
Max. current input	I	24 mA at 20 mA output current	20 mA
Max. load	R_B	600 Ω	(Uv - 14 V) / 20 mA

The position transmitter board (figure P-1) is located under the cover plate (figure P-2).

Figure P-1: Position transmitter board



16.1 Setting for 2-wire system 4 – 20 mA and 3- /4-wire system 0 – 20 mA

- Connect voltage for electronic position transmitter.
- Move valve to **end position CLOSED**.
- If installed, pull off indicator disc.
- Connect ammeter for 0 – 20 mA to measuring points (figure P-2).

The circuit (external load) must be connected (max. load R_B), or the appropriate poles at the terminals (refer to terminal plan) must be linked, otherwise no value can be measured.

- Turn potentiometer (E2) clockwise until stop is felt.
- Turn potentiometer (E2) slightly back from the stop.

Figure P-2

- Turn potentiometer "0" clockwise until output current starts to increase.
- Turn potentiometer "0" back until the following value is reached:
for 3-/4-wire system approx. 0.1 mA
for 2-wire system: approx. 4.1 mA.
This ensures that the signal remains above the dead and live zero point.
- Move valve to end position OPEN.
- Set potentiometer "max." to end value 20 mA.
- Approach end position CLOSED anew and check minimum value (0.1 mA or 4.1 mA). If necessary, correct the setting.

If the maximum value can not be reached, the selection of the reduction gearing must be checked.

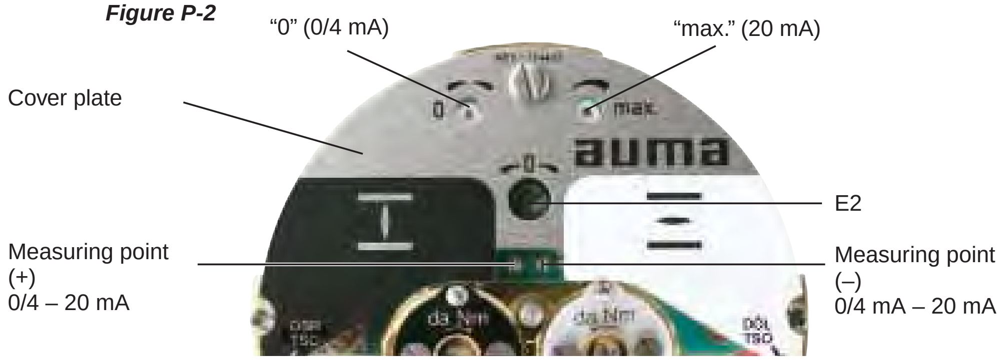
16.2 Setting for 3- / 4- wire system 4 – 20 mA

- Connect voltage for electronic position transmitter.
- Move valve to end position CLOSED.
- If installed, pull off indicator disc.
- Connect ammeter for 0 – 20 mA to measuring points (figure P-2).

The circuit (external load) must be connected (max. load R_B), or the appropriate poles at the terminals (refer to terminal plan) must be linked, otherwise no value can be measured.

- Turn potentiometer (E2) clockwise until stop is felt.
- Turn potentiometer (E2) slightly back from the stop.

Figure P-2



- Turn potentiometer “0” clockwise until output current starts to increase.
- Turn back potentiometer “0” until a residual current of approx. 0.1 mA is reached.
- Move valve to end position OPEN.
- Set potentiometer “max.” to end value 16 mA.
- Move valve to end position CLOSED.
- Set potentiometer “max.” from 0.1 mA to initial value 4 mA.
  This results in a simultaneous shift of the end value by 4 mA, so that the range is now 4 – 20 mA.
- Approach both end positions anew and check setting. If necessary, correct the setting.

If the maximum value can not be reached, the selection of the reduction gearing must be checked.

17. Setting of the mechanical position indicator (option)

A suitable reduction gearing was installed in our works. If the turns per stroke are changed at a later date, the reduction gearing may have to be exchanged, too.

- Place indicator disc on shaft.
- Move valve to end position CLOSED.
- Turn lower indicator disc (figure Q-1) until symbol CLOSED is in alignment with the mark on the cover (figure Q-2).
- Move actuator to end position OPEN.
- Hold lower indicator disc CLOSED in position and turn upper disc with symbol OPEN until it is in alignment with the mark on the cover.

Figure Q-1:

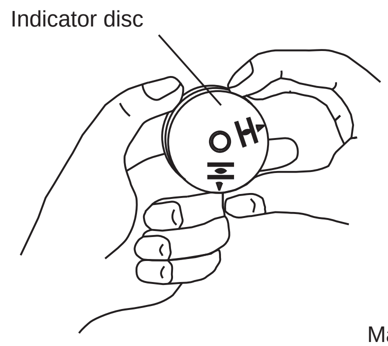


Figure Q-2:

Indicator disc rotates approximately 180° at full travel from OPEN to CLOSED or vice versa.

18. Closing the switch compartment

- Clean sealing faces of housing and cover
- Check whether O-ring is in good condition.
- Apply a thin film of non-acidic grease to the sealing faces.
- Replace cover on switch compartment and fasten bolts evenly crosswise.

Touch up possible defects to paint finish after commissioning.

19. Controls AUMA MATIC BASIC

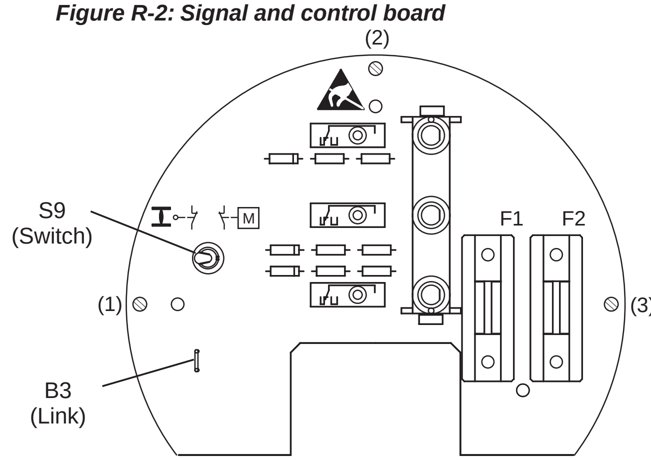
19.1 Removal of the local controls

The local controls must only be removed when settings at the controls have to be performed (subclause 19.2 to 19.4).

- Remove local controls (figure R-1). The signal and control board is located under the local controls (figure R-2).

Figure R-1: Local controls

Figure R-2: Signal and control board



19.2 Setting the type of seating in the end position CLOSED

The valve manufacturer states whether switching off in the end position CLOSED should be by limit seating or torque seating.

This setting should only be changed with the consent of the valve manufacturer.

In case the type of seating is to be changed at a later date:

Limit seating:

- Set change-over switch S9 (figure R-2) to position .

Actuator switches off in end position CLOSED via limit switch WSR (LSC) (S3), see wiring diagram. The tripping of the torque switch DSR (TSC) (S1) in mid-travel or in the end position switches off the actuator and causes a fault signal.

Torque seating:

- Set change-over switch S9 (figure R-2) to position M .

Actuator switches off in the end position CLOSED by torque switch DSR (TSC) (S1), see wiring diagram. The limit switch WSR (LSC) (S3) is used for signalising. It needs to be set in such a way that it is tripped shortly before reaching the end position CLOSED.
If the torque switch trips before the limit switch, the actuator is switched off and a fault signal is given.

19.3 Push-to-run operation or self-retaining in selector switch position LOCAL

Push-to-run operation or self-retaining is set in the factory.
A change at a later date is only possible by cutting the link B3 (see figure R-2).

- Remove local controls (figure R-1). The signal and control board is located under the local controls (figure R-2).
  Link cut: Push-to-run operation LOCAL.
  Link closed: Self-retaining LOCAL.

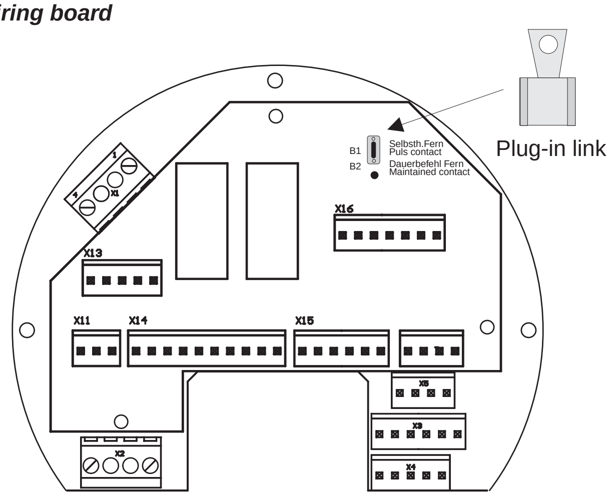
19.4 Push-to-run operation or self-retaining in selector switch position REMOTE

Push-to-run operation or self-retaining is set in the factory.
If the operation mode is to be changed at a later date:

- Loosen the three screws (1-3) and remove signal and control board (figure R-2), but do not interrupt plug-in connections.
- Move red plug-in link (figure S) on wiring board.

Plug-in link on	B1	Self-retaining REMOTE
	B2	
	B1	
Plug-in link on	B2	Push-to-run operation REMOTE (Maintained contact REMOTE)

Figure S: Wiring board



- Fit signal and control board (figure R-2) again.

19.5 Fitting the local controls

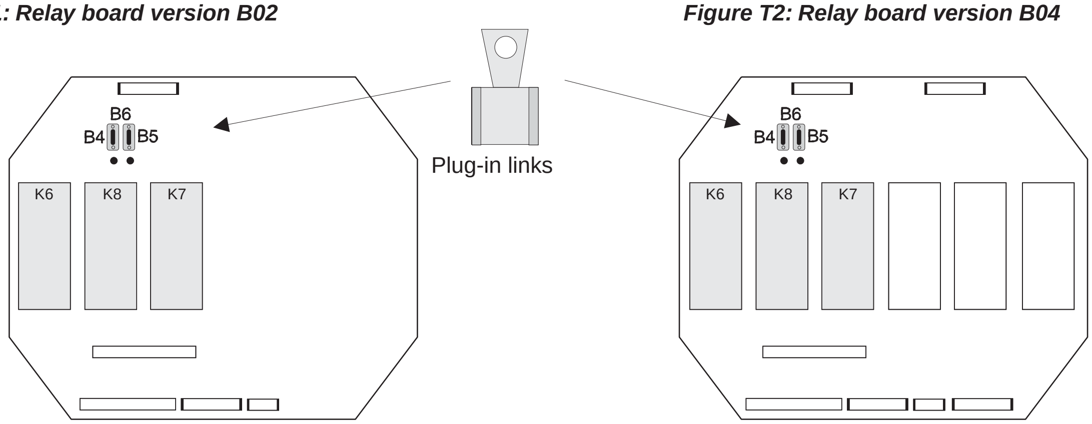
- Clean sealing faces of housing and cover
- Check whether O-ring is in good condition.
- Apply a thin film of non-acidic grease to the sealing faces.
- Place local controls and fasten the bolts evenly crosswise.

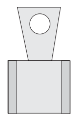
19.6 Settings on relay board for potential-free feedback (option)

Only valid for versions (B02 and B04) with relays K6, K7, K8 on relay board.

Figure T1: Relay board version B02

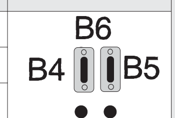
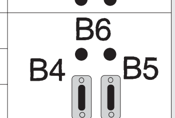
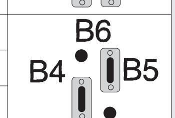
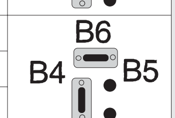
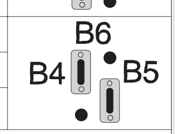
Figure T2: Relay board version B04





- Remove cover (figure R-1, page 23) of AUMA MATIC BASIC.
- Assign the required functions to the terminals XK ... of the customer connection (see wiring diagram) with the red plug-in links, according to table 8.
- Clean sealing faces of housing and cover
- Check whether O-ring is in good condition.
- Apply a thin film of non-acidic grease to the sealing faces.
- Replace cover and fasten bolts evenly crosswise.

Table 8

Function (Signal on terminal XK ... 1) active, if the function is correct)	**Signal** available on terminal 1)	**Link**
Torque switch tripped in mid-travel and/ or thermoswitch or thermal overload relay tripped	XK 16	
No torque switch tripped in mid-travel	XK 15	
No thermoswitch or no thermal overload relay tripped	XK 13	
No torque switch tripped in mid-travel	XK 15	
Torque switch tripped in mid-travel	XK 16	
No function	XK 13	
No torque switch tripped in mid-travel	XK 15	
Torque switch tripped in mid-travel	XK 16	
No thermoswitch or no thermal overload relay tripped	XK 13	
No torque switch tripped in mid-travel	XK 15	
Torque switch tripped in mid-travel	XK 16	
Thermoswitch or thermal overload relay tripped	XK 13	
Torque switch tripped in mid-travel	XK 16	
No torque switch tripped in mid-travel	XK 15	
No function	XK 13	
Common link to XK 14		
1) refer to order-related wiring diagram BSP … KMS TP ...		

20. Fuses

- **Fuses (figures U1 and U2) are accessible after removal of the local controls (refer to page 23, figure R-1).**
- **When exchanging the fuses, only fuses with the same values must be used.**

Figure U1: Fuses on signal and control board

Figure U2: Fuses on power supply board

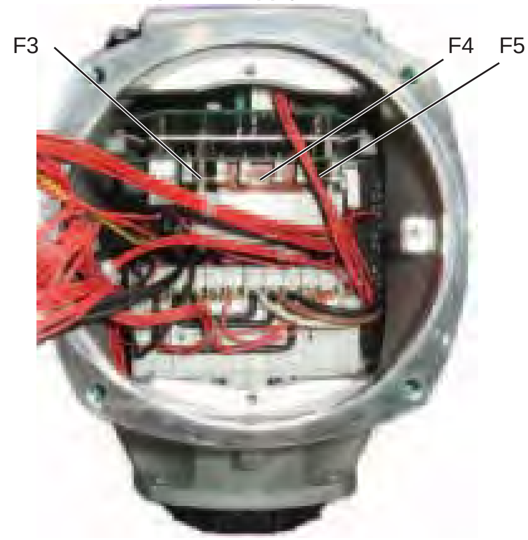


Table 9

G-fuses: (Figure U1 and U2)	**F 1/F 2** (Board A1, refer to wiring diagram)	**F 3/F4*)** (Board A2, refer to wiring diagram)	**F 5** (Board A2, refer to wiring diagram)
Size	6.3 x 32 mm	5 x 20 mm	5 x 20 mm
Control voltage Power supply unit 115 V	1 A T; 500 V	315 mA T	250 mA T
Control voltage Power supply unit 230 V	1 A T; 500 V	160 mA T	160 mA T

*) according to IEC 60127-2/III

F1/ F2:	Primary fuses power supply unit
F3:	Internal 24 V DC supply
F4:	Internal 24 V AC supply (optional: 115 V AC); Heater, tripping device for PTC thermistors, control reversing contactors
F5:	Automatic reset fuse as short-circuit protection (see wiring diagram) for external 24 V DC supply for customer

- After exchanging the fuses screw local controls back on again (refer also to subclause 19.5).

21. Maintenance

After commissioning, check multi-turn actuator for damage to paint finish. Do a thorough touch-up to prevent corrosion. Original paint in small quantities can be supplied by AUMA.

AUMA multi-turn actuators require very little maintenance.
Precondition for reliable service is correct commissioning.

Seals made of elastomers are subject to aging and must therefore regularly be checked and, if necessary, exchanged.

It is also very important that the O-rings at the covers are placed correctly and cable glands fastened firmly to prevent ingress of dirt or water.

We recommend additionally:

- If operated seldom, perform a test run about every 6 months. This ensures that the actuator is always ready to operate.
- Approximately six months after commissioning and then every year check bolts between actuator and valve/gearbox for tightness. If required, tighten applying the torques given in table 3, page 8.
- For multi-turn actuators with output drive type A: at intervals of approx. 6 months from commissioning press in Lithium soap EP multi-purpose grease on mineral oil base at the grease nipple with grease gun (quantity see table 4, page 9).

22. Lubrication

- The gear housing is filled with lubricant in the factory.
- A grease change is recommended after the following operation time:

- If operated seldom after 10 – 12 years
- If operated frequently after 6 – 8 years

Lubrication of the valve stem must be done separately.

23. Disposal and recycling

AUMA actuators have an extremely long lifetime. However, there will come a time when you have to replace them.
Our actuators have a modular design and may therefore easily be disassembled, separated and sorted according to materials, i.e.:

- electronic scrap
- various metals
- plastics
- greases and oils

The following generally applies:

- Collect greases and oils during disassembly. As a rule, these substances are hazardous to water and must not be released into the environment.
- See disassembled material to a sound disposal or to separate recycling according to materials.
- Observe the national regulations for waste disposal.

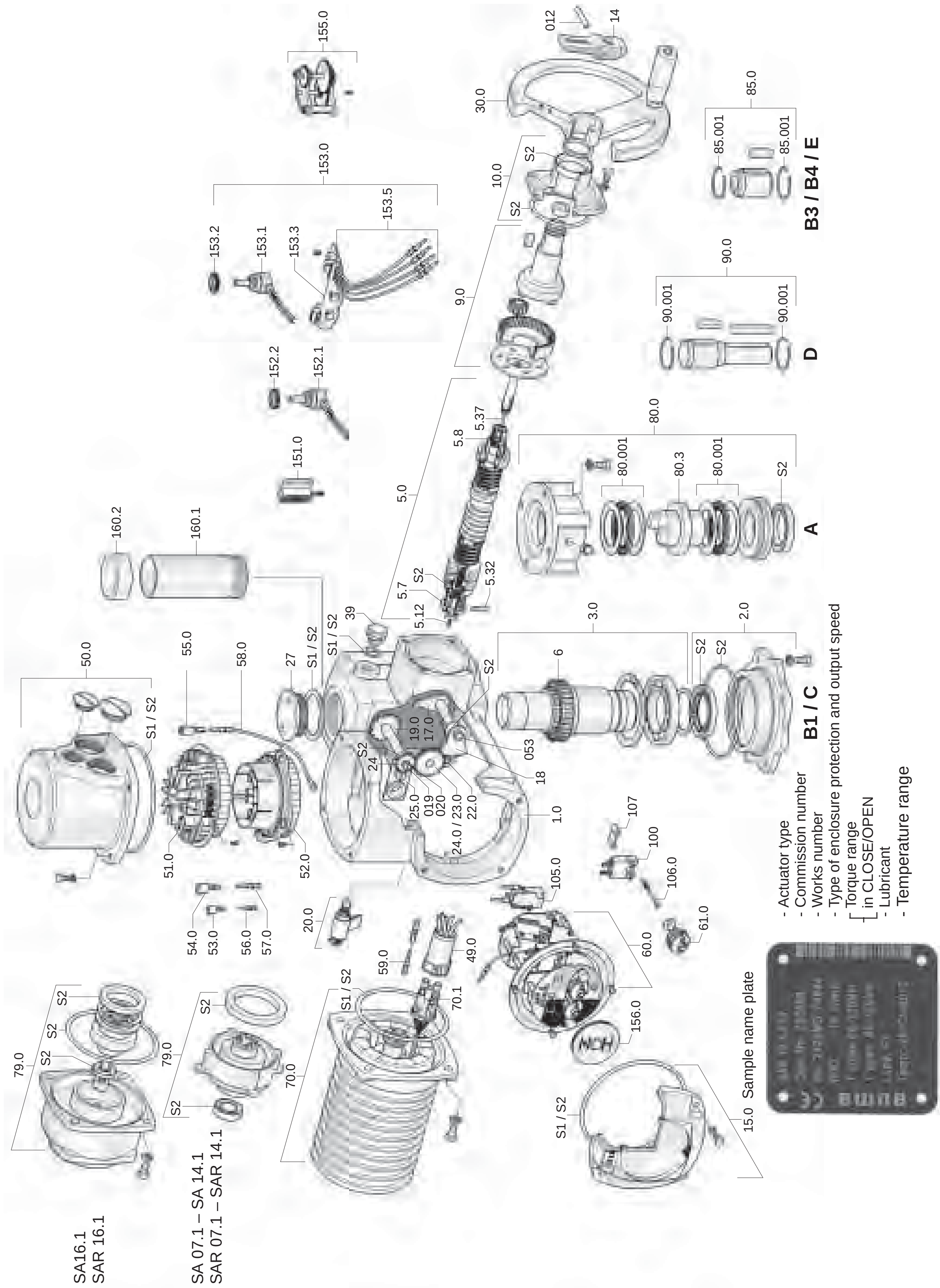
24. Service

AUMA offers extensive services such as maintenance and inspection for actuators. Addresses of AUMA offices and representatives can be found on page 36 and on the Internet (www.auma.com).

Notes

Notes

25. Spare parts list multi-turn actuator SA 07.1 – SA 16.1



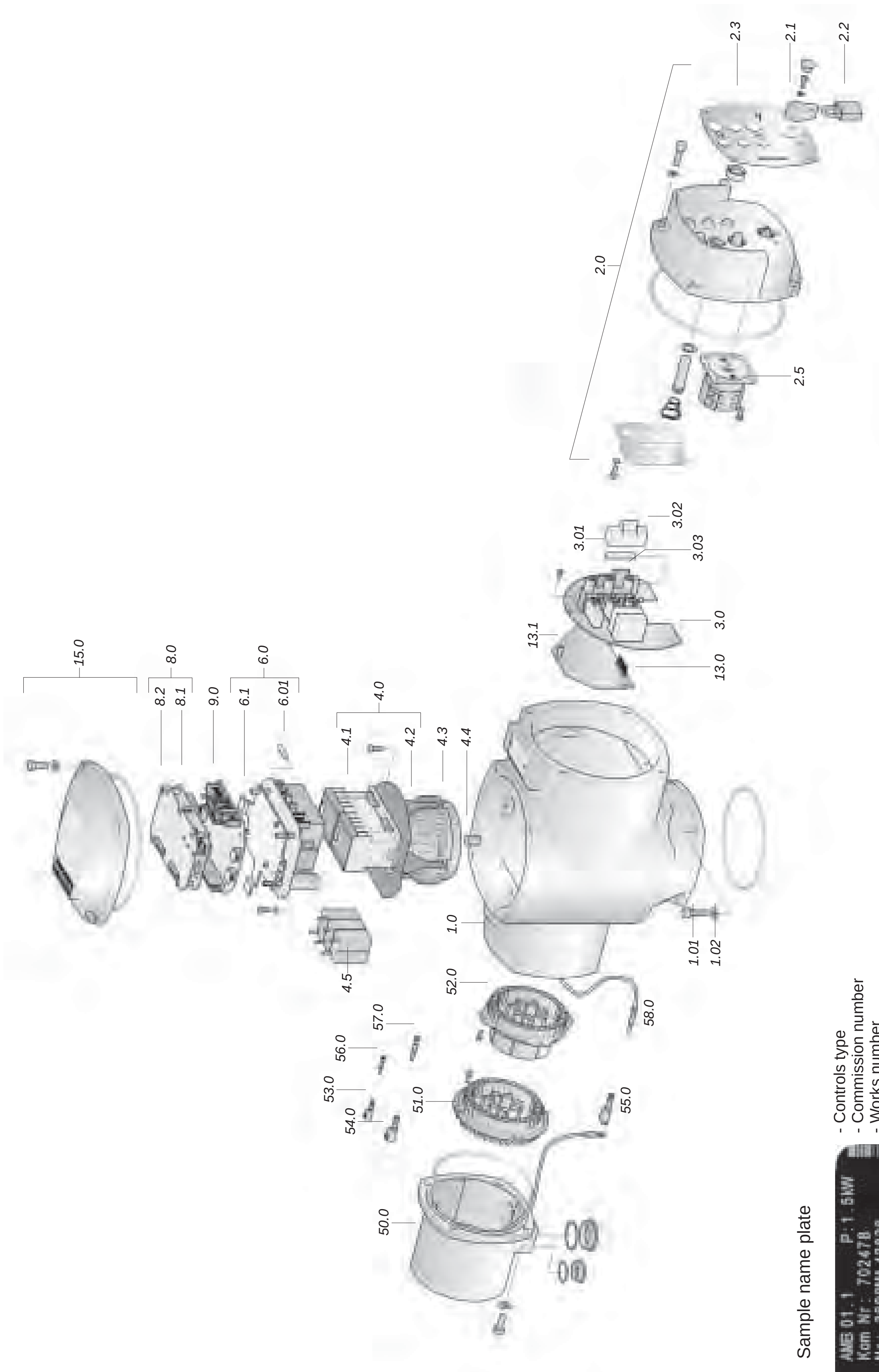
Note:
When placing orders for spare parts, please mention type of actuator and our commission number (refer to name plate).

No.	Type	Designation
012	E	Notched pin
019	E	Cheese head screw
020	E	Clamping washer
053	E	Countersunk screw
1.0	B	Housing assly.
2.0	B	Flange, bottom assly.
3.0	B	Hollow shaft assly. (without worm wheel)
5.0	B	Worm shaft assly.
5.12	E	Grub screw
5.32	E	Coupling pin
5.37	B	Pull rod assly.
5.7	E	Motor coupling
5.8	B	Manual drive coupling assly.
6	E	Worm wheel
9.0	B	Planetary gear for manual drive assly.
10.0	B	Retaining flange assly.
14	E	Change-over lever
15.0	B	Cover for switch compartment assly.
17.0	B	Torque lever assly.
18	E	Gear segment
19.0	B	Crown wheel assly.
20.0	B	Swing lever assly.
22.0	B	Drive pinion II for torque switching assly.
23.0	B	Drive wheel for limit switching assly.
24	E	Drive wheel for limit switching
24.0	B	Intermediate wheel for limit switching assly.
25.0	E	Locking plate
27	E	Screw plug
30.0	B	Handwheel with ball handle assly.
39	E	Screw plug
49.0 [1]	B	Motor plug, socket assly.
50.0	B	Cover assly.
51.0	B	Socket carrier assly. (with sockets)
52.0	B	Pin carrier (without pins)
53.0	B	Socket for control
54.0	B	Socket for motor
55.0	B	Socket for protective earth
56.0	B	Pin for control
57.0	B	Pin for motor

No.	Type	Designation
58.0	B	Wire for protective earth
59.0 [1]	B	Pin for motor and thermoswitch in motor plug
60.0	B	Control unit assly. (but without torque head, without switches)
61.0	B	Torque switching head
70.0	B	Motor
70.1 [1]	B	Motor pin carrier (without pins)
79.0 [2]	B	Planetary gearing for motor drive assly.
80.0 [3]	B	Output drive Form A assly. (without thread in stem nut)
80.001 [3]	E	Thrust bearing set
80.3 [3]	E	Stem nut (without thread)
85.0 [3]	B	Output drive B3
85.001 [3]	E	Snap ring
90.0 [3]	B	Output drive D
90.001 [3]	E	Snap ring
100	B	Switch for limit / torque switching (including pins at wires)
105.0	B	Blinker transmitter including pins at wires (without impulse disc and insulation plate)
106.0	B	Stud bolt for switches
107	E	Spacer
151.0	B	Space heater
152.1 [3]	B	Potentiometer (without slip clutch)
152.2 [3]	B	Slip clutch for potentiometer
153.0 [3]	B	RWG assly.
153.1 [3]	B	Potentiometer for RWG (without slip clutch)
153.2 [3]	B	Slip clutch for RWG
153.3 [3]	B	Electronic board RWG
153.5 [3]	B	Wires for RWG
155.0 [3]	B	Reduction gearing
156.0 [3]	B	Mechanical position indicator
160.1 [3]	E	Protection tube (without cap)
160.2 [3]	E	Cap for stem protection tube
S1	S	Seal-kit, small
S2	S	Seal-kit, large

1) SA 16.1 with output speeds 32 to 180 rpm without motor plug/socket assly.; motor directly wired to pin carrier (no. 52.0)
2) Only required for some output speeds
3) Not included in basic equipment

26. Spare parts list controls AUMA MATIC



Sample name plate

- Controls type
- Commission number
- Works number
- Terminal plan actuator
- Wiring diagram
- Supply voltage/ enclosure protection
- Control voltage

Note:
When placing your order for spare parts, please mention type of the controls and our commission number (refer to name plate of controls).

No.	Type	Designation	No.	Type	Designation
1.0	E	Housing	6.1	B	Mounting plate for power supply
1.01	E	Hexagon socket head cap screw	6.01	S	Secondary fuse
1.02	E	Lock washer	8.0	E	not installed
2.0	B	Cover local controls	8.1		not installed
2.1	B	Switch knob	8.2		not installed
2.2	E	Pad lock	9.0	B	Relay board
2.3	E	Face-plate for local controls	13.0	B	Wiring board
2.5	E	Selector switch	13.1	E	Stud
3.0	B	Signal and control board	15.0	B	Cover assly.
3.01	E	Primary fuse	50.0	B	Plug cover assly.
3.02	E	Fuse cover	51.0	B	Socket carrier assly. (with sockets)
3.03	E	Bulb for indication light	52.0	B	Pin carrier (without pins)
4.0	B	Contactors assly.	53.0	B	Socket for control
4.1	E	Reversing contactors	54.0	B	Socket for motor
4.2	E	Carrier for contactors	55.0	B	Socket for protective earth
4.3	E	Socket carrier (with sockets)	56.0	B	Pin for control
4.4	E	Grub screw	57.0	B	Pin for motor
4.5	E	RC unit	58.0	B	Protective earth
6.0	B	Power supply	S	S	Seal-kit

27. Declaration of Conformity and Declaration of Incorporation

auma®

EU - Declaration of Conformity
according to the Directive of the Council for
the approximation of the laws of the Member States
relating to the EMC Directive (89/336/EEC)
and the Low-Voltage Equipment Directive (73/23/EEC)

AUMA-multi-turn actuators of the type range

SA 07.1 – SA 48.1
SAR 07.1 – SAR 30.1
in versions AUMA NORM,
AUMA SEMIPACT, AUMA MATIC
or AUMATIC

are designed and produced to be installed on industrial valves.

Messrs. WERNER RIESTER GmbH & Co. KG as the manufacturer declares herewith, that the above mentioned electric AUMA multi-turn actuators are in compliance with the following directives:

- **Directive on Electromagnetic Compatibility (EMC) (89/336/EEC)**
- **Low-Voltage Equipment Directive (73/23/EEC)**

The compliance testing of the devices was based on the following standards:

a) concerning the Directive on Electromagnetic Compatibility
EN 61000-6-4: 08/2002
EN 61000-6-2: 08/2002

b) concerning the Low-Voltage Equipment Directive
EN 60204-1
EN 60034-1
VDE 0100-410

auma
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Tel 07631 / 809-0 • Fax 07631 / 809-250

Müllheim, June 10, 2003

H. Newerla, Managing Director

This declaration does not include any guarantee for certain characteristics.
The safety instructions in the product documentation supplied with the actuators must be observed

auma®

Declaration of Incorporation
according to EC - Machinery Directive 98/37/EC
article 4 paragraph 2 (Annex II B)

AUMA multi-turn actuators of the type ranges

SA 07.1 - SA 48.1
SAR 07.1 - SAR 30.1
SA Ex 07.1 - SA Ex 40.1
SAR Ex 07.1 - SAR Ex 16.1
SA ExC 07.1 - SA ExC 16.1
SAR ExC 07.1 - SAR ExC 16.1
in versions AUMA NORM,
AUMA SEMIPACT, AUMA MATIC
or AUMATIC

are designed and produced, as electrical actuating devices, to be installed on industrial valves.

Messrs. WERNER RIESTER GmbH & Co. KG (manufacturer) declares herewith, that when designing the above mentioned electric AUMA multi-turn actuators the following standards were applied:

EN 292 -1	**DIN VDE 0100-410**
EN 292 -2	**EN 60034-1**
EN 60 204 -1	**EN ISO 5210**

AUMA multi-turn actuators covered by this Declaration must not be put into service until the entire machine, into which they are incorporated, has been declared in conformity with the provisions of the Directive.

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Müllheim, April 11, 2003

H. Newerla, Managing Director

Index

Information also available on the Internet:	Terminal plan, inspection records and further actuator information can be downloaded directly from the internet by entering the order no. or comm no. (refer to name plate). Our homepage: **http://www.auma.com**

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For detailed information about the AUMA products refer to the Internet:
www.auma.com

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auma®

Electric multi-turn actuators

SA 07.1 – SA 48.1
SAR 07.1 – SAR 30.1
AUMA NORM
for flanges type FA

AUMA Actuators, Inc.
Registered to ISO 9001
Certificate No. A4682

Operation instructions

Scope of these instructions:	These instructions are valid for multi-turn actuators of the type range SA 07.1 – SA 48.1 and SAR 07.1 – SAR 30.1 in version AUMA NORM. These operation instructions are only valid for “clockwise closing”, i.e. driven shaft turns clockwise to close the valve.

Table of contents

1. Safety instructions

1.1 Range of application

AUMA actuators are designed for the operation of industrial valves, e.g. globe valves, gate valves, butterfly valves and ball valves. For other applications, please consult us. The manufacturer is not liable for any possible damage resulting from use in other than the designated applications. Such risk lies entirely with the user.
Observance of these operation instructions is considered as part of the actuator's designated use.

1.2 Commissioning (electrical connection)

During electrical operation, certain parts inevitably carry lethal voltages. Work on the electrical system or equipment must only be carried out by a skilled electrician themselves or by specially instructed personnel under the control and supervision of such an electrician and in accordance with the applicable electrical engineering rules.

1.3 Maintenance

The maintenance instructions (refer to page 25) must be observed, otherwise a safe operation of the actuator is no longer guaranteed.

1.4 Warnings and notes

Non-observance of the warnings and notes may lead to serious injuries or damage. Qualified personnel must be thoroughly familiar with all warnings and notes in these operation instructions.
Correct transport, proper storage, mounting, and installation, as well as careful commissioning are essential to ensure a trouble-free and safe operation.
During operation, the multi-turn actuator warms up and surface temperatures > 140 °F may occur. Check the surface temperature prior to contact in order to avoid burns.
The following references draw special attention to safety-relevant procedures in these operation instructions. Each is marked by the appropriate pictograph.

This pictograph means: Note!
"Note" marks activities or procedures which have major influence on the correct operation. Non-observance of these notes may lead to consequential damage.

This pictograph means: Electrostatically endangered parts!
If this pictograph is attached to a printed circuit board, it contains parts which may be damaged or destroyed by electrostatic discharges. If the boards need to be touched during setting, measurement, or for exchange, it must be assured that immediately before a discharge through contact with an earthed metallic surface (e.g. the housing) has taken place.

This pictograph means: Warning!
"Warning" marks activities or procedures which, if not carried out correctly, can affect the safety of persons or material.

2. Short description

AUMA multi-turn actuators type SA 07.1 – SA 48.1 and SAR 07.1 – SAR 30.1 have a modular design. The limitation of travel is realized via limit switches in both end positions. Torque seating is also possible in both end positions. The type of seating is determined by the valve manufacturer.

3. Technical data

Table 1: Multi-turn actuator SA 07.1 – SA 48.1 /SAR 07.1 – SAR 30.1

Multi-turn actuators AUMA NORM require electric controls. AUMA offers the controls AUMA MATIC AM or AUMATIC AC for the sizes SA(R) 07.1 - SA(R) 16.1. These can also easily be mounted to the actuator at a later date.

Features and functions	
Type of duty [1]	Standard: SA Short time duty S2 - 15 min SAR Intermittent duty S4 - 25 % Option: SA Short time duty S2 - 30 min SAR Intermittent duty S4 -50 % Intermittent duty S5 - 25 %
Motors	Standard: 3-ph AC asynchronous motor, type IM B9 according to IEC 34 Options: 1-ph AC motor, type IM B14 according to IEC 34 DC shunt motor, type IM B14 according to IEC 34 DC compound motor, type IM B14 according to IEC 34 Special motors
Insulation class	Standard: F, tropicalized Option: H, tropicalized
Motor protection	Standard: Thermoswitches (NC) Option: PTC thermistors (according to DIN 44082)
Supply voltage	Refer to motor nameplate
Self-locking	yes; for output speeds from 4,8 to 108 rpm and from size SA 35.1 for output speeds from 4,8 to 26 rpm
Limit switching	Counter gear mechanism for end positions CLOSED and OPEN for 1 to 500 turns per stroke (optional for 1 to 5,000 turns per stroke) Standard: Tandem switch (2 NC and 2 NO) for each end position; switches galvanically isolated Options: Single switch (1 NC and 1 NO) for each end position Triple switch (3 NC and 3 NO) for each end position, switches galvanically isolated Intermediate position switch (DUO limit switching)
Torque switching	adjustable torque switching for direction OPEN and CLOSE Standard: Single switch (1 NC and 1 NO) for each direction Options: Tandem switch (2 NC and 2 NO) for each direction, switches galvanically isolated
Non-intrusive setting (option)	Magnetic limit and torque transmitter MWG for the sizes SA 07.1 – SA 48.1 (only possible in combination with actuator controls AUMATIC) for 1 to 500 turns per stroke or for 10 to 5,000 turns per stroke
Position feedback signal, analogue (options)	Potentiometer or 0/4 – 20 mA For further details see separate data sheet
Torque feedback signal, analogue (option)	Only in combination with magnetic limit and torque transmitter MWG and actuator controls AUMATIC
Mechanical position indicator (option)	Continuous indication, adjustable indicator disc with symbols OPEN and CLOSED
Running indication (option)	Blinker transmitter
Heater in switch compartment	Standard: self-regulating PTC heater, 5 – 20 W, 110 – 250 V DC/AC Options: 24 – 48 V DC/AC or 380 – 400 V AC A resistance type heater (5 W, 24 V DC) is installed in the actuator in combination with the actuator controls AUMA MATIC or AUMATIC.
Motor heater (option)	SA(R) 07.1 – 10.1: 12.5 W SA(R) 14.1 – 16.1: 25 W SA(R) 25.1 – 30.1: 50 W SA 35.1 – 48.1: 50 W
Manual operation	Manual drive for setting and emergency operation, handwheel does not rotate during electrical operation. Option: Handwheel lockable
Electrical connections	Standard: SA(R) 07.1 – 16.1: AUMA plug/socket connector with screw type connection, SA(R) 25.1 – 48.1: Control connections on AUMA plug/socket connector, motor connection via terminals Option: for special motors: Motor connection directly via terminal board at the motor
Threads for cable glands	Standard: NPT-threads Options: Pg-threads, G-threads
Terminal plan	Terminal plan according to commission number included in delivery

1) Based on 68 °F ambient temperature and at an average load with running torque according to Technical data SA(R).

Service conditions	
Output drive types	A, B1, B2, B3, B4 according ISO 5210 (A, B2, B4 according to MSS SP-102) A, B, D, E according to DIN 3210 C according to DIN 3338 Special output drives: AF, AK, AG, IB1, IB3
Enclosure protection according to EN 60 529[2)]	Standard: IP 67 Options: IP 68 IP 67-DS (Double Sealed) IP 68-DS (Double Sealed) (Double Sealed = additional protection of the interior of the housing against ingress of dust and dirt when removing the plug)
Corrosion protection	Standard: KN Suitable for installation in industrial units, in water or power plants with a low pollutant concentration Options: KS Suitable for installation in occasionally or permanently aggressive atmosphere with a moderate pollutant concentration (e.g. in wastewater treatment plants, chemical industry) KX Suitable for installation in extremely aggressive atmosphere with high humidity and high pollutant concentration KX-G Same as KX, however aluminium-free version (outer parts)
Finish coating	Standard: Two part acrylic polyurethane
Color	Standard: Dark grey (DB 702, similar to RAL 9007) Option: Other colours are possible on request
Ambient temperature [3)]	Standard: SA – 20 to + 80 °C/ – 20 to + 175 °F SAR – 25 to + 60 °C/ – 20 to + 140 °F Options: SA – 40 to + 60 °C/ – 40 to + 140 °F (low temperature) – 50 to + 60 °C/ – 58 to + 140 °F (extreme low temperature) – 60 to + 60 °C/ – 75 to + 140 °F (extreme low temperature) – 0 to + 120 °C/ + 32 to + 250 °F (high temperature) SAR – 40 to + 60 °C/ – 40 to + 140 °F (low temperature)
Vibration resistance according to IEC 60068-2-6	2 g, for 10 to 200 Hz (only for sizes SA(R) 07.1 – SA(R) 16.1 without controls) Resistant to vibrations during start-up or for failures of the plant. However, a fatigue strength may not be derived from this. Valid for multi-turn actuators in version AUMA NORM (with AUMA plug/socket connector, without actuator controls). Not valid in combination with gearboxes
Lifetime[4)]	SA 07.1 – SA 10.1 20,000 operating cycles (OPEN - CLOSE - OPEN) with 30 turns per stroke SA 14.1 – SA 16.1 15,000 operating cycles SA 25.1 – SA 30.1 10,000 operating cycles SA 35.1 – SA 48.1 5,000 operating cycles SAR 07.1 – SAR 10.1[4)] 5 millon starts SAR 14.1 – SAR 16.1[4)] 3.5 million starts SAR 25.1 – SAR 30.1[4)] 2.5 million starts
Other information	
Reference documents	Product description “Electric multi-turn actuators SA” Dimension sheets SA(R) Electrical data sheets SA/SAR Technical data sheets SA/SAR

2) For 3-phase asynchronous motors in enclosure protection IP 68, higher corrosion protection KS or KX is strongly recommended. Additionally, for enclosure protection IP 68, we recommend to use the double sealed terminal compartment DS.
For 1-phase AC motors, DC motors, or special motors, the enclosure protection according the name plate applies.

3) Versions with RWG up to max. to + 158 °F

4) The lifetime depends on the load and the number of starts. A high starting frequency will rarely improve the modulating accuracy. To reach the longest possible maintenance and fault-free operation time, the number of starts per hour chosen should be as low as permissible for the process.

4. Transport, storage and packaging

4.1 Transport

- For transport to place of installation, use sturdy packaging.
- Do not attach ropes or hooks to the handwheel for the purpose of lifting by hoist.
- If multi-turn actuator is mounted on valve, attach ropes or hooks for the purpose of lifting by hoist to valve and not to multi-turn actuator.

Fitting the handwheel:

For transport purposes, handwheels from a diameter of 400 mm (1 inch corresponds to 25.4 mm) are supplied separately.

Engage manual operation prior to mounting the handwheel! If the manual operation is not engaged, damages can occur at the change-over mechanism.

- Engage manual operation (figure A-1):
  Manually lift the red change-over lever while slightly turning the shaft back and forth until manual operation engages. The manual operation is correctly engaged if the change-over lever can be lifted by approx. 85°.

Manual force is sufficient for operating the change-over lever. It is not necessary to use an extension. Excessive force may damage the change-over mechanism.

- Install the hand wheel over the red change-over lever on to the shaft (figure A-2).
- Secure handwheel using the snapring supplied.

Figure A-1

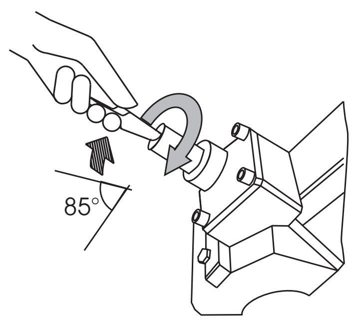
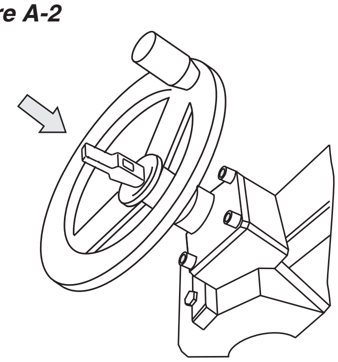


Figure A-2



4.2 Storage

- Store in well-ventilated, dry room.
- Protect against floor dampness by storage on a shelf or on a wooden pallet.
- Cover to protect against dust and dirt.
- Apply suitable corrosion protection agent to uncoated surfaces.

If multi-turn actuators are to be stored for a long time (more than 6 months), in addition, the following points must imperatively be observed :

- Prior to storage: Protect uncoated surfaces, in particular the output drive parts and mounting surface, with long-term corrosion protection agent.
- Check for corrosion approximately every 6 months. If first signs of corrosion show, apply new corrosion protection.

After mounting, connect actuator immediately to electrical system, so that the heater prevents condensation.

4.3 Packaging

Our products are protected by special packaging for the transport ex works. The packaging consists of environmentally friendly materials which can easily be separated and recycled.

We use the following packaging materials: wood, cardboard, paper and Polyurethane foam. For the disposal of the packaging material, we recommend recycling and collection centers.

5. Mounting to valve/gearbox

- **Prior to mounting the multi-turn actuator must be checked for damage. Damaged parts must be replaced by original spare parts.**
- **After mounting, check multi-turn actuator for damage to paint finish. If damage to paint-finish has occurred after mounting, it has to be touched up to avoid corrosion.**

Mounting is most easily done with the valve shaft/gearbox shaft pointing vertically upward. But mounting is also possible in any other position.
The multi-turn actuator leaves the factory in position CLOSED (limit switch CLOSED tripped).

- Check if mounting flange fits the valve/gearbox.

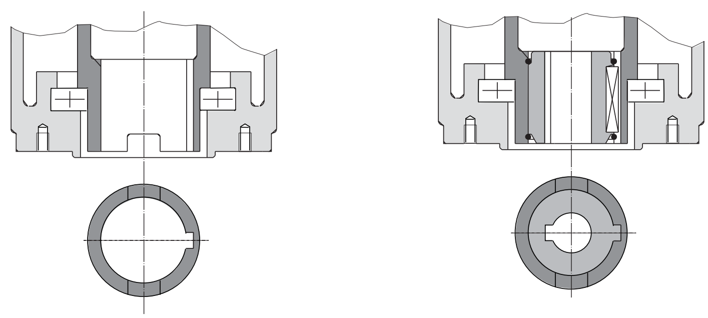
Spigot at flanges should be loose fit!

The output drive types B1, B2, B3 or B4 (figure A-3) are delivered with bore and keyway (usually according to ISO 5210) and are sometimes shipped with bore and keyway according to customer request.

Figure A-3

Output drive type B1/B2
Plug sleeve (option)

Output drive type B3/B4
Bore with keyway (standard)



For output drive type A (figure B-1), the internal thread of the stem nut must match the thread of the valve stem. If not ordered explicitly with thread, the stem nut is unbored or with pilot bore when delivered. For finish machining of stem nut refer to next page.

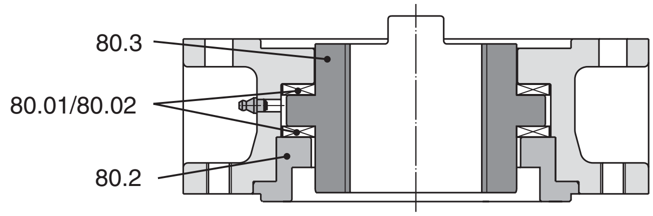
- Check whether bore and keyway match the input shaft of valve/gearbox.
- Thoroughly degrease mounting faces at multi-turn actuator and valve/gearbox.
- Apply a small quantity of grease to input shaft of valve/gearbox.
- Place actuator on valve/gearbox and fasten. Fasten bolts (quality grade 5, refer to table 2) evenly crosswise.

Table 2: Standard dry fastening torques for bolts

UNC threads	T_A (ft lbs)
5/16 - 18	19
3/8 - 16	33
1/2 - 13	78
5/8 - 11	155
3/4 - 10	255
1 - 8	590
1 1/4 - 7	1,2000
Conversion factor: 1 Nm corresponds to 1.3529 ft lbs.	

Finish machining of stem nut (output drive type A):

Figure B-1



The output drive flange does not have to be removed from the actuator.

- Remove spigot ring (80.2, figure B-1) from mounting flange.
- Take off stem nut (80.3) together with thrust bearing (80.01) and thrust bearing races (80.02).
- Remove thrust bearing and thrust bearing races from stem nut.
- Drill and bore stem nut and cut thread.
  When fixing in the chuck, make sure stem nut runs true!
- Clean the machined stem nut.
- Apply Lithium soap EP multi-purpose grease to thrust bearing and races, then place them on stem nut.
- Re-insert stem nut with thrust bearings into the mounting flange. Ensure that dogs are placed correctly in the slots of the hollow shaft.
- Screw in spigot ring until it is firm against the shoulder.
- Press Lithium soap EP multi-purpose grease on mineral oil base into the grease nipple with a grease gun (for quantities, refer to table below):

Table 3: Grease quantities for lubricating bearings

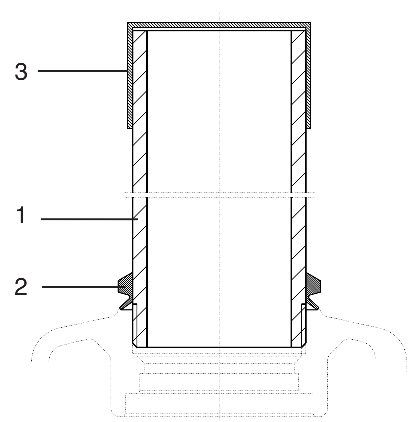
Output drive	A 07.2	A 10.2	A 14.2	A 16.2	A 25.2	A 30.2	A 35.2	A 40.2	A 48.2
Qty[1] in g	1.5 g	2 g	3 g	5 g	10 g	14 g	20 g	25 g	30 g

1) For grease with a density ρ = 900 g/dm^3; conversion factor: 1 oz corresponds to 28.35 g

Protection tube for rising valve stem

- Protection tubes may be supplied loose. Seal thread with hemp, Teflon tape, or thread sealing material.
- Screw protection tube (1) into thread (figure B-2) and tighten it firmly.
- Push down the sealing (2) to the housing.
- Check whether cap (3) is available and without damage.

Figure B-2: Protection tube for rising valve stem



6. Manual operation

The actuator may be operated manually for purposes of setting and commissioning, and in case of motor failure or power failure.
Manual operation is engaged by an internal change-over mechanism.

Engaging manual operation:

- Lift up change-over lever in the center of the handwheel to approx. 85°, while slightly turning the handwheel back and forth until manual operation engages (figure C).

Figure C

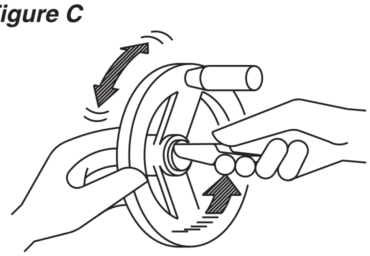
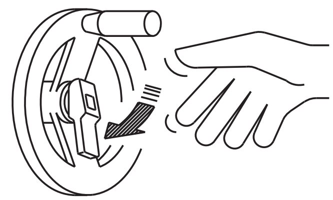


Figure D



Manual force is sufficient for operating the change-over lever. It is not necessary to use an extension. Excessive force may damage the change-over mechanism.

- Release change-over lever (should snap back into initial position by spring action, figure D), if necessary, push it back manually.

Operating the change-over lever while the motor is running (figure E) can lead to increased wear at the change-over mechanism.

Figure E

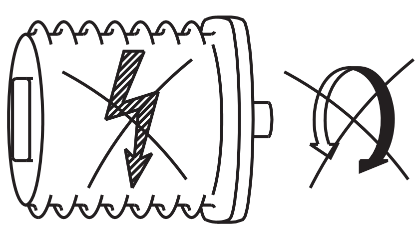
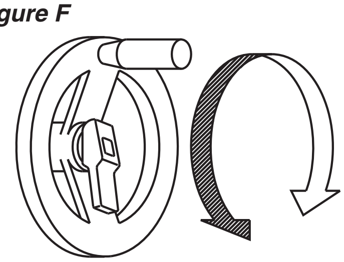


Figure F



- Turn handwheel in desired direction (figure F).

Disengaging manual operation:

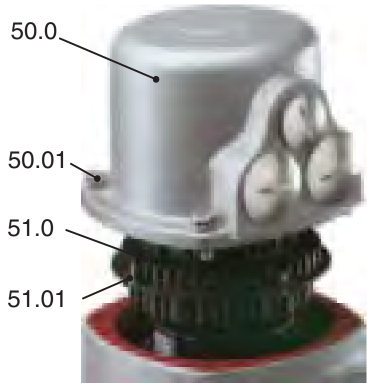
Manual operation is automatically disengaged when the motor is started again.
The handwheel does not rotate during motor operation.

7. Electrical connection

Work on the electrical system or equipment must only be carried out by a skilled electrician themselves or by specially instructed personnel under the control and supervision of such an electrician and in accordance with the applicable electrical engineering rules.

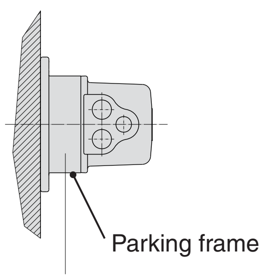
7.1 Connection with AUMA plug/socket connector

Figure G-1: Connection



- Check whether type of current, supply voltage, and frequency correspond to motor data (refer to name plate at motor).
- Loosen bolts (50.01) (figure G-1) and remove plug cover.
- Loosen screws (51.01) and remove socket carrier (51.0) from plug cover (50.0).
- Insert cable glands or conduit fittings suitable for connecting cables. (The enclosure protection stated on the name plate is only ensured if properly sealed connections are made).
- Seal cable entries which are not used with sealed threaded plugs.
- Connect cables according to order-related terminal plan.
- The terminal plan applicable to the actuator is placed inside the terminal compartment, the operation instructions are attached to the handwheel in a weather-proof bag.

Figure G-2: Parking frame (accessory)



A special parking frame (figure G-2) for protection against touching the bare contacts and against environmental influences is available.

Table 4: Technical data AUMA plug/socket connectors

Technical data	Power terminals 1)	Protective earth	Control pins
No. of contacts max.	6 (3 are used)	1 (leading contact)	50 pins/sockets
Marking	U1, V1, W1, U2, V2, W2	according to VDE	1 to 50
Voltage max.	750 V	–	250 V
Nominal current max.	25 A	–	16 A
Type of customer connection	Screws	Screw for ring lug	Screws
Cross section max.	6 mm^2 (10 AWG)	6 mm^2 (10 AWG)	2.5 mm^2 (12 AWG)
Material: Pin/ socket carrier	Polyamide	Polyamide	Polyamide
Contacts	Brass (Ms)	Brass (Ms)	Brass, tin plated or gold plated (option)

1) Suitable for copper wires. For aluminium wires it is necessary to contact AUMA.
From size SA(R) 25.1, the motor connection is realised via a separate terminal board

7.2 Motor connection for the sizes SA(R) 25.1/SAR 30.1 – SA 48.1.

From the size SA(R) 25.1, the power for the motor is connected to separate terminals. For this, the cover at the motor connection compartment has to be removed.
The control contacts are connected to the AUMA plug/socket connector.

Cross section motor terminals:
16 mm² to 70 mm² (6 to 2/0 AWG), depending on the actuator size

Figure G-3: Connection to SA(R) 25.1

AUMA plug/socket connector

Cover motor connection compartment

7.3 Motor connection for special motors

For versions with special motors (e.g. DC motors), the connection is performed directly at the motor (figure G-4).

Figure G-4: Connection special motor

7.4 Delay time

The delay time is the time from the tripping of the limit or torque switches to the motor power being removed. To protect the valve and the actuator, we recommend a delay time < 50 ms. Longer delay times are possible provided the output speed, output drive type, valve type, and the type of installation are taken into consideration.
We recommend to switch off the corresponding contactor directly by the limit or torque switch.

7.5 Controls made by AUMA

In case the required reversing contactors are not to be installed in the control cabinet, the controls AUMA MATIC or AUMATIC for the sizes SA(R) 07.1 – SA(R) 16.1 can be easily mounted to the actuator at a later date.
For enquiries and more information, please state our commission no. (refer to actuator name plate).

7.6 Heater

AUMA multi-turn actuators have a heater installed as standard. To prevent condensation, the heater must be connected.

7.7 Motor protection

In order to protect against overheating and extreme high temperatures at the actuator, PTC thermistors or thermoswitches are embedded in the motor winding. The thermoswitch is tripped as soon as the max. permissible winding temperature has been reached.

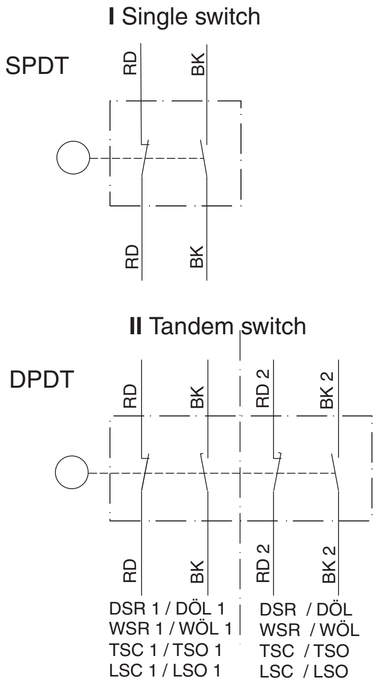
Failure to integrate PTC thermistors or thermoswitches into the control circuit voids the warranty for the motor.

7.8 Remote position transmitter

For the connection of remote position transmitters (potentiometer, RWG) shielded cables must be used.

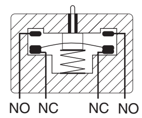
7.9 Limit and torque switches

Figure G-5



Only the same potential can be switched on the two circuits (NC/NO contact) of a limit or torque switch. If different potentials are to be switched simultaneously, tandem switches are required.
To ensure correct actuator indications, the leading contacts of the tandem switches must be used for that purpose and the lagging contacts for motor switching off.

Table 5: Technical data for limit and torque switches

	Mechanical lifetime = 2 x 10^6 starts		
Type of current	**Switch rating I_{max}**		
	30 V	**125 V**	**250 V**
1-phase AC (ind. load) cos phi = 0,8	5 A	5 A	5 A
DC (resistive load)	2 A	0,5 A	0.4 A
with gold plated contacts	**min. 5 V, max. 50 V**		
Current	min. 4 mA, max. 400 mA		

7.10 Fitting of the cover

After connection:

- Insert the socket carrier (51.0) into the plug cover (50.0) and fasten it with screws (51.01).
- Clean sealing faces at the plug cover and the housing.
- Check whether O-ring is in good condition.
- Apply a thin film of non-acidic grease (e.g. Vaseline) to the sealing faces.
- Replace plug cover (50.0) and fasten bolts (50.01) evenly crosswise.
- Fasten conduit connections with the specified torque to ensure the required enclosure protection.

8. Opening the switch compartment

To be able to carry out the following settings (sections 9. to 15.), the switch compartment must be opened and, if installed, the indicator disc must be removed.

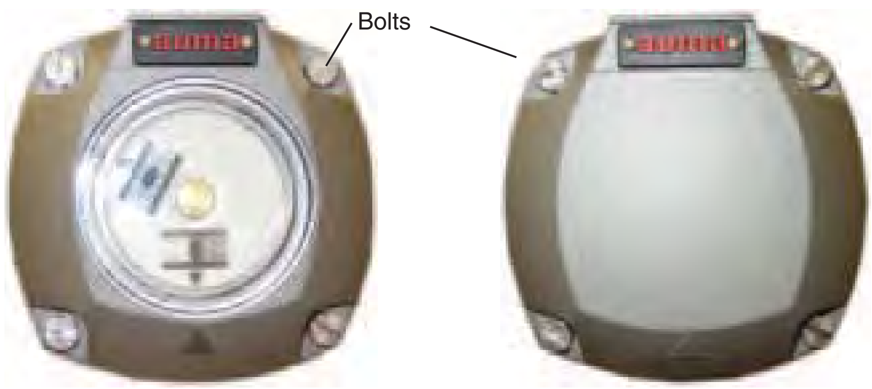
These settings are only valid for “clockwise closing”, i.e. driven shaft turns clockwise to close the valve.

Work on the electrical system or equipment must only be carried out by a skilled electrician themselves or by specially instructed personnel under the control and supervision of such an electrician and in accordance with the applicable electrical engineering rules.

8.1 Removing the switch compartment cover

- Loosen 4 bolts and take off the cover at the switch compartment (figures H) .

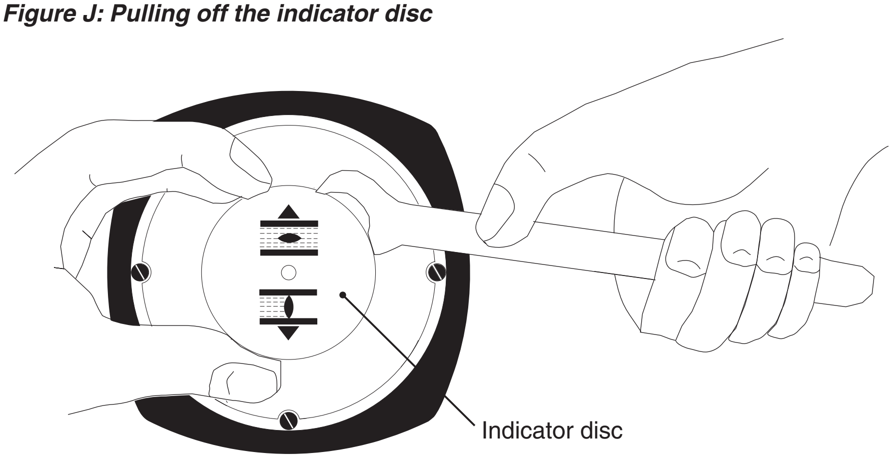
Fig. H-1: Cover with indicator glass *Fig. H-2: Cover without indicator glass*



8.2 Pulling off the indicator disc (option)

- If installed, pull off indicator disc (figure J). Open end wrench may be used as lever.

Figure J: Pulling off the indicator disc

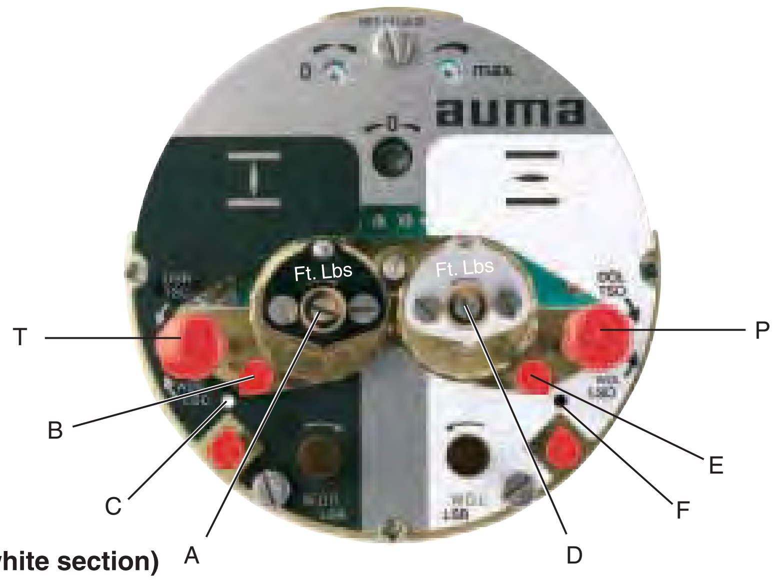


9. Setting the limit switching

9.1 Setting the end position CLOSED (black section)

- Turn handwheel clockwise until valve is closed.
- After having reached the end position, turn back handwheel by approximately ½ a turn (overrun). During test run, check overrun and, if necessary, correct setting of the limit switching.
- **Press down** and turn setting spindle A (figure K-1) with a flat blade screw driver in direction of arrow, thereby observe pointer B.
  While a ratchet is felt and heard, the pointer B moves 90° every time.
  When pointer B is 90° from mark C, continue turning slowly. When pointer B has reached the mark C, stop turning and release setting spindle. If you override the tripping point inadvertently (ratchet is heard after the pointer has rotated), continue turning the setting spindle in the same direction and repeat setting process.

Figure K-1: Control unit



9.2 Setting the end position OPEN (white section)

- Turn handwheel counterclockwise until valve is open, then turn back by approximately ½ a turn.
- **Press down** and turn setting spindle D (figure K-1) with a flat blade screw driver in direction of arrow, thereby observe pointer E.
  While a ratchet is felt and heard, the pointer E moves 90° every time.
  When pointer E is 90° from mark F, continue turning slowly. When pointer E has reached the mark F, stop turning and release setting spindle. If you override the tripping point inadvertently (ratchet is heard after the pointer has rotated), continue turning the setting spindle in the same direction and repeat setting process.

9.3 Checking the limit switches

The red test buttons T and P (figure K-1) are used for manual operation of the limit switches.

- Turning T in direction of the arrow LSC (WSR) triggers limit switch CLOSED.
- Turning P in direction of the arrow LSO (WÖL) triggers limit switch OPEN.

10. Setting the DUO limit switching (option)

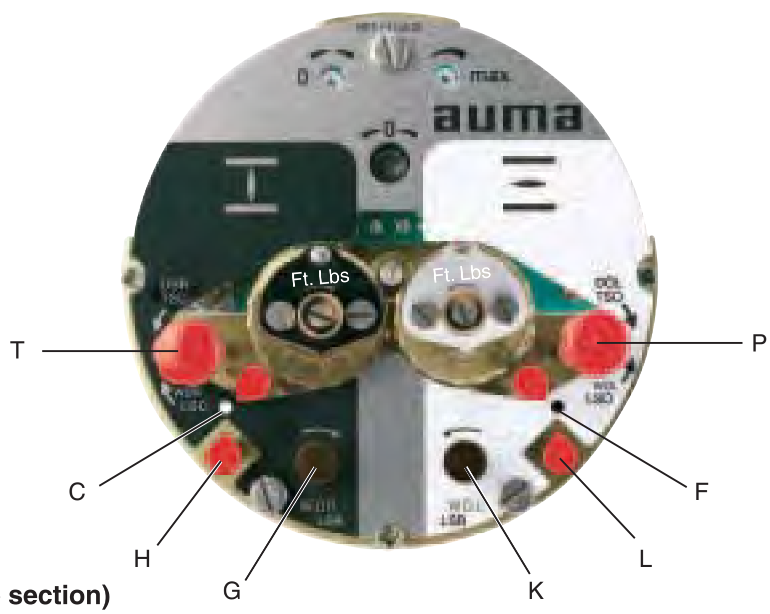
Any application can be switched on or off via the two intermediate position switches.

For setting, the switching point (intermediate position) must be approached from the same direction as later during electrical operation.

10.1 Setting the direction CLOSE (black section)

- Move valve to desired intermediate position.
- **Press down** and turn setting spindle G (figure K-2) with a flat blade screw driver in direction of arrow, thereby observe pointer H.
  While a ratchet is felt and heard, the pointer H moves 90° every time.
  When pointer H is 90° from mark C, continue turning slowly. When pointer H has reached the mark C, stop turning and release setting spindle. If you override the tripping point inadvertently (ratchet is heard after the pointer has rotated), continue turning the setting spindle in the same direction and repeat setting process.

Figure K-2: Control unit



10.2 Setting the direction OPEN (white section)

- Move valve to desired intermediate position.
- **Press down** and turn setting spindle K (figure K-2) with a flat blade screw driver in direction of arrow, thereby observe pointer L.
  While a ratchet is felt and heard, the pointer L moves 90° every time.
  When pointer L is 90° from mark F, continue turning slowly. When pointer L has reached the mark F, stop turning and release setting spindle. If you override the tripping point inadvertently (ratchet is heard after the pointer has rotated), continue turning the setting spindle in the same direction and repeat setting process.

10.3 Checking the DUO switches

The red test buttons T and P (Figure K-2) are used for manual operation of DUO limit switches.

- Turning T in direction of the arrow TSC (DSR) triggers DUO limit switch CLOSED. The torque switch CLOSED is actuated at the same time.
- Turning P in direction of the arrow TSO (DÖL) triggers DUO limit switch OPEN. The torque switch OPEN is actuated at the same time.

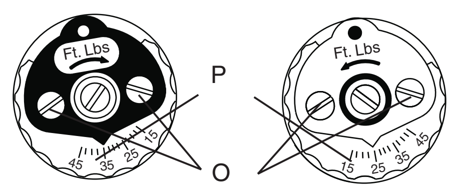
11. Setting the torque switching

11.1 Setting

- **The set torque must suit the valve!**
- **This setting should only be changed with the consent of the valve manufacturer!**

Figure L: Torque switching heads indication in ft lbs

Setting CLOSED Setting OPEN



- Loosen both lock screws O at the torque dial (figure L).
- Turn torque dial P to set it to the required torque.
  Examples:
  Figure L shows the following setting:
  35 ft lbs for direction CLOSE
  25 ft lbs for direction OPEN
- Tighten lock screws O again

- **The torque switches can also be operated in manual operation.**
- **The torque switching acts as overload protection over full travel, also when stopping in the end positions by limit switching.**

11.2 Checking the torque switches

The red test buttons T and P (figure K-2) are used for manual operation of the torque switches:

- Turning T in direction of the arrow TSC (DSR) triggers torque switch CLOSED.
- Turning P in direction of the arrow TSO (DÖL) triggers torque switch OPEN.
- If a DUO limit switching (optional) is installed in the actuator, the intermediate position switches will be operated at the same time.

12. Test run

12.1 Check direction of rotation

- If provided, place indicator disc on shaft.
  The direction of rotation of the indicator disc (figure M-1) indicates the direction of rotation of the output drive.
- If there is no indicator disc, the direction of rotation can also be observed on the hollow shaft. For this, remove screw plug (no. 27) (figure M-2).

Figure M-1: Indicator disc

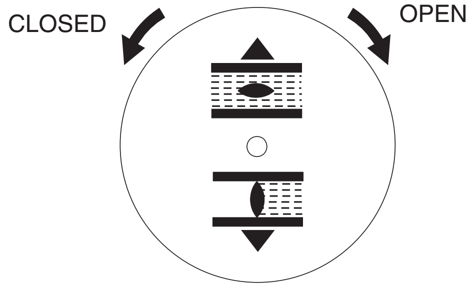
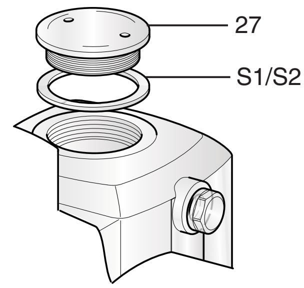


Figure M-2: Opening the hollow shaft



- Move actuator manually to intermediate position or to sufficient distance from end position.
- Switch on actuator in direction CLOSE and observe the direction of rotation:

If the direction of rotation is wrong, switch off immediately
Then, correct phase sequence at motor connection. Repeat test run.

Table 6:

Direction of rotation of the indicator disc:	
counterclockwise	correct
Direction of rotation of the hollow shaft:	
clockwise	correct

12.2 Check limit switching

- Move actuator manually into both end positions of the valve.
- Check if limit switching is set correctly. Hereby observe that the appropriate switch is tripped in each end position and released again after the direction of rotation is changed. If this is not the case, the limit switching must first be set, as described from page 15.

If no other options (sections 13. to 15.) require setting:
- Close switch compartment (see page 23, section 16.).

13. Setting the potentiometer (option)

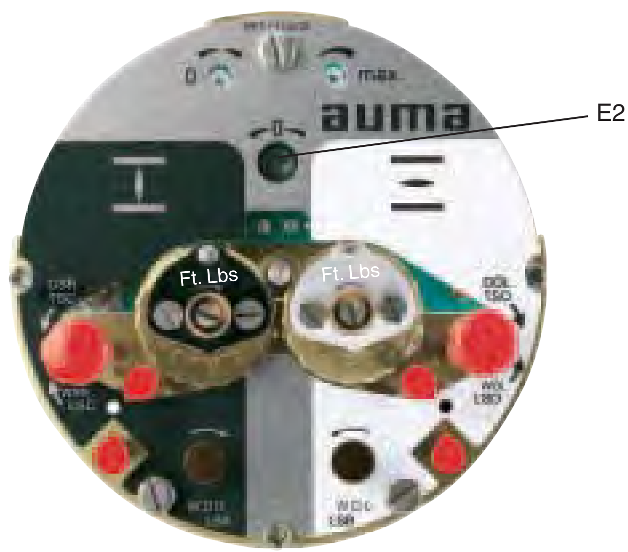
– For remote indication –

- Move valve to end position CLOSED.
- If installed, pull off indicator disc.
- Turn potentiometer (E2) clockwise until stop is felt.
  End position CLOSED corresponds to 0 %, end position OPEN to 100 %.
- Turn potentiometer (E2) back a little.

Due to the ratio of the reduction gearings for the position transmitter the complete resistance range is not always utilized for the whole travel. Therefore, an external possibility for adjustment (setting potentiometer) must be provided.

- Perform fine-tuning of the zero point at external setting potentiometer (for remote indication).

Figure N: Control unit



14. Setting the electronic position transmitter RWG (option)

– For remote indication or external controls –

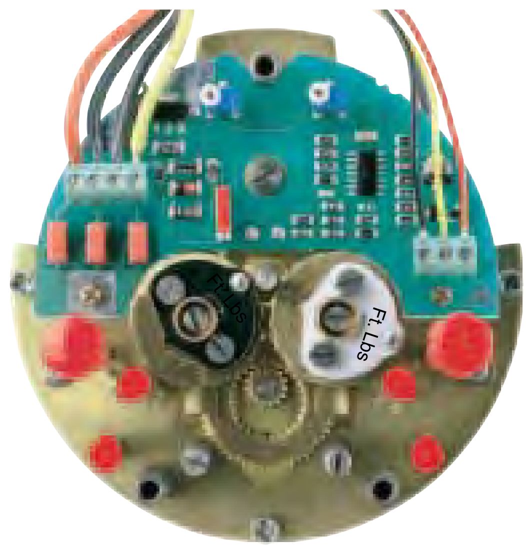
After mounting the multi-turn actuator to the valve, check setting by measuring the output current (see sections 14.1 or 14.2) and re-adjust, if necessary.

Table 7: Technical data RWG 4020

Terminal plans		KMS TP_ _ 4 / _ _ _ 3- or 4-wire system	KMS TP _ 4 _ / _ _ _ KMS TP _ 5 _ / _ _ _ 2-wire system
Output current	I_a	0 – 20 mA, 4 – 20 mA	4 – 20 mA
Power supply	U_v	24 V DC, ± 15 % regulated	14 V DC + (I x R_B), max. 30 V
max. input current	I	24 mA at 20 mA output current	20 mA
max. load	R_B	600 Ω	(Uv - 14 V) /20 mA

The position transmitter board (figure P-1) is located under the cover plate (figure P-2).

Figure P-1: Position transmitter board



14.1 Setting for 2-wire system 4 – 20 mA and 3-/4-wire system 0 – 20 mA

- Connect voltage to electronic position transmitter.
- Move valve to **end position CLOSED**.
- If installed, pull off indicator disc.
- Connect ammeter for 0 – 20 mA to measuring points (figure P-2).

The circuit (external load) must be connected (max. load R_B), or the appropriate connections at the terminals (refer to terminal plan) must be jumpered, otherwise no value can be measured.

- Turn potentiometer (E2) clockwise to the stop.
- Turn potentiometer (E2) back a little.

Figure P-2

- Turn potentiometer "0" clockwise until output current starts to increase.
- Turn potentiometer "0" back until the following value is reached:
  for 3- or 4-wire system: approx. 0.1 mA
  for 2-wire system: approx. 4.1 mA.
  This ensures that the signal remains above the dead and live zero point.
- Move valve to end position OPEN.
- Set potentiometer "max." to end value 20 mA.
- Approach end position CLOSED again and check minimum value (0.1 mA or 4.1 mA). If necessary, correct the setting.

If the maximum value cannot be reached, the selection of the reduction gearing must be checked.

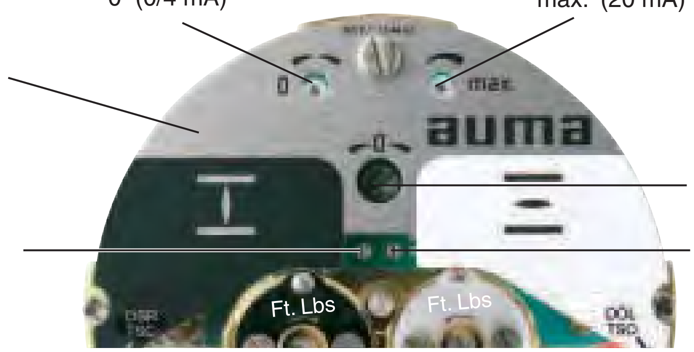
14.2 Setting the 3-/4- wire system 4 – 20 mA

- Connect voltage to electronic position transmitter.
- Move valve to end position CLOSED.
- If installed, pull off indicator disc.
- Connect ammeter for 0 – 20 mA to measuring points (figure P-2).

The circuit (external load) must be connected (max. load R_B), or the appropriate connections at the terminals (refer to terminal plan) must be jumpered, otherwise no value can be measured.

- Turn potentiometer (E2) clockwise to the stop.
- Turn potentiometer (E2) back a little.

Fig. P-3



- Turn potentiometer “0“ clockwise until output current starts to increase.
- Turn back potentiometer “0“ until a residual current of approx. 0.1 mA is reached.

- Move valve to end position OPEN.
- Set potentiometer “max.” to end value 16 mA.
- Move valve to end position CLOSED.
- Set potentiometer “0“ from 0.1 mA to initial value 4 mA.
  This results in a simultaneous shift of the end value by 4 mA, so that the range is now 4 – 20 mA.
- Approach both end positions again and check setting. If necessary, correct the setting.

If the maximum value cannot be reached, the selection of the reduction gearing must be checked.

15. Setting the mechanical position indicator (option)

- Place indicator disc on shaft.
- Move valve to end position CLOSED.
- Turn lower indicator disc (figure Q1) until symbol CLOSED is in alignment with the mark on the cover (figure Q-2).
- Move actuator to end position OPEN.
- Hold lower indicator disc CLOSED in position and turn upper disc with symbol OPEN until it is in alignment with the mark on the cover.

Figure Q-1

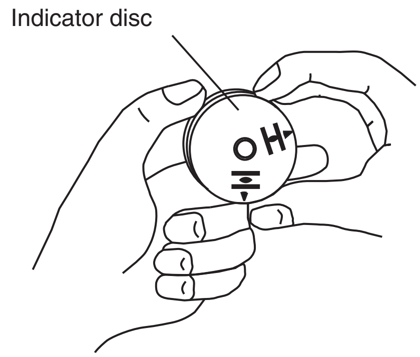


Figure Q-2

Indicator disc rotates by approximately 180° to 230°at full travel from OPEN to CLOSED or vice versa.
A suitable reduction gearing was installed in our factory. If the turns per stroke are changed at a later date, the reduction gearing may have to be exchanged, too.

16. Closing the switch compartment

- Clean sealing faces of housing and cover
- Check whether O-ring is in good condition.
- Apply a thin film of non-acidic grease to the sealing faces.
- Replace cover on switch compartment and fasten bolts evenly crosswise.

After commissioning, check for damage to paint finish of multi-turn actuator. If damage to paint-finish has occurred after mounting, it has to be touched up to avoid corrosion.

17. Enclosure protection IP 68 (option)

Definition

According to EN 60 259, the conditions for meeting the requirements of enclosure protection IP 68 are to be agreed between manufacturer and user.
AUMA actuators and controls in enclosure protection IP 68 meet the following requirements according to AUMA:

- Duration of submersion in water max. 72 hours
- Head of water max. 6 m
- Up to 10 operations during submersion
- Modulating duty is not possible during submersion

Enclosure protection IP 68 refers to the interior of the actuators (motor, gearing, switch compartment, control, and terminal compartment).

For multi-turn actuators, the following has to be observed:
When using output drive types A and AF (stem nut), it cannot be prevented that water enters the hollow shaft along the valve stem during submersion. This leads to corrosion. The water also enters the thrust bearings of output drive type A, causing corrosion and damage of the bearings. The output drive types A and AF should therefore not be used.

Inspection

AUMA actuators and controls in enclosure protection IP 68 undergo a routine testing for tightness in the factory.

Cable glands

- For the entries of the motor and control cables appropriate, cable glands in enclosure protection IP 68 must be used. The size of the cable glands must be suitable for the outside diameter of the cables, refer to recommendations of the cable gland manufacturers.
- As standard, actuators and controls are delivered without cable glands. For delivery, the threads are sealed with plugs in the factory.
- When ordered, cable glands can also be supplied by AUMA at an additional charge. For this, it is necessary to state the outside diameter of the cables.
- The cable glands must be sealed against the housing at the thread with an O-ring.
- It is recommended to additionally apply a liquid sealing material (Loctite or similar).

Commissioning

When commissioning, the following should be observed:

- Sealing faces of housing and covers must be clean
- O-rings of the covers must not be damaged
- A thin film of non-acidic grease should be applied to sealing faces
- Covers should be tightened evenly and firmly

After submersion

- Check actuator.
- In case of ingress of water, dry actuator correctly and check for proper function.

18. Maintenance

After maintenance, check multi-turn actuator for damage to paint finish. If damage to paint-finish has occurred, it has to be touched up to avoid corrosion. Original paint in small quantities can be supplied by AUMA.

AUMA multi-turn actuators require low-level maintenance.
Precondition for reliable service is correct commissioning.

Seals made of elastomers are subject to ageing and must therefore regularly be checked and, if necessary, exchanged.

It is also very important that the O-rings at the covers are placed correctly and cable glands tightened firmly to prevent ingress of dirt or water.

We recommend additionally:

- If rarely operated, perform a test run about every 6 months. This ensures that the actuator is always ready to operate.
- Approximately six months after commissioning and then every year, check bolts between actuator and valve/gearbox for tightness. If required, tighten applying the torques given in table 2, page 8.
- For multi-turn actuators with output drive type A: at intervals of approx. 6 months from commissioning press in Lithium soap EP multi-purpose grease on mineral oil base at the grease nipple with grease gun (quantity see table 3, page 9).

19. Lubrication

- The gear housing is filled with lubricant in the factory.
- A grease change is recommended after the following operation time:

- If rarely operated, after 10 – 12 years
- If operated frequently, after 6 – 8 years

Lubrication of the valve stem must be done separately.

20. Disposal and recycling

AUMA actuators have an extremely long lifetime. However, they have to be replaced at one point in time.
The actuators have a modular design and may therefore easily be disassembled, separated, and sorted according to materials, i.e.:

- electronic scrap
- various metals
- plastics
- greases and oils

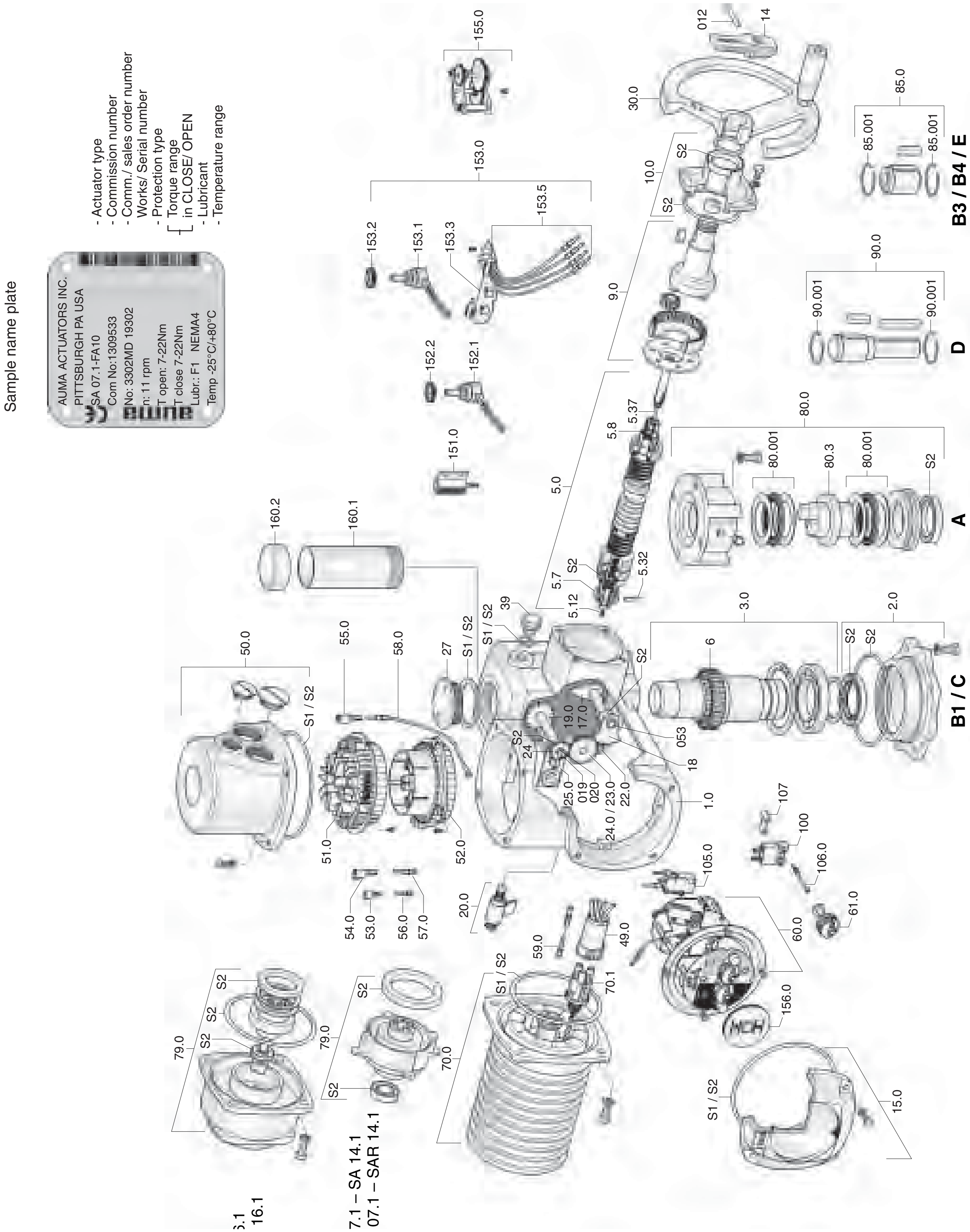
The following generally applies:

- Collect greases and oils during disassembly. As a rule, these substances are hazardous to water and must not be released into the environment.
- Arrange for controlled waste disposal of the disassembled material or for separate recycling according to materials.
- Observe the regional regulations for waste disposal.

21. Service

AUMA offers extensive services such as maintenance and inspection for actuators.
The AUMA service department can be reached at:
phone: 724-743-AUMA (2862)
fax: 724-743-7411
email: mailbox@auma-usa.com
www.auma-usa.com or www.auma.com.

22. Spare parts list Multi-turn actuator SA(R) 07.1 – SA(R) 16.1 with plug/socket connector

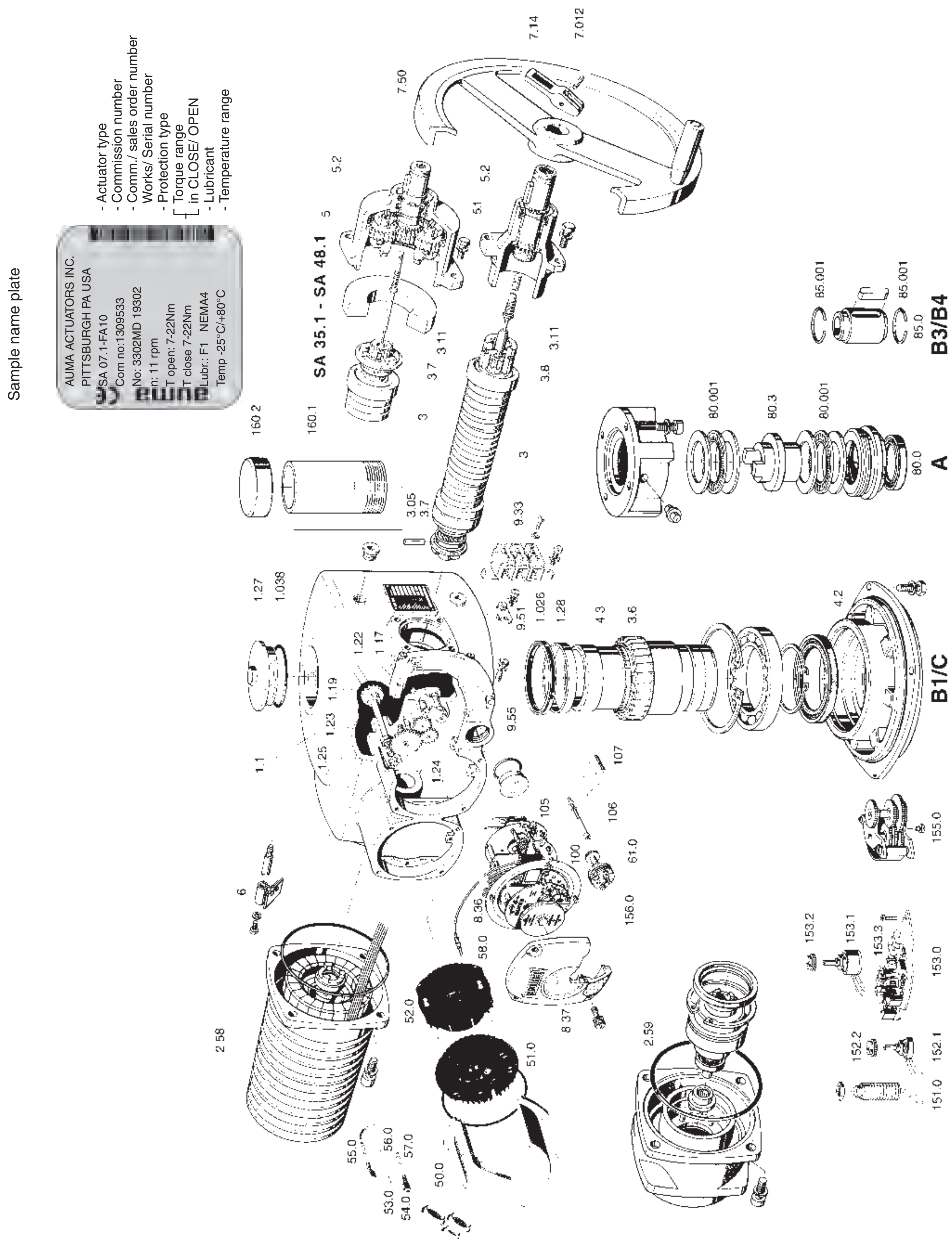


Notes:
When placing orders for spare parts, it is essential to mention type of actuator and our commission number (refer to actuator name plate). Delivered spare parts may slightly vary from the representation in these instructions.

No.	Type	Designation	No.	Type	Designation
012	E	Notched pin	58.0	B	Wire for protective earth
019	E	Cheese head screw	59.0 1)	B	Pin for motor and thermoswitch in motor plug
020	E	Clamping washer			
053	E	Countersunk screw	60.0	B	Control unit assly. (but without torque head, without switches)
1.0	B	Housing assly.			
2.0	B	Flange, bottom assly.	61.0	B	Torque switching head
3.0	B	Hollow shaft assly. (without worm wheel)	70.0	B	Motor
5.0	B	Worm shaft assly.	70.1 1)	B	Motor pin carrier (without pins)
5.12	E	Set screw			
5.32	E	Coupling pin	79.0 2)	B	Planetary gearing for motor drive assly.
5.37	B	Pull rod assly.	80.0 3)	B	Output drive form A assly. (without thread in stem nut)
5.7	E	Motor coupling			
5.8	B	Manual drive coupling assly.	80.001 3	E	Thrust bearing set
6	E	Worm wheel	80.3 3)	E	Stem nut form A (without thread)
9.0	B	Planetary gear assly. for manual drive	85.0 3)	B	Output drive B3
10.0	B	Retaining flange assly.	85.001 3)	E	Snap ring
14	E	Change-over lever	90.0 3)	B	Output drive D
15.0	B	Cover for switch compartment assly.	90.001 3)	E	Snap ring
17.0	B	Torque lever assly.	100	B	Switch for limit/ torque switching (including pins at wires)
18	E	Gear segment			
19.0	B	Crown wheel assly.	105.0	B	Blinker transmitter including pins at wires (without impulse disc and insulation plate)
20.0	B	Swing lever assly.			
22.0	B	Drive pinion II for torque switching assly.	106.0	B	Stud bolt for switches
23.0	B	Drive wheel for limit switching assly.	107	E	Spacer
24	E	Drive wheel for limit switching	151.0	B	Heater
24.0	B	Intermediate wheel for limit switching assly.	152.1 3)	B	Potentiometer (without slip clutch)
25.0	E	Locking plate	152.2 3)	B	Slip clutch for potentiometer
27	E	Screw plug	153.0 3)	B	RWG assly.
30.0	B	Handwheel with ball handle assly.	153.1 3)	B	Potentiometer for RWG (without slip clutch)
39	E	Screw plug			
49.0 1)	B	Motor plug, socket assly.	153.2 3)	B	Slip clutch for RWG
50.0	B	Cover assly.	153.3 3)	B	Electronic board RWG
51.0	B	Socket carrier assly. (with sockets)	153.5 3)	B	Wires for RWG
52.0	B	Pin carrier (without pins)	155.0 3)	B	Reduction gearing
53.0	B	Socket for control	156.0 3)	B	Mechanical position indicator
54.0	B	Socket for motor	160.1 3)	E	Protection tube(without cap)
55.0	B	Socket for protective earth	160.2 3)	E	Cap for stem protection tube
56.0	B	Pin for control	S1	S	Seal kit, small
57.0	B	Pin for motor	S2	S	Seal kit, large

1) SA 16.1 with output speeds of 32 to 216 rpm or SAR 16.1 with output speeds of 32 and 54 rpm without plug/ socket connector; motor directly wired to pin carrier (No. 52.0) .
2) not available for all output speeds
3) not included in basic equipment

23. Spare parts list Multi-turn actuator SA 25.1 – SA 48.1/SAR 25.1 – SAR 30.1



Notes:
When placing orders for spare parts, it is essential to mention type of actuator and our commission number (refer to actuator name plate). Delivered spare parts may slightly vary from the representation in these instructions.

No.	Type	Designation
1.026	E	Quad ring / radial seal
1.038	E	O-ring
1.1	B	Housing assly.
1.17	B	Torque lever assly.
1.19	B	Crown wheel assly.
1.22	B	Drive pinion II for torque switching assly.
1.23	B	Drive wheel for limit switching assly.
1.24	B	Intermediate wheel for limit switching assly.
1.25	E	Locking plate
1.27	E	Screw plug
1.28	E	Bearing bush
2.58	B	Motor
2.59 ●	B	Planetary gear assly. for motor drive
3	B	Drive shaft assly.
3.05	E	Dowel pin
3.11	B	Pull rod assly.
3.6	B	Worm wheel assly.
3.7	E	Motor coupling
3.8	B	Manual drive coupling assly.
4.2	B	Flange, bottom assly.
4.3	B	Hollow shaft assly.
5	B	Planetary gear assly. for manual drive
5.1	E	Mounting flange
5.2	B	Hand wheel shaft assly.
6	B	Swing lever assly
7.012	E	Notched pin
7.14	E	Change-over lever
7.50	B	Handwheel with ball handle assly.
8.36	B	Control unit assly. (but without torque head, without switches)
8.37	B	Switch compartment cover
9.33	B	Terminals for motor connection
9.51	B	Protective earth connection
9.55	B	Cover for motor connection compartment assly.
50.0	B	Plug cover assly.
51.0	B	Socket carrier assly. (with sockets)
52.0	B	Pin carrier (without pins)
53.0	B	Socket for control

No.	Type	Designation
54.0	B	Socket for motor
55.0	B	Socket for protective earth
56.0	B	Pin for control
57.0	B	Pin for motor
58.0	B	Wire for protective earth
61.0	B	Torque switching head
80.0 *	B	Output drive form A assly. (without thread in stem nut)
80.001*	S	Thrust bearing set
80.3 *	E	Stem nut form A (without thread)
85.0 *	B	Output drive form B3 assly.
85.001*	E	Snap ring
100	B	Switch for limit/ torque switching (including pins at wires)
105	B	Blinker transmitter including pins at wires (without impulse disc and insulation plate)
106.0	B	Stud bolts for switches
107	E	Spacer
151.0	B	Heater
152.1 *	B	Potentiometer (without slip clutch)
152.2 *	B	Slip clutch for potentiometer
153.0 *	B	RWG assly.
153.1 *	B	Potentiometer for RWG (without slip clutch)
153.2 *	B	Slip clutch for RWG
153.3 *	B	Printed board for RWG
155.0 *	B	Reduction gearing
156.0 *	B	Mechanical position indicator
160.1 *	E	Protection tube (without cap)
160.2 *	E	Cap
S1	S	Seal kit (small)
S2	S	Seal kit (large)

● not available for all output speeds
* not included in basic equipment

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2005-06-27

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APPENDIX VIII

NTPC Bottom-Outlet Structure Operating Procedure

Section	Operations and Maintenance	Effective Date	
Subject	Bluefish Bottom Outlet Structure Gate Operation	Standard Operating Procedure	

Standard Operating Procedure

For the operation of the Bottom Outlet Structure gate(s) at Bluefish Hydro Facility

Purpose

To ensure that the standard operating procedure is followed to prevent damage of equipment from associated with inappropriate operation.

Procedure

Operation of Gate Hoist

General:

The "**Local-Off-Remote**" Selector Switch is normally set to **"Local"**. In this position the gate(s) can only be operated on site.

1. **Hook up Genset**

Attach ground wire to Genset

Attach Genset cable to Arc tite receptacle

Start Genset

Switch disconnect mounted on front of Genset to **"on"**

Switch disconnect labelled Main disconnect to **"on"**

Switch disconnect labelled XMFR disconnect to **"on"**

Note: photocell light is on the same circuit as XMFR disconnect and will come on in low light conditions

Switch disconnect labelled Large Gate or Small Gate to **"on"** depending on which gate you want to operate

2. **Raising of Gate:**

Turn remote selector switch to local

Push the **"Open"** Push Button.

The gate will move upward until the **"Stop"** button is pushed or until the limit switch stops the upward travel of the gate.

3. **Lowering of Head Gate:**

With the remote selector switch in local:

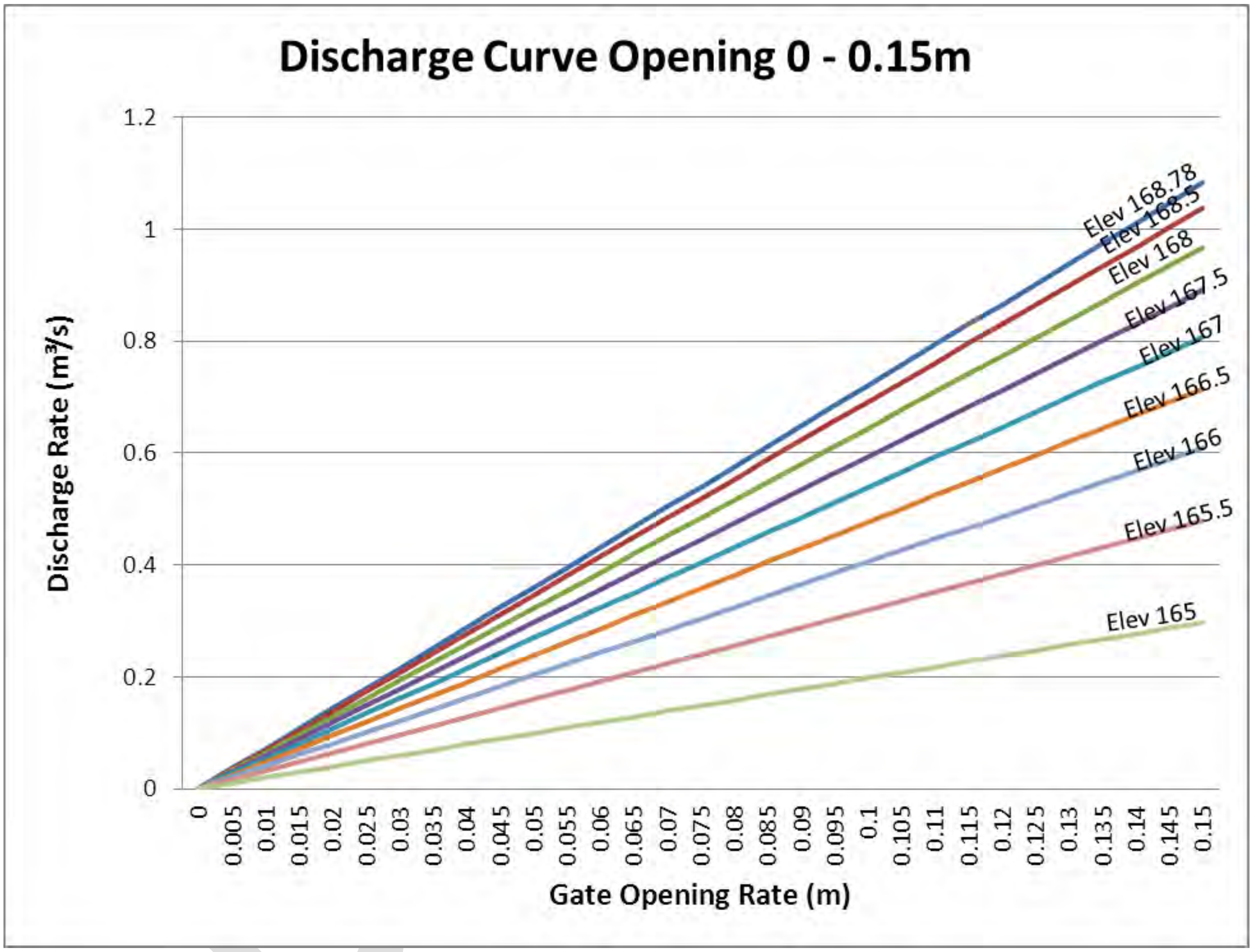
Push the **"Close"** Push Button.

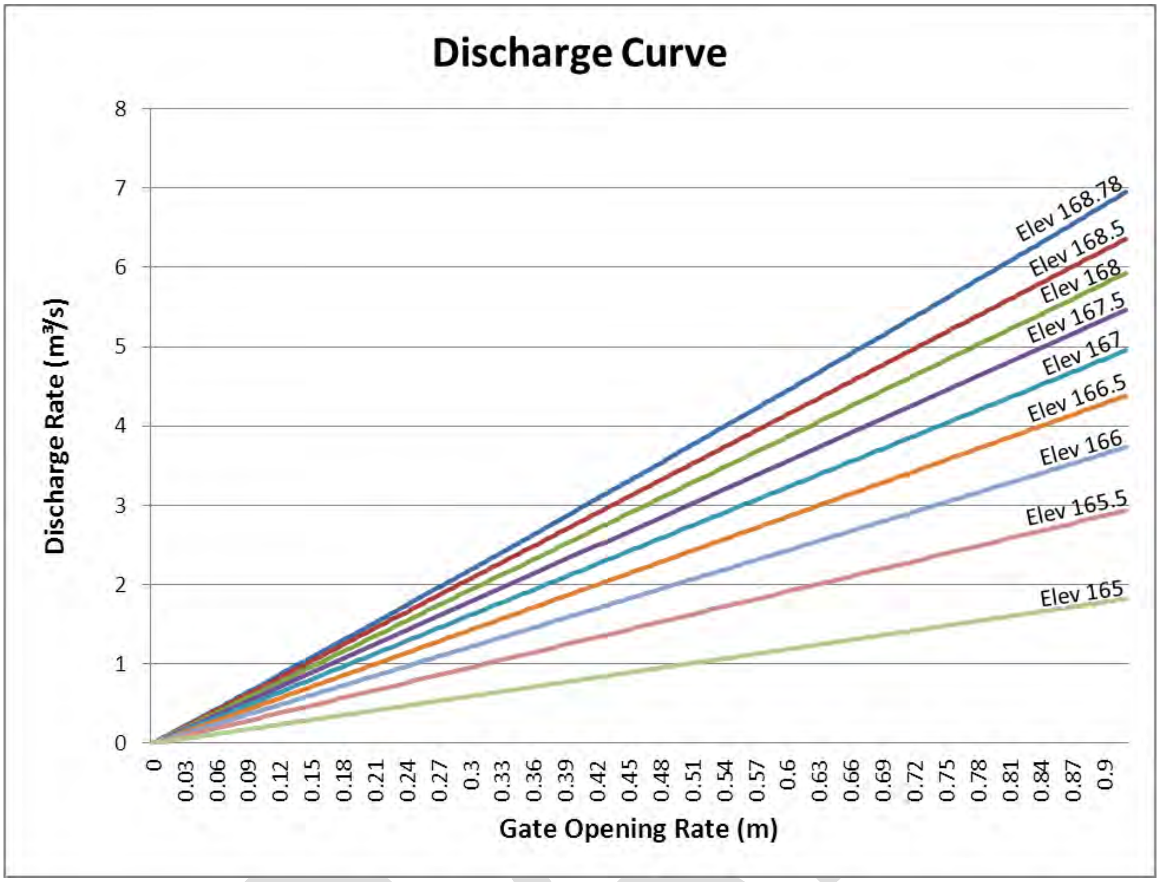
Gate will move downwards until the **"Stop"** button is pushed or until the Limit Switch stops the downward travel of the gate in the normal **"Closed"** position.

Note: a few clockwise turns on the manual hand crank may be required on the large gate to ensure the gate seals properly.

4. Gate settings

Due to regulatory requirements a minimum flow must be passed around the dam of 0.70 m^3/s from May 15 to October 15, and a minimum flow of 0.25 m^3/s for the remainder. The below chart(s) are for reference, and gate settings will be provided by the YK manager of system operations.




Discharge Curve
Discharge Rate (m³/s)
Gate Opening Rate (m)
Elev 168.78
Elev 168.5
Elev 168
Elev 167.5
Elev 167
Elev 166.5
Elev 166
Elev 165.5
Elev 165
0
1
2
3
4
5
6
7
8
0
0.03
0.06
0.09
0.12
0.15
0.18
0.21
0.24
0.27
0.3
0.33
0.36
0.39
0.42
0.45
0.48
0.51
0.54
0.57
0.6
0.63
0.66
0.69
0.72
0.75
0.78
0.81
0.84
0.87
0.9

5. **Shutting down of system**

Switch disconnect labelled Large Gate or Small Gate to **“off”** depending on which gate you were operating

Switch disconnect labelled XMFR disconnect to **“off”**

Switch disconnect labelled Main disconnect to **“off”**

Switch disconnect mounted on front of Genset to **“off”**

Shutdown Genset

Detach Genset cable from Arc tite receptacle

Detach ground wire

6. **Manual operation of Gate(s)**

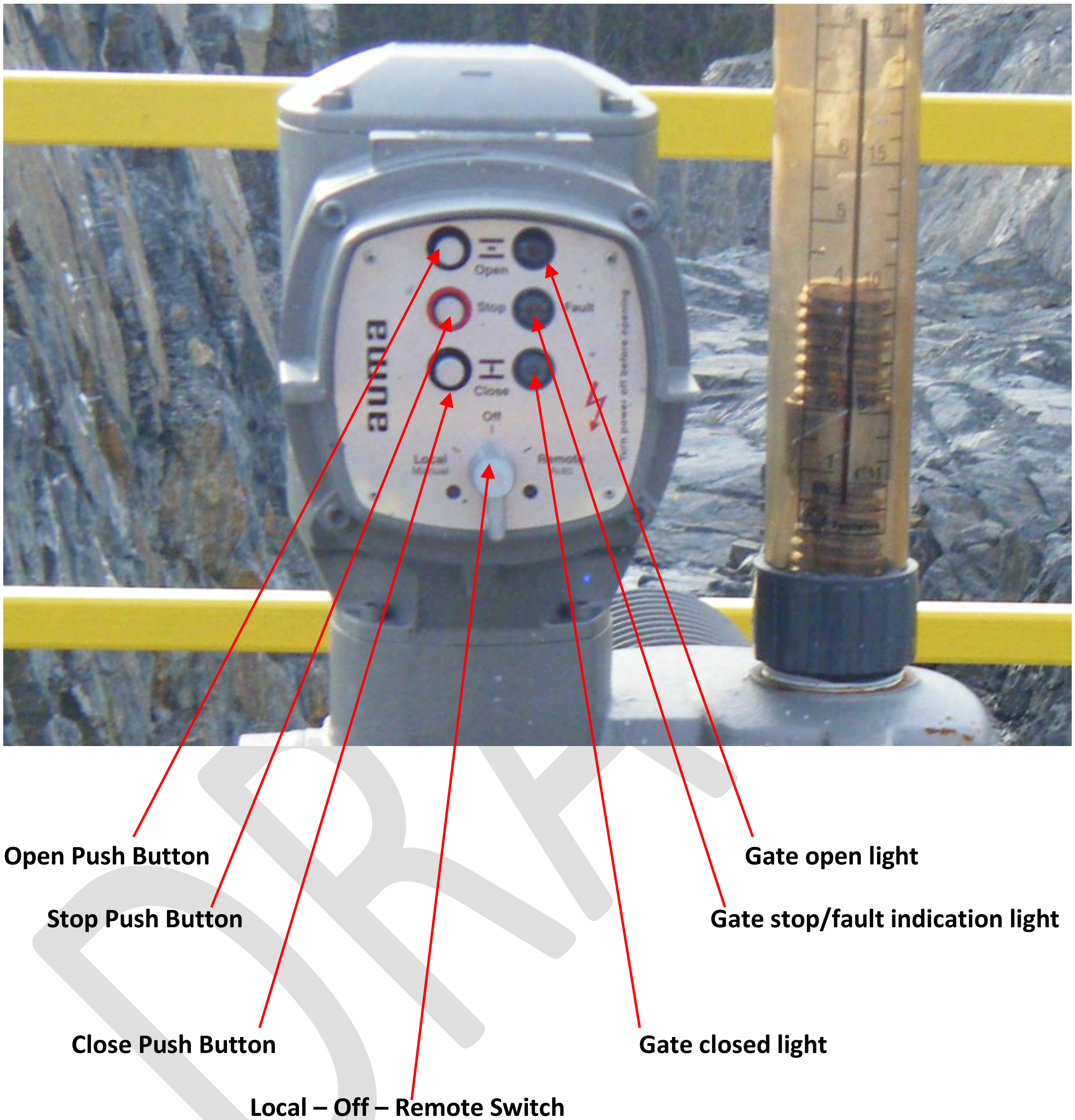
Either gate can be operated manually

Ensure hand wheel is engaged, by locking the clip in the centre of the hand wheel

Turn handle counter clockwise to open and clockwise to close

Note: Operating the large gate manually should be done only as a last resort.

Bluefish Bottom Outlet Gate Control Panel (small gate shown)



NORTHWEST TERRITORIES POWER CORPORATION

Section	Operations and Maintenance	Effective Date	
Subject	Bluefish Bottom Outlet Structure Gate Operation	Standard Operating Procedure	

Authorized by;

Revision and or review date;

Plant Manager

Safety Department

Regional Director

File Location:

APPENDIX IX

Stop Log Hoist Operating Manual

English Français

KITO

O/M NO.ER2-0804-MC-05

ER2 Series Electric Chain Hoist (125kg to 5t)

Owner's Manual

Hook Suspended Type (hoist only) : ER2
Motorized Trolley Type : ER2M
Manual Trolley Type : ER2SP/ER2SG

To Customer

- Thank you for purchasing KITO Electric Hoist (ER2).
- Operators and maintenance engineers are requested to read this manual.
  After reading, please keep this manual at hand for future use.
- This product is designed considering the environment protection. The product contains none of six hazardous substances specified by European RoHS Directives nor asbestos.

Table of Contents

Introduction

This electric hoist ER2 is designed and manufactured for the purpose to lift and lower a load within a normal work environment. The motorized trolley MR2 and the manual trolley are designed and manufactured for the purpose to move the lifted load laterally with the combination with the electric hoist.
Movement of a load in a 3D direction such as up/down, forward/backward and right/left is also enabled by combining with a crane.

This Owner's Manual is intended for those operating the KITO electric hoist ER2 and maintenance engineers
(* pesonnel with expertise).
Other than this manual, Disassembly/Reassembly Manual and Parts List are also available for the maintenance engineers. Assign the maintenance engineers and use these materials for inspection and repair. Please contact the nearest distributor or KITO for these materials.

■Disclaimer

- KITO shall not be liable for any damage incurred thereof due to natural disaster such as fire, earth quake and thunderbolt, conduct by third party, accident, willful conduct or negligence by customer, erroneous use and other use exceeding the operational condition.
- KITO shall not be liable for any incidental damage due to the use or non-use of the product such as the loss of business profit, suspension of business and damage of the lifted load.
- KITO shall not be liable for any damage arising from negligence of the contents in the Owner's Manual and the use of the product exceeding the scope of its specification.
- KITO shall not be liable for any damage arising from the malfunction due to the combination of the product with other devices in which KITO is not concerned.
- KITO shall be indemnified from any loss of life, bodily injury and property damage due to the use of our product for which it has passed 10 years since its delivery.
- KITO shall not be liable to supply the spare parts for the product for which it has passed for 15 years since the discontinue of the product.

■Restriction on Use

- The product described herein is not designed or manufactured for transporting people. Do not use the product for that purpose.
- The product described herein is designed for the materials handling work such as lifting/lowering and traveling the load under ordinary operational condition. Do not use the product for the work other than materials handling work.
- Do not assemble the product into machinery not for materials handling, as a part of it.

■Operators

- Read carefully this Owner’s Manual and the instruction manuals of related products, fully understand their contents, and the use and operate the product.
- Be sure to ware the proper clothing and protective equipment when using and operating the product.

Safety Precautions

Improper use of electric chain hoist causes danger such as drop of lifted load. Read this Owner's Manual carefully before installation, operation and maintenance. Use the product after understanding the product knowledge, safety information and precautions.
This Owner's Manual classifies the safety information and precautions into two categories of "DANGER" "WARNING" and "CAUTION".
Also read the instruction manual of the device associated with electric chain hoist, and follow the described contents.

Description of Signal Words

⚠ DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

Further, the event described in CAUTION may result in serious accident depending on the situation. Both DANGER and CAUTION describe important contents. Please follow the instruction.
After reading, please keep this manual at hand for future use by the user.

Description of Safety Symbols

Prohibited	Means "Prohibited" or "You must not do". Prohibited action is shown in the circle or described near the circle. This Owner's Manual uses ⃠ as the general prohibition.
Mandatory	Means "Mandatory Action" or "You must do". Required action is shown in the circle or described near the circle. This Owner's Manual uses ❗ as the general instruction.

General Matters on Handling and Control

⚠ DANGER

Prohibited

- This product shall not be disassembled and repaird by personnel other than maintenance engineers.
  Other than this manual, Disassembly/Assembly Manual and Parts List are provided for the maintenance engineers. Perform the disassembling and repair by the maintenance engineer in accordance with these materials for maintenance.
- Do not modify the product and its accessories.

Failure to comply with these instructions may result in death or serious injury.

Mandatory

- Understand the contents of the Owner's Manual sufficiently. Then operate the Electric chain hoist.
- Connect properly according to the "Canadian Electrical Code (CEC) Part 1".
- Warning label is affixed to each part of the product. Follow the instruction described in the warning label.

Failure to comply with these instructions may result in death or serious injury.

⚠ CAUTION

Prohibited

- Do not drag or drop the product when carrying.

Otherwise it causes damage or flaw of the electric chain hoist, bodily injury or loss of property due to the drop of the lifted load.

Mandatory

- When discarding the product, disassemble it not to be used and discard in accordance with the ordinances of local government or the rules specified by the business entity.
  Ask the local government or the relevant section for the details.
  Refer to “Disassembly/Assembly Manual” for disassembling, or contact KITO.
  (This product uses oil. We prepare MSDS (Materials Safety Data Sheet) for the oil. Contact KITO for it.)
- Carry out daily inspection by user.
- Carry out inspection (monthly, annual) by maintenance engineer.
- Keep the record of the inspection.

Failure to comply with these instructions causes bodily injury or loss of property.

General Matters on Handling of Dual Speed VFD Model

The dual speed VFD model electric chain hoist is controlled by VFD for important items related to safety such as operation, braking and emergency stop. Be sure to follow the safety precautions below as well as the above safety precautions.

⚠ DANGER

Prohibited

- Do not change parameters.
  When parameters need to be changed, ask distributor or KITO.
- Do not carry out the work such as maintenance and inspection within 5 minutes after power off.
  Wait for the completion of discharging of the capacitor inside the VFD.
- Do not touch the controller cover as it becomes hot during operation.
  Do not touch the controller cover until about 30 minutes elapsed after the stop of operation.
- USE KITO genuine VFD.
  The VFD requires the special specification for KITO. Be sure to use genuine VFD.
- Do not change the connection of the VFD.
  When the wires were removed for any reason, connect them again correctly checking the wiring diagram inside the controller cover.
- Do not carry out withstand voltage test and insulation resistance measurement of a circuit by megger while the VFD is connected.
- Do not turn off the power while operating.

Failure to comply with these instructions may result in death or serious injury and the damage of VFD.

Chapter 1

Handling the Product

This chapter describes mainly how to use, assemble and install, and the check after installation. It also describes the daily inspection items before use.

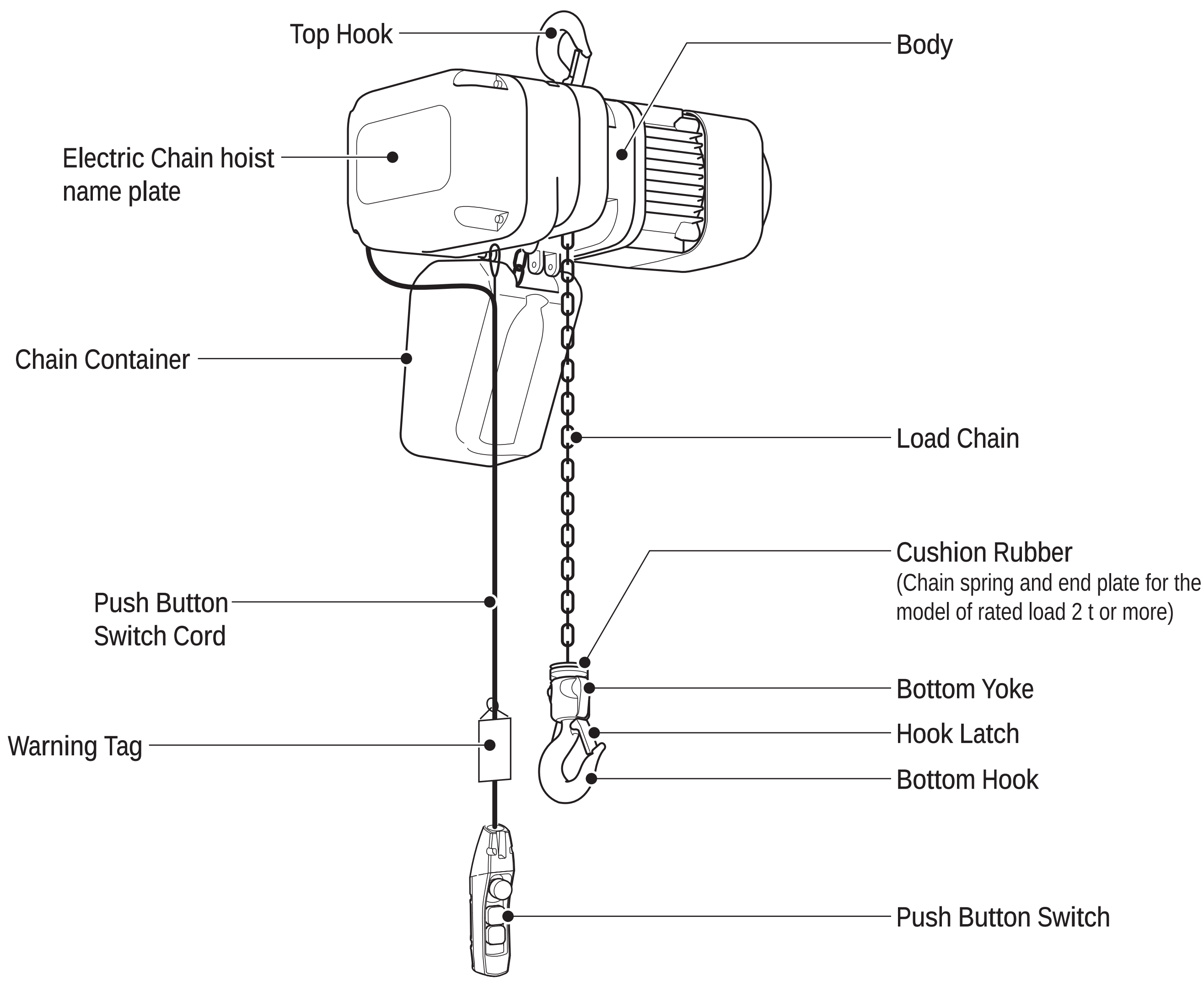
● For Operators and Maintenance Engineers

● For Maintenance Engineers and Installars

Type and Names of Each Part

Hook Suspended Type (ER2)

- **Electric chain hoist dedicated for elevation**



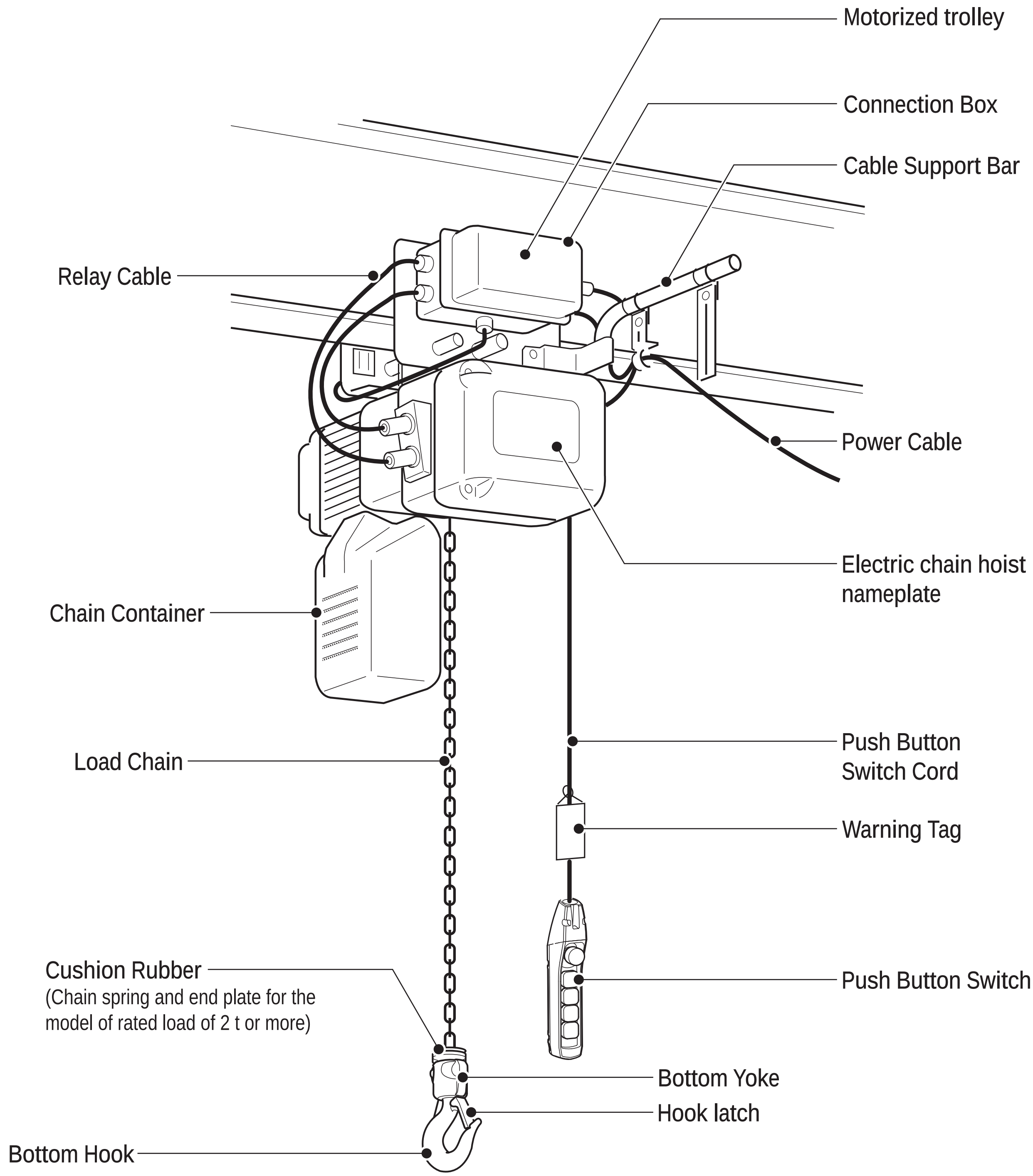
⚠ DANGER

Mandatory

- Warning labels are affixed to each part other than above. Be sure to follow the instructions in the label.
  Failure to comply with the contents of the label may result in death or serious injury.

Motorized Trolley Type (ER2M)

● **Electric Chain Hoist combined with motorized trolley (MR2) for elevation and traveling motion**



⚠ DANGER

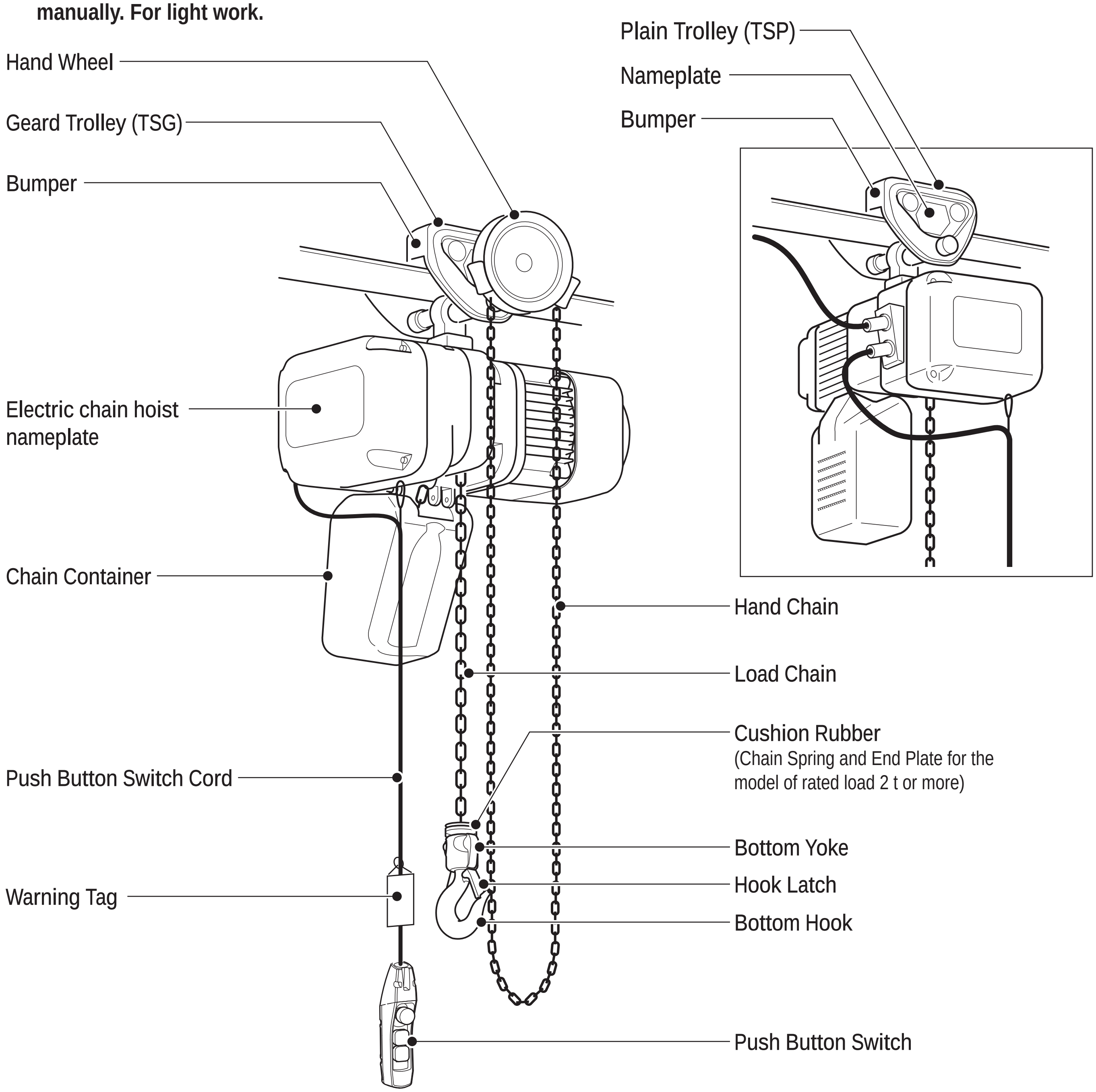
Mandatory

- Warning labels are affixed to each part other than above. Be sure to follow the instructions in the label.
  Failure to comply with the contents of the label can result in serious bodily injury or death.

(to be continued)

■Manual Trolley Type (ER2SG/ER2SP)

- **ER2SG : The electric chain hoist equipped with the geared trolley (TSG) enabling fine adjustable lateral motion of the load by pulling the hand chain.**
- **ER2SP : The electric chain hoist equipped with the plain trolley (TSP) enabling lateral motion by moving the load manually. For light work.**



⚠ DANGER

Mandatory

- Warning labels are affixed to each part other than above. Be sure to follow the instructions in the label.
  Failure to comply with the contents of the label can result in serious bodily injury or death.

Opening the Package

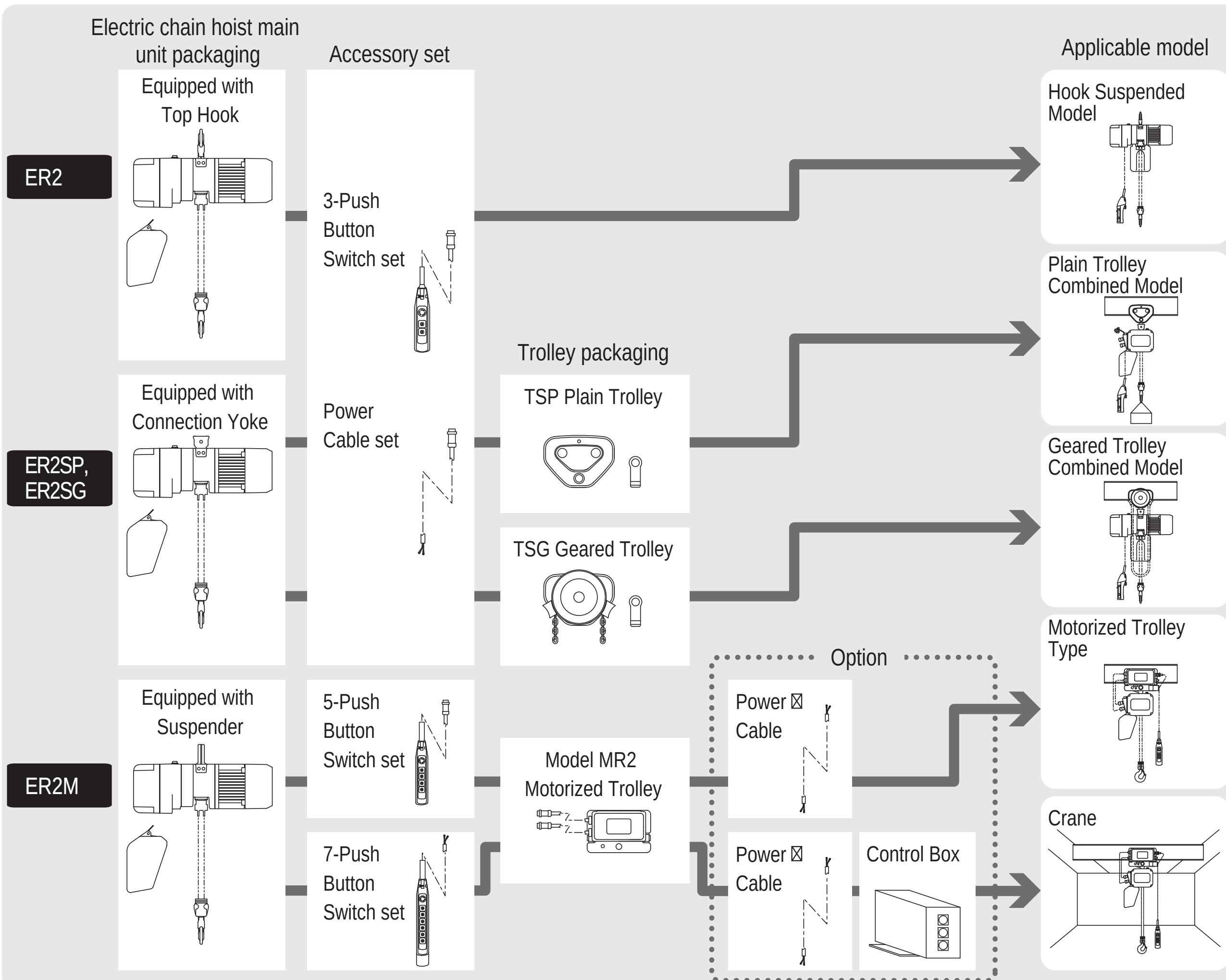
Checking the Product

- **Make sure that the indication on the package and the product coincide with your order.**
- **Make sure that the product is not deformed and damaged due to the accident during transportation.**

Packaging

Packaging

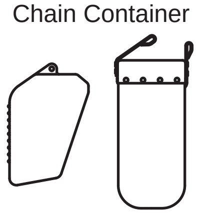
For the customer's convenience, the main parts of our product are packaged individually and delivered.



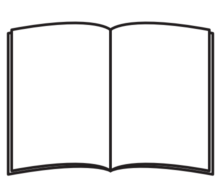
* Power Cable longer than 10 m is available as an optional part.

Parts packaged with the Electric Chain Hoist

Plastic or canvas Chain Container (Option)



Owner's Manual

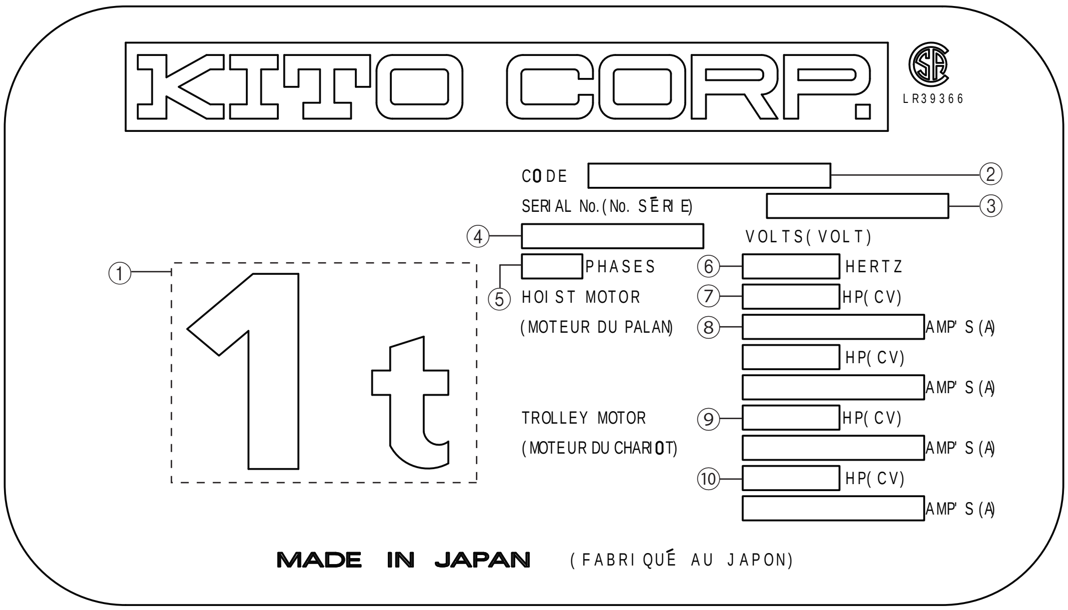


Load Chain Grease Tube

(to be continued)

Nameplate and Product Model

Nameplate Indication of Electric Chain Hoist



① ⬚ · · · Capacity Ex. 1t, 500kg
The maximum mass of the load that can be imposed on the product. The mass of the hook is excluded.

② CODE…Product model Ex. ER2-005S
A code to indicate the model No. of the product, capacity and lifting speed.

③ SERIAL No.
Serial number to indicate the manufacturing sequence of the product.

④ Rated Voltage
⑤ Number of Phase
⑥ Frequency
⑦ Hoist motor output
⑧ Rated hoist motor current
⑨ Trolley motor output
⑩ Rated trolley motor current

Code of ER2

Capacity	Body Size	CODE			
		Single speed model		Dual speed model	
		Standard speed	Low speed	Standard speed	Low speed
125kg	ER2-B	—	(ER2-001H)*	—	(ER2-001IH/HD)*
250kg		ER2-003S	(ER2-003H)*	ER2-003IS/SD	(ER2-003IH/HD)*
500kg	ER2-C	ER2-005S	ER2-005L	ER2-005IS/SD	ER2-005IL/LD
1t	ER2-D	ER2-010S	ER2-010L	ER2-010IS/SD	ER2-010IL/LD
1.5t	ER2-E	ER2-015S	—	ER2-015IS/SD	—
2t	ER2-D	—	ER2-020C	—	ER2-020IC/CD
	ER2-E	ER2-020S	ER2-020L	ER2-020IS/SD	ER2-020IL/LD
2.5t	ER2-F	ER2-025S	—	ER2-025IS/SD	—
3t	ER2-E	ER2-030S	—	ER2-030IS/SD	—
5t	ER2-F	ER2-050S	—	ER2-050IS/SD	—

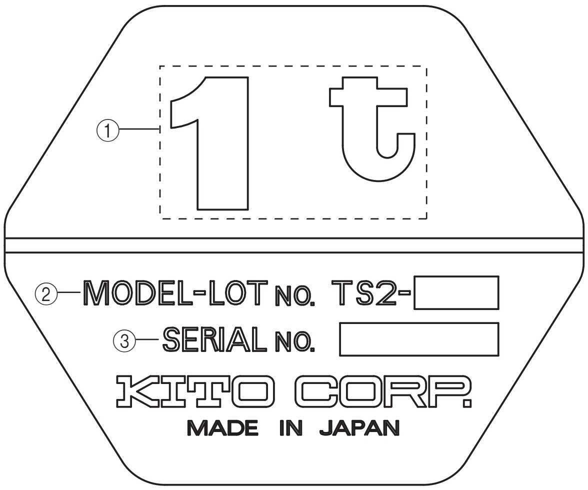
* Hight Speed Type

Code of MR2

Capacity	CODE		
	Single speed model		Dual speed model
	Standard speed	Low speed	Standard speed
125kg	MR2-010S	MR2-010L	MR2-010IS/SD
250kg			
500kg			
1t			
1.5t	MR2-020S	MR2-020L	MR2-020IS/SD
2t			
2.5t	MR2-030S	MR2-030L	MR2-030IS/SD
3t			
5t	MR2-050S	MR2-050L	MR2-050IS/SD

(to be continued)

■ Nameplate Indication of Manual Trolley



① ⬚ · · · Capacity Ex. 1t, 500kg
The maximum mass of the load that can be imposed on the product. The mass of the hook is excluded.

② LOT No.
Manufacture No. to identify the time of manufacture and the production lot.

③ SERIAL No.
Serial number to indicate the manufacturing sequence of the product.

Checking the Marks

⚠ DANGER

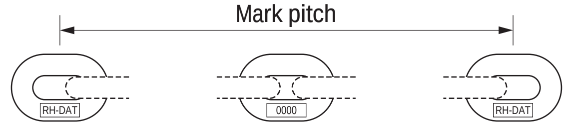
Mandatory

- Be sure to check that the Load Chain has 'RH-DAT' or 'FT-DAT' mark on it and the chain size is appropriate for the ER2 model you are using (See the following table.). The Load Chain of other models (such as model ES or ER) or different rating cannot be used.

Use of the Load Chain of other model or other rating may result in death or serious injury due to the drop of the lifted load.

Code	Load Chain size : diameter (mm)	Mark	Mark pitch
ER2-001H/IH/HD	4.3	FT-DAT	24 Links
ER2-003H/IH/HD			
ER2-003S/IS/SD			
ER2-005L/IL/LD	6.0	RH-DAT	20 Links
ER2-005S/IS/SD			
ER2-010L/IL/LD	7.7		20 Links
ER2-010S/IS/SD			
ER2-015S/IS/SD	10.2		16 Links
ER2-020C/IC/CD	7.7		20 Links
ER2-020L/IL/LD	10.2		16 Links
ER2-020S/IS/SD			
ER2-025S/IS/SD	11.2		12 Links
ER2-030S/IS/SD	10.2		16 Links
ER2-050S/IS/SD	11.2		12 Links

The mark (RH-DAT) to indicate the model of the Load Chain is indicated on it at an equal spacing. Make sure that the Load Chain is of a chain size (wire diameter) appropriate for ER2 referring to the table in the left.



Second mark — Front side : RH-DAT or FT-DAT; Back side : H23

First mark — Front side : Original Lot No. of the Load Chain (4 digits); Back side : KITO

Second mark

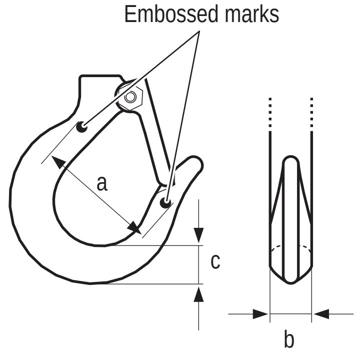
Recording the Product No.

- Fill in the table in the right with product's Lot No., Serial No. (described in the product nameplate), date of purchase and the name of the sales shop where you purchased the product.
  * When requesting repair or ordering a chain hoist part, please inform us of these pieces of information together.

Item	Electric chain hoist	Motorized trolley	Manual trolley
Lot No.	ER2A−	MR2A−	TS2−
Serial No.			
Date of purchase			
Name of the sales shop			

Recording the Initial Value

- When opening the package, fill in the table in the right with the opening dimension "a" between embossed marks on the Bottom Hook, the width of the hook "b" and the thickness of the hook "c". (These values are used for checking. Record the value for the top hook of ER2 when it is used individually.)



Dimensions when the package was opened

Top Hook (For ER2 only)	Dimension a	mm
	Dimension b	mm
	Dimension c	mm
Bottom Hook	Dimension a	mm
	Dimension b	mm
	Dimension c	mm

Product Specification and Operational Environment

The operational environment of the electric chain hoist and motorized trolley is as follows:

■Standard Specification

Short time ratings :ER2 series(Capacity 100 %) : Single speed model — 60 min.
Dual speed VFD model (high speed/low speed) — 30/10 min.
:MR2 series(Capacity 100 %) : Single speed model — 30 min.
Dual speed VFD model (high speed/low speed) — 30/10 min.
Intermittent ratings :ER2 series(63 % of the capacity) : Single speed model — 60 % ED (at 360 rev/h)
Dual speed VFD model (high speed/low speed) — 40/20 % ED (120/240 rev/h)
:MR2 series(63 % of the capacity) : Single speed model — 40 % ED (at 240 rev/h)
Dual speed VFD model (high speed/low speed) — 27/13 % ED (78/162 rev/h)
Grade *1 :ISO-M6, M5 or M4, FEM-3m, 2m or 1Am, ASME-H4
Protection :Hoist IP55, Push button IP65
Operation Push button switch operation / 3-Push Button Switch set for hoist only and Manual trolley type / 5- or 7-Push Button Switch set for motorized trolley combined model
Power supply method....Power supply through cabtyre cable
Color..............................Munsell 7.5YR7/14
Noise level :ER2, single speed 75dB or less (A scale: measured at 1 m away from the Electric chain hoist)
:ER2, dual speed VFD model 80dB or less (A scale: measured at 1 m away from the Electric chain hoist)
:MR2 85dB or less (A scale: measured at 1 m away from the Electric chain hoist)
Braking capacity :150% of the capacity or more
Other..............................Power Cable length 5 m/10 m (Standard)

Product category	Motor Insulation Class	Voltage range		Operating Voltage
		50Hz	60Hz	
220/440V Class (230/460V Class)	B		208-230V	110V (110V~121V)
			415-460V	
500V Class	B	500V	575V	

NOTE

- Operate the electric chain hoist with the rated voltage.
- Do not use the electric chain hoist exceeding the short time ratings and the intermittent ratings.

* Grade

Capacity (kg or t)	Code		GRADE			Code	GRADE		
	Single speed	Dual speed	ISO	ASME	FEM	Dual speed	ISO	ASME	FEM
125	ER2-001H	ER2-001IH/HD	M5	H4	2m	ER2-001IH	M6	H4	3m
250	ER2-003H	ER2-003IH/HD				ER2-003IH			
	ER2-003S	ER2-003IS/SD				ER2-003IS			
500	ER2-005L	ER2-005IL/LD				ER2-005IL			
	ER2-005S	ER2-005IS/SD				ER2-005IS			
1	ER2-010L	ER2-010IL/LD							
	ER2-010S	ER2-010IS/SD							
1.5	ER2-015S	ER2-015IS/SD							
2	ER2-020C	ER2-020IC/CD							
	ER2-020L	ER2-020IL/LD	M4	H4	1Am				
	ER2-020S	ER2-020IS/SD							
2.5	ER2-025S	ER2-025IS/SD							
3	ER2-030S	ER2-030IS/SD							
5	ER2-050S	ER2-050IS/SD							

* For 125kg - 500kg dual speed VFD type equipped with friction clutch with mechanical brake, the grade is ISO M5 and FEM 2m.

- **ISO**

ISO 4301 specifies the total operating hour (service life) of gears and bearings according to the loading status. For example, the total operating hour (service life) of the mechanism when it is constantly applied with the capacity is 1,600 hours for M5. The total operating hour is 6,300 hours when operated with a medium load.

Loading status*	Total operating hour h					
	800	1600	3200	6300	12500	25000
Light				M4	M5	M6
Medium			M4	M5	M6	
Heavy		M4	M5	M6		
Ultra heavy	M4	M5	M6			

* **Rate of loading**
Light : A case where the capacity is rarely applied. Usually the hoist is used with a light load.
Medium : A case where the capacity is applied considerably frequently. Usually the hoist is used with a medium load.
Heavy : A case where the capacity is applied considerably frequently. Usually the hoist is used with a heavy load.
Ultra heavy : A case where the capacity is applied constantly.

- **ASME HST**

Hoist duty class	Typical areas of application	Operation time ratings at K=0.65			
		Unlformly distributed work periods		Infrequent work periods	
		Max. on time, min / hr	Max. No. starts / hr	Max. on time from cold start, min	Max. No. of starts
H2	Light machine shop fabricating, service,and maintenance; loads and utilization randomly distributed; capacitys infrequently handled.	7.6 (12.5%)	75	15	100
H3	General machine shop fabricating, assembly, storage, and warehousing; loads and utilization randomly distributed.	15 (25%)	150	30	200
H4	High volume handing in steel warehouses, machine shops, fabricationg plants and mills, and foundries; manual or automatic cycling operations in heat treating and plating; loads at or near capacity frequently handled.	30 (50%)	300	30	300

* The grade symbols are identical to those of ASME HST-1M. (Performance standard for Electric Chain Hoist)

- **FEM**

Relation between ISO-and FEM-Denominations

1 Dm	1 Cm	1 Bm	1 Am	2 m	3 m	4 m	5 m
M 1	M 2	M 3	M 4	M 5	M 6	M 7	M 8

Load spectrum	Cubic mean value	Class of operation time								
		V0.06	V0.02	V0.25	V0.5	V1	V2	V3	V4	V5
		T0	T1	T2	T3	T4	T5	T6	T7	T8
		Average operation time per day in hours								
		≤0.12	≤0.25	≤0.5	≤1	≤2	≤4	≤8	≤16	>16
1 L1	K≤0.50	–	–	1 Dm	1 Cm	1 Bm	1 Am	2 m	3 m	4 m
2 L2	0.50<K≤0.63	–	1 Dm	1 Cm	1 Bm	1 Am	2 m	3 m	4 m	5 m
3 L3	0.63<K≤0.80	1 Dm	1 Cm	1 Bm	1 Am	2 m	3 m	4 m	5 m	–
4 L4	0.80<K≤1.00	1 Cm	1 Bm	1 Am	2 m	3 m	4 m	5 m	–	–

Class of operating time		Average operating time per day (in hours)	Calculated total operating time (in hours)
V0.06	T0	≤0.12	200
V0.12	T1	≤0.25	400
V0.25	T2	≤0.5	800
V0.5	T3	≤1	1,600
V1	T4	≤2	3,200
V2	T5	≤4	6,300
V3	T6	≤8	12,500
V4	T7	≤16	25,000
V5	T8	>16	50,000

* The grade symbols are identical to those of FEM 9.511.
(Rules for Design of Serial Lifting Equipment: Classification of Mechanisms)

(to be continued)

Operational Environment

Ambient temperature	:	-20°C — +40°C
Gradient of rail	:	No gradient in travel rail (for the hoist with trolley)
Ambient humidity	:	85 % or less (no condensation)
Explosion-proof construction	:	Not applicable to the work environment with explosive gases or explosive vapor
Non-conforming environment	:	A place with organic solvent or volatile powder, and a place with a plenty of powder and dust of general substances
	:	A place with considerable amount of acids and salts

NOTE

When installing the electric chain hoist outdoors or to the place where the hoist is exposed to direct rain, wind and snow, shade the hoist with roof to protect it from rain, wind and snow.

How to Use

ER2 Series Electric Chain Hoist has two models: single speed model and dual speed VFD model. Other than them, such products are provided that can travel/traverse when combined with a trolley or a crane. Their push button switches for operation differ in the size and the operating method. Check the product model of the hoist and use it properly.

⚠ DANGER

Prohibited

- Do not use the Hook without a Hook Latch or damaged Hook.
- Do not use the Load Chain with heavy elongation, abrasion or deformation.
- Do not cut, extend, or weld the Load Chain.
- Do not use the Load Chain with the Bottom Hook without smooth motion.
- Do not use the Load Chain when its brake does not function securely even without load, or when the stopping distance is too long.
- Do not use the product if it moves oppositely to the direction indicated on the push button switch.

Failure to comply with these instructions may result in death or serious injury.

Mandatory

- Carry out daily inspection before operation.
  (When any abnormality was found during inspection, turn off the power, indicate “FAILURE" and ask the maintenance engineer for repair.)
- Check the slinging devices for no abnormality.
  Failure to comply with these instructions may result in death or serious injury.

⚠ CAUTION

Prohibited

- Do not use the product with an illegible nameplate or warning label affixed to the body size.

Failure to this instruction may result in the injury or the property damage.

Mandatory

- When using the product for the first time, affix the labels indicating East, West, North and South on the push button switches.
- Check the contents of the work and make sure that the electric chain hoist has proper performance for the load and lift.
- Check the contents of the work and operate the electric chain hoist at a place enabling to look out the operating area without hindrance.
- When looking out the operating area is difficult, arrange the monitor near the place for safety.
- Operate the electric chain hoist at a place with firm foothold without danger of falling, stumbling, slipping or over turning.
- Before moving the load, warn all the surrounding people.
- Even if the crane or the electric chain hoist is permanently installed and used for the same purpose repeatedly, check the contents of the work and make sure that the work does not exceed the capacity on each occasion.
- Appoint the maintenance engineer or competent personnel among the qualified personnel for operation of cranes and electric chain hoists. Indicate the name of the personnel on a place with legibility.
- The maintenance engineers shall check the result of daily inspection.
- When informed of abnormality of the electric chain hoist, the maintenance engineers shall take immediately any necessary measures such as prohibition of use and repair.
- When carrying out inspection and repair, secure the environment for safe work without electric shock and falling.

Failure to comply with these instructions may result in bodily injury or property damage.

(to be continued)

Daily Inspection of Electric Chain Hoist (Hook Suspended Type)

⚠ DANGER

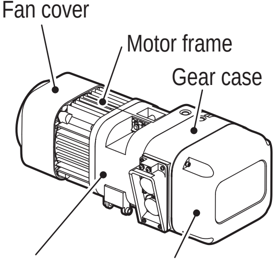
Mandatory

- Carry out daily inspection before use.
  (When any abnormality was found during inspection, turn off the power, indicate “FAILURE" and ask the maintenance engineer for repair.)

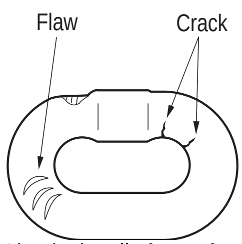
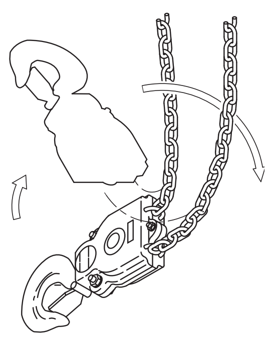
Neglecting to carry out daily inspection may result in death or serious injury.

- Refer to the technical material attached in Appendix (P122) for the structure of the product and the name of each part.

Appearance

Item	Check method	Criteria	When failed
Indication of nameplates and labels	• Check visually.	• No peel off. Indication can be seen clearly.	Carry out cleaning, repair or replace with new nameplate or label. When replacing with a new nameplate or label is required, please inform KITO of the description in “Record of the Product No." (P17) such as Lot No. and Serial No.
Deformation and damage of body size and each part	• Check visually.  	• No apparent deformation, damage, flaw and crack	Replace the parts with deformation, damage, flaw or crack.
Loosened or fallen off bolts, nuts and split pins	• Check visually or using tools.	• Bolts, nuts and split pins are fastened securely. **⚠ DANGER** Mandatory • Even fallen off of a bolt causes for the body size to drop. Be sure to check. Fallen off of a bolt may result in death or serious injury.	Fasten bolts, nuts and split pins securely.

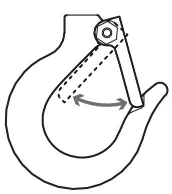
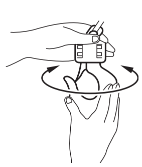
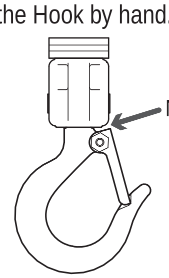
Load Chain

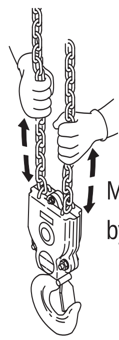
Item	Check method	Criteria	When failed
Elongation of Pitch	• Check visually	• No apparent elongation	Refer to Load Chain (P69) of Chapter 2, Frequent inspection.
Abrasion of Wire Diameter	• Check visually	• No apparent abrasion	Refer to Load Chain (P69) of Chapter 2, Frequent inspection.
Deformation, Flaw, Entanglement	• Check visually  • Check visually for no foreign matter such as attached sputter.	• No deep notch • No deformation such as twist • No attached sputter • No entanglement • No crack	Replace the Load Chain.
Rust, Corrosion	• Check visually	• No apparent rust and corrosion	Replace the Load Chain.
Twist	• Check visually	• No capsized link at Bottom Hook of double type Load Chain 	Untwist the Load Chain.
Lubrication	• Check visually	• To be oiled adequately	Apply oil.
Mark	• Check visually	• Check the mark pitch and the indication. (Refer to “Checking the Marks" (P17).)	Replace the Load Chain.

(to be continued)

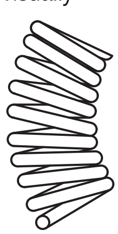
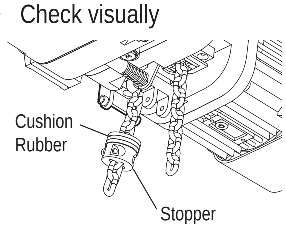
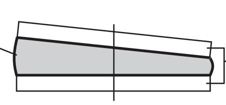
How to use (continued)

■ Top Hook/Bottom Hook

Item	Check method	Criteria	When failed
Opening of the Hook	• Check visually	• No apparent opening of the Hook	Carry out the inspection item of Top and Bottom Hook (P70) of Frequent inspection.
Abrasion	• Check visually	• No apparent abrasion	Carry out the inspection item of Top and Bottom Hook (P70) of Frequent inspection.
Deformation, Flaw, Corrosion	• Check visually	• No apparent deformation, flaw and corrosion	Carry out the inspection item of Top and Bottom Hook (P70) of Frequent inspection.
Hook Latch 	• Check visually and check the movement of the Hook Latch.	• The Hook Latch is mounted securely inside the Hook opening. • No deformation. The Hook Latch moves smoothly. **⚠ DANGER** Prohibited • **Do not use the Hook without the Hook Latch.** Use of the Hook without the Hook Latch may result in death or serious injury.	Replace the Hook Latch.
Hook movement (Rotation) 	• Check visually and rotate the Hook by hand. 	• No apparent gap between the Bottom Yoke and the shank (at the neck). • The Bottom Yoke rotates in both directions equally. • The Bottom Yoke rotates smoothly.	Replace the Hook.

Item	Check method	Criteria	When failed
Movement of the Idle Sheave	• Check the Idle Sheave by moving	**⚠ CAUTION** Mandatory • When checking, wear gloves and be careful for your finger not to be caught. Otherwise it may result in injury. • The Idle Sheave rotates smoothly. * The Idle Sheave does not rotate smoothly when bearing is damaged or sheave shaft is deformed. • The Load Chain moves smoothly.  	Replace the bearing of the Idle Sheave.
Bottom Yoke	• Check visually.	• No loosened bolt or nut	Attach the Bottom Hook to the Load Chain securely.

■ Peripheral parts of the body size

Item	Check method	Criteria	When failed
Chain Spring	• Check visually 	• No apparent shrinkage or compression	Carry out the inspection item of Chain Spring (P77) of Periodic inspection.
Cushion Rubber	• Check visually  	• No apparent shrinkage or compression • No peel off, crack of deformation of rubber  	Replace the Cushion Rubber.

(to be continued)

■ Push Button Switch

Item	Check method	Criteria	When failed
Switch body size	• Check visually	• No deformation, damage and no loosened screw • Label indication of the push button switch can be seen clearly.	Clean and repair the label or replace with a new label. Affix the label securely.

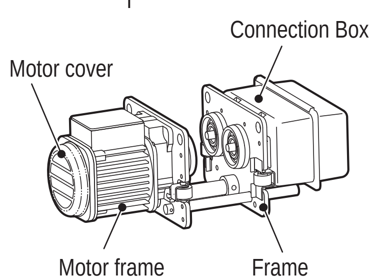
■ Function and Performance

- Check the following item with no load.

Item	Check method	Criteria	When failed
Operational Check	• Press the push button and check each operation.	• The Load Chain can be wound smoothly. • The Electric chain hoist moves in the same direction as that of the push button operation. • When the operation is stopped, the motor stops immediately. • When the Emergency Stop Button is pressed, all hoist motions stop. • When operating other push button while the Emergency Stop Button is pressed, the hoist does not start operation. • When canceling the Emergency Stop Button, the hoist operates normally.	Refer to Chapter 2 “Failure Cause, Guidance for Countermeasure" (P94 to 97).
Brake	• Press the push button and check the operation of the Brake.	• When stopping the operation, the Brake is applied immediately and the Bottom Hook shall stop immediately. (Guideline: The travel of the Load Chain is within 2 to 3 links.)	Carry out the inspection in accordance with the items in Chapter 2 “Periodic inspection" Electromagnetic Brake (P79).
Friction Clutch with Mechanical Brake	• Press the push button and check the operation of the Friction Clutch.	• When lifting, the sound of pawl clicks regularly. (For the friction clutch of standard specification makes no pawl sound.)	Disassemble the Friction Clutch and to check.
Limit Switch	• Press the push button and check the operation of the Limit Switch.	• When the hoist is operated to the upper or lower limit, the motor automatically stops.	Replace the Limit Switch. Disassemble the actuator of the Limit Switch to clean.
Check for no Abnormal Sound	• Press the push button and check the operation. **NOTE** Sound is also an important check point. Always be careful for the noise of the electric chain hoist.	• No abnormal sounds and vibrations	Replace the abnormal part. Apply oil on the Load Chain.
		• No popping sound from the Load Chain.	Check the Load Chain. (Refer to P21.)

Daily Inspection of Motorized Trolley (MR2)

Appearance

Item	Check method	Criteria	When failed
Indication of Nameplates and Labels	• Check visually	• No peel off. Indication can be seen clearly.	Clean and repair the label or replace with a new label.
Deformation and damage of each part  	• Check visually	• No apparent deformation, damage and corrosion	Replace the deformed or damaged part.
Loosened or fallen off bolts, nuts and split pins	• Check visually or using tools.	• Bolts, nuts and split pins are fastened securely. **⚠ DANGER** Mandatory • Even a drop off of a split pin may cause of drop of the body size. Be sure to check it. Drop off of split pin may result in death or serious injury.	Fasten bolts, nuts and split pins securely.

(to be continued)

■ Function and Performance

● Check the following item with no load.

Item	Check method	Criteria	When failed
Operational Check	• Press the push button to check the operation.	• To travel smoothly. No meandering and vibration. • The electric chain hoist moves in the same direction as that of the push button operation. • When the operation is stopped, the motor stops immediately. • When the Emergency Stop Button is pressed, all hoist motions stop. • When operating other push button while the Emergency Stop Button is pressed, the hoist does not start operation. • When canceling the Emergency Stop Button, the hoist operates normally.	Refer to Chapter 2 “Failure Cause, Guidance for Countermeasure" (P94 to 97).
Brake	• Press the push button to check the operation of the Brake.	• When the operation is stopped, the Brake is applied and the motor stops immediately.	Carry out the inspection in accordance with the items in Chapter 2 “Periodic inspection" Electromagnetic Brake (P79).

■ Daily Inspection of Manual Trolley (TSG/TSP)

■ Appearance

Item	Check method	Criteria	When failed
Indication of Nameplates and Labels	• Check visually	• No peel off. Indication can be seen clearly.	Clean and repair the label or replace with a new label.
Deformation and damage of each part	• Check visually	• No apparent deformation and corrosion • No apparent deformation on the Frame	Replace the deformed or damaged part.
Loosened or fallen off bolts, nuts and split pins	• Check visually or using tools.	• Bolts, nuts and split pins are fastened securely. **⚠ DANGER** Mandatory • Even a drop off of a split pin may cause of drop of the body size. Be sure to check it. Drop off of split pin may result in death or serious injury.	Fasten bolts, nuts and split pins securely.

Function and Performance

- Check the following item with no load.

Item	Check method	Criteria	When failed
Operational Check	• Check the traveling motion of the electric chain hoist by moving it manually.	• To travel smoothly. No meandering and vibration.	Carry out Chapter 2 "Periodic inspection".

(to be continued)

How to Operate the Push Button Switches

CAUTION

Prohibited

- Do not hang the Push Button Switch Cord on other object, or pull the cord strongly.
- Do not use the Push Button Switch if its button does not operate smoothly.
- Do not bundle or tie the cord for the adjustment of its length.

Failure to comply with this instruction causes bodily injury or loss of property.

Mandatory

- When taking hand off the Push Button Switch after operation, do not throw it. Be careful not to hit other worker with the Push Button Switch.

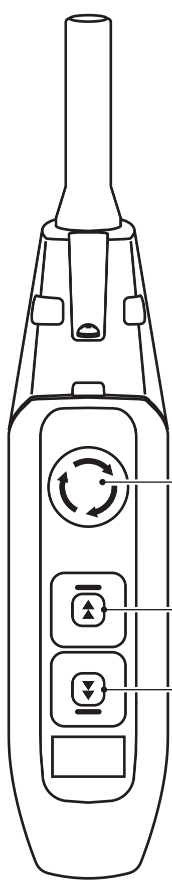
Failure to comply with this instruction causes bodily injury or loss of property.

NOTE

If the Electric chain hoist is tripped due to overheat of the VFD, the VFD cannot be reset soon after the trip. Reset the VFD after a while.

3-Push Button Switch Set

3-Push Button Switch Set is equipped with a lock type emergency stop button (VFD reset button) and lift/lower push buttons. One-step push button switch or two-step push button switch is mounted as Lift/lower push button switches in accordance with the specification of single speed or dual speed VFD specification. Refer to the operation method of the corresponding specification.



● Emergency Stop Button (VFD Reset Button)

1) Press the Emergency Stop Button deeply when carrying out an emergency stop or VFD reset.
   - The button is locked at the pressed end.
2) Turn the Emergency Stop Button clockwise to cancel the lock.
   - Press-locked button returns to the original position.

* When the electric chain hoist is not used, press the Emergency Stop Button deeply to the end.

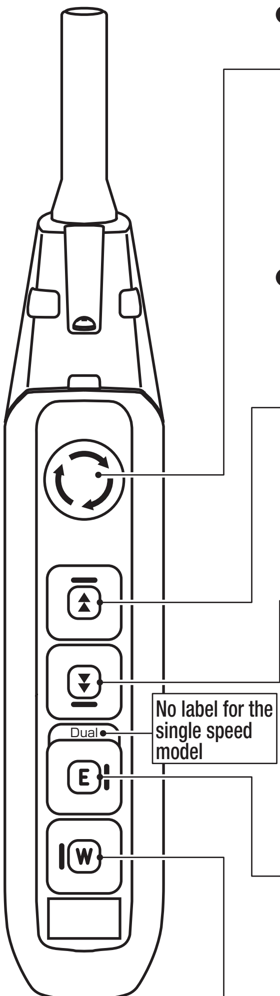
● Operation Button

● Lift/Lower Button

Single Speed Model	Dual Speed VFD Model
1) Press button to lift the load. • The electric chain hoist stops when the button is released.	1) Press button to lift the load. 2) When lifting the load at high speed, press the button further to the end. • The electric chain hoist stops when the button is released.
1) Press button to lower the load. • The electric chain hoist stops when the button is released.	1) Press button to lower the load. 2) When lowering the load at high speed, press the button further to the end. • The electric chain hoist stops when the button is released.

5-Push Button Switch Set

5-Push Button Switch Set is equipped with a lock type emergency stop button (VFD reset button) and lift/lower push buttons. One-step push button switch or two-step push button switch is mounted as Lift/lower push button switches in accordance with the specification of single speed or dual speed VFD specification. Refer to the operation method of the corresponding specification.
Moving direction of the trolley is expressed as East/West for traveling motion in the operational instruction of the Push Button Switch Set.



● Emergency Stop Button (VFD Reset Button)

	1) Press the Emergency Stop Button deeply when carrying out an emergency stop or VFD reset. • The button is locked at the pressed end. 2) Turn the Emergency Stop Button clockwise to cancel the lock. • Press-locked button returns to the original position. * When the electric chain hoist is not used, press the Emergency Stop Button deeply to the end.

● Operation Button

● Lift/Lower Button

	Single Speed Model		Dual Speed VFD Model
	1) Press button to lift the load. • The electric chain hoist stops when the button is released.		1) Press button to lift the load. 2) When lifting the load at high speed, press the button further to the end. • The electric chain hoist stops when the button is released.
	1) Press button to lower the load. • The electric chain hoist stops when the button is released.		1) Press button to lower the load. 2) When lowering the load at high speed, press the button further to the end. • The electric chain hoist stops when the button is released.

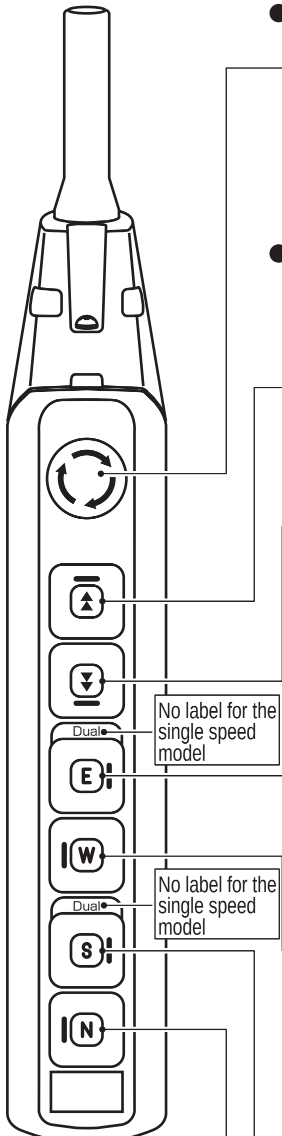
● Travel Button

	Single Speed Model		Dual Speed VFD Model
E	1) Press E button to move the trolley to the east. • The trolley stops when the button is released.	E	1) Press E button to move the trolley to the east at low speed. 2) Press E button further to the end to move the trolley to the east at high speed. • The trolley stops when the button is released.
W	1) Press W button to move the trolley to the west. • The trolley stops when the button is released.	W	1) Press W button to move the trolley to the west at low speed. 2) Press W button further to the end to move the trolley to the west at high speed. • The trolley stops when the button is released.

(to be continued)

7-Push Button Switch Set

7-Push Button Switch Set is equipped with a lock type emergency stop button (VFD reset button) and lift/lower push buttons. One-step push button switch or two-step push button switch is mounted as Lift/lower push button switches in accordance with the specification of single speed or dual speed VFD specification. Refer to the operation method of the corresponding specification.
Moving directions of the trolley are expressed as East/West for traveling motion, and North/South for traversal motion in the operational instruction of the Push Button Switch Set.



● Emergency Stop Button (VFD Reset Button)

1) Press the Emergency Stop Button deeply when carrying out an emergency stop or VFD reset.
   - The button is locked at the pressed end.
2) Turn the Emergency Stop Button clockwise to cancel the lock.
   - Press-locked button returns to the original position.

* When the electric chain hoist is not used, press the Emergency Stop Button deeply to the end.

● Operation Button

• Lift/Lower Button

Single Speed Model		Dual Speed VFD Model	
↑	1) Press ↑ button to lift the load. • The electric chain hoist stops when the button is released.	↑	1) Press ↑ button to lift the load. 2) When lifting the load at high speed, press the ↑ button further to the end. • The electric chain hoist stops when the button is released.
↓	1) Press ↓ button to lower the load. • The electric chain hoist stops when the button is released.	↓	1) Press ↓ button to lower the load. 2) When lowering the load at high speed, press the ↓ button further to the end. • The electric chain hoist stops when the button is released.

• Travel Button

Single Speed Model		Dual Speed VFD Model	
E	1) Press E button to move the trolley to the east. • The trolley stops when the button is released.	E	1) Press E button to move the trolley to the east at low speed. 2) Press E button further to the end to move the trolley to the east at high speed. • The trolley stops when the button is released.
W	1) Press W button to move the trolley to the west. • The trolley stops when the button is released.	W	1) Press W button to move the trolley to the west at low speed. 2) Press W button further to the end to move the trolley to the west at high speed. • The trolley stops when the button is released.

• Traverse Button

Single Speed Model		Dual Speed VFD Model	
S	1) Press S button to move the trolley to the south. • The trolley stops when the button is released.	S	1) Press S button to move the trolley to the south at low speed. 2) Press S button further to the end to move the trolley to the south at high speed. • The trolley stops when the button is released.
N	1) Press N button to move the trolley to the north. • The trolley stops when the button is released.	N	1) Press N button to move the trolley to the north at low speed. 2) Press N button further to the end to move the trolley to the north at high speed. • The trolley stops when the button is released.

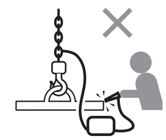
Operation

General

⚠ DANGER

Prohibited

- Do not operate the electric chain hoist in an environment with flammable or explosive gas.
  The electric chain hoist is not designed as explosion proof specification.
- Do not use the electric chain hoist exceeding the ratings (short period rating, intermittent rating) of the lifting motor and the maximum start-up frequency.
- Do not use the electric chain hoist by the voltage other than the rated voltage.
- Do not use the Emergency Stop Button for ordinary stop operation.
- Do not expose the Load Chain to sparks from welding.
- Do not contact welding rods or electrodes with the Load Chain.
- Do not use the Load Chain as the earth for welding work. (Fig. A)



A

Failure to comply with these instructions may result in death or serious injury.

Mandatory

- Follow the operating environment and conditions for the electric chain hoist.

Failure to comply with this instruction may result in death or serious injury.

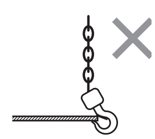
Slinging

⚠ DANGER

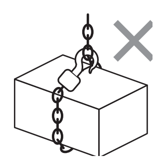
Prohibited

- Do not apply a load to the tip of the Bottom Hook or the Hook Latch. (Fig. B)
- Do not bind a load with the Load Chain directly. (Fig. C)
- Do not operate the Load Chain while it is in contact with any sharp edges. (Fig. D)

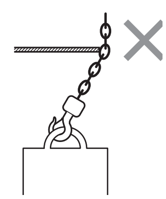
Failure to comply with these instructions may result in death or serious injury.



B



C



D

Mandatory

- Use the sling appropriate for the weight and shape of a load.
  Inappropriate slinging may result in danger such as drop of a lifted load.
- Carry out the slinging with equal load on slinging devices for stable lifting of a load.
- Attach the slinging devices securely to a load.
- Attach the slinging devices to the Bottom Hook correctly.

Failure to comply with these instructions may result in death or serious injury.

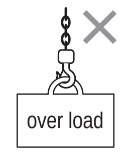
(to be continued)

■ Lifting/Lowering

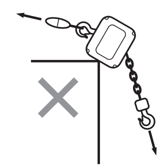
⚠ DANGER

Prohibited

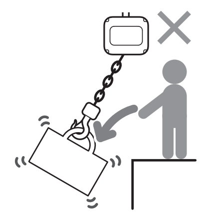
- Do not lift more than the capacity. (Fig. E)
  The capacity is indicated in the nameplate.
- Do not operate the electric chain hoist exceeding the lifting height.
- Do not dare to lift the structure or any other object supposed to be difficult to lift.
- Do not lift a load at no-load side of the Load Chain.
- Do not stop the electric chain hoist with the limit switch (over winding prevention device).
- Do not use the electric chain hoist when the Friction Clutch (overload prevention device) is operated to stop winding.
- Do not lift or lower excessively.
  - Do not remove the Chain Spring or the Cushion Rubber to operate the limit switch by hitting the body size with the Bottom Hook. If such stop operation is repeated, it may result in breaking of the Load Chain.
  - Do not hit the body size with the End Stopper of the Load Chain to cause the operation of the Friction Clutch. If such operation is repeated, it may result in breaking of the Load Chain.
- Do not use the body size as a fulcrum. (Fig. F)
- Do not swing the lifted load.
- Do not wind the slack Load Chain with a load in one action to avoid exposing the Load Chain to shock.
  Stop lifting when the Load Chain is stretched tight. Then lift slowly.
- Do not carry out reverse operation while lifting/lowering a load.
  When reversing the motion, stop the electric chain hoist and then reverse the motion.
- Do not carry out excessively frequent inching.
- Do not carry out plugging.
  When reversing the motion, stop the electric chain hoist and then reverse the motion.
- When lifting off a load from a pallet, lift the load to avoid exposing to shock, such as the load falling. (Fig. G)
- Do not cause the load to come into contact with the Load Chain.
- Do not rotate a lifted load. Use the device for rotation.
- Do not carry out the welding or cutting work on a lifted load.
- Do not repair or disassemble a lifted load.
  When repairing or disassembling an electric chain hoist, ensure that the product is placed down on the floor and that only maintenance engineers maintain the electric chain hoist.
- Do not enter beneath a lifted load.
- Do not hit the Chain Container with a load or slinging devices.
  Otherwise the Load Chain in the Chain Container falls out of the bucket to cause injury.



E



F

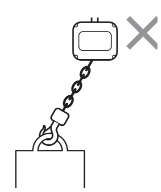


G

Failure to comply with these instructions may result in death or serious injury.

Mandatory

- When the limit switch (over winding prevention device) is operated, stop the lifting work immediately and lower the load.
- Move the electric chain hoist right above the load and then lift the load. (Do not lift the load in an inclined direction.) (Fig. H)
- Do not leave from the operating position while a load is lifted. Watch the lifted load.



H

Failure to comply with these instructions may result in death or serious injury.

⚠ CAUTION

Prohibited

- Do not use the Friction Clutch to measure the weight of a load.

The use of the Friction Clutch other than intended purpose may result in injury or property damage.

Mandatory

- When carrying a lifted load using a lifting magnet or a vacuum chuck, lower the height of the lifted load as low as possible.
- When lifting a load with two electric chain hoists, use the electric chain hoist with the rated lifting capacity of a single hoist exceeding the load.
- When lifting a load with two electric chain hoists, use the electric chain hoists of the same model and capacity and operate the respective electric chain hoist to keep the load lifted or lowered horizontal.

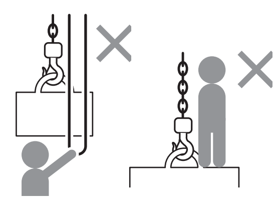
Failure to comply with this instruction causes bodily injury or loss of property.

Traverse / Travel

⚠ DANGER

Prohibited

- Do not operate the electric chain hoist underneath the load or transport a load over people. (Fig. I)
- Do not operate the electric chain hoist when any person is in the area where the lifted load moves.
- Do not allow people to enter into the area where a lifted load moves.
- Do not ride on a lifted load and do not use the electric chain hoist to support, lift, or transport people. (Fig. J)
- Do not strike the stopper or the structure by the body size or the trolley.
- Do not operate or move the electric chain hoist while going backward with a load kept lifted.
  Operate the electric chain hoist while looking forward from the back of a load and going ahead.



I J

Failure to comply with these instructions may result in death or serious injury.

⚠ CAUTION

Prohibited

- Do not impede the lifted load with other structure or wiring.

Failure to comply with this instruction causes bodily injury or loss of property.

Mandatory

- If the Load Chain and the hand chain of the geared trolley are entangled, stop the operation immediately and reset the entangled chains.

Failure to comply with this instruction causes bodily injury or loss of property.

In Abnormality or Failure

⚠ DANGER

Mandatory

- If the electric chain hoist is damaged or abnormal noise or vibration occurs, stop the operation immediately.
- If the electric chain hoist moves in the direction opposite to the indication on the Push Button Switch, stop the operation immediately.
- When the twist, entanglement, crack, deformation, attachment of foreign matters or abnormal engagement of the Load Chain and the Gear is observed, stop the operation immediately.
- When any abnormality is observed during the operation, indicate “FAILURE" and contact with the maintenance engineers.
- When the power is interrupted, secure safety and contact with the maintenance engineers.

Failure to comply with these instructions may result in death or serious injury.

(to be continued)

■Speed Change of Dual Speed VFD Model

You can change the high/low speed of the dual speed VFD model by changing the VFD parameter.

⚠ DANGER

Prohibited

- **Only maintenance engineers or the personnel with expertise are allowed to set or change parameters.**
  Wrong parameter settings may result in danger such as defective operation and drop of lifted load. Contact Please contact KITO for consultation.

Failure to comply with these instructions may result in death or serious injury.

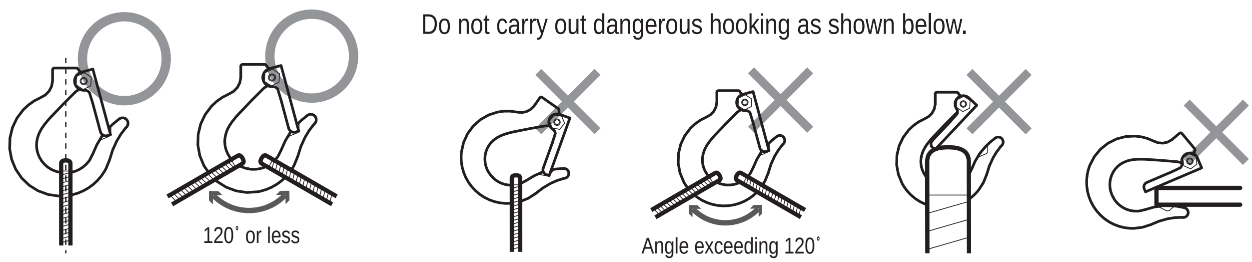
Mandatory

- **When changing the parameter, set it correctly referring to the VFD Manual.**
- **Parameter change requires energizing. Do not touch the energized part.**

Failure to comply with these instructions may result in death or serious injury.

■How to Sling the Load Properly

Do not carry out dangerous hooking as shown below.



Sling the load at the extended line of the hook shaft.

Improper hooking position of the lifted load or the sling

Angle too wide

Unable closing of the Hook Latch

Hooking of the load at the tip of the Hook

■How to Suppress the Swinging of a Load

⚠ DANGER

Prohibited

- **Do not move the electric chain hoist with a load hung at one side of the Crane Saddle.**

Otherwise the load swings and hits a person or object or drops to result in death or serious injury.

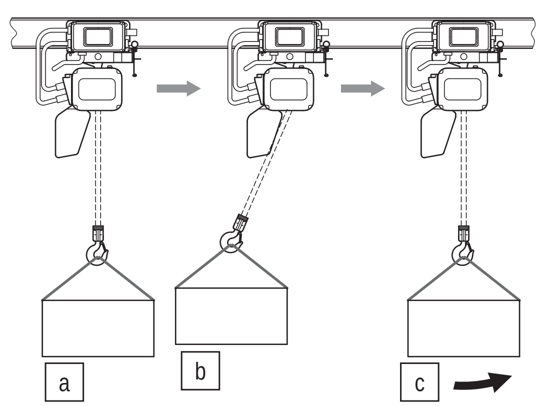
Swinging of a load makes it difficult and dangerous to move the trolley. The basics of operation are not to make a load swing. To do that keep the following instructions.

● Do not lift a load in an inclined direction.
● Start slowly when traveling the load.
● Do not lift suddenly.

Even if you keep the above instructions, the lifted load may swing at the start and the stop of the electric chain hoist.
Following operation can reduce the swing of the lifted load.

■Operation

1) Press the Travel Button. (Fig. a)
2) When the trolley starts to move, the lifted load delays a bit. (Fig. b)
3) Release the button a bit before the time when the lifted load swings to the center position.
4) When the lifted load comes to the position just beneath the electric chain hoist, press the button again and continue to travel the load. (Fig. c)



Precautions After Work

⚠ CAUTION

Prohibited

- Do not store the electric chain hoist at a state of over lifting or over lowering.

Failure to comply with these instructions causes bodily injury or loss of property.

Mandatory

- Store the electric chain hoist with power off.
- Indicate “FAILURE" on the electric chain hoist that needs repair not to be used.
- Wipe off dust and waterdrop, apply oil at the neck of the Hook and the Load Chain and store the hoist.
- Remove the stain, attached foreign matter and waterdrop from the parts such as the Limit Switch and the Chain Container that is scratched by the Load Chain or stored it.
- When the electric chain hoist is installed outdoor, cover it with rain cover or roof after application of rust proof process.

Failure to comply with these instructions causes bodily injury or loss of property.

NOTE

- Clean the push buttons always not to allow the dust and sands attach.
- When storing the electric chain hoist for a long period, it is effective to prevent rusting to operate it at a certain period without load.
- When putting the electric chain hoist on a floor, remove the Chain Container.
  Otherwise the Chain Container may deform or be damaged.
- When not using the electric chain hoist, wind up the Bottom Hook to the height not to hinder persons passing by or other work.
- Decide the place to store the electric chain hoist in advance. It is recommended to hang the push button set on the pillar.

Work Flow of Assembling and Installation

The contents of the work to assemble and install the product by the maintenance engineers and installer are described from this page and after. To eliminate the redo work and for effective assembling and installation, please check the following work flow first and then start assembling and installation work.

Model Check

Hook Suspended Type (hoist only)	Trolley Type	
	Motorized Trolley Type	Manual Trolley Type
ER2	ER2M	ER2SG / ER2SP

Assembling

Assembling Parts to Electric Chain Hoist (P37)

- Preparation
- Mounting the Chain Container
- Lubrication on the Load Chain
- Checking gear oil
- How to use the Oil Cap
  (Only for the Friction Clutch with mechanical brake)

Combination with the Motorized Trolley (P42)

- Part replacement of the electric chain hoist
- Checking the rail width of the motorized trolley
- Checking the number and position of adjusting collars
- Combination of the electric chain hoist and the motorized trolley
- Mounting the balance weight

Combination with the Manual Trolley (P47)

- Part replacement of the electric chain hoist
- Checking the rail width of the manual trolley
- Checking the number and position of adjusting collars
- Combination of the electric chain hoist and the manual trolley

Checking Power and Power Cables (P52)

- Checking the power
  - Checking the breaker ratings
- Checking the Power Cable
  - Permissible cable length and size

Connecting Cables Hook Suspended Type (hoist only) (P54)

- 125 kg~5 t
  - Connecting the Power Cable
  - Connecting Push Button Switch Set Cord

Connecting Cables Motorized Trolley Type (P55)

- 125 kg~5 t
  - Connecting relay cable
  - Connecting the Power Cable
  - Connecting Push Button Switch Set Cord

Connecting Cables Manual Trolley Type (P56)

- 125 kg~5 t
  - Connecting the Power Cable
  - Connecting Push Button Switch Set Cord

Installation

Installation of Hook Suspended Type (hoist only) (P57)

- Connecting Power Cable to the power
- Checking installation method and place

Installation of Trolley Combination Model (P58 to 60)

- Connecting Power Cable to the power
- Mounting the Travel Rail
- Mounting the Stopper
- Power Cable layout of Electric/Manual Trolley Combined Model
  - Case for cable hanger
  - Case for T-shape/angle type hanger

Check after Installation

Checking and Carrying Out "Check Items" (P61)

Carrying Out Operational Check (P61)

Assembling

⚠ DANGER

Prohibited

- Only maintenance engineers or the personnel with expertise are allowed to assemble and disassemble the electric chain hoist.

Assembling or disassembling of the electric chain hoist may result in death or serious injury.

Assembling Parts to Electric Chain Hoist

Preparation for Assembling

* Hang the electric chain hoist body size to facilitate the mounting of the Chain Container.

* Check that the stopper and the cushion rubber are mounted at the link third from the no load side of the Load Chain (the end without the Bottom Hook).

Mounting the Chain Container

The three types of the Chain Container are provided: bucket made of plastic, canvas and steel

This manual describes the method to combine the plastic or canvas Chain Container with the body size of the electric chain hoist. Refer to the separate “Mounting Manual of the Steel Chain Container" for the steel Chain Container.

⚠ DANGER

Mandatory

- The each type of Chain Container has the capacity to store the specific amount of the Load Chain. Use correct capacity of the Chain Container.
  When storing the Load Chain of which amount exceeds the capacity of the Chain Container, it may result in death or serious injury due to the flow over of the Load Chain from the Chain Container or defective operation of the electric chain hoist.
  Improper combination of the Chain Container and the electric chain hoist is very dangerous because of the possibility of drop of the Chain Container.
  The seal to indicate the capacity and lifting height is attached on the Chain Container. Check it before use.
- If the Chain Container is not assembled correctly, it may result in death or serious injury due to a drop of the Chain Container or Load Chain, and malfunction of the Electric Chain Hoist.
  Refer to the assembling instruction on the page 38 and assemble the Chain Container correctly.

Failure to comply with these instructions causes bodily injury or loss of property.

⚠ CAUTION

Mandatory

- When storing the Load Chain into the Chain Container, put the chain end with no-load side first and then store the rest of the Load Chain.

Failure to comply with these instructions causes bodily injury or loss of property.

(to be continued)

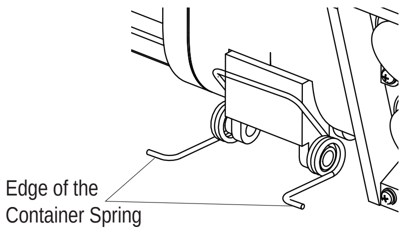
Assembling (continued)

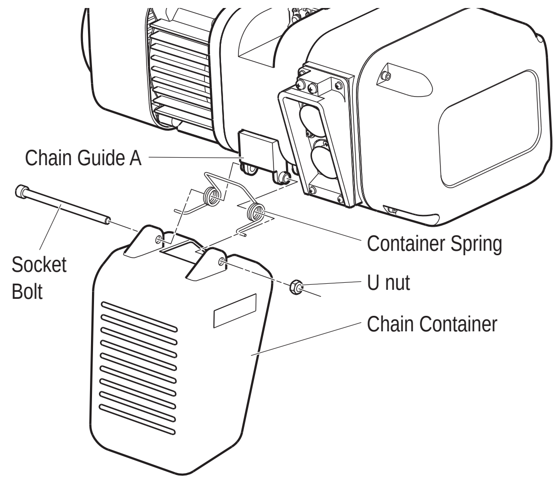
● Chain Container Seal

A seal in the right to indicate the relation between the size of the Load Chain and the lift is attached to the Chain Container. Be sure to check it before installation.

● Plastic Container

1) Mount the Container Spring to the Chain Guide A.

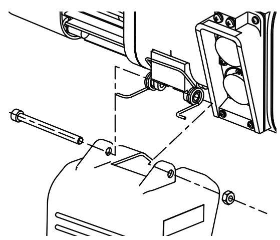


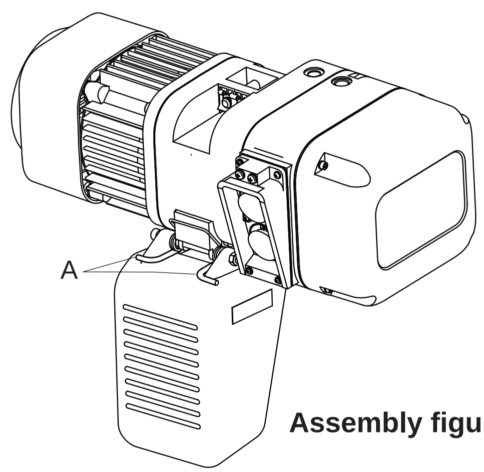


Names of each part

2) Pass a Socket Bolt through all holes of the Chain Container, the Chain Guide A and the Chain Container, in this order to mount the Chain Container.

- Be careful to the direction of the Container Spring.
- As the portion A shown in the right assembly figure, make sure that the edge of the Container Spring is set out of the container when assembling.

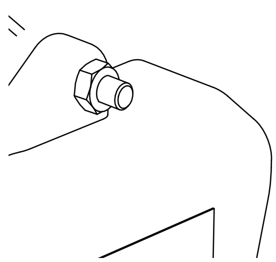




Assembly figure

3) Screw the U nut into the Socket Bolt and tighten it securely.

- The Socket Bolt must protrude from the end face of the nut by three threads or more.

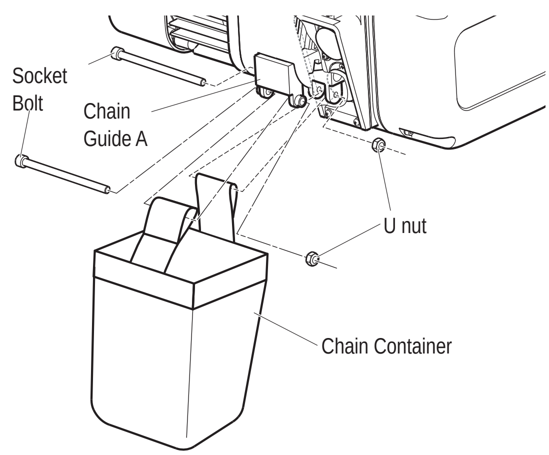


● Canvas Container

1) Pass two Socket Bolts through all holes of the Chain Guide A, the Canvas Container and the Chain Guide A in this order to mount the Chain Container.

2) Screw the U nut securely.

- The Socket Bolt must protrude from the end face of the nut by three threads or more.



● Case without Chain Container

When using the electric chain hoist without the Chain Container, take the following measures.

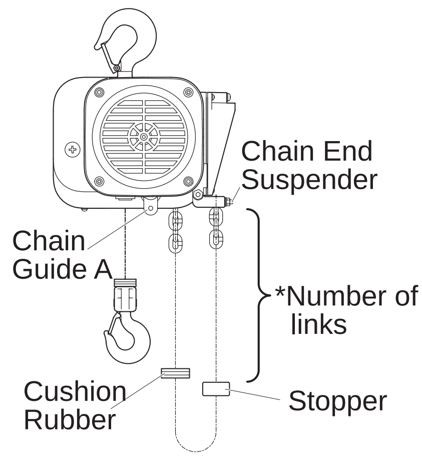
1) Mount the Stopper at the no-load side of the Load Chain.

* Number of Links between Chain End Suspender and the Stopper

Body size	Number of Links
B	21
C	15
D	15
E	15
F	15

* Tightening torque for the Stopper Bolt: 10 N·m

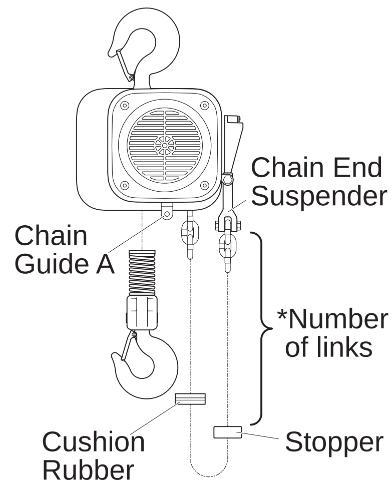
Body size ER2-B/C/D/E



2) Mount the End Link of the no load side of the Load Chain to the Chain End Suspender with a Socket Bolt and a lever nut.

- Chain End Suspender is optional. Please specify the Chain End Suspender when placing an order of the electric chain hoist.

Body size F



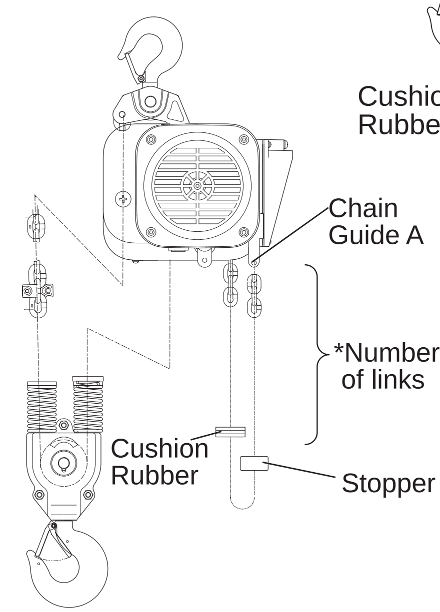
3) Combine the Chain End Suspender and the body size of the electric chain hoist (Chain Guide A) with a Socket Bolt and lever nut.

- Be careful not to twist the Load Chain.

<Double Chain Fall type>

Chain End Suspender is not used for double chain fall type due to the orientation of the chain.
Attach the terminal chain link directly to Chain Guide A.

* When ordering a Chain End Suspender, please refer to the part codes. (P121)



⚠ DANGER

Mandatory

- When using the electric chain hoist, be careful not make the Load Chain at no load side impeded or entangled.

Failure to comply with these instructions may result in death or serious injury.

(to be continued)

■ Oiling the Load Chain

⚠ DANGER

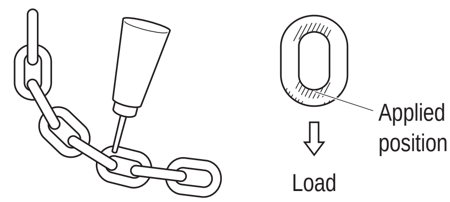
Mandatory

- **Be sure to apply lubricant on the Load Chain. Do not carry out oiling work in the place near the fire or arc.**

Otherwise it will result in fire.

Remove dust and waterdrops attached on the Load Chain and then apply lubricant. Application of lubricant influences on the life of the Load Chain considerably. Apply the lubricant sufficiently.
Use the following genuine lubricant.

- Epinoc Grease AP (N)0 (Nippon Oil Corporation)
- Consistency No.0 (Industrial general lithium grease)



Release all loads from the Load Chain. Apply the lubricant to the linking portion of the Load Chain that engages the Load Sheave and the Idle Sheave (hatched area).
After application of the lubricant lift/lower the electric chain hoist without load to spread the lubricant on the Load Chain.

■ Gear Oil

Inside of the Gear Case is filled with gear oil at the shipping. The level of the oil filled with specified amount comes to the height of the inspection hole. Check the oil level visually.

⚠ DANGER

Mandatory

- **Set the body size to a level and then check the level of gear oil.**

When removing the oil plug without leveling the electric chain hoist, the gear oil flows out. It will result in death or serious injury due to fall by slippery floor.

Mandatory

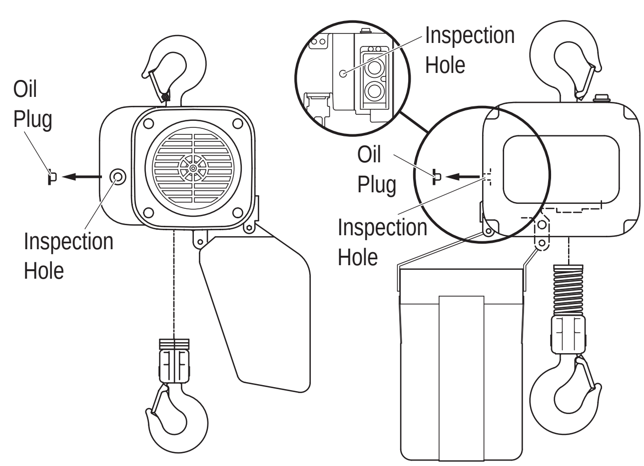
- **Use genuine gear oil.**

Use of the gear oil other than the genuine oil (including mixed use) will result in death or serious injury due to the drop of the lifted load.

● Cheking the Gear Oil Amount

1) **ER2 Body size B/C/D: Remove the Oil Plug on the Main Body at the opposite side of the Chain Container.**
   ER2 Body size E/F: Remove the Oil Plug on the Main Body at the same side of the Chain Container.

2) **If the oil level can be seen close to the inspection hole, the oil amount is normal.**



Body size ER2-B/C/D　　Body size ER2-E/F

How to Use the Oil Cap (only for the Friction Clutch with mechanical brake)

An Oil Cap is packaged along with the electric chain hoist equipped with built-in Friction Clutch with mechanical brake (option). When installing the hoist, remove the oil plug and attach the Oil Cap instead. When combining the motorized trolley, mount the oil cap to the hoist at a position where the Oil Cap and the frame of the Trolley do not interfere. (Any one of the following two positions)

⚠ DANGER

Mandatory

- The gear oil for the electric chain hoist with Friction Clutch with mechanical brake is different from that for the hoist with standard Friction Clutch. Be sure to use the genuine gear oil for the hoist with friction clutch with mechanical brake.

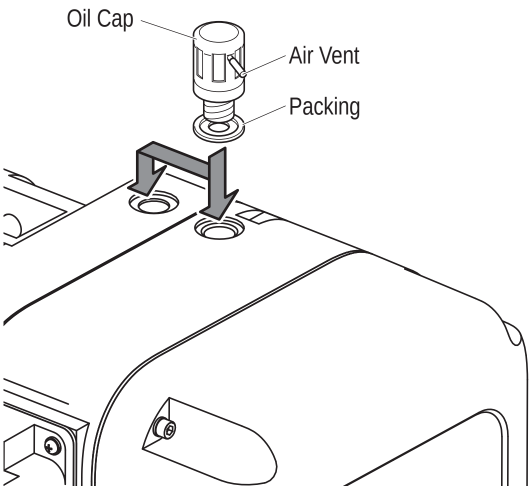
Use of the gear oil other than the specified oil (including mixed use) will result in death or serious injury due to the drop of the lifted load.

● When using the electric chain hoist

To secure the draft between inside and outside of the Gear Case, pull out the Air Vent to the position where the step of the Air Vent can be seen.

● When removing the electric chain hoist

To prevent the oil flow out from inclined electric chain hoist, make sure that the Air Vent is inserted securely.



Combination with the Trolley

* When using the Hook suspended model (Single Unit) “Connection of Power and Power Cable", you can skip the this section. Please proceed with Page 53.

⚠ DANGER

Mandatory

- Adjust the rail width during assembling and install.
- Be careful for the Power Cable and Push Button Switch Set Cord are not pulled off or entangled within the area of traveling area.

Failure to comply with these instructions may result in death or serious injury.

(to be continued)

Combining with the Motorized Trolley

CAUTION

Prohibited

- When using ER2 series electric chain hoist combined with our old type product, specification needs to be changed. Contact your nearest dealer or KITO.

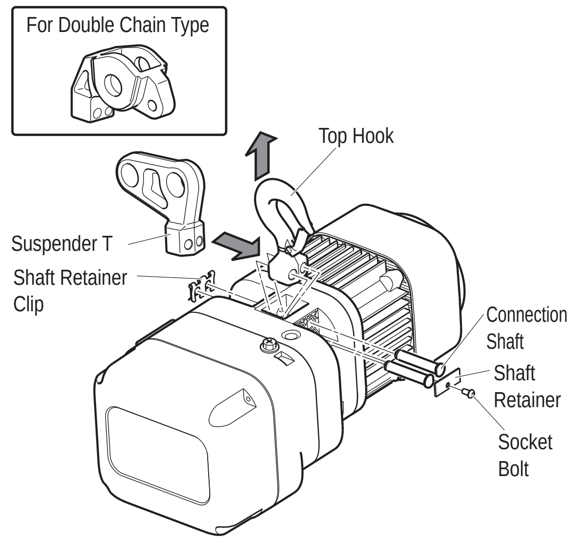
Parts replacement of the electric chain hoist

The Suspender is attached to the electric chain hoist at shipping.

Refer to the following figure to remove the Top Hook and replace the Suspender with the Suspender T.

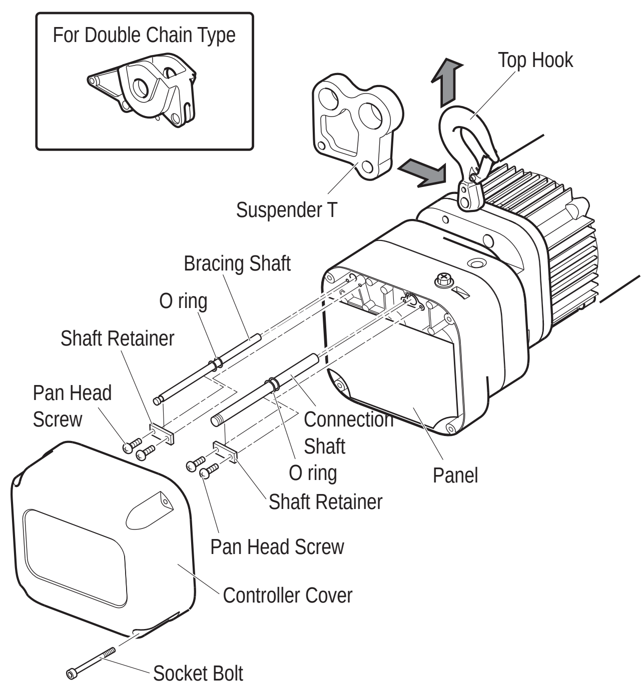
- **Replacing the Top Hook of Body size ER2-B/C/D/E**

1) **Remove the Shaft Retainer Clip using plier.**
2) **Remove the Socket Bolt from the Shaft Retainer, and remove the Shaft Retainer.**
3) **Remove two Connection Shafts.**
4) **Remove the Top Hook and replace it with the Suspender T.**
5) **Insert two Connection Shafts into the hole of the Body size.**
6) **Mount the Shaft Retainer with Socket Bolt.**



- **Replacing the Top Hook of Body size ER2-F**

1) **Remove four Socket Bolts and remove the Controller Cover.**
2) **Remove pan head screws of the Connection Shaft and the Fixing Shaft (two screws each), and remove the Shaft Retainer.**
3) **Pinch the respective upper ends of the Connection Shaft and the Fixing Shaft and pull out them.**
4) **Remove the Top Hook and replace it with the Suspender T.**
5) **Insert the Connection Shaft and Fixing Shaft into the mounting hole.**
6) **Fix the Shaft Retainer of the Connection Shaft and the Fixing Shaft with pan head screws (two screws each).**
7) **Mount the Controller Cover with four pan head screws.**



Checking the Number of the Assembled Adjusting Spacers and Their Positions

When installing a trolley to the beam, the length of the Suspension Shaft (width between frames) must be adjusted in accordance with the rail width.
Wrong number of wrong position of Spacers may result in the drop of the electric chain hoist.
Insert the correct number of Spacers with correct ratings and for rail width at the correct position, referring to the following table.

- **Adjusting spacer arrangement for LOW Head Suspension (Beam flange width 58-170mm)**

Capacity(t)	Parts Name		Number of Adjusting Spacers																								
Beam flange width		(in)	$2\frac{5}{16}$	$2\frac{1}{2}$ $2\frac{5}{8}$	$2\frac{7}{8}$ $2\frac{15}{16}$	3	$3\frac{1}{4}$	$3\frac{9}{16}$	$3\frac{7}{8}$	$3\frac{15}{16}$	4	$4\frac{3}{16}$	$4\frac{5}{16}$	$4\frac{7}{16}$	$4\frac{11}{16}$ $4\frac{3}{4}$	$4\frac{15}{16}$	5	$5\frac{3}{16}$	$5\frac{5}{16}$	$5\frac{3}{8}$	$5\frac{5}{8}$	$5\frac{11}{16}$ $5\frac{3}{4}$	6	$6\frac{1}{8}$	$6\frac{5}{16}$	$6\frac{7}{16}$	$6\frac{11}{16}$
Capacity(t)	Parts Name	(mm)	58	64 66	73 74	75 76	82	90 91	98	100	102	106	110	113	119 120	125	127	131	135	137	143	149 150	153	155	160	163	170
1	Thin spacer	Inner	1+2	2+3	4+4	1+0	1+2	2+3	0	1+0		1+2	2+2	2+3	3+4	4+4	4+1	5+1	2+2		3+3	4+4	4+1	1+1	2+2	2+3	3+0
		Outer	5	3	0	7	5	3	8	7		5	4	3	1	0	3	2	4		2	0	3	6	4	3	5
	Thick spacer	Inner	0						1+1								1+2		2+2				2+3	3+3			3+4
		Outer	5						3								0	2	1				0	3			2
	Fixing spacer	Inner																						0			
		Outer																						2			
	Thick spacer L	Inner	0			1+1																					
		Outer	2			0																					
2	Thin spacer	Inner					1+2	2+3	3+4	0	1+0	1+1	1+2	2+2	3+3	4+4	1+0	1+1	1+2	2+2	3+3	4+0	4+1	1+1	1+2	2+2	3+3
		Outer					5	3	1	8	7	6	5	4	2	0	7	6	5	4	2	4	3	6	5	4	2
	Thick spacer	Inner					0										1+1					1+2		2+2			
		Outer					5										3					2		1			
	Fixing spacer	Inner																									
	Thick spacer L	Inner					0		1+1																		
		Outer					2		0																		
3	Thin spacer	Inner					1+2	2+3	3+4	0	1+0	1+1	1+2	2+2	3+3	4+4	1+0	1+1	1+2	2+2	3+3	4+0	4+1	1+1	1+2	2+2	3+3
		Outer					5	3	1	8	7	6	5	4	2	0	7	6	5	4	2	4	3	6	5	4	2
	Thick spacer	Inner					0										1+1					1+2		2+2			
		Outer					5										3					2		1			
	Fixing spacer	Inner																									
	Thick spacer L	Inner					0		1+1																		
		Outer					2		0																		
5	Thin spacer	Inner								0	1+0	1+1	1+2	2+2	3+3	0	1+0	1+1	2+2		3+3	4+0	4+1	1+1	2+2	2+3	3+0
		Outer								8	7	6	5	4	2	8	7	6	4		2	4	3	6	4	3	5
	Thick spacer	Inner								0												0+1		1+1			1+2
		Outer								3												2		1			0
	Thick spacer L	Inner								0						1+1											
		Outer								2						0											

Remarks) 1) Description for inner spacers
For example, 0+1
0 : the number of spacers on the left side of the shaft
1 : the number of spacers on the right side of the shaft
2) Adjustment of trolley width
Refer to page 45.
Adjust the dimensions by appropriately increasing or decreasing the number of inner or outer adjusting spacers shown in the above table.

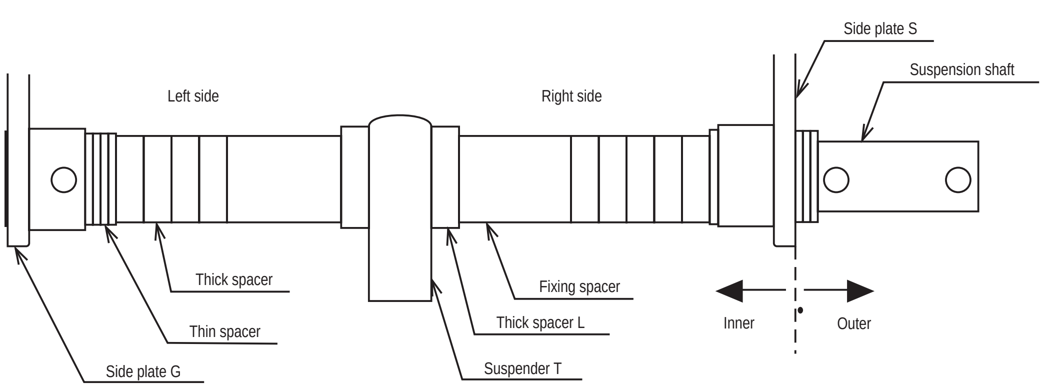
(to be continued)

Assembling (continued)

- **Adjusting spacer arrangement for LOW Head Suspension (Beam flange width 175-305mm)**

Capacity(t)	Parts Name		Number of Adjusting Spacers																								
	Beam flange width	(in)	6 7/8	7	7 1/16 7 1/8	7 1/4 7 5/16	7 7/8	8	8 7/16	8 11/16	9	9 1/8	9 7/8	10	10 1/8	10 1/4	10 3/8	10 1/2	11	11 1/8	11 1/4	11 3/8	11 5/8	11 3/4	11 13/16	11 7/8	12
		(mm)	175	178	180 181	184 185	200	203	215	220	229	232	250	254	257	260	264	267	279	283	286	289	295	298	300	302	305
1	Thin spacer	Inner	4+4	4+1	1+1	1+2	4+4	5+0	2+3	3+4	1+1	1+2	4+0	1+1	1+2	2+2	2+3	3+3	1+1	1+2	2+2	2+3	3+0	4+0	4+1		4+2
		Outer	0	3	6	5	0	3	3	1	6	5	4	6	5	4	3	2	6	5	4	3	5	4	3		2
	Thick spacer	Inner	3+3	3+4	0			0+1	1+1		2+2		2+3	3+3					4+4				4+5				
		Outer	3	2	9			8	7		5		4	3					1				0				
	Fixing spacer	Inner	0		1+1																						
		Outer	2		0																						
	Thick spacer L	Inner	1+1																								
		Outer	0																								
2	Thin spacer	Inner	4+4	1+4	1+1	1+2	4+4	1+0	2+3	3+3	4+1	1+1	4+4	4+1	5+1	4+3	2+3	3+3	4+1	1+2	2+2	2+3	3+3	3+4	4+4	4+1	5+1
		Outer	0	3	6	5	0	7	3	2	3	6	0	3	2	1	3	2	3	5	4	3	2	1	0	3	2
	Thick spacer	Inner	2+2	3+2	0			1+1			1+2	2+2		2+3			3+3		3+4	4+4						4+5	
		Outer	1	0	9			7			6	5		4			3		2	1						0	
	Fixing spacer	Inner						1+1																			
	Thick spacer L	Inner	1+1																								
		Outer	0																								
3	Thin spacer	Inner	4+4	1+4	1+1	1+2	4+4	1+0	2+3	3+3	4+1	1+1	4+4	4+1	5+1	4+3	2+3	3+3	4+1	1+2	2+2	2+3	3+3	3+4	4+4	4+1	5+1
		Outer	0	3	6	5	0	7	3	2	3	6	0	3	2	1	3	2	3	5	4	3	2	1	0	3	2
	Thick spacer	Inner	2+2	3+2	0			1+1			1+2	2+2		2+3			3+3		3+4	4+4						4+5	
		Outer	1	0	9			7			6	5		4			3		2	1						0	
	Fixing spacer	Inner						1+1																			
	Thick spacer L	Inner	1+1																								
		Outer	0																								
5	Thin spacer	Inner	4+4	4+1	5+1	4+3	4+4	1+0	2+3	3+4	1+1	1+2	4+4	1+1	1+2	2+2	2+3	3+3	5+1	1+2	2+2	2+3	4+3	4+4	4+0	4+1	5+1
		Outer	0	3	2	1	0	7	3	1	6	5	0	6	5	4	3	2		5	4	3	1	0	4	3	2
	Thick spacer	Inner	1+1	1+2			2+2	3+3			4+4			5+5					5+6	6+6					6+7		
		Outer	1	0	10		9	7			5			3					2	1					0		
	Thick spacer L	Inner	1+1																								
		Outer	0																								

Remarks) 3) Thin Spacer arrangement example



- **Adjusting spacer arrangement for Lug Suspension**

Number of Adjusting Spacers																														
Beam flange width		(in)	2 5/16	2 1/2 2 5/8	2 7/8 2 15/16	3	3 1/4	3 9/16	3 7/8	3 15/16	4	4 3/16	4 5/16	4 7/16	4 11/16 4 3/4	4 15/16	5	5 3/16	5 5/16	5 3/8	5 5/8	5 11/16 5 3/4	6	6 1/8	6 5/16	6 7/16	6 11/16
Capacity(t)	Parts Name	(mm)	58	64 66	73 74	75 76	82	90 91	98	100	102	106	110	113	119 120	125	127	131	135	137	143	149 150	153	155	160	163	170
5	Thin spacer									0	1+0	1+1	1+2	2+2	3+3	0	1+0	1+1	2+2		3+3	4+0	4+1	1+1	2+2	2+3	3+0
										8	7	6	5	4	2	8	7	6	4		2	4	3	6	4	3	5
	Thick spacer									0						1+1						1+2		2+2			2+3
										5						3						2		1			0

Number of Adjusting Spacers																										
Beam flange width		(in)	6 7/8	7	7 1/16 7 1/8	7 1/4 7 5/16	7 7/8	8	8 7/16	8 11/16	9	9 1/8	9 7/8	10	10 1/8	10 1/4	10 3/8	10 1/2	11	11 1/8	11 1/4	11 3/8	11 5/8	11 3/4	11 13/16	11 7/8	12
Capacity(t)	Parts Name	(mm)	175	178	180 181	184 185	200	203	215	220	229	232	250	254	257	260	264	267	279	283	286	289	295	298	300	302	305
5	Thin spacer		4+4	4+1	5+1	4+3	4+4	1+0	2+3	3+4	1+1	1+2	4+4	1+1	1+2	2+2	2+3	3+3	5+1	1+2	2+2	2+3	4+3	4+4	4+0	4+1	5+1
			0	3	2	1	0	7	3	1	6	5	0	6	5	4	3	2		5	4	3	1	0	4	3	2
	Thick spacer		2+2	2+3			3+3	4+4			5+5			6+6					6+7	7+7					7+8		
			1	0	10		9	7			5			3					2	1					0		

(to be continued)

■ Combination of the Electric Chain Hoist and the Motorized Trolley

⚠ DANGER

Mandatory

- Use new split pins. After insertion, bend the pin securely at its both ends.

Use of old split pins may result in death or serious injury due to drop.

● 125 kg~5 t

1) Fix the Suspension Shaft to the Frame G with a Suspension Shaft Bolt, a slotted nut and a split pin.

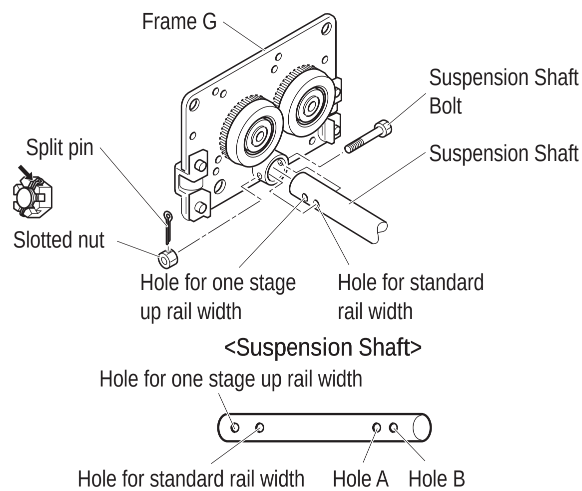
- When fixing the Frame S and the Suspension Shaft, use the hole A. If the gap between the rail end and the wall of the housing is scarce to install the electric chain hoist to the travel rail, use the hole B. (Refer to “Mounting the Hoist to the Travel Rail" (P58).)

⚠ DANGER

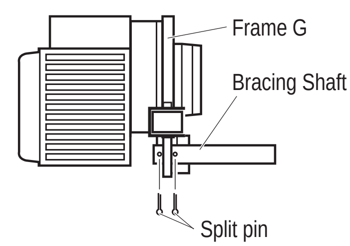
Prohibited

- The hole B on the Suspension Shaft is the hole for mounting work (temporary assembly). Do not use the hole for the adjustment of rail width.

Failure to comply with this instruction may result in death or serious injury.



2) Fix the Fixing Shaft to the Frame G with a split pin.



3) Set the Suspension Shaft with a Thin Spacer, Thick Spacer and a Thick Spacer L.

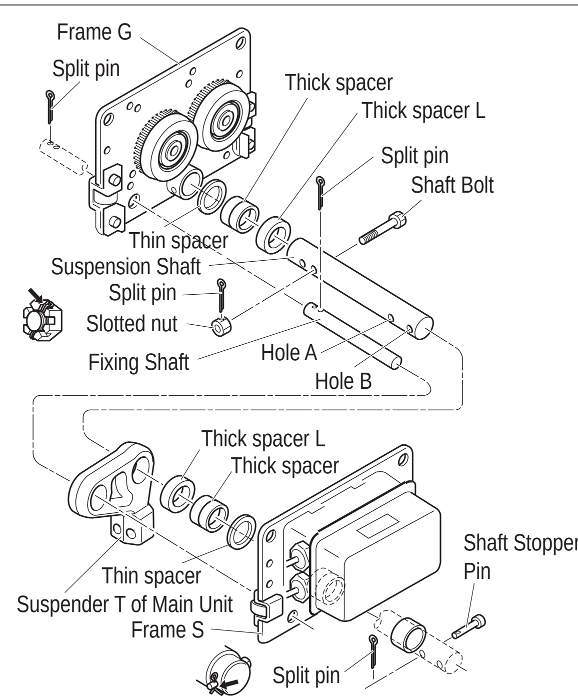
4) Set the Suspender T of ER2 Body size with the Suspension Shaft and the Fixing Shaft.

5) Set the Suspension Shaft with another Thin Spacer, Thick Spacer and Thick Spacer L. Then insert the Suspension Shaft into the Frame S.

- Adjust the Spacers in accordance with the rail width. (Refer to “Checking the Number of the Assembled Adjusting Spacers and their positions" (P45) for the number of Spacers.)

6) Set the Suspension Shaft with a Thick Spacer. Insert the Shaft Stopper Pin into the Hole A and fix it with a split pin.

- Insert the Shaft Stopper Pin in the direction that the split pin comes to the left when viewed from the front side of the MR2 Connection Box.



Combination with the Manual Ttrolley

Parts replacement of the Electric Chain Hoist

Remove the Top Hook and replace it with a Connection Yoke.

- **Replacing the Top Hook of Body size ER2-B/C/D/E**

1) Remove the Shaft Retainer Clip using plier.

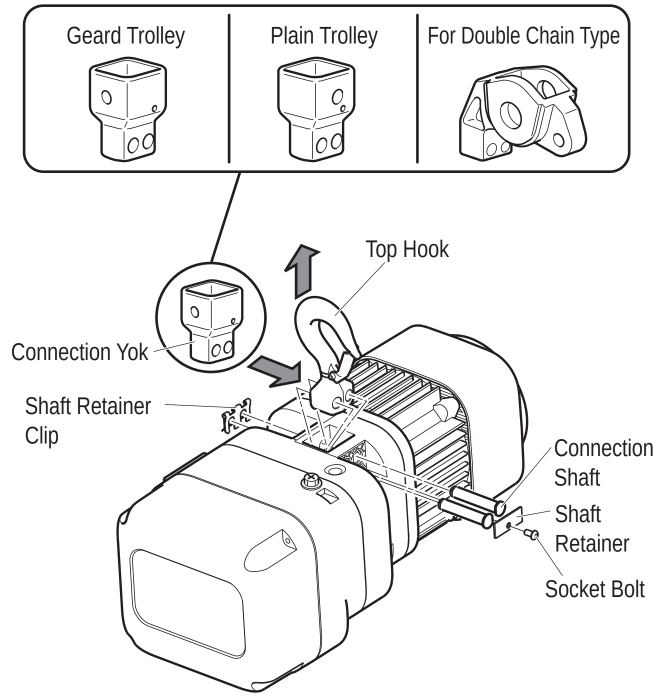
2) Remove Socket Bolt from the Shaft Retainer, and remove the Shaft Retainer.

3) Remove two Connection Shafts.

4) Remove the Top Hook and replace it with the Connection Yoke.

5) Insert two Connection Shafts into the hole of the Body size.

6) Mount the Shaft Retainer with Socket Bolt.



- **Replacing the Top Hook of Body size ER2-F**

1) Remove four Socket Bolts and remove the Controller Cover.

2) Remove pan head screws of the Connection Shaft and the Fixing Shaft (two screws each), and remove the Shaft Retainer.

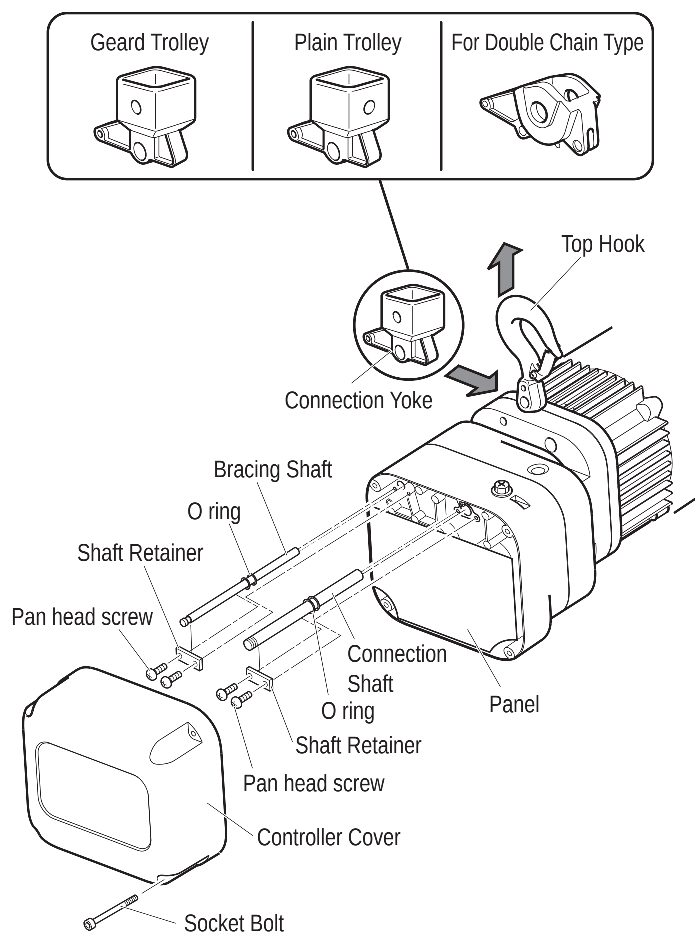
3) Pinch the respective upper ends of the Connection Shaft and the Fixing Shaft and pull out them.

4) Remove the Top Hook and replace it with the Suspender T.

5) Insert the Connection Shaft and Fixing Shaft into the mounting hole.

6) Fix the Shaft Retainer of the Connection Shaft and the Fixing Shaft with pan head screws (two screws each).

7) Mount the Controller Cover with four pan head screws.



(to be continued)

Assembling (continued)

■ Checking the Number of the Assembled Adjusting Spacers and Their Positions

When installing a trolley to the beam, the length of the Suspension Shaft (width between frames) must be adjusted in accordance with the rail width. Wrong number of wrong position of Spacers may result in the drop of the electric chain hoist. Insert the correct number of Spacers with correct ratings and for rail width at the correct position, referring to the following table.

Number of Adjusting Spacers																											
Beam flange width		(in)	2	2 5/16	2 1/2 2 5/8	2 7/8 2 15/16	3	3 1/4	3 9/16	3 7/8	3 15/16	4	4 3/16	4 15/16	4 7/16	4 11/16 4 3/4	4 15/16	5	5 3/16	5 5/16	5 3/8	5 5/8	5 7/8 5 15/16	6	6 1/8	6 5/16	6 7/16
Capacity	Parts	(mm)	50	58	64 66	73 74	75 76	82	90 91	98	100	102	106	110	113	119 120	125	127	131	135	137	143	149 150	153	155	160	163
0.5	Thin spacer	Inner	2+3	3+4	0+1	1+2	2+2	3+3	0+1	1+2	2+2	2+3	1+1	1+2	2+2	3+3	0+0	0+1	1+1	1+2	2+2	3+3	0+0	0+1	1+1	1+2	2+2
		Outer	4	2	8	6	5	3	8	6	5	4	7	6	5	3	9	8	7	6	5	3	9	8	7	6	5
	Thick spacer	Inner	0+0	0+0	1+1	1+1	1+1	1+1	2+2	2+2	2+2	2+2	0+0	0+0	0+0	0+0	1+1	1+1	1+1	1+1	1+1	1+1	2+2	2+2	2+2	2+2	2+2
		Outer	4	4	2	2	2	2	0	0	0	0	7	7	7	7	5	5	5	5	5	5	3	3	3	3	3
	Fixing spacer	Inner	–	–	–	–	–	–	–	–	–	–	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1
1	Thin spacer	Inner		3+3	0+0	1+1	1+2	2+3	0+0	1+1	1+2	2+2	2+3	3+3	3+4	0+1	1+2	2+2	1+1	1+2	2+2	3+3	0+0	0+1	1+1	1+2	2+2
		Outer		2	8	6	5	3	8	6	5	4	3	2	1	7	5	4	7	6	5	3	9	8	7	6	5
	Thick spacer	Inner		0+0	1+1	1+1	1+1	1+1	2+2	2+2	2+2	2+2	2+2	2+2	2+2	3+3	3+3	3+3	0+0	0+0	0+0	0+0	1+1	1+1	1+1	1+1	1+1
		Outer		6	4	4	4	4	2	2	2	2	2	2	2	0	0	0	5	5	5	5	3	3	3	3	3
	Fixing spacer	Inner		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1
2	Thin spacer	Inner						2+2	3+4	0+1	1+1	1+2	2+2	2+3	3+3	0+0	1+1	1+2	2+2	2+3	3+3	0+0	1+1	1+2	1+1	1+2	2+2
		Outer						3	0	6	5	4	3	2	1	7	5	4	3	2	1	7	5	4	7	6	5
	Thick spacer	Inner						0+0	0+0	1+1	1+1	1+1	1+1	1+1	1+1	2+2	2+2	2+2	2+2	2+2	2+2	3+3	3+3	3+3	0+0	0+0	0+0
		Outer						6	6	4	4	4	4	4	4	2	2	2	2	2	2	0	0	0	11	11	11
	Fixing spacer	Inner						–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1+1	1+1	1+1
3	Thin spacer	Inner						1+2	3+3	0+0	0+1	1+1	1+2	2+2	2+3	3+4	0+1	1+1	1+2	2+2	2+3	3+4	1+4	1+5	1+1	1+2	2+2
		Outer						7	4	10	9	8	7	6	5	3	9	8	7	6	5	3	5	4	7	6	5
	Thick spacer	Inner						2+2	2+2	3+3	3+3	3+3	3+3	3+3	3+3	3+3	4+4	4+4	4+4	4+4	4+4	4+4	5+4	5+4	0+0	0+0	0+0
		Outer						5	5	3	3	3	3	3	3	3	1	1	1	1	1	1	0	0	11	11	11
	Fixing spacer	Inner						–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1+1	1+1	1+1
5	Thin spacer	Inner									0+0	0+1	1+1	1+2	2+2	3+3	0+0	0+1	1+1	1+2	2+2	3+3	0+0	0+1	1+2	1+2	2+2
		Outer									8	7	6	5	4	2	8	7	6	5	4	2	8	7	6	5	4
	Thick spacer	Inner									0+0	0+0	0+0	0+0	0+0	0+0	1+1	1+1	1+1	1+1	1+1	1+1	2+2	2+2	2+2	2+2	2+2
		Outer									5	5	5	5	5	5	3	3	3	3	3	3	1	1	1	1	1
	Fixing spacer	Inner									–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

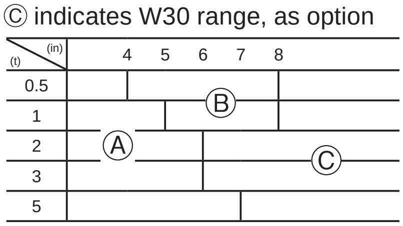
Number of Adjusting Spacers																													
Beam flange width		(in)	6 11/16	6 7/8	7	7 1/16 7 1/8	7 1/4 7 5/16	7 7/8	8	8 7/16	8 11/16	9	9 1/8	9 7/8	10	10 1/8	10 1/4	10 3/8	10 1/2	11	11 1/8	11 1/4	11 3/8	11 5/8	11 3/4	11 13/16	11 7/8	12
Capacity	Parts	(mm)	170	175	178	180 181	184 185	200	203	215	220	229	232	250	254	257	260	264	267	279	283	286	289	295	298	300	302	305
0.5	Thin spacer	Inner	3+3	0+0	0+1	1+1	1+2	4+4	4+5	2+3	3+3	4+5	1+1	0+0	0+1	1+1	1+2	2+2	2+3	4+5	1+1	1+2	2+2	3+3	3+4	4+4	4+5	1+5
		Outer	3	9	8	7	6	1	0	4	3	0	7	9	8	7	6	5	4	0	7	6	5	3	2	1	0	3
	Thick spacer	Inner	2+2	3+3	3+3	3+3	3+3	3+3	3+3	0+0	0+0	0+0	1+1	2+2	2+2	2+2	2+2	2+2	2+2	2+2	3+3	3+3	3+3	3+3	3+3	3+3	3+3	4+3
		Outer	3	1	1	1	1	1	1	7	7	7	5	3	3	3	3	3	3	3	1	1	1	1	1	1	1	0
	Fixing spacer	Inner	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1
1	Thin spacer	Inner	3+3	0+0	0+1	1+1	1+2	4+4	4+5	2+3	3+3	4+5	1+1	0+0	0+1	1+1	1+2	2+2	2+3	4+5	1+1	1+2	2+2	3+3	3+4	4+4	4+5	1+5
		Outer	3	9	8	7	6	1	0	4	3	0	7	9	8	7	6	5	4	0	7	6	5	3	2	1	0	3
	Thick spacer	Inner	1+1	2+2	2+2	2+2	2+2	2+2	2+2	0+0	0+0	0+0	1+1	2+2	2+2	2+2	2+2	2+2	2+2	2+2	3+3	3+3	3+3	3+3	3+3	3+3	3+3	4+3
		Outer	3	1	1	1	1	1	1	7	7	7	5	3	3	3	3	3	3	3	1	1	1	1	1	1	1	0
	Fixing spacer	Inner	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1
2	Thin spacer	Inner	3+3	0+0	0+1	1+1	1+2	0+0	0+1	2+3	3+3	4+5	1+1	0+0	0+1	1+1	1+2	2+2	2+3	4+5	1+1	1+2	2+2	3+3	3+4	4+4	4+5	1+5
		Outer	3	9	8	7	6	9	8	4	3	0	7	9	8	7	6	5	4	0	7	6	5	3	2	1	0	3
	Thick spacer	Inner	0+0	1+1	1+1	1+1	1+1	2+2	2+2	2+2	2+2	2+2	3+3	4+4	4+4	4+4	4+4	4+4	4+4	4+4	5+5	5+5	5+5	5+5	5+5	5+5	5+5	6+5
		Outer	11	9	9	9	9	7	7	7	7	7	5	3	3	3	3	3	3	3	1	1	1	1	1	1	1	0
	Fixing spacer	Inner	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1
3	Thin spacer	Inner	3+3	0+0	0+1	1+1	1+2	0+0	0+1	2+3	3+3	4+5	1+1	0+0	0+1	1+1	1+2	2+2	2+3	4+5	1+1	1+2	2+2	3+3	3+4	4+4	4+5	1+5
		Outer	3	9	8	7	6	9	8	4	3	0	7	9	8	7	6	5	4	0	7	6	5	3	2	1	0	3
	Thick spacer	Inner	0+0	1+1	1+1	1+1	1+1	2+2	2+2	2+2	2+2	2+2	3+3	4+4	4+4	4+4	4+4	4+4	4+4	4+4	5+5	5+5	5+5	5+5	5+5	5+5	5+5	6+5
		Outer	11	9	9	9	9	7	7	7	7	7	5	3	3	3	3	3	3	3	1	1	1	1	1	1	1	0
	Fixing spacer	Inner	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1
5	Thin spacer	Inner	3+3	0+4	1+4	1+1	1+2	0+0	0+1	2+3	3+3	0+1	1+1	0+0	0+1	1+1	1+2	2+2	2+3	0+1	1+1	1+2	2+2	3+3	3+4	4+4	1+4	1+5
		Outer	2	4	3	6	5	8	7	3	2	7	6	8	7	6	5	4	3	7	6	5	4	2	1	0	3	2
	Thick spacer	Inner	2+2	3+2	3+2	0+0	0+0	1+1	1+1	1+1	1+1	2+2	2+2	3+3	3+3	3+3	3+3	3+3	3+3	4+4	4+4	4+4	4+4	4+4	4+4	4+4	5+4	5+4
		Outer	1	0	0	9	9	7	7	7	7	5	5	3	3	3	3	3	3	1	1	1	1	1	1	1	0	0
	Fixing spacer	Inner	–	–	–	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1

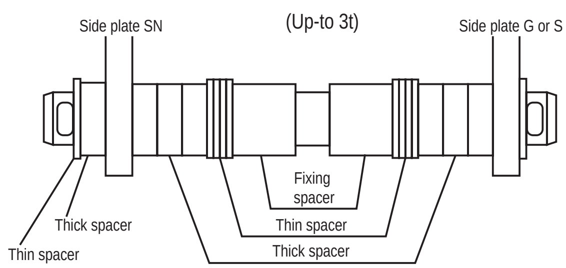
NOTE) 1) Take note the numbers on spacers of innner side as follows.
Example of 0 + 1 0 + 1
Number on side plate G or S
Number on side plate SN

2) Adjustment of trolley width
See clause 3–3.
Adjust the dimensions by appropriately increasing or decreasing the number of inner or outer adjusting spacers, without strictly adhering to the number in the above table.

3) The spacers are delivered in different colors as follows:
Type A: Thick Spacer and Thin Spacer in yellow, and Fixing Spacer in white
Type B: Thick Spacer and Thin Spacer in white, and Fixing Spacer in black

3) Ⓐ indicates standard range.
Ⓑ indicates W20 range, as option
Ⓒ indicates W30 range, as option





(to be continued)

■ Combination of the Electric Chain Hoist and the Manual Trolley

⚠ DANGER

Mandatory

- Use new split pins. After insertion, bend the pin securely at its both ends.

Use of old split pins may result in death or serious injury due to drop.

● 125 kg~3 t

1) **After setting the Suspension Shaft with Spacers, insert it into Frame G or Frame S and fix it with a Shaft Stopper Pin and a Split Pin.**
   - Insert the Shaft Stopper Pin in the direction that the split pin comes to the right when viewed from the side of the Frame G or Frame S.
   - Open the both ends of the Split Pin by 70˚ or more.

2) **Set the Suspension Shaft with a Thin Spacer, Thick Spacer and Fixing Spacer.**

3) **Set the Suspender with the Suspension Shaft.**

4) **Set the Suspension Shaft with another Thin Spacer, Thick Spacer and Fixing Spacer. Then insert the Suspension Shaft into the Frame SN.**
   - Adjust the Spacers in accordance with the rail width. (Refer to “Checking the Number of the Assembled Adjusting Spacers and Their Positions" (P50) for the number of Spacers.)

5) **Set the Suspension Shaft with a Thick Spacer. Fix it with a Shaft Stopper Pin and a split pin.**
   - Insert the Shaft Stopper Pin in the direction that the split pin comes to the right when viewed from the front side of the Frame SN.
   - Open the both ends of the Split Pin by 70˚ or more.

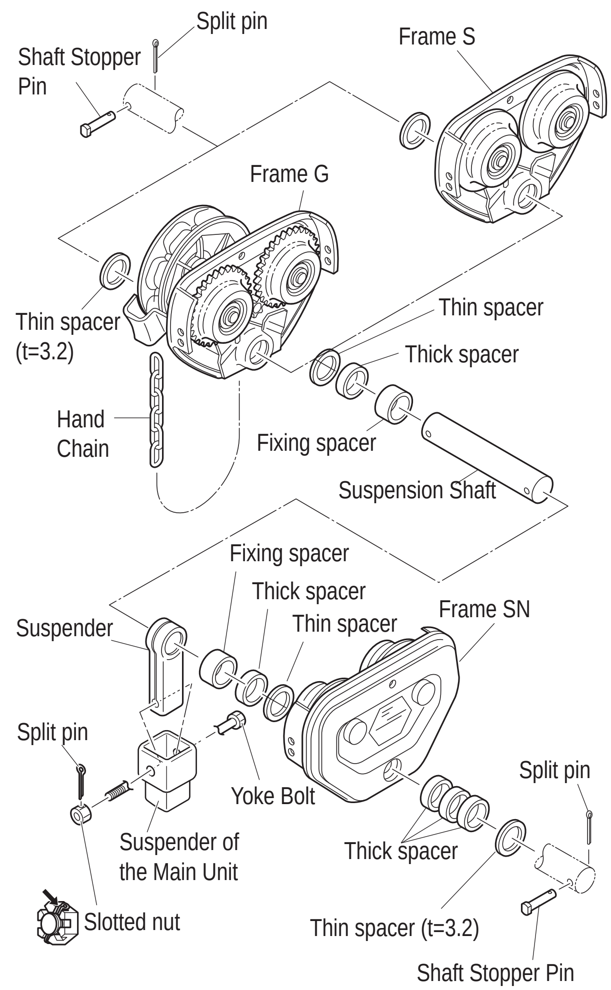
6) **Mount the Suspender to the Connection Yoke with a Yoke Bolt, a slotted nut and a split pin.**

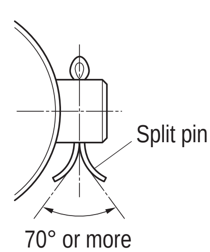
⚠ CAUTION

Mandatory

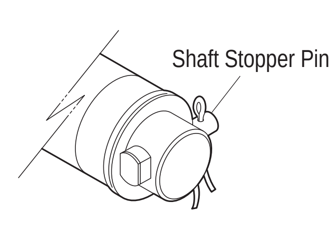
- The orientation of the Geared Trolley with the rating of 2.5 t or less combined with the electric chain hoist differs from that of the Plain Trolley combined with the electric chain hoist by 90 degrees. Combine the trolley and the electric chain hoist correctly referring to the figure in “Models and Names of Each Part" (P12).

Failure to comply with this instruction causes bodily injury or loss of property.





Bending the split pin



Orientation of Shaft Stopper Pin

● **5 t**

1) Fix the Suspension Shaft to the Frame G or the Frame S with a Suspension Shaft Bolt, a slotted nut and a split pin.
- When fixing the Frame G or the Frame S to the Suspension Shaft, use the hole for standard rail width. Use the hole for rail width 190 mm for one stage up rail width. Open the both ends of the split pin by 70˚ or more.
- Attach the split pin to the right side when viewed from the Frame G or the Frame S.
- Open the both ends of the split pin by 70˚ or more.

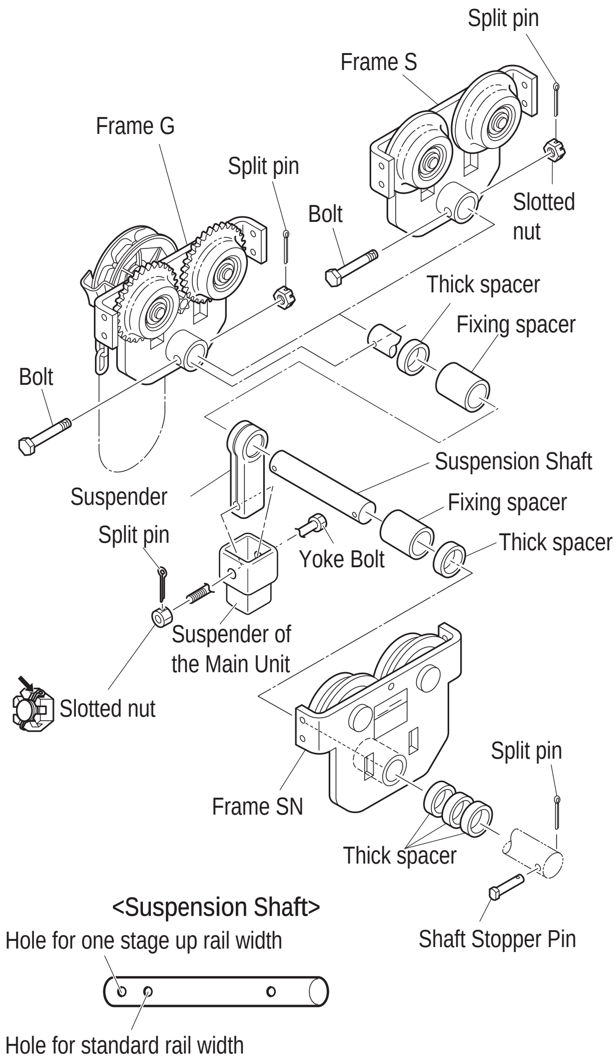
2) Set the Suspension Shaft with a Thin Spacer, Thick Spacer and Fixing Spacer.

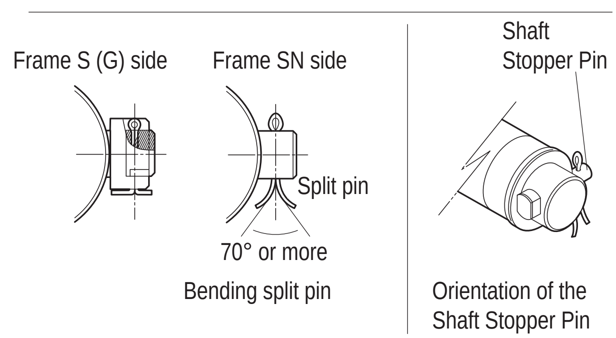
3) Set the Suspender with the Suspension Shaft.

4) Set the Suspension Shaft with another Thin Spacer, Thick Spacer and Fixing Spacer. Then insert the Suspension Shaft into the Frame SN.
- Adjust the Spacers in accordance with the rail width. (Refer to “Checking the Number of the Assembled Adjusting Spacers and Their Positions" (P50) for the number of Spacers.)

5) Set the Suspension Shaft with a Thick Spacer. Fix it with a Shaft Stopper Pin and a split pin.
- Insert the Shaft Stopper Pin in the direction that the split pin comes to the right when viewed from the front side of the Frame SN.
- Open the both ends of the Split Pin by 70˚ or more.

6) Mount the Suspender to the Connection Yoke with a Yoke Bolt, a slotted nut and a split pin.





(to be continued)

Checking Power and Power Cable

DANGER

Mandatory

- Check that the rating of the breaker satisfies the specification required by the electric chain hoist.
- Check that the source voltage satisfies the rated voltage of the electric chain hoist.
- Use a breaker with a capacity in conformance with the product specifications.

Failure to comply with this instruction may result in death or serious injury.

Checking the Power

Hook suspendeed Type:ER2
Manual trolly type:ER2SP/ER2SG

Code	Capacity of fuse and circuit breaker (A)		
	Wire size (mm^2)	220/440V Class	
		Single speed	Dual speed
ER2-001H/IH	AWG16	5/5	5/5
ER2-003S/IS			
ER2-005L/IL			
ER2-003H/IH		10/5	10/5
ER2-005S/IS			
ER2-010L/IL			
ER2-010S/IS		15/10	15/10
ER2-015S/IS			
ER2-020C/IC			
ER2-020L/IL			
ER2-020S/IS	AWG14	30/10	30/15
ER2-025S/IS			
ER2-030S/IS			
ER2-050S/IS			

Code	Wire size (mm^2)	Capacity of fuse and circuit breaker (A)	
		500V Class	
		Single speed	Dual speed
ER2-001H/HD	1.25	5	5
ER2-003S/SD			
ER2-005L/LD			
ER2-003H/HD			
ER2-005S/SD			
ER2-010L/LD			
ER2-010S/SD			
ER2-015S/SD			
ER2-020C/CD			
ER2-020L/LD			
ER2-020S/SD	2	10	10
ER2-025S/SD			
ER2-030S/SD			
ER2-050S/SD			

Motorized trolly type:ER2M

Code	Capacity of fuse and circuit breaker (A)		
	Wire size (mm^2)	220/440V Class	
		ER Single MR Single	ER Dual MR Dual
ER2-001H/IH	AWG14	10/5	10/5
ER2-003S/IS			
ER2-005L/IL			
ER2-003H/IH		15/10	15/10
ER2-005S/IS			
ER2-010L/IL			
ER2-010S/IS			20/10
ER2-015S/IS			
ER2-020C/IC			
ER2-020L/IL			
ER2-020S/IS	AWG12	30/15	30/15
ER2-025S/IS			
ER2-030S/IS			
ER2-050S/IS			

Code	Wire size (mm^2)	Capacity of fuse and circuit breaker (A)	
		500V Class	
		ER Single MR Single	ER Dual MR Dual
ER2-001H/HD	2	5	5
ER2-003S/SD			
ER2-005L/LD			
ER2-003H/HD			
ER2-005S/SD			
ER2-010L/LD			
ER2-010S/SD			
ER2-015S/SD			
ER2-020C/CD			
ER2-020L/LD			
ER2-020S/SD	3.5	10	10
ER2-025S/SD			
ER2-030S/SD			
ER2-050S/SD		20	20

Checking the Power Cable

CAUTION

Prohibited

- Do not use the cable other than the cable attached to the Body size or optional Power Cable.

Failure to comply with this instruction causes bodily injury or loss of property.

Mandatory

- Satisfy the maximum permissible length and core cross section of the Power Cable.

Failure to comply with this instruction causes bodily injury or loss of property.

Refer to the following table for the permissible length and the size of the standard Power Cable.
When using the cable of the size other than those described in the table, decide the cable length using the following formula.

$$\text{Permissible length (m)} = \frac{1000}{30.8} \times \frac{\text{Cross section of one core (mm}^2\text{)} \times \text{Rated voltage (V)} \times 0.02}{\text{Rated current (A)}}$$

● Hook suspendeed Type:ER2
Manual trolly type:ER2SP/ER2SG

(Unit: m)

Code	Wire size (mm^2)	220/440V Class Single speed 60Hz 220-230V	Single speed 60Hz 415-440V	Dual speed 60Hz 220-230V	Dual speed 60Hz 415-440V
ER2-001H/IH ER2-003S/IS ER2-005L/IL	AWG16 (AWG14)	49 (79)	197 (316)	46 (74)	186 (298)
ER2-003H/IH ER2-005S/IS ER2-010L/IL	AWG16 (AWG14)	35 (56)	134 (215)	33 (52)	124 (199)
ER2-010S/IS ER2-015S/IS ER2-020C/IC ER2-020L/IL	AWG16 (AWG14)	19 (31)	80 (128)	18 (29)	74 (119)
ER2-020S/IS ER2-025S/IS ER2-030S/IS ER2-050S/IS	AWG14 (AWG12)	16 (28)	68 (119)	15 (27)	64 (113)

(Unit: m)

Code	Wire size (mm^2)	500V Class Single speed 60Hz 575V	Dual speed 60Hz 575V
ER2-001H/HD ER2-003S/SD ER2-005L/LD	1.25 (2)	253 (405)	253 (405)
ER2-003H/HD ER2-005S/SD ER2-010L/LD	1.25 (2)	202 (324)	225 (360)
ER2-010S/SD ER2-015S/SD ER2-020C/CD ER2-020L/LD	1.25 (2)	135 (216)	126 (202)
ER2-020S/SD ER2-025S/SD ER2-030S/SD ER2-050S/SD	2 (3.5)	108 (189)	108 (189)

● Motorized trolly type:ER2M

(Unit: m)

Code	Wire size (mm^2)	500V Class ER single MR single 60Hz 575V	ER dual MR dual 60Hz 575V	ER dual MR single 60Hz 575V	ER single MR dual 60Hz 575V
ER2-001H/HD ER2-003S/SD ER2-005L/LD	2 (3.5)	209 (365)	196 (346)	209 (365)	196 (343)
ER2-003H/HD ER2-005S/SD ER2-010L/LD	2 (3.5)	185 (324)	185 (324)	196 (343)	175 (306)
ER2-010S/SD ER2-015S/SD ER2-020C/CD ER2-020L/LD	2 (3.5)	144 (252)	132 (231)	137 (241)	137 (241)
ER2-020S/SD ER2-025S/SD ER2-030S/SD	3.5 (5.5)	151 (237)	143 (225)	151 (237)	143 (225)
ER2-050S/SD	3.5 (5.5)	138 (217)	143 (225)	138 (217)	143 (225)

(Unit: m)

Code	Wire size (mm^2)	220/440V (Class230/460V Class) ER single MR single 60Hz 220V	ER single MR single 60Hz 440V	ER dual MR dual 60Hz 220V	ER dual MR dual 60Hz 440V	ER dual MR single 60Hz 220V	ER dual MR single 60Hz 440V	ER single MR dual 60Hz 220V	ER single MR dual 60Hz 440V
ER2-001H/IH ER2-003S/IS ER2-005L/IL	AWG14 (AWG12)	40 (71)	163 (285)	38 (67)	153 (268)	39 (69)	158 (276)	39 (69)	158 (276)
ER2-003H/IH ER2-005S/IS ER2-010L/IL	AWG14 (AWG12)	33 (59)	131 (229)	31 (55)	122 (213)	32 (56)	125 (218)	32 (57)	128 (224)
ER2-010S/IS ER2-015S/IS ER2-020C/IC ER2-020L/IL	AWG14 (AWG12)	22 (40)	92 (162)	31 (37)	86 (151)	21 (38)	88 (154)	22 (39)	91 (159)
ER2-020S/IS ER2-025S/IS ER2-030S/IS	AWG12 (AWG10)	24 (37)	99 (155)	22 (35)	94 (147)	23 (36)	95 (149)	23 (37)	98 (154)
ER2-050S/IS	AWG12 (AWG10)	21 (34)	90 (142)	20 (32)	85 (134)	21 (33)	87 (137)	21 (34)	88 (139)

(to be continued)

Connecting Cables

NOTE

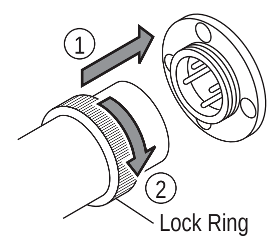
- When clamping a connector, do not use tools. Be sure to clamp it by hand.
  Excessive tightening of a connector may result in the damage or breakage f plastic thread part.
- To prevent wire breakage and unintentional removal of a connector, tie the protection wire attached to the Push Button Switch Cord to the body size of the electric chain hoist or the trolley.
  Be sure to tie the cord with the body size or the trolley to prevent the wire breakage and removal of connector when the cord is pulled strongly.
- Be sure to turn off the power when carrying out the repair work of wire breakage or removal of the connector.

Hook suspended model (hoist only)

125 kg~5 t

● **Connecting the Power Cable**

1) Insert the 4-pin plug of the Power Cable to the socket (4P) and tighten the Lock Ring securely.

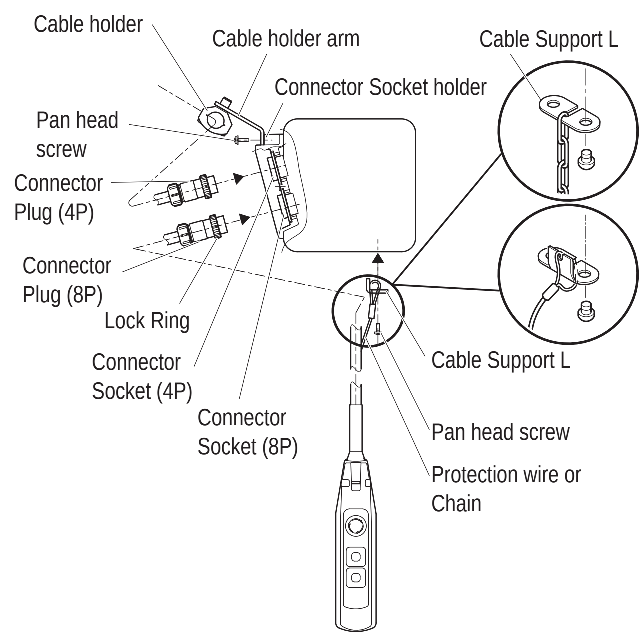


2) Fix the Power Cable using cable support with a slack.

● **Connecting the Push Button Switch Cord**

1) Insert the 8-pin connector plug of the Push Button Cord to the connector socket (8P) and tighten the Lock Ring securely.

2) Pass the Cable Support L into the ring at the end of the Protection Wire. Put the Protection Wire or Chain in the notch of the Cable Support L.
Then fix the Cable Support L to the body size (at the bottom face of the Gear Case).



Motorized Trolley Type

125 kg~5 t

● Connecting the relay cable

1) **Insert the connector plug (4P) of relay cable for power supply in the connector socket (4P) of ER2. Tighten the Lock Ring securely.**

2) **Insert the connector plug (8P) of relay cable for operation in the connector socket (8P) of ER2. Tighten the Lock Ring securely.**

● Connecting the Power Cable

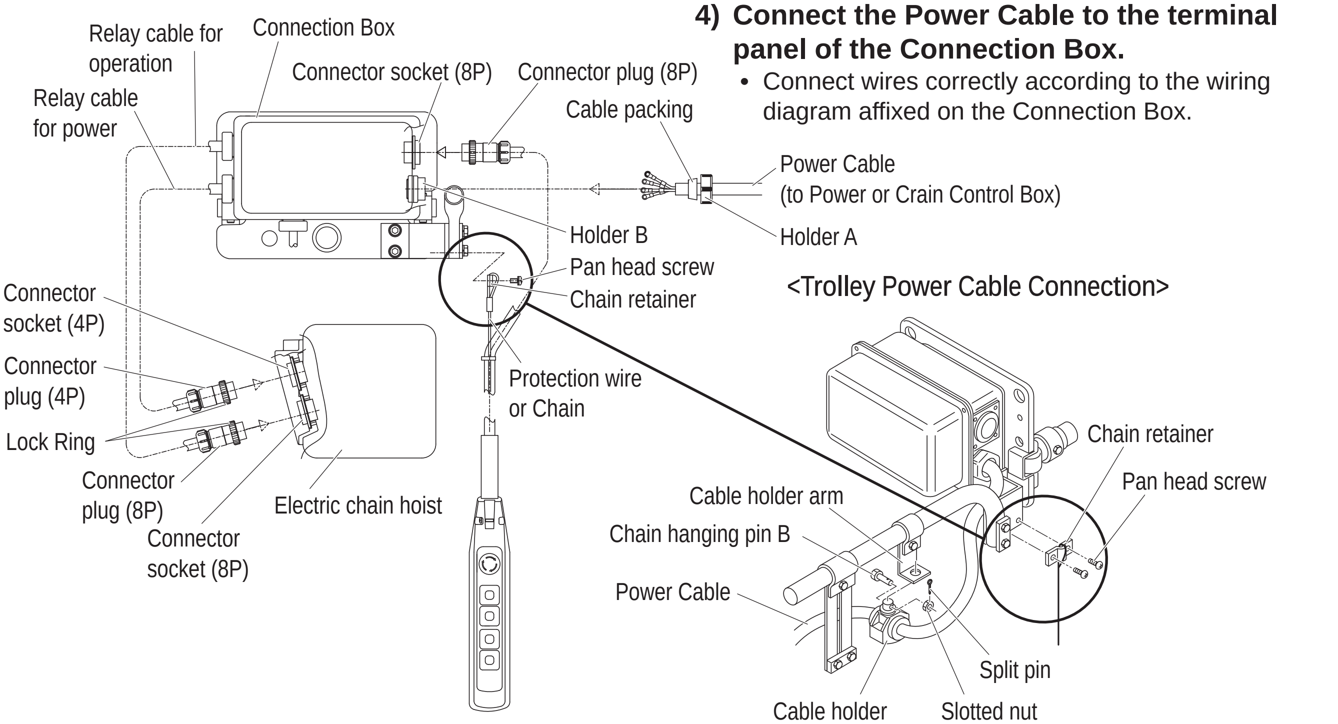
1) **Remove the Holder A mounted to the Connection Box.**

2) **Pass the Power Cable through the Holder A supported by the cable holder and the cable packing.**

3) **Insert the Power Cable to the Holder B of the Connection Box and tighten the Holder A securely.**
   - **Trolley Type**

   1) **Mount the cable holder, which the Power Cable is passed, to the cable holder arm using a chain hanging pin B, a slotted nut and a split pin.**

4) **Connect the Power Cable to the terminal panel of the Connection Box.**
   - Connect wires correctly according to the wiring diagram affixed on the Connection Box.



<Trolley Power Cable Connection>

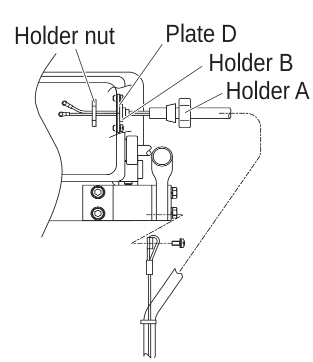
● Connecting the Push Button Switch Cord

1) **Insert the connector plug (8P) of Push Button Switch Cord in the connector socket (8P). Tighten the Lock Ring securely.**
   - **Direct-mount**

   1) **Mount the Holder B, which the Push Button Switch Cord is passed, to the plate D using the holder nut.**
   2) **Connect the Push Button Switch Cord to the terminal panel of the Connection Box.**

2) **Pass the Chain retainer into the hoop at the end of the Protection Wire or Chain and fix it to the bar holder with a pan head screw.**

<Direct-mount Push Button Switch Cord Connection>

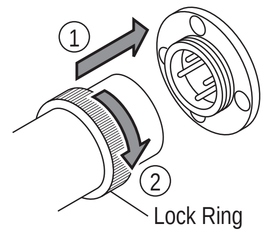


(to be continued)

■Manual Trolley Type

■125 kg~5 t

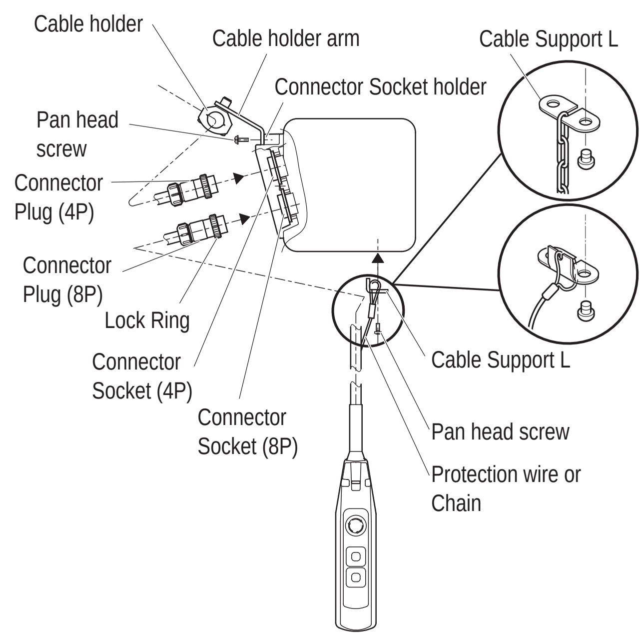
● Connecting the Power Cable



1) **Insert the 4-pin plug of the Power Cable to the socket (4P) and tighten the Lock Ring securely.**

2) **Fix the Power Cable using cable support with a slack.**

● Connecting the Push Button Switch Cord



1) **Insert the 8-pin connector plug of the Push Button Cord to the connector socket (8P) and tighten the Lock Ring securely.**

2) **Pass the Cable Support L into the ring at the end of the Protection Wire or Chain. Put the Protection Wire in the notch of the Cable Support L.**
Then fix the Cable Support L to the body size (at the bottom face of the Gear Case).

Installation

⚠ DANGER

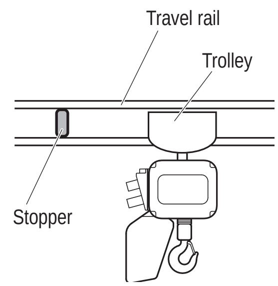
Prohibited

- Installation (removal) of the electric chain hoist must be carried out by special installer or by personnel with expertise.
  Consult with the sales shop or KITO for installation, or consign the installation work to special installer or personnel with expertise.
- Do not install the electric chain hoist at a place exposed to rain or water always or the place different from the Operational Environment (P18).
- Do not install the electric chain hoist in the motion space of other trolley or any other moving equipment (facility).
- Do not use the electric chain hoist contacting with other object, or being fixed.

Failure to comply with these instructions may result in death or serious injury.

Mandatory

- When installing or removing the electric chain hoist, follow the instructions in Owner's Manual.
- Carry out the work for grounding (earthing) and installation of earth leakage breaker.
- When the installation is completed, carry out “Check after Installation". (See P61)
- Connect the power after all installation works have been completed and just before the operation check.
- Mount the stopper at the both ends of the travel rail for trolley. <Fig. A>
- Make sure that the strength of the structure is sufficient to install the electric chain hoist.
- Carry out the installation work after securing the stable hoothold.
- When not using the KITO Standard Trolley and use the Electric Chain Hoist incorporated as part of your travel device, make sure to contact KITO for precautions.



A

Failure to comply with these instructions may result in death or serious injury.

⚠ CAUTION

Mandatory

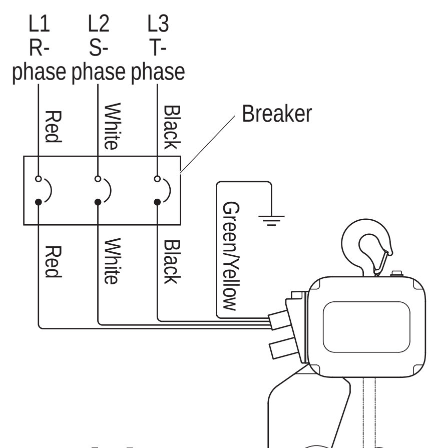
- Connect the Power Cable to the power of rated voltage.

Failure to comply with this instruction causes bodily injury or loss of property.

Connecting Power and Power Cable

When connecting the Power Cable to the power, connect the cable in accordance with the following instructions.

- Connect the electric chain hoist to the power through a breaker.
- Connect the electric chain hoist in the correct phase.
  (When 'Check after Installation (P61)' is completed, carry out the operation check for the correct phase.)
- Earth wire is a green colored covered cable with yellow line. Carry out Class D earthing work.
- Use correct breaker and Power Cable referring to Checking the Power and the Power Cable (P53) for the breaker capacity, Power Cable length and its size.



Installing the Hook Suspended Type (hoist only)

Checking Installation Method and Place

⚠ DANGER

Mandatory

- When using an electric chain hoist suspended (as a single unit) without combination with a trolley, make sure that the Hook Latch of the Top Hook closes securely.
- Make sure that the Top Hook and body can swing freely. Do not restrain the Top Hook and body during use.
- Do not install and use the electric chain hoist upside down.

Failure to comply with these instructions may result in death or serious injury.

(to be continued)

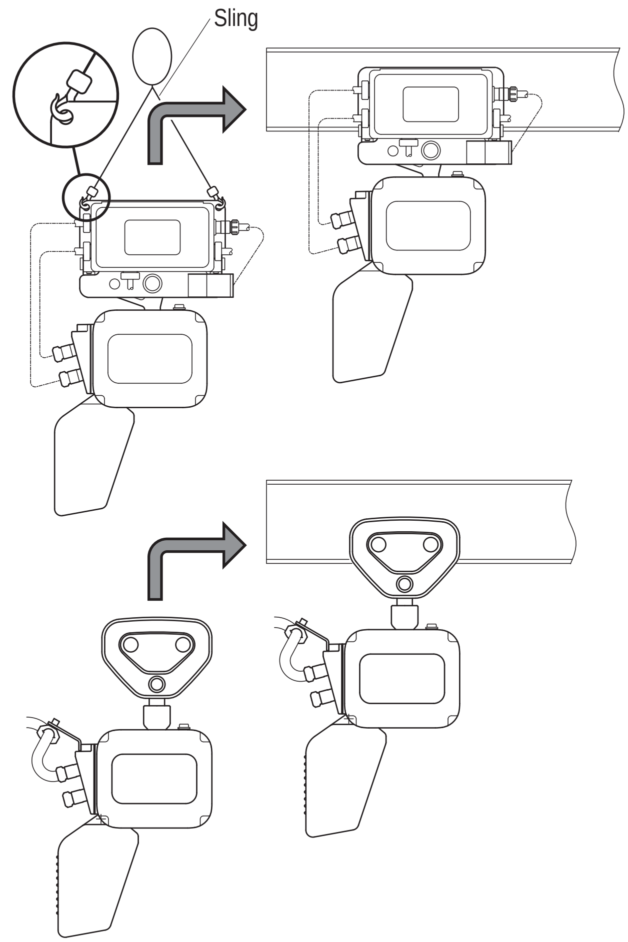
■Installing the Trolley Combined Model

■Mounting the Hoist to the Travel Rail

1) Make sure that the dimensions of the Trolley Frame satisfy the size of the rail to which the trolley is installed.

2) Make sure that the rail is set to a level.

3) Install the electric chain hoist combined with the trolley to the rail from its one end



● **When the gap between the rail end the wall of the housing is scarce**

⚠ CAUTION

Mandatory

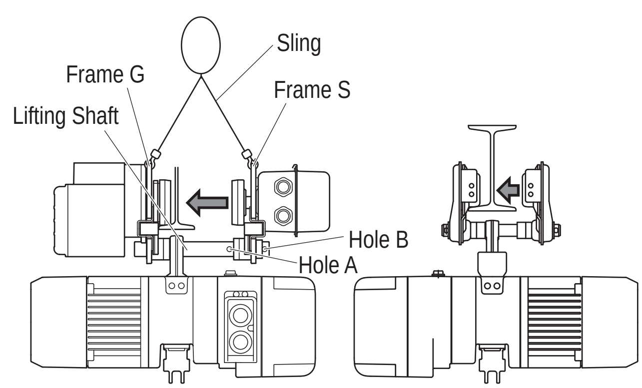
- Securely support the electric chain hoist Mode ER2 not to tilt.

Failure to comply with this instruction causes bodily injury or loss of property.

1) Assemble the Trolley temporarily using the hole B of the Suspension Shaft and install the electric chain hoist from the bottom side of the Travel Rail.

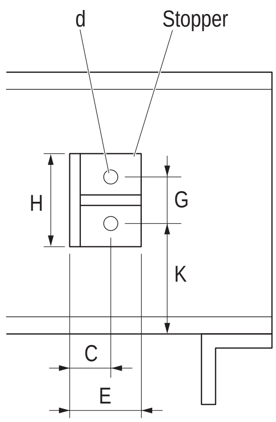
2) Set the wheel at G side of the Trolley Frame on the running face of the Travel Rail. Then push the Frame S into the Frame G.

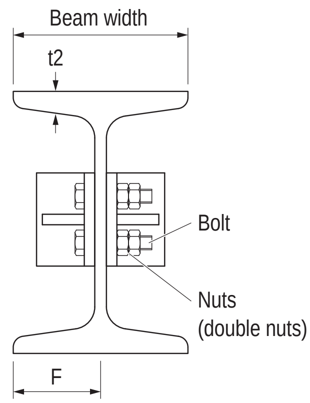
3) Insert the Shaft Stopper Pin into the Hole A of the Suspension Shaft. Then mount a split pin securely.



Mounting the Stopper

Be sure to mount the stoppers at the both ends of the rail to prevent drop.
Decide the mounting position in accordance to the size of the wheel.
When the customer wants to make the stopper by oneself, refer to the following figures.





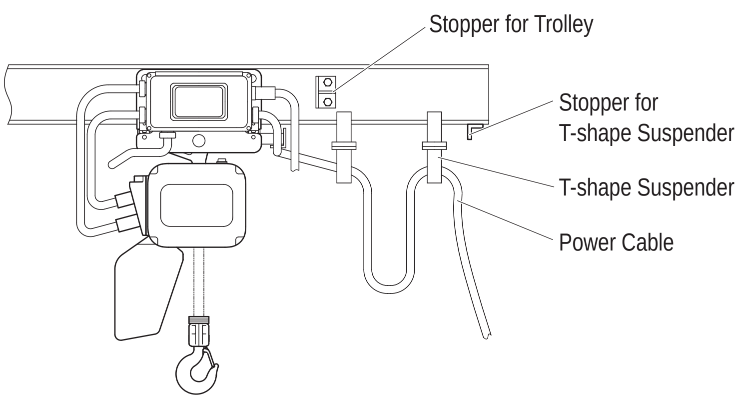
(Unit: mm)

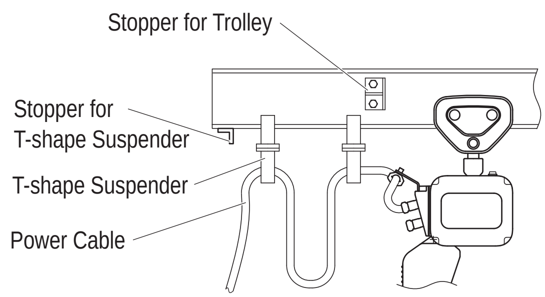
Capacity	~2t				2.5t~5t		
Beam width	100	125	150	175	125	150	175
Material dimensions	L-50x50x6	L-50x50x6	L-65x65x8	L-75x75x9	L-50x50x6	L-65x65x8	L-75x75x9
H	80	80	80	80	100	100	100
E	50	50	65	75	50	65	75
F	40	50	65	75	50	65	75
G	50	50	50	50	60	60	60
C	30	30	35	40	30	35	40
K	65	t2+50	t2+50	t2+50	t2+60	t2+60	t2+60
d	ϕ14	ϕ14	ϕ14	ϕ14	ϕ18	ϕ18	ϕ18
Bolt size	M12x50x50	M12x55x55	M12x55x55	M12x60x60	M16x65x65	M16x65x65	M16x65x65

NOTE) Dimension K is for the case to use combining the hoist with the motorized trolley. When using the hoist combined with a manual trolley, mount the stopper in accordance with the bumper position.

● When using T-shape Suspender

Install the additional stopper for T-shape Suspender at the end of one rail.



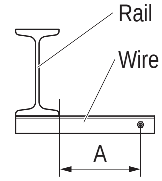


(to be continued)

■ Power Cable Layout for Motorized/Manual trolley type

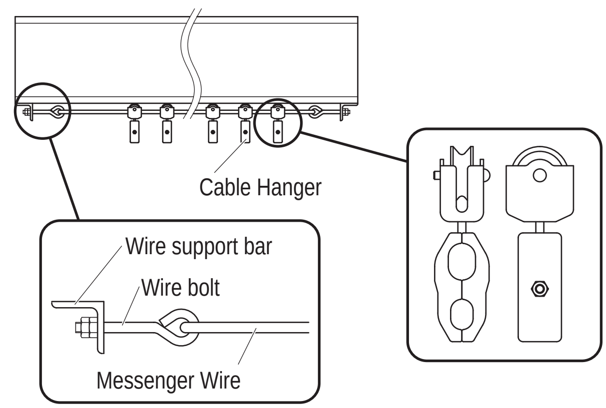
- In the standard specification the Suspender is provided. T-shape Suspender and angle type Suspender are also available as optional parts. T-shape Suspender can be applicable to curved rail, however, the application method differs depending on the condition such as radius of curvature. In such case, contact KITO.

1) Mount the wire support bar at the both ends of the rail.



2) Tie the Messenger Wire passed through the Cable Hanger to the Wire Support Bar with two Wire Bolts.

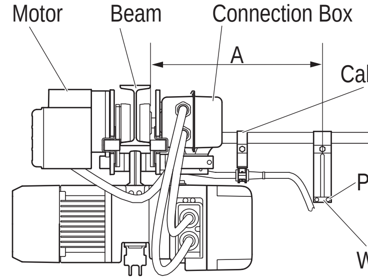
- The recommended mounting interval of the Cable Hangers is 1.5 m to 2 m.
- Use steel wire of 3 to 6 mm in diameter for the Messenger Wire.



3) Loosen two pan head screws and remove the end clip of the wire guide.

4) Pass the Messenger Wire through the groove of the messenger guide. Mount the end clip with two pan head screws.

- The dimension A between the side face of the rail and the groove of the wire guide must be same as that of mounting hole of the Wire support bar for the Messenger Wire and the side face of the rail.

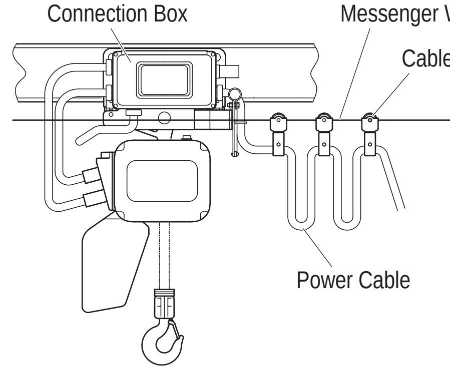


5) Fix the Power Cable to the Cable Hanger.

6) Mount the Cable Support to the Cable Support Arm.

7) Insert the Power Cable into the Connection Box of MR2 and connect it to the terminal panel.

- Connect wires correctly according to the wiring diagram affixed on the Connection Box.



Check after Installation

Wrong assembling or installation causes death or serious injury. To prevent such danger check the following.

Check items

Make sure that the following are satisfied:

- No bolt, nut nor split pin is lost. Tightening and assembling are completed.
- Protection Wire for Push Button Switch Cord is securely tied to accept and endure the force instead of Push Button Switch Cord when the Push Button Switch Set is drawn.
- The Power Cable is fixed to the Cable Support.
- Source voltage is the rated voltage
- Grounding Wire (earth wire) is connected securely.

● When using with a Trolley

Check the following:

- The electric chain hoist and the trolley are combined correctly.
- The stoppers for trolley are securely mounted to Travel Rail where the Trolley travels.
- The surface of Travel Rail is not attached with paint or oil. (The surface of the Travel Rail must be basis metal. Do not paint.) There is no obstacle for the trolley to travel. The Travel Rail is set to a level.)

Operational Check

Carry out the operational check in accordance with Daily inspection (P20).

Chapter 2

Inspection

This chapter describes frequent inspection items and periodic inspection items. Refer to Chapter 1 for the “Handling the Product”. Inspection is the first step of safety. Carry out daily inspection, frequent inspection and periodic check.

Table of Contents

● Reference

Daily inspection is described in Chapter 1 "How to Use the Product". Refer to the following daily inspection items and their relevant pages.

Safety Precautions

General Matters related to Inspection

⚠ DANGER

Prohibited

- Disassembly and assembly of the electric chain block must be performed by maintenance engineer.
- Do not use the part exceeding the service limit or criteria and the parts other than genuine part for KITO electric chain hoist.
  Even if the part is genuine KITO part, it cannot be used for other model. Refer to Disassembly/Assembly Manual (Annex) for the correct use of the part.
- Do not adjust or disassemble the Electromagnetic Brake, the Friction Clutch and the Friction Clutch with Mechanical Brake.
- Do not adjust the set nut.
- When oiling the Friction Clutch and the Friction Clutch with Mechanical Brake, use KITO genuine oil (manufacturer specified oil).
- Do not carry out the inspection of electric chain hoist with a lifted load.
- Do not use the electric chain hoist removing the cushion rubber, the chain spring and the stopper.
- Turn off the main power when carrying out the inspection.
- When using oils such as gear oil and grease, avoid places with fire or sparks.

Failure to comply with these instructions may result in death or serious injury.

Mandatory

- Put the electric chain hoist on the floor or work bench when performing the repair and disassembling of the electric chain hoist.
- Even if each component of the electric chain hoist does not exceed the service limit, replace the part exceeding the total operating hours derived from the grade indicated on the electric chain hoist and the load factor.
- Do not use the electric chain hoist when any abnormality was observed during the inspection. Indicate "FAILURE" on the hoist and contact with maintenance engineer or KITO for repair.
- After completion of the inspection (frequent, periodic), perform the functional check and make sure that the electric chain hoist operates correctly.
- When performing the functional check, be sure to perform the capacity test after no load test.

Failure to comply with these instructions may result in death or serious injury.

⚠ CAUTION

Mandatory

- Indicate "CHECKING" when performing the inspection.
  When a crane is operated erroneously during the inspection, it may result in the accident such as fall-off of parts and tools and downfall.
- Wear protection equipment such as protection goggles and gloves depending on the work contents.
  Otherwise it may result in the injury due to scattered oil or sharp edge of a part.
- Pay attention to work method, work procedure and work posture.
  If the product or the part is heavy, your hand is caught or your waist is hurt.
  Especially be careful for the work on an unstable scaffold such as the work at high lifted place using stepladder.
- Wear helmet and safety belt when carrying the high lift work.
  Otherwise it may result in injury or downfall accident.
- Remove the oil attached to the product or spilt on the floor.
  Otherwise it may result in injury due to drop of the product or overturning.
- Keep the work area clean when disassembling the product.
  Assembling or mixing the part other than genuine part may result in the damage of the product or the accident due to defective operation.

NOTE

- When performing the frequent inspection, carry out the daily inspection at the same time.
- When performing the periodic inspection, carry out the frequent inspection at the same time.
- When detecting any abnormality during inspection due to erroneous use, instruct the operator and user for correct use of the electric chain hoist.
  Ex. (1) The flaw on the Chain Guide A hit with the Chain (Cause: lifting incline)
  (2) The deformation of the Cushion Rubber and the Chain Spring (Cause: excessive use of the limit switch)

Frequent Inspection

General Matters on Frequent Inspection

⚠ DANGER

Mandatory

- After completion of the frequent inspection, perform the functional check and make sure that the electric chain hoist operates correctly.

Neglecting to perform the functional check may result in death or serious injury.

General Matters on Handling the Dual Speed VFD Model

⚠ DANGER

Prohibited

- Do not change the VFD parameter.
  When parameters need to be changed, ask our distributors nearest to the customer or KITO.
- Do not carry out the work such as maintenance and inspection within 5 minutes after power off.
  Wait for the completion of discharging of the capacitor inside the VFD.
- Do not touch the controller cover as it becomes hot during operation.
- Do not touch the controller cover until about 30 minutes elapsed after the stop of operation.
- USE KITO genuine VFD.
  The VFD requires the special specification for KITO. Be sure to use genuine VFD.
- Do not change the connection of the VFD.
  When the wires were removed for any reason, connect them again correctly checking the wiring diagram inside the controller cover.
- Do not carry out withstand voltage test of a circuit while the VFD is connected.
- Do not turn off the power while operating.

Failure to comply with these instructions may result in death or serious injury and the damage of VFD.

NOTE

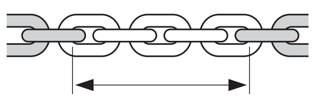
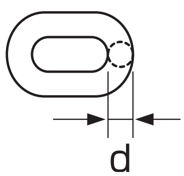
When performing the frequent inspection, carry out the daily inspection at the same time.

- Check the electric chain hoist as installed, standing on the floor.
- Refer to Appendix “Technical Material” (P122) for the structure of the product and the name of each part.

Electric Chain Hoist (ER2) Frequent Inspection

Load Chain

- Check the Load Chain after removing the stain on the chain.
- Use the needle head caliper (point caliper) to measure the sum of pitches and wire diameter.
- Apply oil on the Load Chain after inspection.
- Application of lubricant influences on the life of the Load Chain considerably. Use the KITO genuine lubricant or equivalent (industrial lithium grease: consistency No.0)
- Release all loads from the Load Chain. Apply the lubricant to the linking portion of the Load Chain that engages the Load Sheave and the Idle Sheave and the linking portion of the Load Chain.
- After application of the lubricant lift/lower the electric chain hoist without load to spread the lubricant on the Load Chain.

Item	Check method	Criteria	When failed
Elongation of Pitch	• Measure the elongation of pitch with point caliper. (Measure the sum of pitches of 5 links)  Sum of pitches of 5 links	**NOTE** Check the engaging point of the Load Sheave and the Idle Sheave especially carefully. • The limit value of the following "Sum of pitches of five links" must not be exceeded.	Replace the Load Chain.
Abrasion of wire diameter	• Measure the wire diameter (d) with point caliper.  	• The limit value of the following "Wire diameter of the Load Chain" must not be exceeded. **NOTE** When the abrasion of the Load Chain is observed, be sure to check the abrasion of the Load Sheave and the Idle Sheave also. (Refer to "Periodic Inspection", "Load Sheave" (P81).)	Replace the Load Chain.

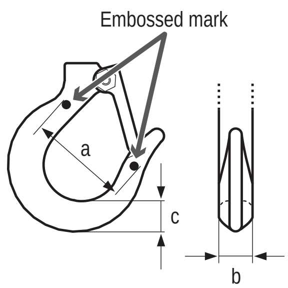
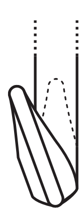
Load Chain Pitch and Wire Diameter for Each Capacity

Code	Capacity	Load Chain diameter (mm)	Sum of 5 Links (mm)		Load Chain diameter (mm)	
			Do not exceed the limit		Do not fall under the limit	
			Standard	Limit	Standard	Limit
ER2-001H/IH	125kg	ϕ4.3×1	60.5	62.5	4.3	3.9
ER2-003S/IS/SD	250kg					
ER2-003H/IH/HD		ϕ6.0×1	84	86.5	6	5.4
ER2-005L/IL/LD	500kg					
ER2-005S/IS/SD						
ER2-010L/IL/LD	1t	ϕ7.7×1	108	111.2	7.7	6.9
ER2-010S/IS/SD						
ER2-015S/IS/SD	1.5t	ϕ10.2×1	143	147.2	10.2	9.2
ER2-020C/IC/CD	2t	ϕ7.7×2	108	111.2	7.7	6.9
ER2-020L/IL/LD		ϕ10.2×1	143	147.2	10.2	9.2
ER2-020S/IS/SD						
ER2-025S/IS/SD	2.5t	ϕ11.2×1	157	161.7	11.2	10.1
ER2-030S/IS/SD	3t	ϕ10.2×2	143	147.2	10.2	9.2
ER2-050S/IS/SD	5t	ϕ11.2×2	157	161.7	11.2	10.1

(to be continued)

Frequent Inspection (continued)

■ Top Hook, Bottom Hook

<table>
<tr><th>Item</th><th>Check method</th><th>Criteria</th><th>When failed</th></tr>
<tr>
<td>Opening and Abrasion of the Hook</td>
<td>• Check visually and measure with vernier caliper.

</td>
<td>
⚠ CAUTION
Mandatory
• Compare the dimensions of a, b and c with those at purchasing. Check that they are within the criteria.
The use of the Hooks with these dimensions exceeding the criteria may result in bodily injury or property damage.
<table>
<tr><th>Measured value (mm)</th><th>Limit value</th></tr>
<tr><td>Dimension a</td><td>Not to exceed the dimension at purchasing</td></tr>
<tr><td>Dimension b</td><td rowspan="2">Abrasion not to exceed 5%</td></tr>
<tr><td>Dimension c</td></tr>
</table>
• Following tables shows the nominal standard values. Please be aware that these values include tolerance because of forging.
ER2 Hook Service Limit (P92) or Criteria
<table>
<tr><th rowspan="2">Code</th><th rowspan="2">Capacity</th><th>Dimension a (mm)</th><th colspan="2">Dimension b (mm)</th><th colspan="2">Dimension c (mm)</th></tr>
<tr><th>Standard</th><th>Standard</th><th>Limit value</th><th>Standard</th><th>Limit value</th></tr>
<tr><td>ER2-001H/IH/HD</td><td>125kg</td><td rowspan="4">45.0</td><td rowspan="4">17.5</td><td rowspan="4">16.6</td><td rowspan="4">23.5</td><td rowspan="4">22.3</td></tr>
<tr><td>ER2-003S/IS/H/IH/HD</td><td>250kg</td></tr>
<tr><td>ER2-005L/IL/LD</td><td rowspan="2">500kg</td></tr>
<tr><td>ER2-005S/IS/SD</td></tr>
<tr><td>ER2-010L/IL/LD</td><td rowspan="2">1t</td><td rowspan="2">50.0</td><td rowspan="2">22.5</td><td rowspan="2">21.4</td><td rowspan="2">31.0</td><td rowspan="2">29.5</td></tr>
<tr><td>ER2-010S/IS/SD</td></tr>
<tr><td>ER2-015S/IS/SD</td><td>1.5t</td><td>60.0</td><td>26.5</td><td>25.2</td><td>36.5</td><td>34.7</td></tr>
<tr><td>ER2-020L/IL/LD</td><td rowspan="2">2t</td><td rowspan="3">69.0</td><td rowspan="3">31.5</td><td rowspan="3">29.9</td><td rowspan="3">43.5</td><td rowspan="3">41.3</td></tr>
<tr><td>ER2-020S/IS/SD</td></tr>
<tr><td>ER2-025S/IS/SD</td><td>2.5t</td></tr>
<tr><td>ER2-030S/IS/SD</td><td>3t</td><td>73.0</td><td>34.5</td><td>32.8</td><td>47.5</td><td>45.1</td></tr>
<tr><td>ER2-050S/IS/SD</td><td>5t</td><td>83.0</td><td>42.5</td><td>40.4</td><td>56.0</td><td>53.2</td></tr>
</table>
</td>
<td>Replace the Hook.</td>
</tr>
<tr>
<td>Deformation, Flaw, Corrosion
</td>
<td>• Check visually.</td>
<td>• No deformation such as bend or twist
• No deep cut
• No loosened bolt or not, or their fall off
• No considerable corrosion
• No attachment of foreign matter such as sputter</td>
<td>Replace the Hook.</td>
</tr>
</table>

Peripheral parts of the Body size

● Use check stand to check the electric chain hoist from the close point.

Item	Check method	Criteria	When failed
Chain Container	• Check visually.	• To be mounted to the body size securely • No damage, tear, abrasion or deformation • Check no foreign matter inside the Chain Container. * Especially be careful when the electric chain hoist is used outdoor. • Make sure that the lift of the Load Chain is smaller than the capacity of the Chain Container. **⚠ DANGER** Mandatory • Do not use the torn Chain Container. • Use the Chain Container with the capacity larger than the lift of the Load Chain. Otherwise it may result in death or serious injury due to drop of the Load Chain.	Replace the Chain Container. Discard the foreign matter in the Chain Container. If the capacity of the Chain Container is smaller than the lift of the Load Chain, replace the Chain Container with the adequate Chain Container referring to “Mounting the Chain Container”.

Electromagnetic Brake

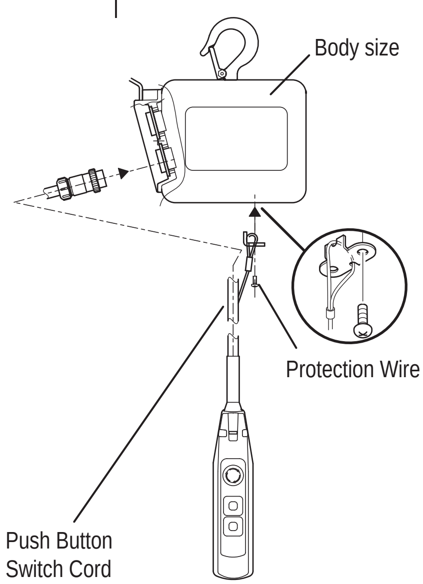
Item	Check method	Criteria	When failed
Number of start	• Check the number of start with the CH Meter.	• The number of start must be less than one million times. * Estimate the time to reach at one million times.	Perform the inspection in accordance with “Guidelines on Brake Inspection” (P91).

(to be continued)

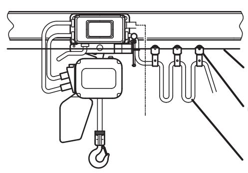
Frequent Inspection (continued)

■ Push Button Switch

Item	Check method	Criteria	When failed
Push Button Switch Body size	• Check visually and by operation.	• No damage, deformation and loosened bolt. • Push Button Switches can be operated smoothly. • Emergency Stop Button can be operated and cancelled.	Replace the Push Button Switch.
Push Button Switch Cord	• Check visually.	• Push Button Switch Cord is securely connected. • The Protection Wire is tied with the body size so that Push Button Switch Cord is not strained directly even if the Push Button Switch is pulled.	Tie the Push Button Switch Cord and the Protection Wire to the body size properly.
		• To have no damage	Replace the Push Button Switch Cord.



Power Supply

Item	Check method	Criteria	When failed
Power Cable	• Check visually.	• Power Cable to have enough length. • To have no damage • To be connected securely	Replace the Power Cable.
Cable Hanger	• Check visually and by moving by hand. 	• To have no damage • To move smoothly • To be mounted at equal interval ··· Appropriate interval 1.5 m	Re-mount the Cable Hangers for no hindrance to cable motion.
Messenger Wire	• Check visually.	• To have no sag	Remove the sag.

Function and Performance

● Check the following item with no load.

Item	Check method	Criteria	When failed
Abnormal Noise	• Check the noise of gear, motor and the Load Chain during operation with no load. **NOTE** Sound is also an important check point. Always be careful for the noise of the electric chain hoist.	• To sound no irrotating noise • To sound no howling of motor and scraping sound of the Brake • To sound no abnormal noise	Replace the abnormal part.
		• To sound no popping sound from the Load Chain	Check the Load Chain. (Refer to P69.)

(to be continued)

Motorized Trolley (MR2) Frequent Inspection

Appearance

Item	Check method	Criteria	When failed
Travel Rail	• Check visually.	• To have no considerable deformation and damage	Check items in accordance with “Travel Rail” described in Chapter 2 “Periodic Inspection”. (P86)
Oiling (to the gears of wheel)	• Check visually.	• To be oiled adequately	Apply oil to gears.

Push Button Switch, Power Supply

Carry out the inspection referring to “Frequent Inspection Items” of the electric chain hoist (ER2). (P72, 73)

Manual Trolley (TS2) Frequent Inspection

Appearance

Item	Check method	Criteria	When failed
Combination	• Shake the manual trolley to check.	• The motorized trolley shakes lightly to right and left.	Combine the electric chain hoist and the manual trolley securely.
Travel Rail	• Check visually.	• To have no considerable deformation and damage	Check items in accordance with “Travel Rail” described in Chapter 2 “Periodic Inspection”. (P86)
Oiling (to the gears of wheel)	• Check visually.	• To be oiled adequately	Apply oil to gears.

Periodic Inspection

General Matters on Periodic Inspection

⚠ DANGER

Mandatory

- Put the electric chain hoist on the floor or work bench when inspecting the electric chain hoist.
- After completion of the periodic inspection, perform the functional check and make sure that the electric chain hoist operates correctly.
  · Wear insulating gloves when measuring voltage.
  · When measuring the electric characteristics (insulation resistance, but except voltage measurement), turn off the power.

Failure to comply above instructions may result in death or serious injury.

General Matters on Handling the Dual Speed VFD Model

⚠ DANGER

Prohibited

- Do not change the VFD parameters.
  When parameters need to be changed, ask our distributors nearest to the customer or KITO.
- Do not carry out the work such as maintenance and inspection within 5 minutes after power off.
  Wait for the completion of discharging of the capacitor inside the VFD.
- Do not touch the controller cover as it becomes hot during operation.
- Do not touch the controller cover until about 30 minutes elapsed after the stop of operation.
- USE KITO genuine VFD.
  The VFD requires the special specification for KITO. Be sure to use genuine VFD.
- Do not change the connection of the VFD.
  When the wires were removed for any reason, connect them again correctly checking the wiring diagram inside the controller cover.
- Do not carry out withstand voltage test of a circuit while the VFD is connected.
- Do not turn off the power while operating.

Failure to comply with these instructions may result in death or serious injury and the damage of VFD.

NOTE

When performing the periodic inspection, carry out the daily inspection at the same time.

- Disassemble the electric chain hoist and check that it is assembled correctly without abnormal parts.
- Refer to Appendix “Technical Material” (P122) for the structure of the product and the name of each part.

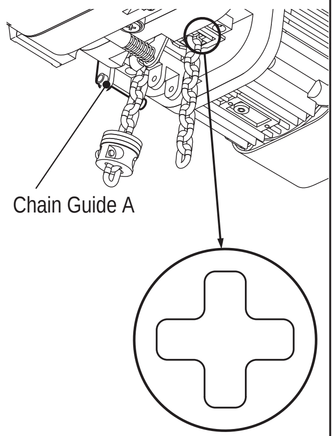
(to be continued)

Electric Chain Hoist (ER2) Periodic Inspection

Top Hook, Bottom Hook

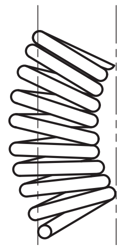
Item	Check method	Criteria	When failed
Number of start	• Check the number of start with the CH Meter.	• Number of start must not exceed the guidelines for replacement.	Replace the Top Hook and Bottom Hook.

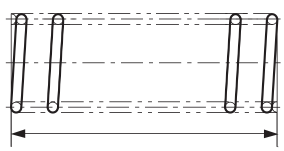
Peripheral parts of the Body size

Item	Check method	Criteria	When failed
Chain Guide A	• Check visually. 	• To have no apparent abrasion, deformation and damage • To have no flaw due to hitting by the Load Chain **⚠ CAUTION** Mandatory • The flaw due to hitting is caused by wrong use such as lifting a load in an inclined direction. If the abrasion is observed on the Chain Guide, the Load Chain may be worn also. Refer to the item of Load Chain Abrasion and check the abrasion. Neglecting the check of the Load Chain abrasion may result in bodily injury or property damage.	Replace the Chain Guide A.

<table>
<tr><th>Item</th><th>Check method</th><th>Criteria</th><th>When failed</th></tr>
<tr><td>Chain Spring</td><td>

• Check visually and measure the dimensions.





Dimensional standard

</td><td>

• Check visually to have no apparent setting (deformation).

⚠ CAUTION

Mandatory

• The deformation of the Cushion Rubber and the Chain Spring is caused by excessive use of the Friction Clutch and the Limit Switch. Operate the electric chain hoist properly.

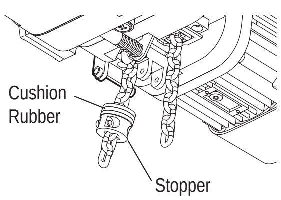
Otherwise it may result in bodily injury or property damage.

Service Limit of Chain Spring for Capacity (Do not fall short of the limit value.)

<table>
<tr><th rowspan="2">Code</th><th rowspan="2">Capacity</th><th colspan="2">Length of Chain Spring</th></tr>
<tr><th>Standard</th><th>Limit value</th></tr>
<tr><td>ER2-015S</td><td rowspan="2">1.5t</td><td rowspan="2">–</td><td rowspan="2">–</td></tr>
<tr><td>ER2-015IS/SD</td></tr>
<tr><td>ER2-020C</td><td rowspan="6">2t</td><td rowspan="2">100</td><td rowspan="2">95</td></tr>
<tr><td>ER2-020IC/CD</td></tr>
<tr><td>ER2-020L</td><td rowspan="2">70</td><td rowspan="2">67</td></tr>
<tr><td>ER2-020IL/LD</td></tr>
<tr><td>ER2-020S</td><td rowspan="2">85</td><td rowspan="2">81</td></tr>
<tr><td>ER2-020IS/SD</td></tr>
<tr><td>ER2-025S</td><td rowspan="2">2.5t</td><td rowspan="2">75</td><td rowspan="2">72</td></tr>
<tr><td>ER2-025IS/SD</td></tr>
<tr><td>ER2-030S</td><td rowspan="2">3t</td><td rowspan="2">135</td><td rowspan="2">129</td></tr>
<tr><td>ER2-030IS/SD</td></tr>
<tr><td>ER2-050S</td><td rowspan="2">5t</td><td rowspan="2">135</td><td rowspan="2">129</td></tr>
<tr><td>ER2-050IS/SD</td></tr>
</table>

</td><td>Replace the Chain Spring.</td></tr>
<tr><td>Stopper</td><td>

• Check visually.



</td><td>

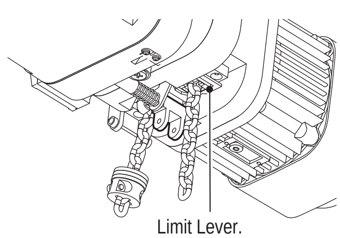
• The stopper must be attached securely at the third link from the no load end of the Load Chain.

</td><td>Attach the Stopper at the third link.</td></tr>
<tr><td>Limit Lever</td><td>

• Check visually and by moving by hand.

</td><td>

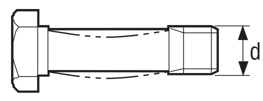
• To have no deformation, damage and abrasion
• To move smoothly
• To have no stain

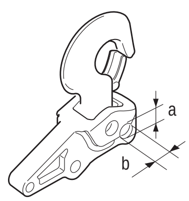
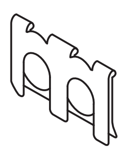


</td><td>Replace the Limit Lever.
Disassemble the Limit Lever and clean.</td></tr>
</table>

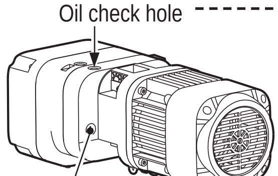
(to be continued)

Periodic Inspection (continued)

<table>
<tr><th>Item</th><th>Check method</th><th>Criteria</th><th>When failed</th></tr>
<tr><td>Chain Pin
(double type only)</td><td>• Check visually and measure with vernier caliper.


Chain Pin</td><td>• To have no apparent deformation and flaw.
Service Limit of Chain Pin
(Do not fall short of the limit value.)
<table><tr><th rowspan="2">Code</th><th colspan="2">Diameter d (mm)</th></tr><tr><th>Standard</th><th>Limit value</th></tr><tr><td>030S/IS/SD</td><td>10.8</td><td>10.3</td></tr><tr><td>050S/IS/SD</td><td>12.9</td><td>12.3</td></tr></table></td><td>Replace the Chain Pin.</td></tr>
<tr><td>Connection Yoke D
(double type only)
Deformation of mounting hole for the Chain Pin</td><td>• Measure the dimensions a and b with vernier caliper.

</td><td>• The difference between dimensions a (vertical) and b (lateral) must be within 0.5 mm.
• To have no apparent deformation and abrasion</td><td>Replace the Connection Yoke D.</td></tr>
<tr><td>Shaft Retainer Clip</td><td>• Check visually.

Shaft Retainer Clip</td><td>• To have no deformation, abrasion and damage
• To be attached securely without loosening</td><td>Replace the Shaft Retainer Clip.</td></tr>
</table>

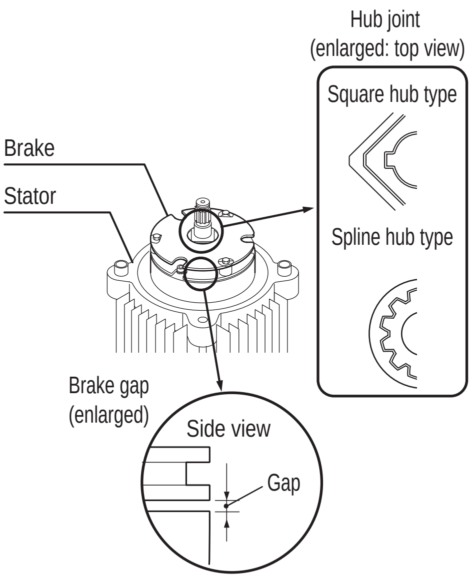
■ Oil

<table>
<tr><th>Item</th><th>Check method</th><th>Criteria</th><th>When failed</th></tr>
<tr><td>Oil Leakage</td><td>• Check visually.</td><td>• To have no leakage of gear oil from packings, oil seals or oil plugs.</td><td>Replace the Packing and the Oil Seal.</td></tr>
<tr><td rowspan="3">Oil amount and stain</td><td rowspan="3">• Check the oil level from the oil check hole. (The position of the oil check hole depends on the model. See P40.)


• Check the operating hours using the CH Meter.</td><td>• Oil is filled enough close to the oil check hole.</td><td>Replace the Oil.</td></tr>
<tr><td colspan="2">• Check the oil level through the oil cap at the top (shown by an arrow) for electric chain hoist equipped with the friction clutch with mechanical brake. (Do not open the oil check hole at the side. Or, oil leaks out.) When checking the oil level, insert the check bar into the oil check hole, tilting the bar slightly, to see the oil level.
• The distance between the hole and the oil level is 75 mm for the body size B, 100 mm for the body size C/D, 120 mm for the body size E, and 130 mm for the body size F respectively.</td></tr>
<tr><td>• Gear oil has viscosity but not stained.
• Refer to “Guidelines and Precautions on Gear Oil Change Cycle” for the replacement of oil. (P90)</td><td></td></tr>
</table>

Electromagnetic Brake

Item	Check method	Criteria	When failed
Appearance	• Remove the Brake Cover and check visually.	• To have no loosened bolt and screw.	Tighten bolts and screws.
		• To have no flaw and damage.	Replace the Electromagnetic Brake.
Gap	• Measure the gap with thickness gauge.	• Electromagnetic Brake Gap Limit (not to exceed the limit)	Replace the Electromagnetic Brake.



Single speed model		Dual speed VFD model		Pole change model	
Code	Gap limit (mm)	Code	Gap limit (mm)	Code	Gap limit (mm)
ER2-001H	0.75	ER2-001IH	0.60	ER2-001HD	0.60
ER2-003S		ER2-003IS		ER2-003SD	
ER2-005L		ER2-005IL		ER2-005LD	
ER2-003H		ER2-003IH	0.40	ER2-003HD	
ER2-005S		ER2-005IS		ER2-005SD	
ER2-010L		ER2-010IL		ER2-010LD	
ER2-010S		ER2-010IS		ER2-010SD	0.90
ER2-015S		ER2-015IS		ER2-015SD	
ER2-020C		ER2-020IC		ER2-020CD	
ER2-020L		ER2-020IL		ER2-020LD	
ER2-020S	1.10	ER2-020IS	0.50	ER2-020SD	
ER2-030S		ER2-030IS		ER2-030SD	
ER2-025S		ER2-025IS		ER2-025SD	
ER2-050S		ER2-050IS		ER2-050SD	

⚠ DANGER

Prohibited

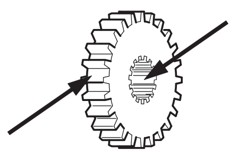
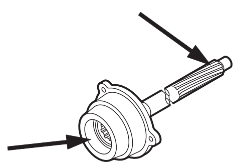
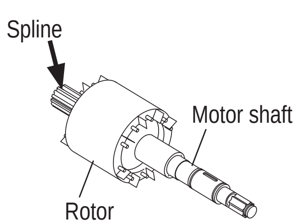
- **Do not adjust or disassemble the Electromagnetic Brake.**

Adjusting or disassembling the Electromagnetic Brake may result in death or serious injury.

Hub Joint	• Check visually.	• To have no apparent deformation and abrasion • Hub spring must be seated.	Replace the Hub and the Electromagnetic Brake.
Number of start	• Check the number of start with the CH Meter.	• The number of start must be less than one million times.	When the number of start exceeds one million times, perform the inspection in accordance with “Guidelines on Brake Inspection” (P91).

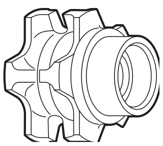
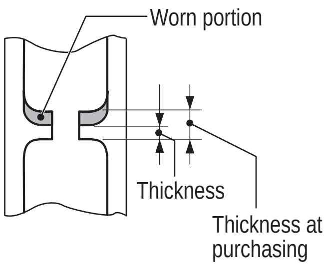
(to be continued)

■ Driving Mechanism

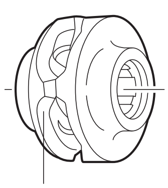
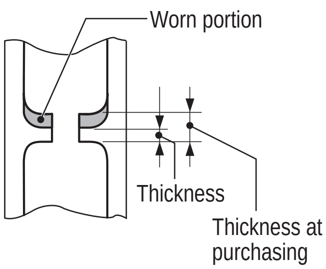
Item	Check method	Criteria	When failed
Bearing	• Check visually and rotate the Bearing by hand. • Check the operating hours with the CH Meter.	• To have no harmful deficiency such as apparent abrasion, flaw and damage. To rotate smoothly. • The operating hours must not exceed the guidelines for replacement. (Refer to Guidelines on Bearing Replacement (P92).)	Replace the Bearing.
Load Gear, Gear B, Pinion	• Disassemble the electric chain hoist and check the arrowed portion. • Check the operating hours using the CH Meter.    	• To have no apparent abrasion • To have no damage • Operating hours not to exceed the guidelines for replacement (Refer to "Guidelines on Gear Parts Replacement" (P91).)	• Replace the Gear. • Replace the Pinion. • Replace the oil at the same time.
Friction Clutch	• Check visually • Check the operating hours using the CH Meter.	• To have no apparent abrasion, deformation, flaw and damage. • Pawl must have no apparent deformation and abrasion. **⚠ DANGER** Prohibited • **Do not adjust or disassemble the Friction Clutch.** Adjusting and disassembling the Friction Clutch may result in death or serious injury. • Operating hours not to exceed the guidelines for replacement (Refer to "Guidelines on Gear Parts Replacement" (P91).)	Replace the Friction Clutch.

<table>
<tr><th>Item</th><th>Check method</th><th>Criteria</th><th>When failed</th></tr>
<tr><td>Friction Clutch with Mechanical Brake</td><td>• Check visually.
• Check the operating hours using the CH Meter.</td><td>• To have no apparent abrasion, deformation, flaw and damage
• Pawl must have no apparent deformation and abrasion.

⚠ DANGER
Prohibited
• Do not adjust or disassemble the Friction Clutch with Mechanical Brake.
Adjusting and disassembling the Friction Clutch with Mechanical Brake may result in death or serious injury.

• Operating hours not to exceed the guidelines for replacement
(Refer to “Guidelines on Gear Parts Replacement” (P91).)</td><td>Replace the Pawl and the Friction Clutch with Mechanical Brake.</td></tr>
<tr><td>Abrasion and flaw of the Load Sheave
</td><td>• Disassemble the Load Sheave and check it visually.
• Measure the thickness with vernier caliper.
</td><td rowspan="2">• To have no apparent abrasion, deformation and damage
• To have neither abrasion of the sheave pocket nor the run-on flaw on the crest.

NOTE
If the abrasion is observed on the Load Sheave, the Load Chain may be worn also. Refer to the item of Load Chain Abrasion and check the abrasion.

• Service limit of the Load Sheave and Idle Sheave (Do not fall under the limit)
<table>
<tr><th rowspan="2">Code</th><th rowspan="2">Capacity (t)</th><th colspan="2">Thickness (mm)</th></tr>
<tr><th>Standard</th><th>Limit</th></tr>
<tr><td>ER2-001H/IH/HD</td><td>125kg</td><td rowspan="3">1.5</td><td rowspan="3">1.0</td></tr>
<tr><td>ER2-003S/IS/SD</td><td rowspan="2">250kg</td></tr>
<tr><td>ER2-003H/IH/HD</td></tr>
<tr><td>ER2-005L/IL/LD</td><td rowspan="2">500kg</td><td rowspan="2">3.0</td><td rowspan="2">2.0</td></tr>
<tr><td>ER2-005S/IS/SD</td></tr>
<tr><td>ER2-010L/IL/LD</td><td rowspan="2">1</td><td rowspan="2">4.5</td><td rowspan="2">3.0</td></tr>
<tr><td>ER2-010S/IS/SD</td></tr>
<tr><td>ER2-015S/IS/SD</td><td>1.5</td><td rowspan="4">6.5</td><td rowspan="4">4.3</td></tr>
<tr><td>ER2-020L/IL/LD</td><td rowspan="2">2</td></tr>
<tr><td>ER2-020S/IS/SD</td></tr>
<tr><td>ER2-030S/IS/SD</td><td>3</td></tr>
<tr><td>ER2-025S/IS/SD</td><td>2.5</td><td rowspan="2">7.3</td><td rowspan="2">4.9</td></tr>
<tr><td>ER2-050S/IS/SD</td><td>5</td></tr>
</table></td><td>Replace the Load Sheave.</td></tr>
<tr><td>Abrasion and flaw of the Idle Sheave
</td><td>• Disassemble the Load Sheave and check it visually.
• Measure the thickness with vernier caliper.
</td><td>Replace the Idle Sheave.</td></tr>
<tr><td>V ring</td><td>• Check visually.
• Check the operating hours using the CH Meter.</td><td>• To have no deformation and crack
• Operating hour must not exceed 200 hours.</td><td>Perform the inspection items of “Guidelines on V ring Inspection” (P92).</td></tr>
</table>

(to be continued)

■ Electrical Equipment

Item	Check method	Criteria	When failed
Electrical Parts	• Remove the Controller Cover and check the electrical parts visually. • Check the number of start with the CH Meter.	• To have no damaged or burnt part. • To have no loosened bolt. Electrical parts must be mounted securely. • The number of start must not exceed the guidelines for replacement (P91).	Replace the damaged or burnt electrical part. Mount the electrical part securely. Replace the electrical part with service life.
Wiring		• Wiring must be fixed to the Electrical Parts securely. • Connectors must be inserted securely. • To have no wire breakage and burning	Connect wirings securely. Replace the wiring with new wiring, referring to Chapter 3 Guidance on Failure Cause and Countermeasures. (P94 to 96)
Contamination and attachment of foreign matter		• To have not waterdrop or foreign matter.	Remove the foreign matter.
VFD	• Check the parts with service life (see VFD Manual.)	• Electrolytic capacitor: 3000 hours (depending on the use)	• Replace the VFD.

■ Electric Characteristics Measurement

Item	Check method	Criteria	When failed
Source Voltage	• Measure the voltage with a circuit tester.	• The source voltage of the rated voltage ± 10 % at the receiving terminal must be supplied when operating with the capacity. **⚠ DANGER** Mandatory • **Be careful of electric shock when measuring the voltage.** Electric shock may result in death or serious injury.	Supply proper voltage.
Insulation Resistance	• Measure the insulation resistance with megger. (Resistance between energized and non-energized parts ··· Each phase of R(L1), S(L2) and T(L3) and the earth wire)	• Insulation resistance must be 5 MΩ or higher. **⚠ DANGER** Mandatory • **Turn off the power when measuring the insulation resistance.** Measuring the insulation resistance without turning off the power may result in death or serious injury.	Replace the Body size.

Item	Check method	Criteria	When failed
Grounding Resistance	• Measure the grounding resistance with earth-resistance meter.	• grounding resistance 100Ω or less **DANGER** Mandatory • **Turn off the power when measuring the grounding resistance.** Measuring the grounding resistance without turning off the power may result in death or serious injury due to electric shock.	Make a grounding correctly.

■ Function and Performance

DANGER

Mandatory

- **After completion of the inspection of each part, perform the operational check for correct operation.**

Neglecting to perform the operational check may result in death or serious injury.

● Perform the following inspections with capacity.

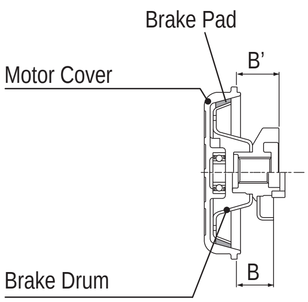
Item	Check method	Criteria	When failed
Operational Check	• Perform the daily inspection items with capacity. (Refer to Daily inspection Items. (P24))	**DANGER** Mandatory • **Be sure to perform the capacity test after completion of the no-load test.** Performing the capacity test without prior no-load test may result in death or serious injury. • Refer to “Daily inspection Items”. (P24)	Disassemble the electric chain hoist to check whether it is assembled correctly and has no abnormal part.
Brake	• Operate the electric chain hoist with a capacity and then stop it.	• When stopping the operation, the Brake must be applied immediately and the motor must stop. Up/Down: Stop distance must be 1 % or less of the traveling distance for one minute.	Disassemble the Brake to check whether it is assembled correctly and has no abnormal part.

(to be continued)

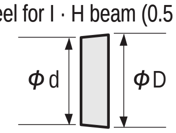
■Motorized Trolley (MR2) Periodic Inspection

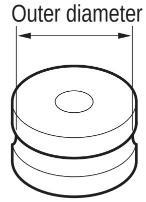
■ Brake

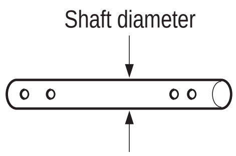
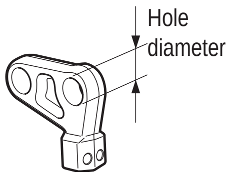
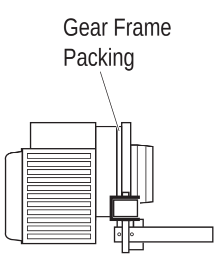
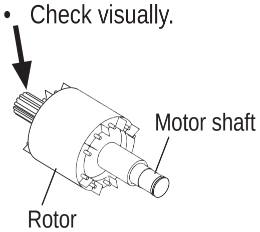
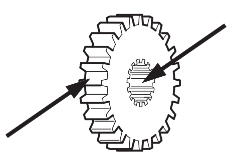
<table>
<tr><th>Item</th><th>Check method</th><th>Criteria</th><th>When failed</th></tr>
<tr><td rowspan="2">Appearance</td><td rowspan="2">• Disassemble the Brake and check it visually.</td><td>• To have no deformation, flaw and damage on the Brake Drum and the Motor Cover.</td><td>Replace the Part.</td></tr>
<tr><td>• To have no deformation and damage on the Brake Spring.</td><td>Replace the Brake Spring.</td></tr>
<tr><td>Abrasion of Brake Pad</td><td>• Disassemble the Brake and measure the abrasion.</td><td>Trolley Brake Service Limit
(Do not fall under the limit.)
<table>
<tr><th>Speed</th><th>Dimension</th><th>Standard</th><th>Limit</th></tr>
<tr><td>Single Speed</td><td rowspan="2">B</td><td rowspan="2">32.5</td><td rowspan="2">31.0</td></tr>
<tr><td>Dual Speed (VFD)</td></tr>
<tr><td>Dual Speed (500V Class)</td><td>B'</td><td>36.8</td><td>36.3</td></tr>
</table>
</td><td>Replace the Motor Cover.</td></tr>
</table>



■ Body size Components

<table>
<tr><th>Item</th><th>Check method</th><th>Criteria</th><th>When failed</th></tr>
<tr><td>Wheel</td><td>• Check visually.
• Measure dimensions D and d with vernier caliper.
Wheel for I · H beam (0.5 to 5 t)


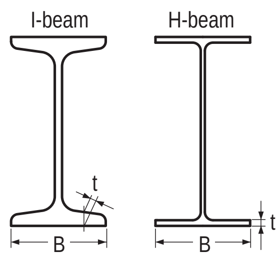
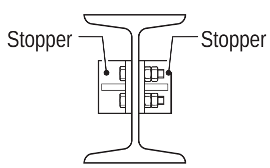
Measure the outer diameter with vernier caliper.</td><td>• To have no considerable deformation and damage
• Abrasion Limit of Wheel
(Do not fall under the limit.)
<table>
<tr><th rowspan="2">Capacity (t)</th><th rowspan="2">Beam type</th><th colspan="2">D (mm)</th><th colspan="2">d (mm)</th></tr>
<tr><th>Standard</th><th>Limit</th><th>Standard</th><th>Limit</th></tr>
<tr><td>125, 250, 500kg</td><td>I · H</td><td>95</td><td>91</td><td>91.5</td><td>87.5</td></tr>
<tr><td>1</td><td>I · H</td><td>95</td><td>91</td><td>91.5</td><td>87.5</td></tr>
<tr><td>1.5, 2</td><td>I · H</td><td>110</td><td>105</td><td>106</td><td>101</td></tr>
<tr><td>2.5, 3</td><td>I · H</td><td>125</td><td>118</td><td>121</td><td>114</td></tr>
<tr><td>5</td><td>I · H</td><td>140</td><td>132</td><td>135</td><td>127</td></tr>
</table>
</td><td>Replace the Wheel.</td></tr>
<tr><td>Side Roller</td><td>• Check visually.
• Measure outer diameter of the worn part with vernier caliper.

</td><td>• To have no considerable deformation and damage
• Abrasion Limit of Side Roller
(Do not fall under the limit.)
<table>
<tr><th rowspan="2">Capacity (t)</th><th colspan="2">Outer diameter (mm)</th></tr>
<tr><th>Standard</th><th>Limit</th></tr>
<tr><td>125, 250, 500kg</td><td>38</td><td>37</td></tr>
<tr><td>1</td><td>38</td><td>37</td></tr>
<tr><td>1.5, 2</td><td>43</td><td>42</td></tr>
<tr><td>2.5, 3</td><td>43</td><td>42</td></tr>
<tr><td>5</td><td>55</td><td>54</td></tr>
</table>
</td><td>Replace the Side Roller.</td></tr>
</table>

Item	Check method	Criteria	When failed
Lifting Shaft	• Check visually. • Measure the shaft diameter with vernier caliper. 	• To have no considerable deformation and abrasion • The shaft with obvious deformation reaches at the service limit. • Abrasion limit of the shaft is 5% of its diameter respectively.	Replace the Lifting Shaft.
Suspender	• Check visually. • Measure the diameter of the hole with vernier caliper. 	• The Suspender must be combined securely with the top pin and the Yoke bolt. • Abrasion limit of the hole is 5 % of its diameter.	Replace the Suspender.
Gear Frame Packing	• Check visually. 	• To have no damage and breakage.	Replace the Gear Frame Packing.
Gears and Motor Shaft	• Check visually.  	• To have no apparent abrasion, deformation and damage	Replace the Part.

(to be continued)

Periodic Inspection (continued)

■ Travel Rail

Item	Check method	Criteria	When failed
Rail Surface	• Check visually.	• To have no attachment of paint, oil and foreign matter. • To have no dust and powder due to abrasion	Clean the Travel Rail.
Deformation and Abrasion	• Check the deformation and abrasion visually and measure them with vernier caliper. 	• To have no deformation of beam flange such as twist and shear drop • To have no exceeding abrasion of rail surface • Service limit of B: up to 95 % of the dimension at purchasing • Service limit of c: up to 90 % of the dimension at purchasing	Replace or repair the Travel Rail.
Rail Mounting Bolt	• Check visually.	• To have no loosened bolt or fall-off	Tighten the bolts securely.
Stopper	• Check visually. 	• The stoppers must be mounted at the both ends of the Travel Rail securely.	Tighten the Stoppers.

■ Relay Cable

Item	Check method	Criteria	When failed
Appearance	• Check the cable surface visually.	• The Relay Cable has no deformation or damage. To be mounted securely.	Replace the Relay Cable.

■ Electrical Equipment and Electric Characteristics

Refer to Electric Chain Hoist (ER2) Periodic Inspection (P82).

Function and Performance

⚠ DANGER

Mandatory

- **After completion of the inspection of each part, perform the operational check for correct operation.**

Neglecting to perform the operational check may result in death or serious injury.

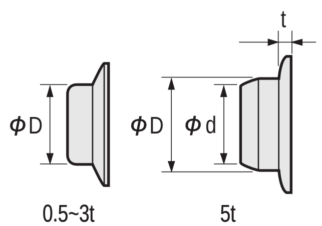
● Perform the following inspections with capacity.

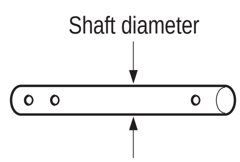
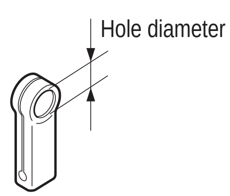
Item	Check method	Criteria	When failed
Operational Check	• Perform the daily inspection items with capacity. (Refer to "Daily inspection Items". (P24))	**⚠ DANGER** Mandatory • **Be sure to perform the capacity test after completion of the no-load test.** Performing the capacity test without prior no-load test may result in death or serious injury. • Refer to "Daily inspection Items". (P24)	Disassemble the electric chain hoist to check whether it is assembled correctly and has no abnormal part.
Brake	• Operate the electric chain hoist with a capacity and then stop it.	• When stopping the operation, the Brake must be applied immediately and the motor must stop. Traveling : Stop distance must be 10 % or less of the traveling distance for one minute. (Without swinging of the load. Except the case when the load is swinging.)	Disassemble the Brake to check whether the brake is assembled correctly without abnormal part.
Abnormal Noise	• Operate the electric chain hoist with a capacity and then stop it.	• To have no irrotating noise • To sound no howling of motor and scraping sound of the Brake.	Disassemble the electric chain hoist to check whether it is assembled correctly and has no abnormal part.

(to be continued)

■Manual Trolley (TSG/TSP) Periodic Inspection

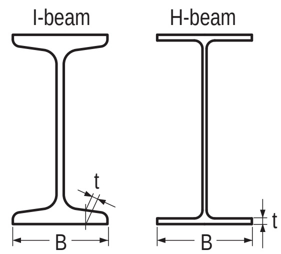
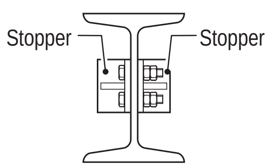
■ Body size Components

<table>
<tr><th>Item</th><th>Check method</th><th>Criteria</th><th>When failed</th></tr>
<tr><td>Wheel</td><td>• Check visually.
• Measure dimensions D and t with vernier caliper.


• Measure the outer diameter with vernier caliper.</td><td>• To have no considerable deformation and damage
• Abrasion Limit of Wheel
(Do not fall under the limit.)
<table>
<tr><th colspan="2">Capacity</th><th colspan="2">D (mm)</th><th colspan="2">Flange thickness t (mm)</th></tr>
<tr><th>TSP</th><th>TSG</th><th>Standard</th><th>Limit</th><th>Standard</th><th>Limit</th></tr>
<tr><td>125, 250, 500kg</td><td>–</td><td>60</td><td>58.5</td><td>3.2</td><td>2.5</td></tr>
<tr><td>1t</td><td>125, 250, 500kg, 1t</td><td>71</td><td>68.5</td><td>4</td><td>3.3</td></tr>
<tr><td colspan="2">1.5t, 2t</td><td>85</td><td>83.5</td><td>4.5</td><td>3.8</td></tr>
<tr><td colspan="2">2.5t, 3t</td><td>100</td><td>98.5</td><td>5</td><td>4.3</td></tr>
<tr><td colspan="2">5t</td><td>118</td><td>112</td><td>9.6</td><td>6.7</td></tr>
</table></td><td>Replace the Wheel.</td></tr>
<tr><td>Lifting Shaft</td><td>• Check visually.
• Measure the shaft diameter with vernier caliper.

</td><td>• To have no considerable deformation and abrasion
• The shaft with obvious deformation reaches at the service limit.
• Abrasion limit of the shaft and the hole is 5 % of its diameter respectively.</td><td>Replace the Lifting Shaft.</td></tr>
<tr><td>Suspender</td><td>• Check visually.
• Measure the diameter of the hole with vernier caliper.

</td><td>• The Suspender must be combined securely with the top pin and the Yoke bolt.
• Abrasion limit of the hole is 5 % of its diameter.</td><td>Replace the Suspender.</td></tr>
</table>

■ Travel Rail

Item	Check method	Criteria	When failed
Rail Surface	• Check visually.	• To have no attachment of paint, oil and foreign matter. • To have no dust and powder due to abrasion	Clean the Travel Rail.

Item	Check method	Criteria	When failed
Deformation and Abrasion	• Check the deformation and abrasion visually and measure them with vernier caliper. 	• To have no deformation of beam flange such as twist and shear drop • To have no exceeding abrasion of rail surface • Service limit of B: up to 95 % of the dimension at purchasing • Service limit of c: up to 90 % of the dimension at purchasing	Replace or repair the Travel Rail.
Rail Mounting Bolt	• Check visually.	• To have no loosened bolt or fall-off	Tighten the bolts securely.
Stopper	• Check visually. 	• The stoppers must be mounted at the both ends of the Travel Rail securely.	Tighten the Stoppers.

■ Function and Performance

⚠ DANGER

Mandatory

- **After completion of the inspection of each part, perform the operational check for correct operation.**

Neglecting to perform the operational check may result in death or serious injury.

● Perform the following inspections with capacity.

Item	Check method	Criteria	When failed
Operational Check	• Perform the daily inspection items with capacity. (Refer to Daily inspection Items. (P24))	**⚠ DANGER** Mandatory • **Be sure to perform the capacity test after completion of the no-load test.** Performing the capacity test without prior no-load test may result in death or serious injury. • Refer to “Daily Inspection Items”. (P24)	Disassemble the electric chain hoist to check whether it is assembled correctly and has no abnormal part.
Abnormal Noise	• To make the electric chain hoist travel with a capacity	• To have no irrotating sound	Disassemble the electric chain hoist to check whether it is assembled correctly and has no abnormal part.

Guidelines for Parts Replacement based on Indication of CH Meter

When performing the inspection, check the number of start and operating hours and utilize them for operation status control and maintenance control.

For single speed model, check the number of start and operating hours using the CH Meter. (Refer to "Check of Operating Hours and Number of Start (CH Meter)". (P92))

For dual speed VFD model, check the number of start and operating hours with the indicator of the VFD by the maintenance engineer in accordance with the separate "VFD Manual".

■Guidelines and Precautions on Gear Oil Change Cycle

Change the gear oil in accordance with the rate of loading and the operating hours.

● Change the oil at every five years even if the operating hours do not reach at the following hours.

Rate of loading \ Operating hour for gear oil change		Every 120 hrs	Every 240 hrs	Every 360 hrs
Light	A case where the capacity is rarely applied. Usually the hoist is used with a light load.			○
Medium	A case where the capacity is applied considerably frequently. Usually the hoist is used with a medium load.		○	
Heavy	A case where the capacity is applied considerably frequently. Usually the hoist is used with a heavy load.	○		
Ultra heavy	A case where the capacity is applied constantly.	○		

⚠ CAUTION

Mandatory

- Gear oil differs depending on the specification. Use of wrong gear oil may result in the drop of the lifted load. Be sure to use the designated gear oil.

Type of gear oil and its amount for one body size

Specification	Code	Gear oil amount (ml)	Oil manufacturer	Oil type
Friction Clutch	ER2-001H, 001IH, 003S, 003IS, 001HD, 003SD	520	KITO genuine oil	KITO genuine oil
	ER2-003H, 003IH, 005L, 005IL, 005S, 005IS, 003HD, 005SD, 005HD	540		
	ER2-010L, 010IL,010SD,010LD, 020C, 020IC, 020CD	620		
	ER2-010S, 010IS	680		
	ER2-015S, 015IS, 020L, 020IL, 015SD, 015LD	1300		
	ER2-020S, 020IS, 030S, 030IS	1900		
	ER2-025S, 025IS, 050S, 050IS	1900		
Friction Clutch with Mechanical Brake	ER2-001H, 001IH, 003S, 003IS, 001HD, 003SD	680	KITO genuine oil	KITO genuine oil
	ER2-005L, 005IL, 005SD	820		
	ER2-003H, 003IH, 005S, 005IS	900		
	ER2-010L, 010IL, 010SD, 010LD, 020C, 020IC, 020CD	1050		
	ER2-010S, 010IS	1100		
	ER2-015S, 015IS,020L,020IL, 015SD, 020LD	2000		
	ER2-020S, 020IS, 030S, 030IS, 030SD	2500		
	ER2-025S, 025IS, 050S, 050IS, 025SD, 050SD	2700		

* Oil is available in 0.7L and 1.0L bottles only.

Guidelines on the service life of contactor and its replacement

Replace the Contactor in accordance with the following rate of inching and the number of start. Replace the Contactor every five years even if the number of start does not reach at the following.

Rate of inching \ Number of start to replace contactor		Every 200,000 times	Every 500,000 times	Every 1 million times
Low	Normally operating with scarce inching			○
Medium	Normally operating with occasional inching		○	
High	Normally operating with inching at a half times or more	○		

NOTE) · For single speed model, check the number of start with the CH Meter. (Refer to “Check of Operating Hours and Start Times (CH Meter)”. (P92))

· For dual speed VFD model, check the number of start and operating hours with the indicator of the VFD by the maintenance engineer in accordance with the separate “VFD Manual”.

NOTE

Be sure to use the designated contactor.

Guidelines on Brake Inspection

When the number of start reaches at one million times, inspect the brake gap and carry out the following treatment depending on the condition of the brake gap.
When the number of start reaches at two million times, replace the brake unit as a whole irrespective of the condition of the brake gap.

Condition of brake gap	Treatment
Brake gap reaches at the limit gap.	Replace the brake as a whole.
Brake gap reaches at 50 to 100 % of the limit gap.	Check the Brake at every 100,000 times until the brake gap reaches at the limit gap.
Brake gap is less than 50 % of the limit gap.	Check the Brake at every 200,000 times.

Guidelines on Gear Parts Replacement (Load Gear, Gear B, Pinion, Friction Clutch, Friction Clutch with Mechanical Brake)

Body size grade \ Operating hours to replace parts	Every 800 hours	Every 1600 hours	Every 3200 hours
M6, 3m	–	–	Parts replacement
M5, 2m	–	Parts replacement	–
M4, 1Am	Parts replacement	–	–

Guidelines on Motor Shaft (with Rotor) Replacement

Body size grade \ Operating hours to replace parts	Every 400 hours	Every 800 hours	Every 1600 hours	Every 3200 hours
M6, 3m	–	Apply grease on spline*	–	Parts replacement
M5, 2m	–	Apply grease on spline	Parts replacement	–
M4, 1Am	Apply grease on spline	Parts replacement	–	–

* Grease needs to be applied on spline part every 800, 1600 and 2400 hours.

(to be continued)

Guidelines on Bearing Replacement

Body size grade \ Operating hours to replace parts	Every 800 hours	Every 1600 hours	Every 3200 hours
M6, 3m	–	–	Parts replacement
M5, 2m	–	Parts replacement	–
M4, 1Am	Parts replacement	–	–

Guidelines on Hook and Yoke Replacement

Replace the Hook and Yoke in accordance with the rate of loading and the number of start in the following table.

Rate of loading \ Number of start to replace parts		Every million times	Every 1.5 million times	Every 2 million times
Light	A case where the capacity is rarely applied. Usually the hoist is used with a light load.			○
Medium	A case where the capacity is applied considerably frequently. Usually the hoist is used with a medium load.		○	
Heavy	A case where the capacity is applied considerably frequently. Usually the hoist is used with a heavy load.	○		
Ultra heavy	A case where the capacity is applied constantly.	○		

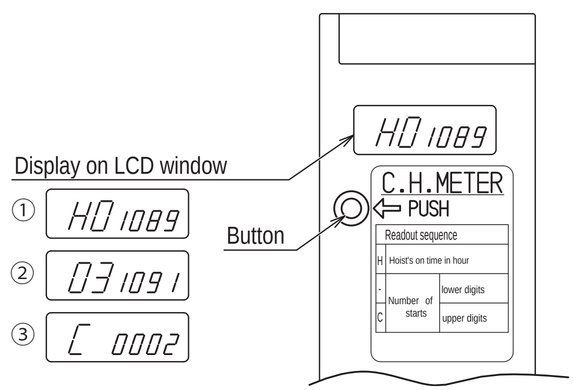
Guidelines on V ring Inspection

Apply grease MOLITHERM No.2 on the V ring when the operating hours reaches at every 200 hours.
Refer to “Product Structure and Name of Each Part” (P122) for the location of the V ring.

Check of Operating Hours and Number of Start (CH Meter)

CH Meter: Start Times/Operating Hour Display Device

Contactor ON/OFF (lowering) times and operating hours (motor energizing hours for lowering × 2) are displayed. Use these values for control of operating condition and maintenance at inspection and periodic inspection.



<How to use the CH Meter>
Open the controller cover and press the button at the side of the terminal panel.
The display ①, ② and ③ appears in the LCD window in the sequence and then disappears automatically.
① Operating hours (1,089 hours in the right example)
③ + ② Number of start (2,031,091 times in the right example)
NOTE) For the operating hours and the number of start of the dual speed VFD model, refer to the separate “VFD Manual” to check the operating hours and the number of start.

⚠ CAUTION

Prohibited

- Do not disassemble or replace the battery.

Failure to comply with this instruction causes bodily injury or loss of property.

Chapter 3

Troubleshooting

This chapter describes the main failure cause and inspection items based on the fault conditions. The repair work (and maintenance work as well) of the electric chain hoist is accompanied with disassembling/assembling work. Refer to the separate “Disassembling/Assembling Manual” for the correct work.

Guidance on Troubleshooting

Guidance on Troubleshooting

Following table is the summary of the main failure causes based on the failure conditions and their inspection items. Refer to the page of each item for the check method, treatment and the details of countermeasure.

- Refer to “Technical Materials” (P122) for the product structure and the component name of each part.

Single speed model

Conditions			Main fault contents	Check item	Reference page
Electric chain hoist does not operate without load	Sounds no brake operating sound	Sounds no Electromagnetic contactor operating sound	Improper source voltage	Power	99
			Breakage or burning of control circuit Faulty electrical part	Circuit breaker	99
				Power Cable	100
				Internal wiring	102
				Electromagnetic Contactor	105
				Transformer	104
				Fuse	105
				Upper/Lower Limit Switch	106
				Push Button Switch	107
		Sounds contactor Electromagnetic operating sound	Breakage or burning of power circuit, Faulty motor or brake	Motor	101
				Brake	102
				Internal wiring	104
				Electromagnetic Contactor (melted contact points)	105
	Sounds brake operating sound		Breakage of driving part Sticking of Bearing	Gears and Joints	115
				Bearing	116
Electric chain hoist operates without load	Does not operate with a load (Motor sounds howling)		Open phase (single phase operation)	Power	99
				Power Cable	100
				Motor	101
				Electromagnetic Contactor (melted contact points)	105
			Overload (clutch activated)	Friction Clutch	109
				Friction Clutch with Mechanical Brake	110
	Operates slowly with a load		Voltage drop	Power Cable	100
Operates differently from the indication of the Push Button Switch.	Operates differently from the indication of the Push Button Switch (operates in the opposite direction)		Negative phase connection	Power Cable	100
			Wrong connection	Internal wiring	104
				Push Button Switch	107
	Does not operate when operating any one of the Push Button Switch		Breakage of control circuit	Internal wiring	104
				Push Button Switch	107
			Faulty electrical part	Electromagnetic Contactor	105
				Upper/Lower Limit Switch	106
Does not stop normally.	Does not stop even if the Push Button Switch is released.		Melted contact point	Electromagnetic Contactor	105
	Too long (or short) stopping distance		Abrasion of brake lining	Brake	102
	Does not stop at the upper/lower limit.		Negative phase connection	Power Cable	100
			Wrong connection	Internal wiring	104
				Push Button Switch	107

Conditions			Main fault contents	Check item	Reference page
Abnormal noise	Popping sound		Abrasion of the Load Chain	Load Chain	113
			Abrasion of the Load Sheave	Load Sheave, Idle Sheave	115
	Sounds strange operating sound		Abrasion or breakage of Gear	Gears and Joints	115
			Deterioration of Bearing	Bearing	116
	Brake noise	Sounds when applied (scraping noise)	Dragging	Brake	102
		Sounds when released	Abrasion of brake lining	Brake	102
	Friction Clutch with Mechanical Brake (sounds when lowering)	Scraping noise	Use of improper oil other than the designated oil	Friction Clutch with Mechanical Brake	110
	Sounds at curved rail (friction noise)		Mechanical interference of the rail and the wheel	Traveling motion of the Trolley	116
Unable to travel	Motorized Trolley/Manual Trolley		Slipping wheel	Traveling motion of the Trolley	116
			Inclined rail		
			Pulling a load in an inclined direction (floating wheel)		
			Defective gear engagement		
			Locking of brake		
	Motorized Trolley		Electric system failure (refer to the item of electric chain hoist)		
	Manual Trolley		Defective engagement of the Hand Wheel and the Hand Chain		
Serpentine motion Sounds strange noise	Motorized Trolley/Manual Trolley		Mechanical interference of the rail and the wheel	Traveling motion of the Trolley	116
			Wrong adjustment of collar		
			Uneven abrasion of the wheel		
			Deformation of the wheel		
			Deterioration of Bearing		
			Deformation and abrasion of the rail		
			Deterioration of the Bearing		
			Abrasion of the Brake Pad		
Hook and those related to Hook			Deformation	Hook	111
Load Chain and those related to Load Chain			Abrasion, elongation, twist	Load Chain	113
Electric shock when touching the body size and Push Button Switch			Improper grounding, breakage of earth wire	Electric shock	109

(to be continued)

■Dual Speed VFD Model

Conditions		Main fault contents	Check item	Reference page
Unable to restart the VFD by resetting with emergency stop (the case when the VFD cannot be reset even after cool down)		Those related to VFD	Check the error code of VFD referring to "VFD Manual".	"VFD Manual" (annex)
Electric chain hoist does not operate without load	Sounds no brake operating sound	Improper source voltage	Power	99
		Breakage and burning of control circuit Faulty electrical part	Circuit breaker	99
			Power Cable	100
			Internal wiring	104
			Transformer	104
			Fuse	105
			Relay	105
			Interface Board	108
			VFD	108
			Upper/Lower Limit Switch	106
			Push Button Switch	107
		Breakage and burning of power circuit Failure of motor or brake	Motor	101
			Brake	102
			Internal wiring	104
			Relay (melted contact point)	105
		VFD trip due to motor overheat (electronic thermal relay)	VFD	108
		VFD overheat	VFD	108
	Sounds brake operating sound	Breakage of driving part Sticking of Bearing	Gears and Joints	115
			Bearing	116
Electric chain hoist operates without load	Does not operate with a load (Motor sounds howling)	Overload (Clutch activated)	Friction Clutch	109
			Friction Clutch with Mechanical Brake	110
	Operates slowly with a load	Voltage drop	Power Cable	100
	Electric chain hoist operates in low speed mode, but does not operate in high speed mode or operates slowly.	Low source voltage	Power	99
		Voltage drop	Power Cable	100
	Does not operate in lowering or in low speed mode.	Faulty Braking Resistor	Braking Resistor	108
Operates differently from the indication of the Push Button Switch.	Operates differently from the indication of the Push Button Switch (operates in the opposite direction)	Negative phase connection of motor lead wires	Motor	100
		Wrong connection	Internal wiring	104
			Push Button Switch	107
	Does not operate when operating any one of the Push Button Switch	Breakage of control circuit	Internal wiring	104
			Push Button Switch	107
		Faulty electrical part	VFD	108
			Interface Board	108
			Upper/Lower Limit Switch	106

Conditions			Main fault contents	Check item	Reference page
Does not stop normally.	Too long stopping distance		Relay failure or melted contact point	Relay	105
	Too long (or short) stopping distance		Abrasion of brake lining	Brake	102
	Does not stop at the upper/lower limit.		Negative phase connection of motor lead wires	Power Cable	100
			Wrong connection	Internal wiring	104
				Push Button Switch	107
Abnormal noise	Popping sound		Abrasion of the Load Chain	Load Chain	113
			Abrasion of the Load Sheave	Load Sheave, Idle Sheave	115
	Sounds strange operating sound		Abrasion or breakage of Gear	Gears and Joints	115
			Deterioration of Bearing	Bearing	116
	Brake noise	Sounds when applied (scraping noise)	Dragging	Brake	102
		Sounds when released	Abrasion of brake lining	Brake	102
	Friction Clutch with Mechanical Brake (sounds when lowering)	Scraping noise	Use of improper oil other than the designated oil	Friction Clutch with Mechanical Brake	110
	Sounds at curved rail (friction noise)		Mechanical interference of the rail and the wheel	Traveling motion of the Trolley	116
Unable to travel	Motorized Trolley/Manual Trolley		Slipping wheel	Traveling motion of the Trolley	116
			Inclined rail		
			Pulling a load in an inclined direction (floating wheel)		
			Defective gear engagement		
			Locking of brake		
	Motorized Trolley		Electric system failure (refer to the item of electric chain hoist)		
	Manual Trolley		Defective engagement of the Hand Wheel and the Hand Chain		
Serpentine motion Sounds strange noise	Motorized Trolley/Manual Trolley		Mechanical interference of the rail and the wheel	Traveling motion of the Trolley	116
			Wrong adjustment of collar		
			Uneven abrasion of the wheel		
			Deformation of the wheel		
			Deterioration of Bearing		
			Deformation and abrasion of the rail		
			Deterioration of the Bearing		
			Abrasion of the Brake Pad		
Hook and those related to Hook			Deformation	Hook	111
Load Chain and those related to Load Chain			Abrasion, elongation, twist	Load Chain	113
Electric shock when touching the body size and Push Button Switch			Improper grounding, breakage of earth wire	Electric shock	109

Safety Precautions

General Matters on Failure Cause and Countermeasure

DANGER

Prohibited

- Do not disassemble or repair the electric chain hoist by the personnel other than maintenance engineer.
  "Disassembling/Assembling Manual" and "Parts List" are provided separately for the maintenance. Disassembling and repair must be performed by the maintenance engineer in accordance with these materials for maintenance.
- When replacing the part, be sure to use the genuine part for KITO electric chain hoist ER2, ER2M, ER2SP and ER2SG.
  Even if the part is the KITO genuine part, the part for different model may not be used. Use the correct part in accordance with separate "Disassembling/Assembling Manual".

Failure to comply with this content may result in death or serious injury.

Mandatory

- When any abnormality is observed during the maintenance (repair) of the electric chain hoist, survey the cause by the maintenance engineer and carry out the repair.
- Be sure to keep the following when repairing the electric chain hoist:
  - Be sure to turn off the power.
  - Be sure to indicate "INSPECTION".
  - Carry out the repair without lifting a load.
- Be sure to pay attention to the change of the operating sound of electric chain hoist and trolley.
  The change of operating sound is an important factor to judge the failure.

Failure to comply with this content may result in death or serious injury.

General Matters on Handling the Dual Speed VFD Model

DANGER

Prohibited

- Do not change the VFD parameters.
  When parameters need to be changed, ask our distributors nearest to the customer or KITO.
- Do not carry out the work such as maintenance and inspection within 5 minutes after power off.
  Wait for the completion of discharging of the capacitor inside the VFD.
- Do not touch the controller cover as it becomes hot during operation.
- Do not touch the controller cover until about 30 minutes elapsed after the stop of operation.
- USE KITO genuine VFD.
  The VFD requires the special specification for KITO. Be sure to use genuine VFD.
- Do not change the connection of the VFD.
  When the wires were removed for any reason, connect them again correctly checking the wiring diagram inside the controller cover.
- Do not carry out withstand voltage test of a circuit while the VFD is connected.
- Do not turn off the power while operating.

Failure to comply with these instructions may result in death or serious injury and the damage of VFD.

Troubleshooting

Power

Symptom	Cause	Remedy	Main factor	Countermeasure
Electric chain hoist does not operate.	Improper source voltage	Measure the voltage of each phase at power receiving terminal. If the source voltage is improper, check the power receiving facility.	Faulty power receiving facility	Check the power receiving facility regularly.

⚠ DANGER

Mandatory

- Be careful about electric shock when checking the power.

Careless power check may result in death or serious injury due to electric shock.

Circuit breaker (Distribution panel)

Symptom	Cause	Remedy	Main factor	Countermeasure
Electric chain hoist does not operate.	Breaker was tripped due to short circuit.	Replace or repair the short-circuited part.	Cable breakage, burning of electrical parts	Refer to each item of Power Cable, Motor, Brake, Internal Wiring, Transformer and Electromagnetic Contactor.
	Breaker was tripped due to insufficient breaker capacity.	Check the breaker capacity. Replace it if the capacity is insufficient.	Wrong selection of breaker capacity	Use the breaker with proper capacity. (See P54.)
	Breaker was tripped due to over current.	Check the cause of over current and take the necessary countermeasure. (Refer to each item of Power Cable, Motor, Brake, Internal Wiring, Transformer and Contactor.)	Over voltage, low voltage, over load	Refer to each item of Power Cable, Motor, Brake, Internal Wiring, Transformer and Electromagnetic Contactor.

(to be continued)

Troubleshooting (continued)

Power Cable

Symptom	Cause	Remedy	Main factor	Countermeasure
Electric chain hoist does not operate.	Wire breakage (more than two wires)	Check the conduction, flaw, crimping of terminals and soldering of plug. When any deficiency was observed, repair or replace the cable.	Excessive force applied on the cable	Support the cable with Cable Support Arm securely.
			Non use of shake proof cable	Use shake proof cable to the moving part.
			Twist of wire	Layout the wires without twisting.
			Cable was impeded by other facility.	Fix the cable not to be impeded by other facility.
	Wire burning (more than two wires)	Check the cable. Replace it if burnt.	Temperature rise due to insufficient cable capacity	Use the cable with proper capacity. (See P54.)
			Cables are bundled.	Do not bundle wires.
	Insufficient insertion of plug	Insert the connector plug to the end of the receptacle. Tighten the coupling ring securely.	Insufficient insertion at the installation	Fix the connector plug to the receptacle securely.
			Loosening of the fixing thread due to impact or vibration	Use the electric chain hoist avoiding the large impact.
Slow start or unable to start	Insufficient cable capacity	Check the cable size for adequacy. Replace with the proper cable if the cable capacity is insufficient.	Voltage drop due to insufficient cable capacity	Use the cable with proper capacity. (See P54.)
Electric chain hoist operates but unable to lift a load. (single phase status)	Breakage or burning of one phase only	Refer to the breakage and burning of above items.		
For single speed model, the electric chain hoist operates in the direction different to the push button operation (negative phase). * For dual speed VFD model, refer to the item of VFD.	Wrong connection of power line when wiring	Change two wires of power line.	Wrong connection when assembling	Refer to the connection diagram and connect wires correctly.

⚠ DANGER

Prohibited

- **Do not change the connection at the Push Button Switch circuit.**

The change of circuit at the Push Button Switch circuit is very dangerous as the limit switch becomes not to function.

Motor

Symptom	Cause	Remedy	Main factor	Countermeasure
Motor does not operate.	Motor coil burning (two or more phases)	Measure the coil resistance of each phase. Replace the motor when the resistance of all phases are infinity.	Over current due to over voltage or low voltage	Operate the electric chain hoist at the rated voltage.
			Over current due to over load	Use the electric chain hoist with a load less than the capacity.
			Operation exceeding short time rating or intermittent rating	Check the short time rating and intermittent rating. Use the electric chain hoist within these ratings.
			Excessive inching or plugging operation (consecutive impression of start rush current)	Do not perform excessive operation.
			Over current due to brake dragging	Refer to the items of Brake.
	Lead wire breakage (more than two lead wires)	Measure the coil resistance of each phase. Replace the motor when the resistance of all phases are infinity.	Lead wire damaged at assembling	Assemble with care.
			Vibration, impact	Use the electric chain hoist avoiding the impact.
Electric chain hoist operates but unable to lift a load. (single phase status)	Motor coil burning (only one phase)	Measure the coil resistance of each phase. Replace the motor when the resistance of all phases are infinity.	Layer short due to poor insulation of coil (between phases)	Be careful about the intrusion of foreign matter into the motor when assembling.
	Lead wire breakage (only in one lead wire)	Measure the coil resistance of each phase. Replace the motor when the resistance of all phases are infinity.	Lead wire damaged at assembling	Be careful not to have the lead wire caught when assembling.
			Vibration, impact	Use the electric chain hoist avoiding the impact.

(to be continued)

Troubleshooting (continued)

Brake

⚠ DANGER

Prohibited

- Do not adjust/disassemble the Electromagnetic Brake.

Adjusting or disassembling the Electromagnetic Brake may result in death or serious injury.

Symptom	Cause	Remedy	Main factor	Countermeasure
Electromagnetic Brake does not operate.	Brake coil burning	Measure the coil resistance of the Brake coil. Replace the Electromagnetic Brake when the resistance is infinity.	Over current due to over voltage or low voltage	Operate the electric chain hoist at the rated voltage.
			Excessive inching or plugging operation (consecutive impression of start rush current)	Do not perform excessive operation.
			Over current due to over load	Use the electric chain hoist with a load less than the capacity.
			Operation exceeding short time rating or intermittent rating	Check the short time rating and intermittent rating. Use the electric chain hoist within these ratings.
			Over current due to open phase operation	The electric chain hoist cannot lift a load in open phase operation. When any abnormality is observed, stop the operation immediately and check the cause of open phase operation.
	Abrasion of Brake Lining (exceeding the magnetic attraction of the electromagnetic brake)	Measure the brake gap. If the gap exceeds the service limit, replace the electromagnetic brake unit as a whole (See P79.)	Excessive inching operation	Do not perform excessive operation.
	Breakage of Electromagnetic Brake lead wire	Check the conduction of the lead wire. Replace the wire without conduction.	Lead wire damaged at assembling	Be careful not to have the lead wire caught when assembling.
	Insufficient connection of brake lead wire at insertion terminal	Connect the insertion terminal securely. Replace the loose insertion terminal if any.	Insufficient connection at assembling	Connect the insertion terminal securely at assembling.

Symptom	Cause	Remedy	Main factor	Countermeasure
Electromagnetic Brake does not operate.	Rusting	When the Brake is rusted shut, replace the brake unit as a whole.	Wrong assembling of packings	Assemble the brake cover packings and V ring securely. Replace the packing if deteriorated.
			Leaving the electric chain hoist in an environment with rich moisture	Operate the electric chain hoist regularly.
			Dew condensation	Pay attention to the use in an environment where the ambient temperature changes rapidly.
	Breakage of rectifier	Measure the resistance of the rectifier with circuit tester. Anode terminal : Negative probe of the circuit tester Cathode terminal : Positive probe of the circuit tester (measure the resistance in kΩ range) When the resistance is almost zero, the rectifier is normal. In other cases, replace the rectifier.	Over current due to over voltage or low voltage	Operate the electric chain hoist at the rated voltage.
			Excessive inching or plugging operation (consecutive impression of start rush current)	Do not perform excessive operation.
			Over current due to over load	Use the electric chain hoist with a load less than the capacity.
			Operation exceeding short time rating or intermittent rating	Check the short time rating and intermittent rating. Use the electric chain hoist within these ratings.
			Over current due to open phase operation	The electric chain hoist cannot lift a load in open phase operation. When any abnormality is observed, stop the operation immediately and check the cause of open phase operation.
Too long (or short) stopping distance (stopping distance may change slightly depending on the temperature.)	Abrasion of brake lining	Measure the brake gap. If the gap exceeds the service limit, replace the electromagnetic brake unit as a whole (See P79.)	Excessive inching operation	Do not perform excessive operation.
Louder operating sounds	Abrasion of brake lining	Measure the brake gap. If the gap exceeds the service limit, replace the electromagnetic brake unit as a whole (See P79.)	Excessive inching operation	Do not perform excessive operation.

(to be continued)

Troubleshooting (continued)

Internal wiring

Symptom	Cause	Remedy	Main factor	Countermeasure
Electric chain hoist does not operate.	Breakage of wire	Check the wire. Repair the wire if broken.	Vibration, impact	Use the electric chain hoist avoiding the impact.
			Lead wire damaged at assembling	Be careful not to have the lead wire caught when assembling.
		Check the terminal. Repair the terminal without conduction.	Improper crimping	Use the proper crimping tool.
	Wrong wiring	Check the wiring in accordance with the wiring diagram. Correct the wiring if it is wrong.	Wrong wiring at assembling	Correct the wiring in accordance with the wiring diagram.
	Loosened terminal screw (results in heat generation to burn)	Tighten the loosened screws.	Insufficient tightening at assembling	Tighten screws securely.
			Vibration, impact	Use the electric chain hoist avoiding the impact.
	Incomplete connection of plug, connector and insertion terminal	Connect plug, connector and insertion terminal correctly if they are not connected securely. Tighten the lock ring of the connector plug securely.	Incomplete connection at assembling	Connect plug, connector and insertion terminal securely.

Transformer

Symptom	Cause	Remedy	Main factor	Countermeasure
Electric chain hoist does not operate. (Electromagnetic Contactor does not operate.)	Burnout or breakage of transformer coil	Measure the resistance of transformer coil. If it is infinity, replace the transformer.	Over voltage	Operate the electric chain hoist with the rated voltage.
			Excessive inching or plugging operation (consecutive impression of start rush current)	Do not perform excessive operation.
			Over current due to defective operation of Electromagnetic contactor	Refer to the items of Electromagnetic Contactor.
			Vibration, impact	Use the electric chain hoist avoiding the impact.
	Breakage of lead wire	Check the lead wires of the transformer. Repair or replace the transformer if the lead wire has no conduction.	Vibration, impact	Use the electric chain hoist avoiding the impact.

Electromagnetic Contactor, Relay

Symptom	Cause	Remedy	Main factor	Countermeasure
Electric chain hoist does not stop	Electromagnetic Contact point welding, or fusing	Operate the contactor manually to check the conduction. When the contact point is welded or fused, replace the contactor. When the device is a miniature relay, check the contact point visually.	Excessive inching or plugging operation (consecutive impression of start rush current)	Do not perform excessive operation.
			Over voltage	Operate the electric chain hoist with the rated voltage.
			Over current due to over load	Use the electric chain hoist with a load less than the capacity.
Electric chain hoist does not operate.	Burnout or breakage of relay coil or contactor coil	Measure the resistance of relay coil or contactor coil. If it is infinity, replace the relay or the contactor.	Excessive inching or plugging operation (consecutive impression of start rush current)	Do not perform excessive operation.
			Over voltage	Operate the electric chain hoist with the rated voltage.
			Chattering due to low voltage (consecutive impression of start rush current)	Operate the electric chain hoist with the rated voltage.
	Damaged moving parts	Operate the Electromagnetic contactor by its manual operation part. Replace the contactor if it does not move smoothly. Check the miniature relay visually if it does not have damaged part.	Vibration, impact	Use the electric chain hoist avoiding the impact.

Fuse

Symptom	Cause	Remedy	Main factor	Countermeasure
Electric chain hoist does not operate. (Electromagnetic Contactor does not operate.)	Blown out	Check the conduction of the fuse. When no conduction, check the cause and then replace the fuse.	Short circuit of the control circuit, burnout of electrical part	Refer to the items related to the electrical part in failure.
			Over current due to defective operation of Electromagnetic contactor	Refer to the items of Electromagnetic Contactor.

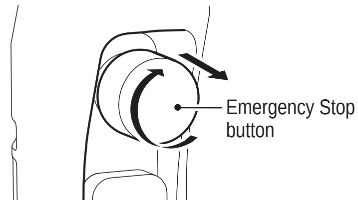
(to be continued)

Troubleshooting (continued)

Upper/Lower Limit Switch

Symptom	Cause	Remedy	Main factor	Countermeasure
Electric chain hoist does not operate. (Electromagnetic Contactor or VFD does not operate.)	Contact point fusing	Actuate the limit switch manually to check the conduction of the contact points. Replace the limit switch as a whole when no conduction.	Habitual use of the limit switch	Do not use the limit switch habitually.
	Breakage	Check the wiring. Repair or replace the limit switch as a whole if the limit switch has no conduction.	Vibration, impact	Use the electric chain hoist avoiding the impact.
	Moving part rusted shut (defective return action of the moving part)	Check the moving part of the limit switch such as actuator lever is not stiff. If it is stiff, remove the rust or replace the stiff part.	Leaving the electric chain hoist for a long time at the upper/lower limit.	Do not leave the electric chain hoist at the upper/ lower limit.
Electric chain hoist does not stop at the upper/lower limit.	Contact point welding	Actuate the limit switch manually to check the conduction of the contact points. Replace the limit switch as a whole when it does not turn off.	Habitual use of the limit switch	Do not use the limit switch habitually.
	Moving part rusted shut	Check the moving part of the limit switch such as actuator lever is not stiff. If it is stiff, remove the rust or replace the stiff part.	No use for a long time, use in an environment with rich moisture	Check the electric chain hoist regularly.
	Wrong wiring	Check the wiring in accordance with the wiring diagram. Perform the wiring correctly. If the wiring of the limit switch is correct, the cause is in the negative phase connection. Change two wires of the power line.	Wrong wiring	Correct the wiring in accordance with the wiring diagram.

Push Button Switch

Symptom	Cause	Remedy	Main factor	Countermeasure
Electric chain hoist does not operate. (Electromagnetic Contactor does not operate.)	Emergency Stop button is pressed to its end and locked.	When the Emergency Stop button is pressed and locked, turn it clockwise to release the lock. 	Forgot releasing the Emergency Stop button	Read "How to operate the push button" (P28) and use the electric chain hoist.
	Faulty switch unit	Check the conduction of the contact points. Replace the Push Button Switch if it has no conduction.	Vibration, impact	Use the electric chain hoist avoiding the impact.
	Breakage inside the switch	Check that the Push Button Switch cord is connected with the switch unit correctly. Repair the cord if it has no conduction.	Vibration, impact	Use the electric chain hoist avoiding the impact.
	Loosened terminal screw inside the switch unit	Tighten the screw if loosened	Vibration, impact	Use the electric chain hoist avoiding the impact.
	Wire breakage of Push Button Switch Cord	Check the conduction of the Push Button Switch Cord. If it has no conduction, replace the cable, or the Push Button Switch Cord as a set.	Damage of cable cover	Operate the electric chain hoist not to impede with other facility.
			External force applied on the cable due to improper tying of the protection wire	Tie the protection wire securely. (See "Cable Connection" (P55).)
The electric chain hoist does not operate as indicated.	Wrong wiring	Check the wiring in accordance with the wiring diagram. Perform the wiring correctly. If the wiring of the Push Button Switch is correct, the cause is in the negative phase connection. Change two wires of the power line.	Wrong wiring	Correct the wiring in accordance with the wiring diagram.
	Wrong affixing of N-E-S-W label	Affix the label in the correct direction.	Affixing the label in an improper direction	Affix the label correctly.
Electric chain hoist does not stop even if the Push Button is released	Defective return action of the switch unit	Replace the Push Button Switch if it does not operate smoothly.	Vibration, impact	Use the electric chain hoist avoiding the impact.

(to be continued)

Troubleshooting (continued)

VFD

Symptom	Cause	Remedy	Main factor	Countermeasure
Electric chain hoist does not operate.	VFD failure	Reset the VFD by pressing Emergency Stop button. It the VFD still does not operate, check it.	VFD failure	Check the error code indicated by VFD referring to the "VFD Manual".
	Motor overheat	Stop by motor thermal relay function of the VFD Motor resumes operation when the VFD is reset by pressing the Emergency Stop after cool down.	Operation exceeding short time rating or intermittent rating	Check the short time rating and intermittent rating. Use the electric chain hoist within these ratings.
	VFD overheat	Stop by overheat preventive function of the VFD Motor resumes operation when the VFD is reset by pressing the Emergency Stop after cool down.	Operation exceeding short time rating or intermittent rating	Check the short time rating and intermittent rating. Use the electric chain hoist within these ratings.
	Expired service life of the VFD (capacitor)	Refer to the "VFD Manual".	Operation exceeding short time rating or intermittent rating	Check the short time rating and intermittent rating. Use the electric chain hoist within these ratings.

Interface Board

Symptom	Cause	Remedy	Main factor	Countermeasure
Electric chain hoist does not operate.	Damaged circuit component	Press the Push Button to check whether LED on the board lights or not. If LED does not light, replace the board. ✻ This test is carried out with energizing the VFD. Be careful about electric shock.	Over current, over voltage, service life expiry	Operate the electric chain hoist at the rated voltage. Replace the Interface Board.
	Contact failure of connector	Check the conduction of the connector. Replace the connector if it has no conduction.	Defective assembling of the connector	Crimp and insert the connector pins securely.

Braking Resistor

Symptom	Cause	Remedy	Main factor	Countermeasure
Electric chain hoist does not operate.	Resistor breakage	Measure the resistance of the resistor. Replace the resistor if the resistance is infinity.	Operation exceeding short time rating or intermittent rating, over load	Use the electric chain hoist within the ratings.

Electric shock

Symptom	Cause	Remedy	Main factor	Countermeasure
Electric shock when touching the body size and Push Button Switch	Improper grounding	Measure the grounding resistance. If it exceeds 100 Ω, perform grounding work in accordance with the relevant laws and regulations.	Defective grounding work	Perform the grounding work securely.
			Contact failure of the grounding wire	Connect the grounding wire securely without loosened screw
			Breakage of grounding wire	Layout the grounding wire to avoid the stress applied on it. (See the item of Power Cable and Push Button Switch.)
	Attachment of waterdrop	Remove the waterdrop, dry the electric chain hoist and then use it.	Operation by wet hand	Do not operate the electric chain hoist by wet hand.

Friction Clutch

⚠ DANGER

Prohibited

- **Do not adjust/disassemble the Friction Clutch.**

Adjusting or disassembling the Friction Clutch may result in death or serious injury.

Symptom	Cause	Remedy	Main factor	Countermeasure
Unable to lift a load, or the load lowers after stop.	Clutch is activated (normal)	Lighten the load less than the rated load and use the electric chain hoist.	Over load	Use the electric chain hoist with a load less than the rated load.
	Abrasion of Clutch Disk	Replace the Friction Clutch.	Too many use of the Friction Clutch	Avoid the over load.
			Approaching service life limit	Do not use the body size exceeding the service limit.
	Secular change in mechanical characteristics of the Friction Clutch		Use of oil other than the designated oil	Use KITO genuine oil.
			Leaving the electric chain hoist for a long time without use	Pay attention to the place to use and the storage place.
	Temperature rise inside the gear box	Resume the operation after cool down. When it is still unable to lift a load, replace the Friction Clutch.	Use in a hot environment, or excessively frequent use	Avoid the use in a hot environment or excessively frequent use.

⚠ DANGER

Mandatory

- **Use KITO genuine gear oil.**
  (The gear oil for Friction Clutch with Mechanical Brake is different from the standard specification oil.)

Use of the oil other than KITO genuine oil may result in death or serious injury due to the drop of a lifted load.

(to be continued)

Troubleshooting (continued)

Friction Clutch with Mechanical Brake

⚠ DANGER

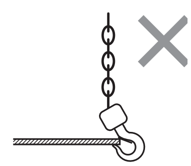
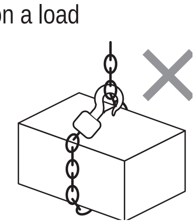
Prohibited

- **Do not adjust/disassemble the Friction Clutch with Mechanical Brake.**

Adjusting or disassembling the Friction Clutch with Mechanical Brake may result in death or serious injury.

Symptom	Cause	Remedy	Main factor	Countermeasure
Unable to lift a load.	Clutch is activated (normal)	Lighten the load less than the rated load and use the electric chain hoist.	Over load	Use the electric chain hoist with a load less than the rated load.
	Abrasion of Clutch Disk	Replace the Friction Clutch with Mechanical Brake.	Too many use of the Friction Clutch	Avoid the over load.
			Use of oil other than the designated oil	Use KITO genuine oil. **⚠ DANGER** Mandatory • **Use KITO genuine gear oil. (The gear oil for Friction Clutch with Mechanical Brake is different from the standard specification oil.)** Use of the oil other than KITO genuine oil may result in death or serious injury due to the drop of a lifted load.
	Secular change in mechanical characteristics of the Friction Clutch with Mechanical Brake		Leaving the electric chain hoist for a long time without use	Do not use the body size exceeding the service limit.
	Temperature rise inside the gear box	Resume the operation after cool down. When it is still unable to lift a load, replace the Friction Clutch with Mechanical Brake.	Use in a hot environment, or excessively frequent use	Avoid the use in a hot environment or excessively frequent use.
Unable to lift a load, or the load lowers after stop.	Deteriorated braking performance	Replace the Friction Clutch with Mechanical Brake.	Use of oil other than the designated oil	Use KITO genuine oil.
	Abrasion of the Brake Pad		Approaching service life limit	Do not use the body size exceeding the service limit.
Electric chain hoist of VFD specification became tripped frequently at lowering a load.	Abrasion of the Brake Pad	When the electric chain hoist trips frequently, replace the Friction Brake with Mechanical Brake with a new one.	Approaching service life limit	Check the Mechanical Brake if the tripping time increased. (See P81)

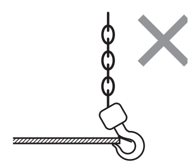
Hook

Symptom	Cause	Remedy	Main factor	Countermeasure
Widened Hook opening	Deformation of the Hook	Replace the Hook if the deformation exceeds the criteria. (See P70.)	Over load	Use the electric chain hoist with a load less than the capacity.
			Earth lifting	Do not carry out earth lifting. Be careful not to impede the Hook with protruding object during lifting.
			Slinging a load at the tip of the Hook.  Lateral pulling of the Hook	Sling a load at the center of the Hook
			Improper slinging	Angle formed by two slings must be 120 degrees or less.  120 degrees or less
			Use of the sling with a size improper to the Hook	Use the proper sling.
Twisted hanging of the Hook			Use of the Hook with the Load Chain wound on a load 	Do not wind the Load Chain directly on a load.
Hook unable to swivel smoothly at the neck	Rusting shut or corrosion of Bearing	Swivel the Hook at the neck by hand. If it is difficult to swivel smoothly, overhaul or replace the Bearing.	Insufficient grease application, corrosion due to environment of use	Apply grease regularly. Use the sling to avoid the dipping of the Hook into chemicals.
	Damaged Bearing		Intrusion of dust	Be careful about the intrusion of foreign matter into the neck.

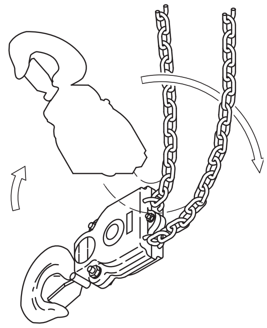
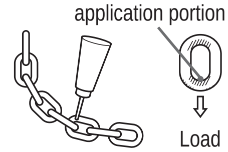
(to be continued)

Troubleshooting (continued)

Hook (continued)

Symptom	Cause	Remedy	Main factor	Countermeasure
Hook Latch has come off	Deformation of the Hook	Replace the Hook if the deformation exceeds the criteria. (See P70.)	Over load	Use the electric chain hoist with a load less than the capacity.
			Earth lifting	Do not carry out earth lifting. Be careful not to impede the Hook with protruding object during lifting.
			Use of the sling with a size improper to the Hook	Use the proper sling.
	Deformation and come-off of the Hook Latch	Replace the Hook Latch if it has come off or is deformed.	Sling put on the Hook Latch	Do not put the sling on the Hook Latch.
Hook bent at the neck (shank)	Deformation or damage of the Hook at its neck	Replace the Hook bent at the neck	Lifting a load at the tip of the Hook  Lateral pulling of the Hook	Sling a load at the center of the Hook
Hook unable to swivel smoothly at the neck	Rusting shut or corrosion of Bearing	Swivel the Hook at the neck by hand. If it is difficult to swivel smoothly, overhaul or replace the Bearing.	Insufficient grease application, corrosion due to environment of use	Apply grease regularly. Use the sling to avoid the dipping of the Hook into chemicals.
	Damaged Bearing		Intrusion of dust	Be careful about the intrusion of foreign matter into the neck.

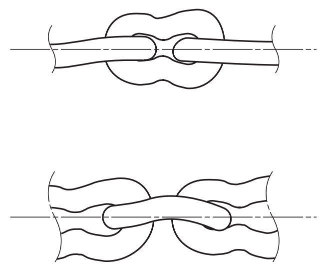
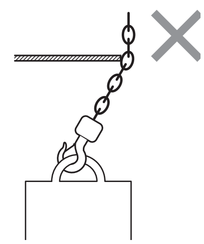
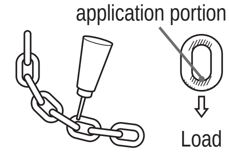
Load Chain

Symptom	Cause	Remedy	Main factor	Countermeasure
Twisted Load Chain	Capsized Bottom Hook	Turn over the Bottom Hook to the original position to cancel the capsizing. 	Bottom Hook was turned over by one turn during working.	When using multi fall model hoist, check that the Hook is not capsized before use.
	Load Chain is twisted inside the main body of the electric chain hoist.	Remove the Chain Guide A and the Load Chain, and then reassemble them.	Improper assembling	Assemble the electric chain hoist correctly. (See Disassembling/Assembling Manual)
Sudden activation of the Friction Clutch when lowering	Knot of the Load Chain due to entanglement in the Chain Container	Check the capacity of the Chain Container (with the nameplate on the Chain Container). If insufficient, replace the Chain Container with a larger capacity.	Insufficient capacity of the Chain Container	When installing the electric chain hoist, check the lift and the capacity of the Chain Container, and assemble them correctly.
Sounds the popping sound	Abrasion of the Load Chain links	Measure the abrasion of wire diameter. Replace the Load Chain if it reaches at the abrasion limit. (See P69)	Long hour operation without grease	Apply lubricant regularly. (See P40) 
			Excessive inching operation	Do not perform excessive operation.
			Over load	Use the electric chain hoist with a load less than the capacity.
			Pulling a load in an inclined direction	Do not pull a load in an inclined direction.
			Abrasion of Load Sheave, Idle Sheave	Refer to the item of Load Sheave, Idle Sheave.
	Elongation of pitch	Measure the sum of pitches of 5 links. Replace the Load Chain if this value exceeds the limit value. (See P69)	Over load	Use the electric chain hoist with a load less than the capacity.

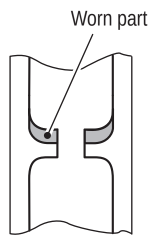
(to be continued)

Troubleshooting (continued)

Load Chain (continued)

Symptom	Cause	Remedy	Main factor	Countermeasure
Irregular noise	Flaw and deformation of the Load Chain surface	Replace the Load Chain with apparent flaw or deformation. 	Use of the Load Chain without canceling capsized state	When using multi fall model hoist, check that the Hook is not capsized before use.
			Use of the Load Chain as twisted	Assemble the electric chain hoist correctly. (See Disassembling/Assembling Manual)
	Hit flaw on the Load Chain surface		Hit with other object strongly 	Use the electric chain hoist carefully paying attention not to impede with other object.
Surface losing lust and discolored	Rusting and corrosion	Remove rust and apply oil. Replace the Load Chain if the rust and corrosion is apparent.	Run-out of oil	Apply lubricant regularly. (See P40) 
			Use of electric chain hoist exposed to rain	Store the electric chain hoist indoor or under the roof when not using.
			Influence of sea water and chemicals	Contact KITO for the use in special environment in advance. Use the electric chain hoist correctly within the scope guaranteed by the manufacturer.
Breakage of the Load Chain	Expiry of the service life	Check the Load Chain and replace it if exceeded the criteria. (See P69)	Mechanical service life expiry	Handle the Load Chain correctly and perform the appropriate control including daily inspection and inspection.

Load Sheave, Idle Sheave

<table>
<tr><th>Symptom</th><th>Cause</th><th>Remedy</th><th>Main factor</th><th>Countermeasure</th></tr>
<tr><td rowspan="4">Sounds popping sound</td><td rowspan="4">Abrasion of sheave pocket or flaw by the Load Chain out of mesh with the Sheave
</td><td rowspan="4">Measure the thickness of the crest. Replace the Sheave if the thickness is less than the criteria. (See P81)
The Load Chain may be worn. Check also the Load Chain.</td><td>Long hour operation without grease, expiry of service life</td><td>Apply lubricant regularly. (See P40)</td></tr>
<tr><td>Excessive inching operation</td><td>Do not perform excessive operation.</td></tr>
<tr><td>Over load</td><td>Use the electric chain hoist with a load less than the capacity.</td></tr>
<tr><td>Pulling a load in an inclined direction</td><td>Do not pull a load in an inclined direction.</td></tr>
</table>

Chain Guide A

Symptom	Cause	Remedy	Main factor	Countermeasure
Swinging of a load became larger than when purchasing	Abrasion of cross guide	Measure the standard dimension. Replace the cross guide if the standard dimension exceeds the criteria. (See P76) The Load Chain may be worn. Check also the Load Chain.	Pulling a load in an inclined direction	Do not pull a load in an inclined direction.

Gears and Joints

<table>
<tr><th>Symptom</th><th>Cause</th><th>Remedy</th><th>Main factor</th><th>Countermeasure</th></tr>
<tr><td rowspan="3">Unable to lift a load.</td><td rowspan="3">Abrasion, Damage</td><td rowspan="5">Replace gear or joint if it is worn apparently or damaged</td><td>Long hour operation without oil</td><td>Keep the oil change cycle. (See P90)</td></tr>
<tr><td colspan="2">⚠ DANGER
Mandatory
• Use KITO genuine gear oil. (The gear oil for Friction Clutch with Mechanical Brake is different from the standard specification oil.)
Use of the oil other than KITO genuine oil may result in death or serious injury due to the drop of a lifted load.</td></tr>
<tr><td>Long hour operation without grease (motor joint)</td><td>Apply grease at periodic inspection. (See P91)</td></tr>
<tr><td rowspan="2">Irregular motion</td><td rowspan="2">Partial abrasion or damage</td><td>Too many use of the Friction Clutch</td><td>Avoid the over load.</td></tr>
<tr><td>Habitual use of Upper/ Lower Limit Switch</td><td>Do not use Upper/Lower Limit Switch habitually.</td></tr>
</table>

(to be continued)

Troubleshooting (continued)

Bearing

Symptom	Cause	Remedy	Main factor	Countermeasure
Unable to lift a load.	Sticking, Breakage	Replace the bearing.	Use under hot environment or excessively frequent use	Avoid using under hot environment or excessively frequent use
Strange noise	Deterioration	Replace the bearing.	Use under hot environment or excessively frequent use	Avoid using under hot environment or excessively frequent use

Traveling motion of the Trolley (common for motorized/manual trolley)

Symptom	Cause	Remedy	Main factor	Countermeasure
Unable to travel due to slipping of wheel	Inclination of Travel Rail	Make sure that rail gradient is within 1 degree.	Improper installation of Travel Rail	Install the Travel Rail correctly.
Unable to travel due to slipping of wheel, or unable to travel in uniform motion	Oil attachment on running surface of the rail	Wipe off the attached foreign matter.	Use under the environment likely to attach foreign matter	Clean the Travel Rail regularly.
Sounds abrasion sound when running on a curved rail	Friction resistance between wheel and rail	Apply small amount of oil on the rail surface where noise generates.		
Unable to travel on the curved rail	Interference of the trolley and the curved rail	Make sure that the rail curvature is larger than the minimum turning radius. (See P43, 48)	Use of the curved rail of curvature less than minimum turning radius	Do not use the curved rail of curvature less than minimum turning radius
Unable to travel due to wheel floating	Pulling a load in an inclined direction (floating wheel)	—	Operating method	Use the electric chain hoist correctly.
Wheel unable to rotate	Defective gear engagement	Remove the stain and foreign matter on the wheel and the gear.	Ambient conditions, environment	Check regularly.
Meandering Strange noise	Wrong adjustment of collar	Check the number of collars and their assembled positions	Incomplete checking	Assemble correctly.
	Uneven abrasion of the wheel	Check the abrasion of the wheel	Traveling on curved rail or unevenness of running surface	Check regularly.
	Deformation of wheel	Check the distortion of wheel and damage of running surface	Excessively frequent collision with stopper or unevenness of running surface	Replace the wheel Use the electric chain hoist correctly.
	Deterioration of wheel bearing	Check if rolling noise sounds when the wheel is rotating.	Expiry of service life	Replace the wheel bearing.
	Deformation and abrasion of the rail	Check the abrasion and deformation of the rail.	Over load or expiry of service life	Replace the rail. Use the electric chain hoist correctly.

Traveling motion of the Trolley (only for motorized trolley)

Symptom	Cause	Remedy	Main factor	Countermeasure
Wheel unable to rotate	Locking of brake	Disassemble the motor cover. Remove rust and stains.	Ambient conditions, environment	Check regularly.
	Electric system failure (Refer to the items of Electric chain hoist)	(Refer to the items of Electric chain hoist)		
Serpentine motion Strange noise	Abrasion of the side roller	Check the abrasion	Traveling on curved rail or expiry of service life	Check regularly.
	Abrasion of the Brake Pad	Check the abrasion of the Brake Pad	Expiry of service life	Check regularly.

Traveling motion of the Trolley (only for manual trolley)

Symptom	Cause	Remedy	Main factor	Countermeasure
Unable to pull the Hand Chain	Defective engagement of the Hand Wheel and the Hand Chain	Engage the Hand Chain with the Hand Wheel correctly.	Rapid operation	Replace the Hand Chain with abrasion or deformation.

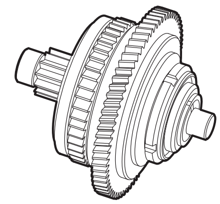
Appendix

This Appendix summarizes the information helpful for the use of KITO electric chain hoist, such as optional parts, technical materials and service network.

Optional Parts

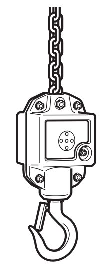
Friction Clutch with Mechanical Brake

KITO's original friction clutch equipped with mechanical brake



Load Bell: Over load alarm

An alarm unit to detect over load
Detection load: 100 to 110 % of the capacity
Alarm sound level: 85 dB or more

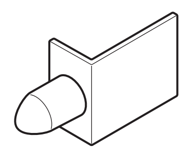


NR Relay: Negative Phase Connection Preventive Device

A device to detect the negative phase connection and open phase connection immediately and shut down the power automatically.

Bumper: Stopper for Trolley MR2

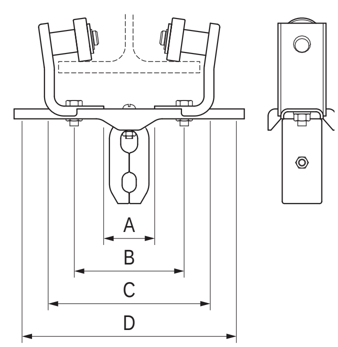
A shock absorber for collision (special for MR2)
Be sure to use the bumper when the trolley uses urethane wheel.



T-shape Suspender: Attachment for power feeding

Code	Travel Rail width (mm)	Hole pitch
T-shape Suspender 100	75	A : (53mm)
	100	B : (78mm)
	125	C : (103mm)
	150	D : (128mm)
T-shape Suspender 175	175	A : (153mm)

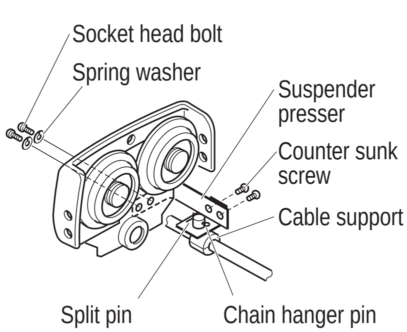
- Contact KITO when the Travel Rail width exceeds 175 mm.



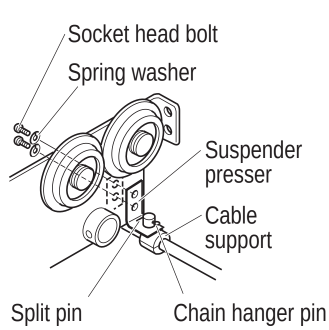
● Mounting Suspender Presser

- When using T-shape Suspender, the suspender presser needs to be mounted to the trolley.
- Following holes to mount the suspender presser are worked on the main frame of the trolley. Mount the suspender presser with socket head bolts.
- Fix the cable support to the suspender presser with Chain Pin and split pin and mount the power cable.

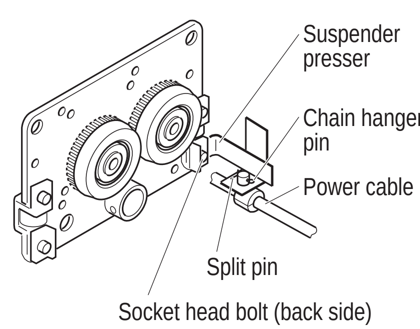
< Manual Trolley 125 kg to 3 t >



< Manual Trolley 5 t >

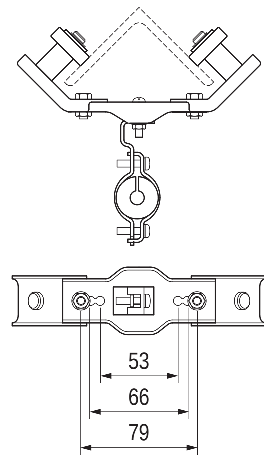


< MR2 >

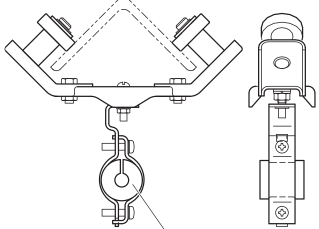


Angle Suspender: Accessory for power feeding

Code	Angle	Hole pitch
THLT and THLP	50×50	53 mm
	65×65	66 mm
	75×75	79 mm

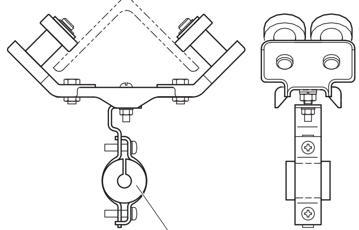


< THLT (for intermediate support >



Cable guard

< THLP (for Push Button Switch cord >



Cable guard

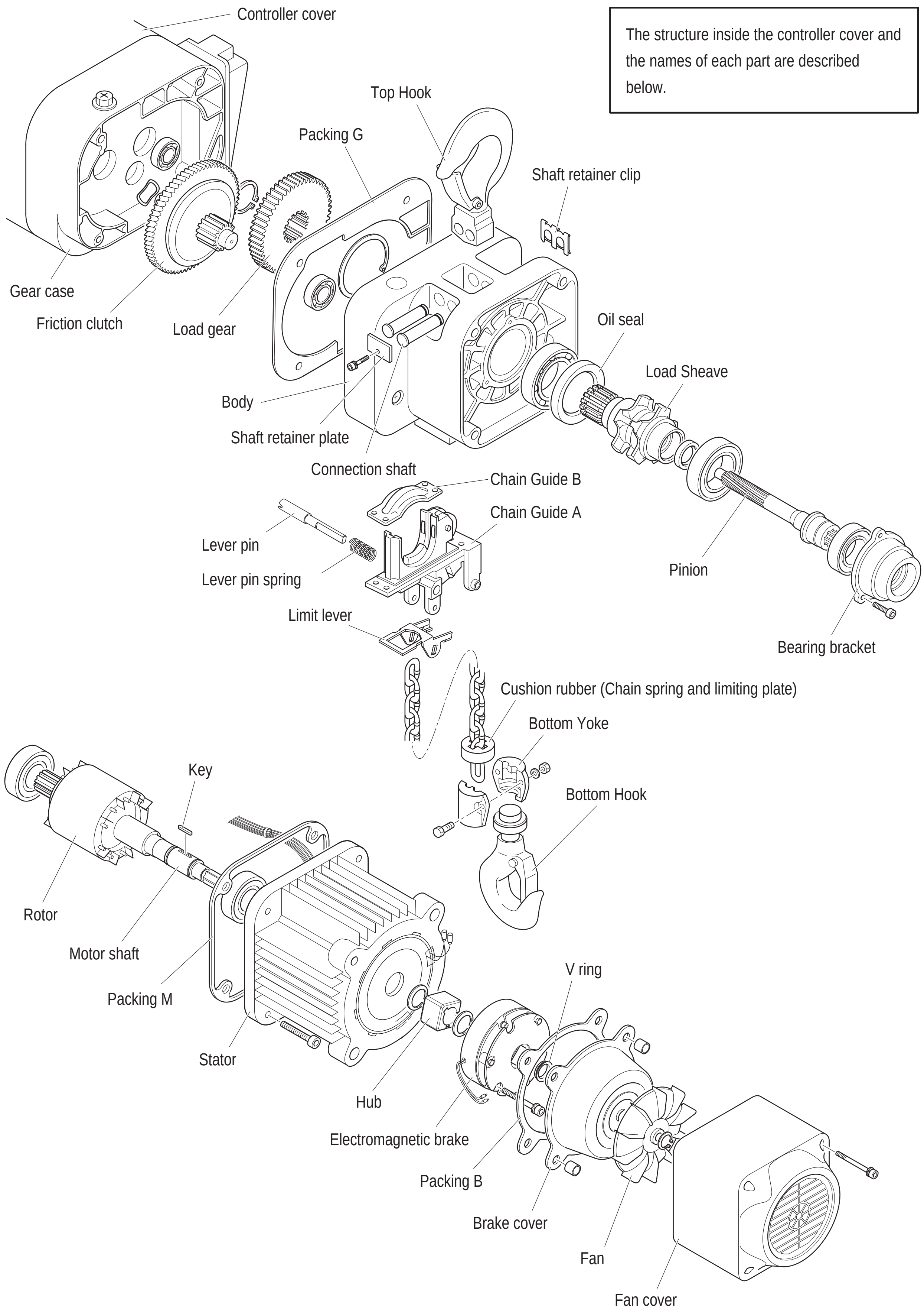
Chain End Suspender

Capac-ity	Code						Part number	Part name	Part code	Note
	Single speed			Dual speed						
	Standard speed	Low speed	High speed	Standard speed	Low speed	High speed				
125kg 250kg			ER2-001H			ER2-001IH/HD	408	Chain End Suspender	ER2BS9408	
	ER2-003S		ER2-003H	ER2-003IS/SD		ER2-003IH/HD	417	Socket Bolt	J1BE1-0806528	
							418	Lever Nut	C2BA100-9074	
							396	Socket Bolt	J1BE1-0503012	
							397	U Nut	E2DBX10S9853	
							399	Plain Washer	J1WD011-00050	
500kg	ER2-005S	ER2-005L		ER2-005IS/SD	ER2-005IL/LD		408	Chain End Suspender	ER2CS9408	
							417	Socket Bolt	J1BE1-0807528	
							418	Lever Nut	C2BA100-9074	
							396	Socket Bolt	J1BE1-0604018	
							397	U Nut	E5SE003S9855	
							399	Plain Washer	J1WD011-00060	
980kg 1t (2t)	ER2-009S	ER2-009L		ER2-009IS	ER2-009IL		408	Chain End Suspender	ER2CS9408	
	ER2-010S	ER2-010L		ER2-010IS/SD	ER2-010IL/LD		417	Socket Bolt	J1BE1-0809012	
		ER2-020C			ER2-020IC/CD		418	Lever Nut	C2BA100-9074	
							396	Socket Bolt	J1BE1-0804013	
							397	U Nut	C2BA100-9074	
1.5t 1.6t 2t	ER2-015S			ER2-015IS/SD			408	Chain End Suspender	ER2ES9408	
	ER2-016S	ER2-020L		ER2-016IS	ER2-020IL/LD		417	Socket Bolt	J1BE1-1010532	
	ER2-020S			ER2-020IS/SD			418	Lever Nut	C2BA200-9074	
							396	Socket Bolt	J1BE1-0804013	
							397	U Nut	C2BA100-9074	
2.5t	ER2-025S			ER2-025IS/SD			408	Chain End Suspender	ER1ES9408	
							417	Socket Bolt	J1BE1-1008532	
							418	Lever Nut	C2BA200-9074	
							396	Socket Bolt	J1BE1-1006032	
							397	U Nut	C2BA200-9074	
2.8t 3t 3.2t	ER2-028S			ER2-028IS			417	Socket Bolt	J1BE1-1010032	*
	ER2-030S			ER2-030IS/SD			418	Lever Nut	C2BA200-9074	
	ER2-032S			ER2-032IS						
5t	ER2-050S			ER2-050IS/SD			417	Socket Bolt	J1BE1-1008532	*
							418	Lever Nut	C2BA200-9074	

* Chain End Suspender is not used for double chain fall type due to the orientation of the chain.
For double chain fall type, attach the terminal chain directly to Chain Guide A.

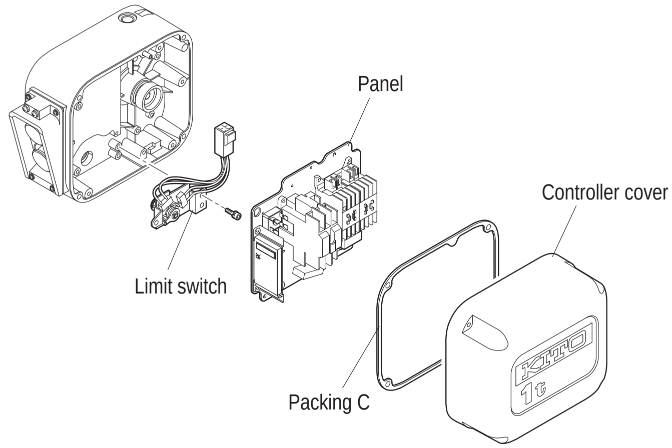
Product Structure and Names of Each Part

The structure inside the controller cover and the names of each part are described below.

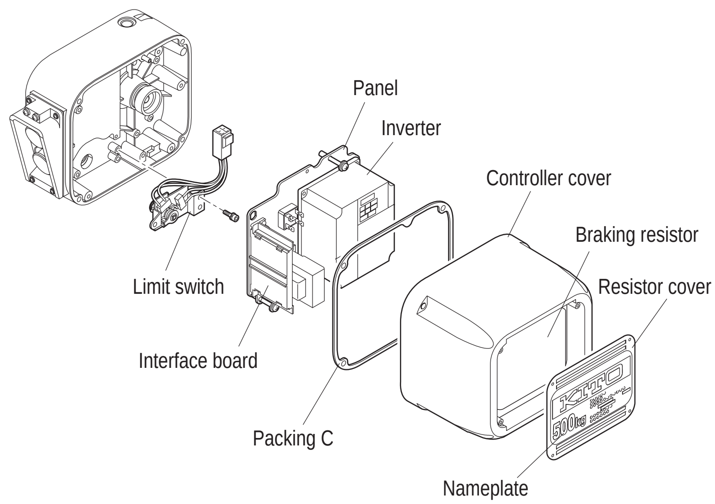


■Single Speed Model

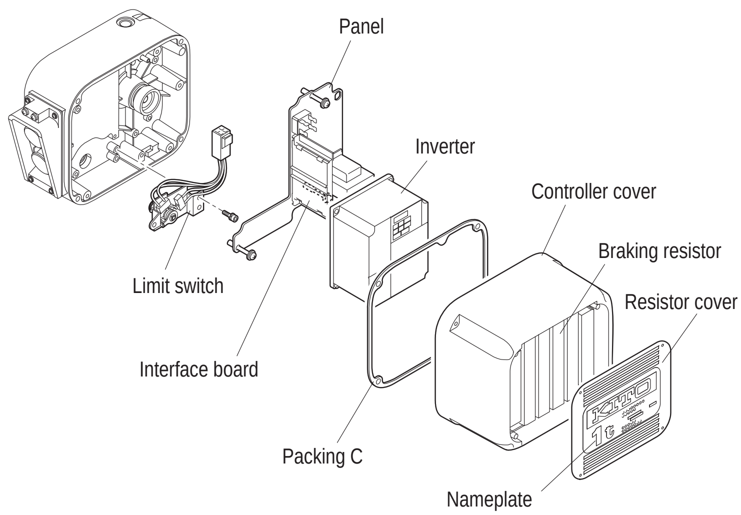
(500V Class Dual Speed Model)



■Dual Speed VFD Model (Body size B, C)



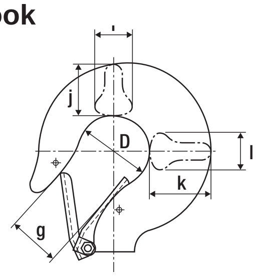
■Dual Speed VFD Model (Body size D, E, F)

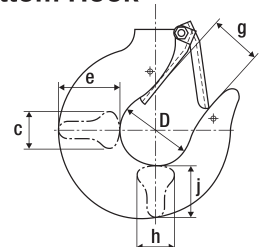


Technical Material

Hook Dimensions (for ER2)

● **Top Hook** ● **Bottom Hook**





Code	Top Hook (mm)						Bottom Hook (mm)					
	D	g	i	j	k	l	D	g	h	j	e	c
ER2-001H/IH/HD	35.5	27.0	17.5	23.5	28.0	17.5	35.5	27.0	17.5	23.5	28.0	17.5
ER2-003S/IS/SD												
ER2-003H/IH/HD												
ER2-005L/IL/LD												
ER2-005S/IS/SD												
ER2-010L/IL/LD	42.5	31.0	22.5	31.0	36.5	22.5	42.5	31.0	22.5	31.0	36.5	22.5
ER2-010S/IS/SD												
ER2-015S/IS/SD	53.0	39.0	31.5	43.5	51.5	31.5	47.5	34.0	26.5	36.5	43.5	26.5
ER2-020C/IC/CD							53.0	39.0	31.5	43.5	51.5	31.5
ER2-020L/IL/LD												
ER2-020S/IS/SD												
ER2-025S/IS/SD	60.0	44.0	32.5	44.0	52.0	32.5						
ER2-030S/IS/SD			34.5	47.5	56.0	34.5	60.0	44.0	34.5	47.5	56.0	34.5
ER2-050S/IS	63.0	47.0	42.5	56.0	67.0	42.5	63.0	47.0	42.5	56.0	67.0	42.5

Table of Lifting Load

Capacity (t)	125kg	250kg	500kg	1	1.5	2	2.5	3	5
Lifting Load (t)	0.126	0.251	0.501	1.002	1.504	2.004	2.504	3.005	5.014

Note) Above figures are for the standard specification Hook for Electric Chain Hoist ER2.

Rated Motor Current

Lifting motor (Single speed)

(Unit:A)

Capacity (t)	Code	Motor output (kW)	230/460V Class		500V Class	
			208-230V	415-460V	500V	575V
			60Hz		50Hz	60Hz
125kg	ER2-001H	0.56	3.4	1.7	1.6	1.4
250kg	ER2-003S					
500kg	ER2-005L					
250kg	ER2-003H	0.9	4.8	2.5	2.0	1.8
500kg	ER2-005S					
1	ER2-010L					
	ER2-010S	1.8	8.6	4.2	3.0	3.3
1.5	ER2-015S					
2	ER2-020C	0.9	4.8	2.5	2.0	11.8
	ER2-020L	1.8	8.6	4.2	3.0	3.3
	ER2-020S	3.5	16.4	7.9	6.0	6.2
2.5	ER2-025S					
3	ER2-030S					
5	ER2-050S					
Motor Insulation Class			B		B	

Technical Material

A

Lifting motor (Dual speed)

(Unit:A)

Capacity (t)	Code	Motor output (kW)	230/460V Class		500V Class		
			208-230V	415-460V	Motor output (kW)	500V	575V
			60Hz			50Hz	60Hz
125kg	ER2-001IH	0.56	3.6	1.8	0.5	1.6/0.9	1.4/0.9
250kg	ER2-003IS						
500kg	ER2-005IL						
250kg	ER2-003IH	0.9	5.1	2.7	0.9	1.8/1.4	1.7/1.4
500kg	ER2-005IS						
1	ER2-010IL						
	ER2-010IS	1.8	9.1	4.5	1.8	3.2/2.2	3.2/2.0
1.5	ER2-015IS						
2	ER2-020IC	0.9	5.1	2.7	0.9	1.8/1.4	1.7/1.4
	ER2-020IL	1.8	9.1	4.5	1.8	3.2/2.2	3.2/2.0
	ER2-020IS	3.5	17.3	8.3	3.5	6.0/3.7	6.0/3.4
2.5	ER2-025IS						
3	ER2-030IS						
5	ER2-050IS						
Motor Insulation Class			B			B	

Traveling motor (Single speed)

(Unit:A)

Capacity (t)	Code	Motor output (kW)	230/460V Class		500V Class	
			208-230V	415-460V	500V	575V
			60Hz		50Hz	60Hz
125kg	MR2-010S/L	0.4	3.2	1.6	1.5	1.1
250kg						
500kg						
1						
1.5	MR2-020S/L					
2						
2.5	MR2-030S/L					
3						
5	MR2-050S/L	0.75	5.1	2.5	2.2	1.8
Motor Insulation Class			B		B	

Traveling motor (Dual speed)

(Unit:A)

Capacity (t)	Code	Motor output (kW)	230/460V Class		500V Class		
			208-230V	415-460V	Motor output (kw)	500V	575V
			60Hz			50Hz	60Hz
125kg	MR2-010IS	0.4	3.4	1.7	0.32 /0.08	1.7/1.0	1.1/0.8
250kg							
500kg							
1							
1.5	MR2-020IS						
2							
2.5	MR2-030IS				0.64/ 0.16	1.9/1.5	1.3/1.1
3							
5	MR2-050IS	0.75	5.4	2.7			
Motor Insulation Class			B		B		

(to be continued)

Technical Material

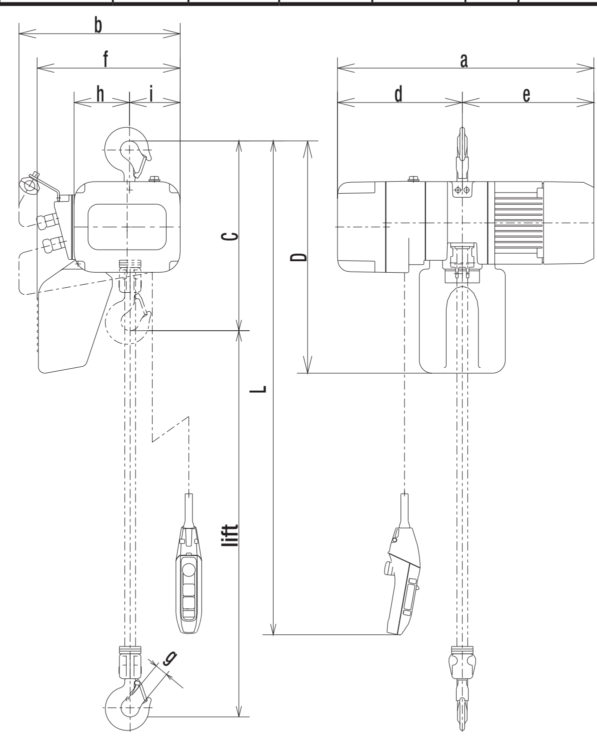
A

Specification and Dimensions of Single Speed ER2

Specification

Capacity (t)	Code	Specification of ER2											
		Body size	Standard lift (m)	Push Button Switch cord length L (m)	Lifting motor: Output (kW)	Lifting motor: Intermittent rating (% ED)	Lifting speed (m/min): 50Hz	Lifting speed (m/min): 60Hz	Load chain: Wire diameter (mm) × Number of falls	Grade	Test Weight (t)	Mass (kg)	Additional mass per another 1 m lift (kg)
125kg	ER2-001H	B	4·6	3.5	0.56	60	14.1	16.9	ϕ 4.3×1	M5	156kg	27 (28)	0.42
250kg	ER2-003S						9.1	10.9			313kg		
	ER2-003H	C			0.9		13.4	16.1	ϕ 6.0×1			37 (38)	0.81
0.5	ER2-005L				0.56		3.8	4.6			625kg	33 (37)	
	ER2-005S				0.9		7.3	8.8			613kg	37 (38)	
1	ER2-010L	D					3.5	4.2	ϕ 7.7×1		1.25	48 (51)	1.33
	ER2-010S				1.8		7.1	8.5				55	
1.5	ER2-015S	E					4.5	5.4	ϕ 10.2×1		1.88	74 (79)	2.3
2	ER2-020C	D	3	2.5	0.9		1.8	2.2	ϕ 7.7×2		2.5	59 (61)	2.7
	ER2-020L	E	4.6	3.5	1.8		3.7	4.4	ϕ 10.2×1	M4		75 (81)	2.3
	ER2-020S				3.5		7.0	8.4				93 (92)	
2.5	ER2-025S	F					5.7	6.8	ϕ 11.2×1		3.13	106 (105)	2.8
3	ER2-030S	E		3.8			4.4	5.3	ϕ 10.2×2		3.75	111	4.7
5	ER2-050S	F					2.9	3.5	ϕ 11.2×2		6.25	137 (135)	5.6

* Mass is for the lift of 4 m.
* The mass values in parenthesis ( ) are for friction clutch with mechanical brake type.



Dimensions (mm)

Capacity (t)	Code	Minimum distance between Hooks: C	D	a (MFC)	b (MFC)	d (MFC)	e (MFC)	f (MFC)	g	h	i (MFC)
125kg	ER2-001H	350	430	478 (564)	321 (345)	219 (305)	259	260 (284)	27	99	93 (117)
250kg	ER2-003S										
	ER2-003H	370	490	510 (593)	348	242 (325)	268	283		113	106
0.5	ER2-005L			513 (599)			271 (273)				
	ER2-005S			510 (593)			268				
1	ER2-010L	430	550	589 (632)	376	291 (332)	298 (300)	335	31	129	118
	ER2-010S			598 (639)			307				
1.5	ER2-015S	510	630	646 (738)	427	308 (397)	338 (341)	384.5	34	160.5	137.5
2	ER2-020C	705		589 (632)	376	291 (332)	298 (300)	335	37	178	69
	ER2-020L	575		646 (738)	427	308 (397)	338	384.5	39	160.5	137.5
	ER2-020S	590		703 (782)		347 (426)	356				
2.5	ER2-025S	625	840	736 (826)	445	337 (427)	399	437.5		173.5	142.5
3	ER2-030S	785	920	703 (782)	427	347 (426)	356	397	44	216	82
5	ER2-050S	850		736 (826)	445	337 (427)	399	439	47	231.5	84.5

* Dimensions D and f are for the lift of 4 m.
* The values in parenthesis ( ) are for friction clutch with mechanical brake type.

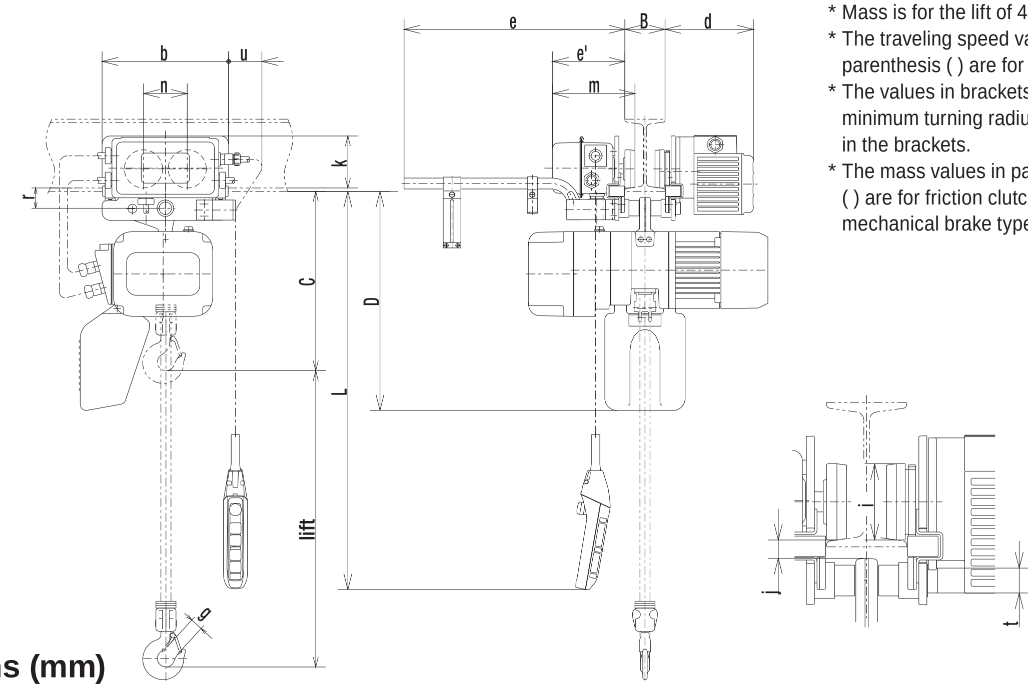
Technical Material

A

Specification and Dimensions of Single Speed ER2M

Specification

Capacity (t)	Code	Specification of ER2										Specification of MR2							Other specification	
		ER2 series	Body size	Standard lift (m)	Push Button Switch cord length L (m)	Lifting motor Output (kW)	Lifting motor Intermittent rating (% ED)	Lifting speed (m/min) 50Hz	Lifting speed (m/min) 60Hz	Load chain Wire diameter (mm) × Number of falls	Grade	MR2 series	Traveling motor Output (kW)	Traveling motor Intermittent rating (% ED)	Traveling speed (m/min) 50Hz	Traveling speed (m/min) 60Hz	Rail Width: B (mm)	Mlinimum Turning Radius (mm)	Mass (kg)	Additional mass per another 1 m lift (kg)
125kg	ER2M001H-S/L	ER2-001H	B	4·6	3.5	0.56	60	14.1	16.9	ϕ 4.3×1	M5	MR2-010S(L)	0.4	40	20 (10)	24 (12)	58 to 153	800 [3500]	58 (59)	0.42
250kg	ER2M003S-S/L	ER2-003S						9.1	10.9											
	ER2M003H-S/L	ER2-003H	C			0.9		13.4	16.1	ϕ 6.0×1									68 (69)	0.81
0.5	ER2M005L-S/L	ER2-005L				0.56		3.8	4.6										64 (67)	
0.49	ER2M005S-S/L	ER2-005S				0.9		7.3	8.8										68 (69)	
1	ER2M010L-S/L	ER2-010L	D					3.5	4.2	ϕ 7.7×1									78 (81)	1.33
	ER2M010S-S/L	ER2-010S				1.8		7.1	8.5										85	
1.5	ER2M015S-S/L	ER2-015S	E					4.5	5.4	ϕ 10.2×1		MR2-020S(L)					82 to 178	800 [1000]	112 (117)	2.3
2	ER2M020C-S/L	ER2-020C	D	3	2.5	0.9		1.8	2.2	ϕ 7.7×2									97 (99)	2.7
	ER2M020L-S/L	ER2-020L	E	4.6	3.5	1.8		3.7	4.4	ϕ 10.2×1	M4								113 (118)	2.3
	ER2M020S-S/L	ER2-020S				3.5		7.0	8.4										131 (130)	
2.5	ER2M025S-S/L	ER2-025S	F					5.7	6.8	ϕ 11.2×1		MR2-030S(L)					100 to 178	1000	154 (153)	2.8
3	ER2M030S-S/L	ER2-030S	E		3.8			4.4	5.3	ϕ 10.2×2									159	4.7
5	ER2M050S-S/L	ER2-050S	F					2.9	3.5	ϕ 11.2×2		MR2-050S(L)	0.75					1800	207 (205)	5.6



* Mass is for the lift of 4 m.
* The traveling speed values in parenthesis ( ) are for the low speed.
* The values in brackets [ ] are for the minimum turning radius of the value in the brackets.
* The mass values in parenthesis ( ) are for friction clutch with mechanical brake type.

Dimensions (mm)

Capacity (t)	Code	Minimum distance between Hooks: C	D	b	d	e	e'	g	i	j	k	m	n	r	t	u
125kg	ER2M001H-S/L	375	450	315	220	515	179	27	95	22	130	205	109	51	31	83
250kg	ER2M003S-S/L															
	ER2M003H-S/L	395	510													
0.5	ER2M005L-S/L															
	ER2M005S-S/L															
1	ER2M010L-S/L	435	550					31								
	ER2M010S-S/L															
1.5	ER2M015S-S/L	505	630	325	225	520	184	34	110	27	125	212	118	60	36	76
2	ER2M020C-S/L	690	620					37								
	ER2M020L-S/L	570	630					39								
	ER2M020S-S/L	585														
2.5	ER2M025S-S/L	620	830	340	226	521	186		125	29	131	215	132	68	43	70
3	ER2M030S-S/L	765	900					44								
5	ER2M050S-S/L	840	910	400	281	528	192	47	140	44	145	233	150	86	54	56

* Dimensions D is for the lift of 4 m.

(to be continued)

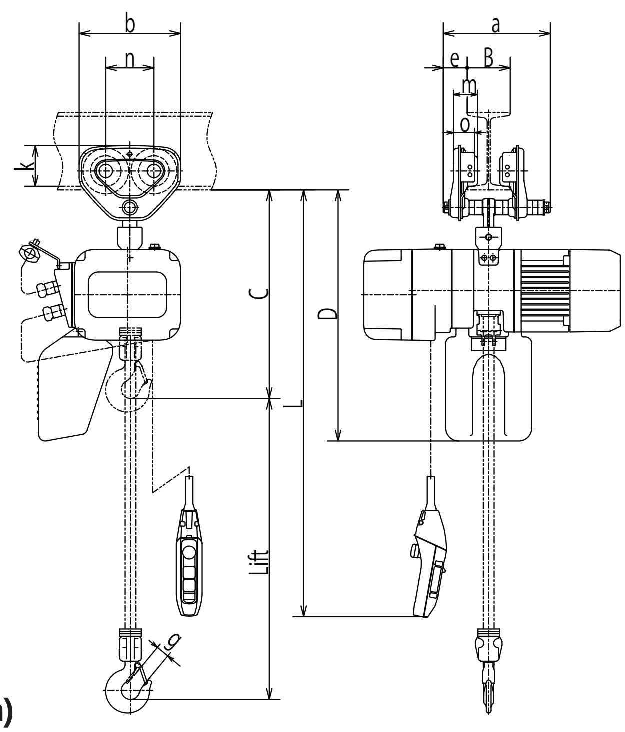
Specification and Dimensions of Single Speed ER2SP

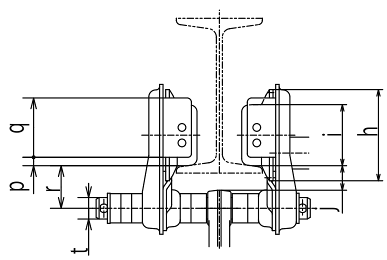
Specification

Capacity (t)	Code	Specification of ER2: ER2 series	Body size	Standard lift (m)	Push Button Switch cord length L (m)	Lifting motor: Output (kW)	Lifting motor: Intermittent rating (% ED)	Lifting speed (m/min): 50Hz	Lifting speed (m/min): 60Hz	Load chain: Wire diameter (mm) × Number of falls	Grade	Specification of TSP (plain trolley): TSP series	Hand Chain length: E (m)	Rail Width: B (mm)	Mlinimum Turning Radius (mm)	Specification of ER2SP: Mass (kg)	Additional mass per another 1 m lift (kg)
125kg	ER2SP001H	ER2-001H	B	4·6	3.5	0.56	60	14.1	16.9	ϕ 4.3×1	M5	TSP005		50 to 102	1100	32 (33)	0.42
250kg	ER2SP003S	ER2-003S						9.1	10.9								
	ER2SP003H	ER2-003H	C			0.9		13.4	16.1	ϕ 6.0×1						42 (43)	0.81
0.5	ER2SP005L	ER2-005L				0.56		3.8	4.6							38 (42)	
	ER2SP005S	ER2-005S				0.9		7.3	8.8							42 (43)	
1	ER2SP010L	ER2-010L	D					3.5	4.2	ϕ 7.7×1		TSP010		58 to 127	1300	56 (59)	1.33
	ER2SP010S	ER2-010S				1.8		7.1	8.5							63	
1.5	ER2SP015S	ER2-015S	E					4.5	5.4	ϕ 10.2×1		TSP020		82 to 153	1500	87 (93)	2.3
2	ER2SP020C	ER2-020C	D	3	2.5	0.9		1.8	2.2	ϕ 7.7×2						73 (75)	2.7
	ER2SP020L	ER2-020L	E	4·6	3.5	1.8		3.7	4.4	ϕ 10.2×1	M4					88 (94)	2.3
	ER2SP020S	ER2-020S				3.5		7.0	8.4							107 (106)	
2.5	ER2SP025S	ER2-025S	F					5.7	6.8	ϕ 11.2×1		TSP030			1700	130 (129)	2.8
3	ER2SP030S	ER2-030S	E		3.8			4.4	5.3	ϕ 10.2×2						134 (133)	4.7
5	ER2SP050S	ER2-050S	F					2.9	3.5	ϕ 11.2×2		TSP050		100 to 178	2300	187 (185)	5.6

* Mass is for the lift of 4 m.

* The mass values in parenthesis ( ) are for friction clutch with mechanical brake type.





Dimensions (mm)

Capacity (t)	Code	Minimum distance between Hooks: C	D	a	b	e	g	h	i	j	k	m	n	o	p	q	r	t
125kg	ER2SP001H	395	470	204	182	46	27	82	60	21	76	47.5	84	42	10	54	38	22
250kg	ER2SP003S																	
	ER2SP003H	415	530															
0.5	ER2SP005L																	
	ER2SP005S																	
1	ER2SP010L	470	590	249	236	56	31	106	71	28	95	56	112	50		69	50	25
	ER2SP010S																	
1.5	ER2SP015S	570	690	300	280	69	34	127	85	34	112	71	131	63		83	62	32
2	ER2SP020C	695	620				37											
	ER2SP020L	635	690				39											
	ER2SP020S	650																
2.5	ER2SP025S	680	890	320	324	79		148	100	36	134	80	152	74		102	68	36
3	ER2SP030S	780	910				44											
5	ER2SP050S	840		297	400	53	47	169	118	46	144	81	178	70		104	88	54

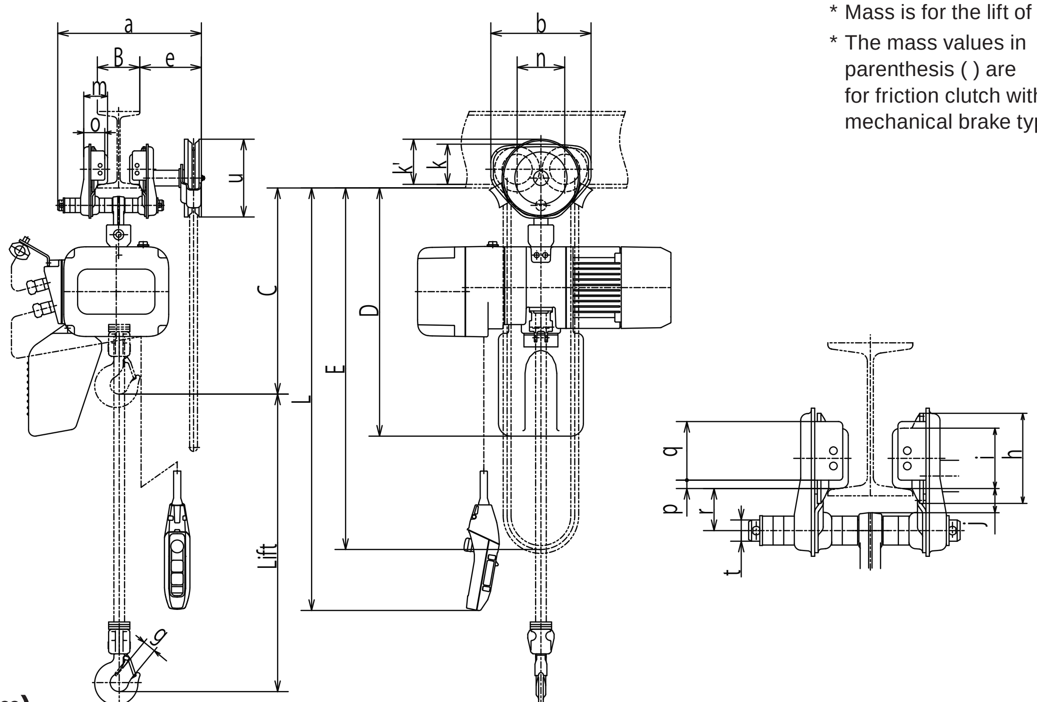
* Dimensions D is for the lift of 4 m.

Specification and Dimensions of Single Speed ER2SG

Specification

Capacity (t)	Code	Specification of ER2: ER2 series	Body size	Standard lift (m)	Push Button Switch cord length L (m)	Lifting motor: Output (kW)	Lifting motor: Intermittent rating (% ED)	Lifting speed (m/min): 50Hz	Lifting speed (m/min): 60Hz	Load chain: Wire diameter (mm) × Number of falls	Grade	Specification of TSG (geared trolley): TSG series	Hand Chain length: E (m)	Rail Width: B (mm)	Minimum Turning Radius (mm)	Specification of ER2SG: Mass (kg)	Additional mass per another 1 m lift (kg)
125kg	ER2SG001H	ER2-001H	B	4·6	3.5	0.56	60	14.1	16.9	ϕ 4.3×1	M5	TSG010	3.7 · 5.7	58 to 127	1300	41 (42)	1.4
250kg	ER2SG003S	ER2-003S						9.1	10.9								
	ER2SG003H	ER2-003H	C			0.9		13.4	16.1	ϕ 6.0×1						51 (52)	1.7
0.5	ER2SG005L	ER2-005L				0.56		3.8	4.6							47 (50)	
	ER2SG005S	ER2-005S				0.9		7.3	8.8								
1	ER2SG010L	ER2-010L	D					3.5	4.2	ϕ 7.7×1						61 (64)	2.3
	ER2SG010S	ER2-010S				1.8		7.1	8.5							68	
1.5	ER2SG015S	ER2-015S	E					4.5	5.4	ϕ 10.2×1		TSG020		82 to 153	1500	92 (98)	3.2
2	ER2SG020C	ER2-020C	D	3	2.5	0.9		1.8	2.2	ϕ 7.7×2						78 (80)	3.6
	ER2SG020L	ER2-020L	E	4·6	3.5	1.8		3.7	4.4	ϕ 10.2×1	M4					93 (99)	3.2
	ER2SG020S	ER2-020S				3.5		7.0	8.4							112 (111)	
2.5	ER2SG025S	ER2-025S	F					5.7	6.8	ϕ 11.2×1		TSG030			1700	135 (134)	3.7
3	ER2SG030S	ER2-030S	E		3.8			4.6	5.5	ϕ 10.2×2						139 (138)	5.6
5	ER2SG050S	ER2-050S	F					2.9	3.5	ϕ 11.2×2		TSG050	4.2 · 6.2	100 to 178	2300	194 (192)	6.5

* Mass is for the lift of 4 m.
* The mass values in parenthesis ( ) are for friction clutch with mechanical brake type.



Dimensions (mm)

Capacity (t)	Code	Minimum distance between Hooks: C	D	a	b	e	g	h	i	j	k	k'	m	n	o	p	q	r	t	u
125kg	ER2SG001H	415	490	345	236	152	27	106	71	28	95	107	56	112	50	10	69	50	25	183
250kg	ER2SG003S																			
	ER2SG003H	435	550																	
0.5	ER2SG005L																			
	ER2SG005S																			
1	ER2SG010L	470	590				31													
	ER2SG010S																			
1.5	ER2SG015S	570	690	385	280	154	34	127	85	34	112	109	71	131	63		83	62	32	
2	ER2SG020C	695	620				37													
	ER2SG020L	635	690				39													
	ER2SG020S	650																		
2.5	ER2SG025S	680	890	398	324	157		148	100	36	134	115	80	152	74		102	68	36	
3	ER2SG030S	780	910				44													
5	ER2SG050S	840		401	400	156	47	169	118	46	144	131	81	178	70		104	88	54	

* Dimensions D is for the lift of 4 m.

(to be continued)

Specification and Dimensions of Dual Speed VFD ER2

Specification

Capacity (t)	Code	Specification of ER2: Body size	Standard lift (m)	Push Button Switch cord length L (m)	Lifting motor: Output (kW)	Lifting motor: Intermittent rating (% ED)	Lifting speed (m/min)	50Hz/60Hz: High speed	50Hz/60Hz: Low speed	Load chain: Wire diameter (mm) × Number of falls	Grade	Test Weight (t)	Mass (kg)	Additional mass per another 1 m lift (kg)
125kg	ER2-001IH	B	4·6	3.5	0.56	40/20	INIT.	16.6	2.8	ϕ 4.3×1	M6	156kg	27 (29)	0.42
							RANGE	16.6	1.4					
250kg	ER2-003IS						INIT.	10.8	1.8			313kg		
							RANGE	10.8	0.9					
	ER2-003IH	C			0.9		INIT.	15.7	2.6	ϕ 6.0×1			36 (38)	0.81
							RANGE	15.7	1.3					
0.5	ER2-005IL				0.56		INIT.	4.5	0.8			613kg (625kg)	32 (37)	
							RANGE	4.5	0.4					
	ER2-005IS				0.9		INIT.	8.5	1.4			625kg	36 (38)	
							RANGE	8.5	0.7					
1	ER2-010IL	D					INIT.	4.2	0.7	ϕ 7.7×1	M5	1.25	46 (50)	1.33
							RANGE	4.2	0.3					
	ER2-010IS				1.8		INIT.	8.2	1.4				53 (54)	
							RANGE	8.2	0.7					
1.5	ER2-015IS	E					INIT.	5.3	0.9	ϕ 10.2×1		1.88	74 (80)	2.3
							RANGE	5.3	0.4					
2	ER2-020IC	D	3	2.5	0.9		INIT.	2.1	0.3	ϕ 7.7×2		2.5	56 (60)	2.7
							RANGE	2.1	0.2					
	ER2-020IL	E	4·6	3.5	1.8		INIT.	4.3	0.7	ϕ 10.2×1	M4		75 (81)	2.3
							RANGE	4.3	0.4					
	ER2-020IS				3.5		INIT.	8.2	1.4				91 (94)	
							RANGE	8.2	0.7					
2.5	ER2-025IS	F					INIT.	6.6	1.1	ϕ 11.2×1		3.13	102 (108)	2.8
							RANGE	6.6	0.6					
3	ER2-030IS	E		3.8			INIT.	5.2	0.9	ϕ 10.2×2		3.75	109 (113)	4.7
							RANGE	5.2	0.4					
5	ER2-050IS	F					INIT.	3.3	0.6	ϕ 11.2×2		6.25	133 (139)	5.6
							RANGE	3.3	0.3					

* Mass is for the lift of 4 m.

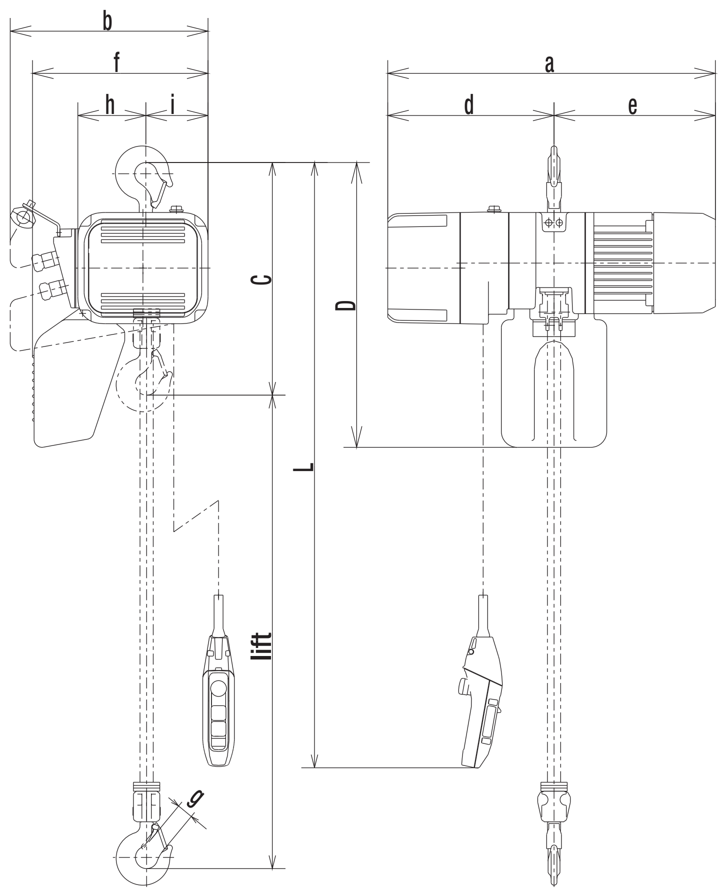
* For 125kg - 500kg dual speed type equipped with friction clutch with mechanical brake, the grade is M5.

.*The mass values in parenthesis ( ) are for friction clutch with mechanical brake type.

Dimensions (mm)

<table>
<tr><th>Capacity (t)</th><th>Code</th><th>Minimum distance between Hooks: C</th><th>D</th><th>a (MFC)</th><th>b</th><th>d (MFC)</th><th>e (MFC)</th><th>f</th><th>g</th><th>h</th><th>i</th></tr>
<tr><td>125kg</td><td>ER2-001IH</td><td rowspan="2">350</td><td rowspan="2">430</td><td rowspan="2">535 (564)</td><td rowspan="2">345</td><td rowspan="2">276 (305)</td><td rowspan="2">259</td><td rowspan="2">284</td><td rowspan="5">27</td><td rowspan="2">99</td><td rowspan="2">117</td></tr>
<tr><td rowspan="2">250kg</td><td>ER2-003IS</td></tr>
<tr><td>ER2-003IH</td><td rowspan="3">370</td><td rowspan="3">490</td><td>568 (593)</td><td rowspan="3">348</td><td rowspan="3">300 (325)</td><td>268</td><td rowspan="3">283</td><td rowspan="3">113</td><td rowspan="3">106</td></tr>
<tr><td rowspan="2">0.5</td><td>ER2-005IL</td><td>571 (598)</td><td>271 (273)</td></tr>
<tr><td>ER2-005IS</td><td>568 (593)</td><td>268</td></tr>
<tr><td rowspan="2">1</td><td>ER2-010IL</td><td rowspan="2">430</td><td rowspan="2">550</td><td>614 (632)</td><td rowspan="2">376</td><td rowspan="2">316 (332)</td><td>298 (300)</td><td rowspan="2">335</td><td rowspan="2">31</td><td rowspan="2">129</td><td rowspan="2">118</td></tr>
<tr><td>ER2-010IS</td><td>623 (639)</td><td>307</td></tr>
<tr><td>1.5</td><td>ER2-015IS</td><td>510</td><td rowspan="4">630</td><td>710 (737)</td><td>427</td><td>372 (397)</td><td>338 (340)</td><td>384.5</td><td>34</td><td>160.5</td><td>137.5</td></tr>
<tr><td rowspan="3">2</td><td>ER2-020IC</td><td>705</td><td>614 (632)</td><td>376</td><td>316 (332)</td><td>298 (300)</td><td>335</td><td>37</td><td>178</td><td>69</td></tr>
<tr><td>ER2-020IL</td><td>575</td><td>710 (737)</td><td rowspan="2">427</td><td>372 (397)</td><td>338 (340)</td><td rowspan="2">384.5</td><td rowspan="3">39</td><td rowspan="2">160.5</td><td rowspan="2">137.5</td></tr>
<tr><td>ER2-020IS</td><td>590</td><td>767 (782)</td><td>411 (426)</td><td>356</td></tr>
<tr><td>2.5</td><td>ER2-025IS</td><td>625</td><td>840</td><td>800 (826)</td><td>445</td><td>401 (427)</td><td>399</td><td>437.5</td><td>173.5</td><td>142.5</td></tr>
<tr><td>3</td><td>ER2-030IS</td><td>785</td><td rowspan="2">920</td><td>767 (782)</td><td>427</td><td>411 (426)</td><td>356</td><td>397</td><td>44</td><td>216</td><td>82</td></tr>
<tr><td>5</td><td>ER2-050IS</td><td>850</td><td>800 (826)</td><td>445</td><td>401 (427)</td><td>399</td><td>439</td><td>47</td><td>231.5</td><td>84.5</td></tr>
</table>

* Dimensions D and f are for the lift of 4 m.
* The values in parenthesis ( ) are for friction clutch with mechanical brake type.



(to be continued)

Technical Material

A

Specification and Dimensions of Dual Speed ER2 (500V class)

Specification

Capacity (t)	Code	Specification of ER2											
		Body size	Standard lift (m)	Push Button Switch cord length L (m)	Lifting motor		Lifting speed (m/min)		Load chain	Grade	Test Weight (t)	Mass (kg)	Additional mass per another 1 m lift (kg)
					Output (kW)	Intermittent rating (% ED)	60Hz		Wire diameter (mm) × Number of falls				
							High speed	Low speed					
125kg	ER2-001HD	B	4·6	3.5	0.5/0.13	40/20	17.0	4.2	ϕ 4.3×1	M5	156kg	31 (32)	0.42
250kg	ER2-003SD						8.6	2.2			313kg		
0.5	ER2-005LD	C					4.3	1.1	ϕ 6.0×1		625kg	39 (43)	0.81
	ER2-005SD				0.9/0.23		8.5	2.2				43 (44)	
1	ER2-010LD	D					4.2	1.1	ϕ 7.7×1		1.25	57 (59)	1.33
	ER2-010SD				1.8/0.45		8.6	2.0				59	
2	ER2-020CD		3	2.5	0.9/0.23		2.0	0.6	ϕ 7.7×2		2.5	67 (69)	2.7
1.5	ER2-015SD	E	4·6	3.5	1.8/0.45		5.8	1.4	ϕ 10.2×1		1.88	76 (82)	2.3
2	ER2-020LD						4.4	1.1		M4	2.5	78 (84)	
	ER2-020SD				3.5/0.88		8.3	1.9				99 (98)	
2.5	ER2-025SD	F					6.6	1.6	ϕ 11.2×1		3.13	110 (109)	2.8
3	ER2-030SD	E		3.8			5.3	1.2	ϕ 10.2×2		3.75	117 (116)	4.7
5	ER2-050SD	F					3.4	0.7	ϕ 11.2×2		6.25	139 (138)	5.6

* Mass is for the lift of 4 m.

* The mass values in parenthesis ( ) are for friction clutch with mechanical brake type.

Technical Material

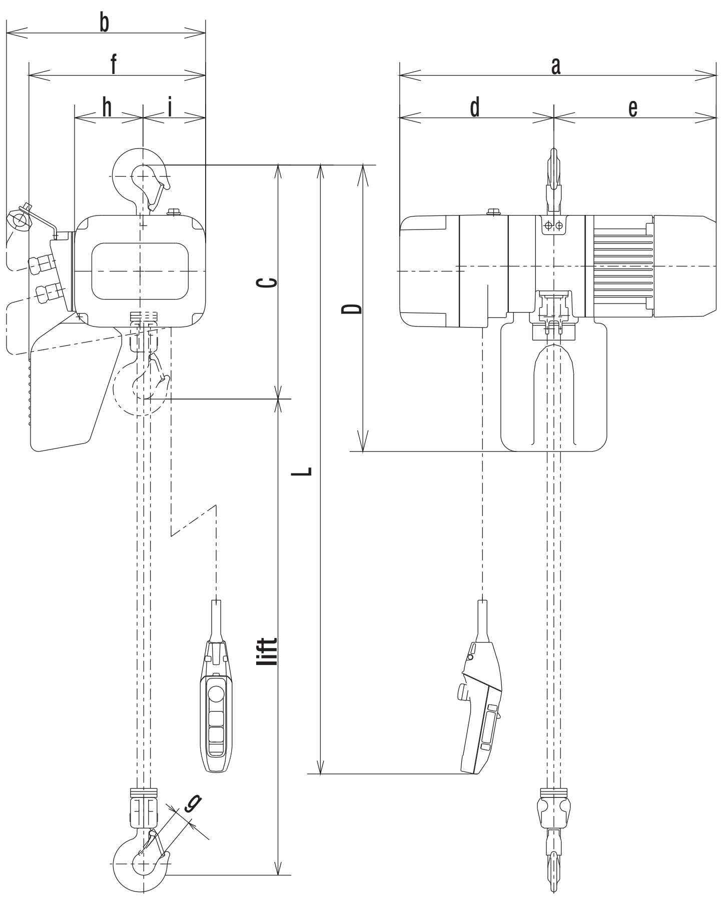
A

Dimensions (mm)

Capacity (t)	Code	Minimum distance between Hooks: C	D	a (MFC)	b (MFC)	d (MFC)	e (MFC)	f (MFC)	g	h	i (MFC)
125kg	ER2-001HD	350	430	478 (564)	321 (345)	219 (305)	259	260 (284)	27	99	93 (117)
250kg	ER2-003SD										
0.5	ER2-005LD	370	490	513 (598)	348	242 (325)	271 (273)	283	27	113	106
	ER2-005SD			533 (616)			291				
1	ER2-010LD	430	550	589 (632)	376	291 (332)	298 (300)	335	31	129	118
	ER2-010SD			615 (656)			324				
2	ER2-020CD	705	630	589 (632)	376	291 (332)	298 (300)	335	37	178	69
1.5	ER2-015SD	510		646 (737)	427	308 (397)	338 (340)	384.5	34	160.5	137.5
2	ER2-020LD	575							39		
	ER2-020SD	590		737 (816)		347 (426)	390				
2.5	ER2-025SD	625	840	736 (826)	445	337 (427)	399	437.5	39	173.5	142.5
3	ER2-030SD	785 *	920	737 (816)	427	347 (426)	390	397	44	216	82
5	ER2-050SD	850 *		736 (826)	445	337 (427)	399	439	47	231.5	84.5

* Dimensions D and f are for the lift of 4 m.

* The values in parenthesis ( ) are for friction clutch with mechanical brake type.



Technical Material

A

Specification and Dimensions of Dual Speed VFD ER2M

Specification

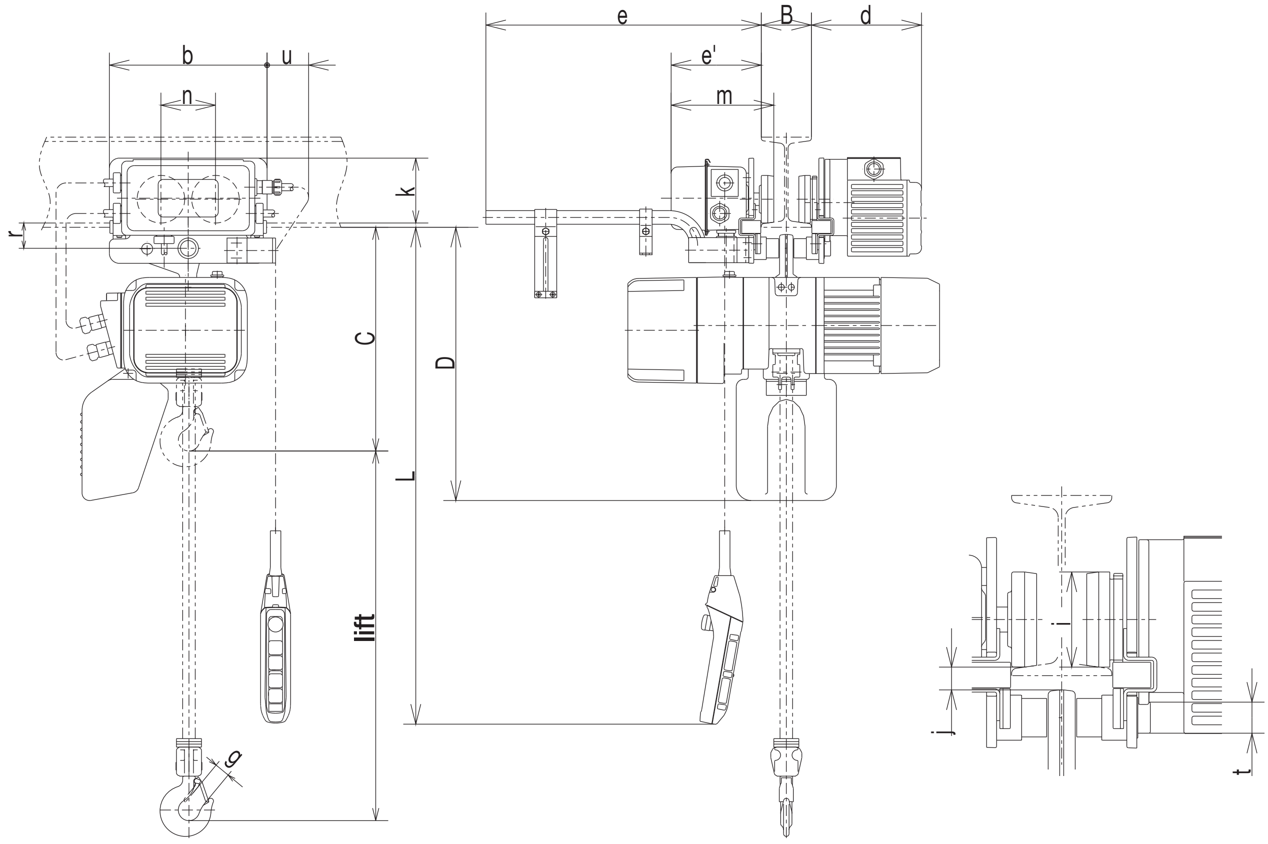
Capacity (t)	Code	Specification of ER2: ER2 series	Body size	Standard lift (m)	Push Button Switch cord length L (m)	Lifting motor: Output (kW)	Lifting motor: Intermittent rating (% ED)	Lifting speed (m/min)	Lifting speed 50Hz/60Hz: High speed	Lifting speed 50Hz/60Hz: Low speed	Load chain: Wire diameter (mm) × Number of falls	Grade
125kg	ER2M-001IH-IS/IL	ER2-001IH	B	4·6	3.5	0.56	40/20	INIT.	16.6	2.8	ϕ 4.3×1	M6
								RANGE	16.6	1.4		
250kg	ER2M-003IS-IS/IL	ER2-003IS						INIT.	10.8	1.8		
								RANGE	10.8	0.9		
	ER2M-003IH-IS/IL	ER2-003IH	C			0.9		INIT.	15.7	2.6	ϕ 6.0×1	
								RANGE	15.7	1.3		
0.5	ER2M005IL-IS/IL	ER2-005IL				0.56		INIT.	4.5	0.8		
								RANGE	4.5	0.4		
	ER2M005IS-IS/IL	ER2-005IS				0.9		INIT.	8.5	1.4		
								RANGE	8.5	0.7		
1	ER2M010IL-IS/IL	ER2-010IL	D					INIT.	4.2	0.7	ϕ 0.77×1	M5
								RANGE	4.2	0.3		
	ER2M010IS-IS/IL	ER2-010IS				1.8		INIT.	8.2	1.4		
								RANGE	8.2	0.7		
1.5	ER2M015IS-IS/IL	ER2-015IS	E					INIT.	5.3	0.9	ϕ 10.2×1	
								RANGE	5.3	0.4		
2	ER2M020IC-IS/IL	ER2-020IC	D	3	2.5	0.9		INIT.	2.1	0.3	ϕ 0.77×2	
								RANGE	2.1	0.2		
	ER2M020IL-IS/IL	ER2-020IL	E	4·6	3.5	1.8		INIT.	4.3	0.7	ϕ 10.2×1	M4
								RANGE	4.3	0.4		
	ER2M020IS-IS/IL	ER2-020IS				3.5		INIT.	8.2	1.4		
								RANGE	8.2	0.7		
2.5	ER2M025IS-IS/IL	ER2-025IS	F					INIT.	6.6	1.1	ϕ 11.2×1	
								RANGE	6.6	0.6		
3	ER2M030IS-IS/IL	ER2-030IS	E		3.8			INIT.	5.2	0.9	ϕ 10.2×2	
								RANGE	5.2	0.4		
5	ER2M050IS-IS/IL	ER2-050IS	F					INIT.	3.4	0.6	ϕ 11.2×2	
								RANGE	3.4	0.3		

Capacity (t)	Code	Specification of MR2: MR2 series	Traveling motor: Output (kW)	Traveling motor: Intermittent rating (% ED)	Traveling speed (m/min)	Traveling speed 50Hz/60Hz: High speed	Traveling speed 50Hz/60Hz: Low speed	Rail Width: B (mm)	Mlinimum Turning Radius (mm)	Specification of ER2M: Mass (kg)	Additional mass per another 1 m lift (kg)
125kg	ER2M-001IH-IS	MR2-010IS	0.4	27/13	INIT.	24	4	58 to 153	800 [3500]	59 (61)	0.42
250kg	ER2M-003IS-IS										
	ER2M-003IH-IS									69 (71)	0.81
0.5	ER2M005IL-IS									65 (69)	
	ER2M005IS-IS									69 (71)	
1	ER2M010IL-IS									78 (82)	1.33
	ER2M010IS-IS									85 (86)	
1.5	ER2M015IS-IS	MR2-020IS						82 to 178	800 [1000]	113 (120)	2.3
2	ER2M020IC-IS									97 (101)	2.7
	ER2M020IL-IS				RANGE		2.4			114 (121)	2.3
	ER2M020IS-IS									131 (134)	
2.5	ER2M025IS-IS	MR2-030IS							1000	153 (159)	2.8
3	ER2M030IS-IS									159 (164)	4.7
5	ER2M050IS-IS	MR2-050IS	0.75					100 to 178	1800	205 (211)	5.6

* Mass is for the lift of 4 m.
* Be careful that the values in brackets [ ] are for the minimum turning radius of the value in the brackets.
* For 125kg - 500kg dual speed type equipped with friction clutch with mechanical brake, the grade is M5.
* The mass values in parenthesis ( ) are for friction clutch with mechanical brake type.

Dimensions (mm)

Other dimensions are the same with those of Single Speed ER2M.



(to be continued)

Specification and Dimensions of Dual Speed ER2M (500V class)

Specification

Capacity (t)	Code	Specification of ER2: ER2 series	Body size	Standard lift (m)	Push Button Switch cord length L (m)	Lifting motor: Output (kW)	Lifting motor: Intermittent rating (% ED)	Traveling speed (m/min) 60Hz: High speed	Traveling speed (m/min) 60Hz: Low speed	Load chain: Wire diameter (mm) × Number of falls	Grade
125kg	ER2M001HD-SD	ER2-001HD	B	4·6	3.5	0.5/0.13	40/20	17.0	4.2	ϕ 4.3×1	M5
250kg	ER2M003SD-SD	ER2-003SD						8.6	2.2		
0.5	ER2M005LD-SD	ER2-005LD	C					4.3	1.1	ϕ 6.0×1	
	ER2M005SD-SD	ER2-005SD				0.9/0.23		8.5	2.2		
1	ER2M010LD-SD	ER2-010LD	D					4.2	1.1	ϕ7.7×1	
	ER2M010SD-SD	ER2-010SD				1.8/0.45		8.6	2.0		
2	ER2M020CD-SD	ER2-020CD		3	2.5	0.9/0.23		2.0	0.5	ϕ 7.7×2	
1.5	ER2M015SD-SD	ER2-015SD	E	4·6	3.5	1.8/0.45		5.8	1.4	ϕ 10.2×1	
2	ER2M020LD-SD	ER2-020LD						4.4	1.1		M4
	ER2M020SD-SD	ER2-020SD				3.5/0.88		8.3	1.9		
2.5	ER2M025SD-SD	ER2-025SD	F					6.6	1.6	ϕ 11.2×1	
3	ER2M030SD-SD	ER2-030SD	E		3.8			5.3	1.2	ϕ 10.2×2	
5	ER2M050SD-SD	ER2-050SD	F					3.4	0.7	ϕ 11.2×2	

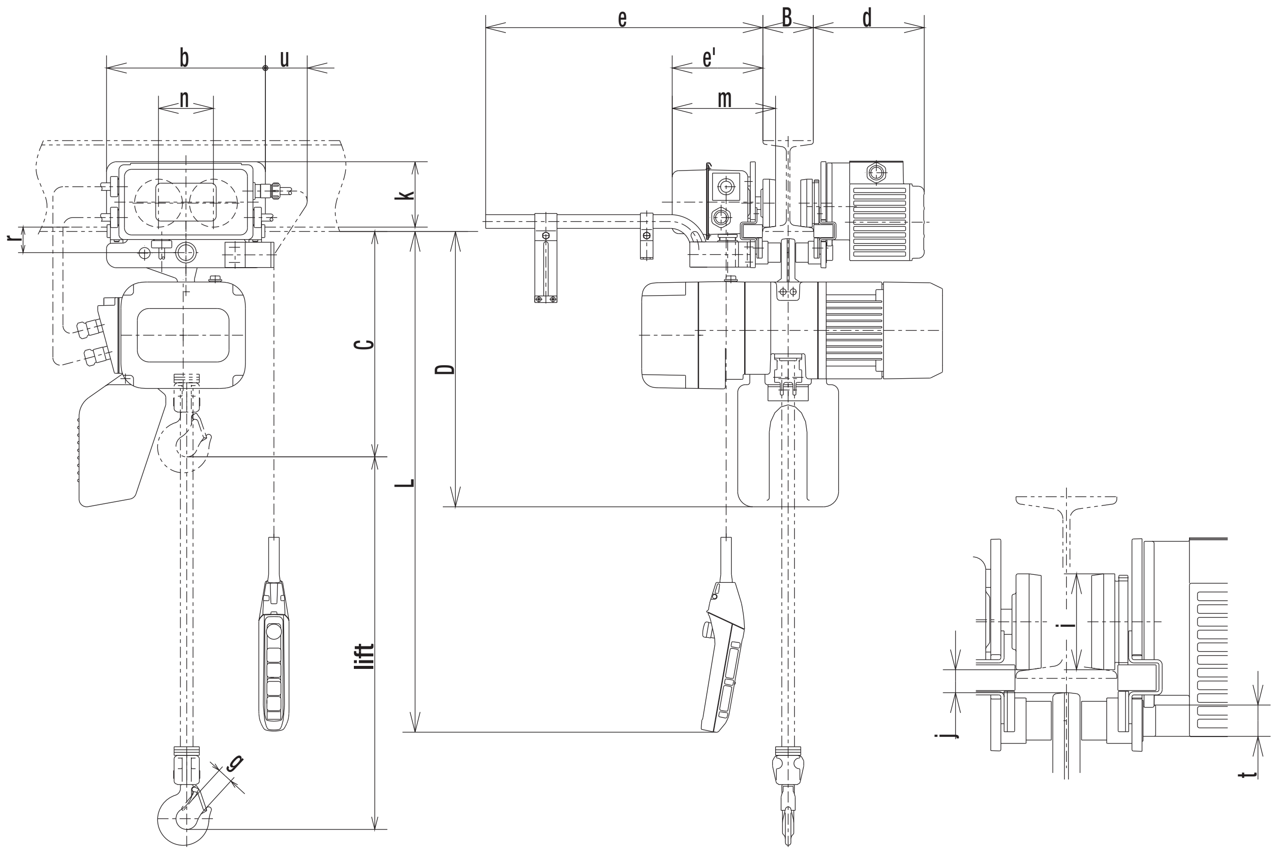
Capacity (t)	Code	Specification of MR2: MR2 series	Traveling motor: Output (kW)	Traveling motor: Intermittent rating (% ED)	Traveling speed (m/min): 50Hz	Traveling speed (m/min): 60Hz	Rail Width: B (mm)	MIinimum Turning Radius (mm)	Specification of ER2M: Mass (kg)	Additional mass per another 1 m lift (kg)
125kg	ER2M001HD-SD	MR2-010SD	0.32/0.08	27/13	20/5	24/6	58 to 153	800 [3500]	66 (67)	0.42
250kg	ER2M003SD-SD									
0.5	ER2M005LD-SD								74 (77)	0.81
	ER2M005SD-SD								77 (78)	
1	ER2M010LD-SD								90 (93)	1.33
	ER2M010SD-SD								93	
2	ER2M020CD-SD	MR2-020SD					82 to 178	800 [1000]	109 (112)	2.7
1.5	ER2M015SD-SD								118 (124)	2.3
2	ER2M020LD-SD								119 (125)	
	ER2M020SD-SD								140	
2.5	ER2M025SD-SD	MR2-030SD	0.64/0.16				82 to 178	1000	161	2.8
3	ER2M030SD-SD								168 (167)	4.7
5	ER2M050SD-SD	MR2-050SD					100 to 178	1800	213 (212)	5.6

* Mass is for the lift of 4 m.
* Be careful that the values in brackets [ ] are for the minimum turning radius of the value in the brackets.
* The mass values in parenthesis ( ) are for friction clutch with mechanical brake type.

Dimensions (mm)

<table>
<tr><th>Capacity
(t)</th><th>Code</th><th>Minimum distance
between Hooks: C</th><th>D</th><th>b</th><th>d</th><th>e</th><th>e'</th><th>g</th><th>i</th><th>j</th><th>k</th><th>m</th><th>n</th><th>r</th><th>t</th><th>u</th></tr>
<tr><td>125kg</td><td>ER2M001HD-SD</td><td rowspan="2">375</td><td rowspan="2">450</td><td rowspan="6">315</td><td rowspan="6">268</td><td rowspan="6">515</td><td rowspan="6">179</td><td rowspan="4">27</td><td rowspan="6">95</td><td rowspan="6">22</td><td rowspan="6">130</td><td rowspan="6">205</td><td rowspan="6">109</td><td rowspan="6">51</td><td rowspan="6">31</td><td rowspan="6">83</td></tr>
<tr><td>250kg</td><td>ER2M003SD-SD</td></tr>
<tr><td rowspan="2">0.5</td><td>ER2M005LD-SD</td><td rowspan="2">395</td><td rowspan="2">510</td></tr>
<tr><td>ER2M005SD-SD</td></tr>
<tr><td rowspan="2">1</td><td>ER2M010LD-SD</td><td rowspan="2">435</td><td rowspan="2">550</td><td rowspan="2">31</td></tr>
<tr><td>ER2M010SD-SD</td></tr>
<tr><td>2</td><td>ER2M020CD-SD</td><td>690</td><td>620</td><td rowspan="4">325</td><td rowspan="4">273</td><td rowspan="4">520</td><td rowspan="4">184</td><td>37</td><td rowspan="4">110</td><td rowspan="4">27</td><td rowspan="4">125</td><td rowspan="4">212</td><td rowspan="4">118</td><td rowspan="4">60</td><td rowspan="4">36</td><td rowspan="4">76</td></tr>
<tr><td>1.5</td><td>ER2M015SD-SD</td><td>505</td><td rowspan="3">630</td><td rowspan="2">34</td></tr>
<tr><td rowspan="2">2</td><td>ER2M020LD-SD</td><td>570</td></tr>
<tr><td>ER2M020SD-SD</td><td>585</td><td rowspan="2">39</td></tr>
<tr><td>2.5</td><td>ER2M025SD-SD</td><td>620</td><td>830</td><td rowspan="2">340</td><td rowspan="2">274</td><td rowspan="2">521</td><td rowspan="2">186</td><td rowspan="2">125</td><td rowspan="2">29</td><td rowspan="2">131</td><td rowspan="2">215</td><td rowspan="2">132</td><td rowspan="2">68</td><td rowspan="2">43</td><td rowspan="2">70</td></tr>
<tr><td>3</td><td>ER2M030SD-SD</td><td>765 *</td><td>900</td><td>44</td></tr>
<tr><td>5</td><td>ER2M050SD-SD</td><td>840 *</td><td>910</td><td>400</td><td>281</td><td>528</td><td>192</td><td>47</td><td>140</td><td>44</td><td>145</td><td>233</td><td>150</td><td>86</td><td>54</td><td>56</td></tr>
</table>

* Dimensions D is for the lift of 4 m.



■Conversion Table between Lift/Travel/Speed (m/s→m/min)

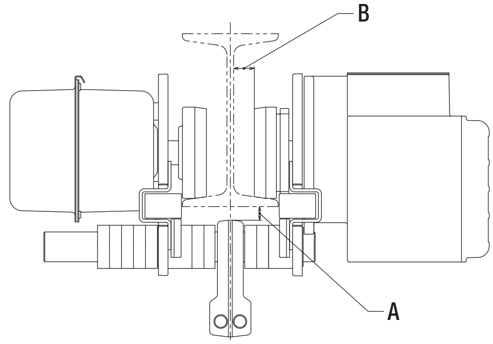
Converted value (m/s)	Conventional value (m/min)	Converted value (m/s)	Conventional value (m/min)	Converted value (m/s)	Conventional value (m/min)	Converted value (m/s)	Conventional value (m/min)	Converted value (m/s)	Conventional value (m/min)	Converted value (m/s)	Conventional value (m/min)
		0.067	4.0	0.133	8.0	0.200	12.0	0.267	16.0	0.333	20.0
0.002	0.1	0.068	4.1	0.135	8.1	0.202	12.1	0.268	16.1	0.335	20.1
0.003	0.2	0.070	4.2	0.137	8.2	0.203	12.2	0.270	16.2	0.337	20.2
0.005	0.3	0.072	4.3	0.138	8.3	0.205	12.3	0.272	16.3	0.338	20.3
0.007	0.4	0.073	4.4	0.140	8.4	0.207	12.4	0.273	16.4	0.340	20.4
0.008	0.5	0.075	4.5	0.142	8.5	0.208	12.5	0.275	16.5	0.342	20.5
0.010	0.6	0.077	4.6	0.143	8.6	0.210	12.6	0.277	16.6	0.343	20.6
0.012	0.7	0.078	4.7	0.145	8.7	0.212	12.7	0.278	16.7	0.345	20.7
0.013	0.8	0.080	4.8	0.147	8.8	0.213	12.8	0.280	16.8	0.347	20.8
0.015	0.9	0.082	4.9	0.148	8.9	0.215	12.9	0.282	16.9	0.348	20.9
0.017	1.0	0.083	5.0	0.150	9.0	0.217	13.0	0.283	17.0	0.350	21.0
0.018	1.1	0.085	5.1	0.152	9.1	0.218	13.1	0.285	17.1	0.352	21.1
0.020	1.2	0.087	5.2	0.153	9.2	0.220	13.2	0.287	17.2	0.353	21.2
0.022	1.3	0.088	5.3	0.155	9.3	0.222	13.3	0.288	17.3	0.355	21.3
0.023	1.4	0.090	5.4	0.157	9.4	0.223	13.4	0.290	17.4	0.357	21.4
0.025	1.5	0.092	5.5	0.158	9.5	0.225	13.5	0.292	17.5	0.358	21.5
0.027	1.6	0.093	5.6	0.160	9.6	0.227	13.6	0.293	17.6	0.360	21.6
0.028	1.7	0.095	5.7	0.162	9.7	0.228	13.7	0.295	17.7	0.362	21.7
0.030	1.8	0.097	5.8	0.163	9.8	0.230	13.8	0.297	17.8	0.363	21.8
0.032	1.9	0.098	5.9	0.165	9.9	0.232	13.9	0.298	17.9	0.365	21.9
0.033	2.0	0.100	6.0	0.167	10.0	0.233	14.0	0.300	18.0	0.367	22.0
0.035	2.1	0.102	6.1	0.168	10.1	0.235	14.1	0.302	18.1	0.368	22.1
0.037	2.2	0.103	6.2	0.170	10.2	0.237	14.2	0.303	18.2	0.370	22.2
0.038	2.3	0.105	6.3	0.172	10.3	0.238	14.3	0.305	18.3	0.372	22.3
0.040	2.4	0.107	6.4	0.173	10.4	0.240	14.4	0.307	18.4	0.373	22.4
0.042	2.5	0.108	6.5	0.175	10.5	0.242	14.5	0.308	18.5	0.375	22.5
0.043	2.6	0.110	6.6	0.177	10.6	0.243	14.6	0.310	18.6	0.377	22.6
0.045	2.7	0.112	6.7	0.178	10.7	0.245	14.7	0.312	18.7	0.378	22.7
0.047	2.8	0.113	6.8	0.180	10.8	0.247	14.8	0.313	18.8	0.380	22.8
0.048	2.9	0.115	6.9	0.182	10.9	0.248	14.9	0.315	18.9	0.382	22.9
0.050	3.0	0.117	7.0	0.183	11.0	0.250	15.0	0.317	19.0	0.383	23.0
0.052	3.1	0.118	7.1	0.185	11.1	0.252	15.1	0.318	19.1	0.385	23.1
0.053	3.2	0.120	7.2	0.187	11.2	0.253	15.2	0.320	19.2	0.387	23.2
0.055	3.3	0.122	7.3	0.188	11.3	0.255	15.3	0.322	19.3	0.388	23.3
0.057	3.4	0.123	7.4	0.190	11.4	0.257	15.4	0.323	19.4	0.390	23.4
0.058	3.5	0.125	7.5	0.192	11.5	0.258	15.5	0.325	19.5	0.392	23.5
0.060	3.6	0.127	7.6	0.193	11.6	0.260	15.6	0.327	19.6	0.393	23.6
0.062	3.7	0.128	7.7	0.195	11.7	0.262	15.7	0.328	19.7	0.395	23.7
0.063	3.8	0.130	7.8	0.197	11.8	0.263	15.8	0.330	19.8	0.397	23.8
0.065	3.9	0.132	7.9	0.198	11.9	0.265	15.9	0.332	19.9	0.398	23.9
										0.400	24.0
										0.500	30.0
										0.600	36.0

Clearance between Trolley and Applicable Rail

Motorized Trolley

(Unit:mm)

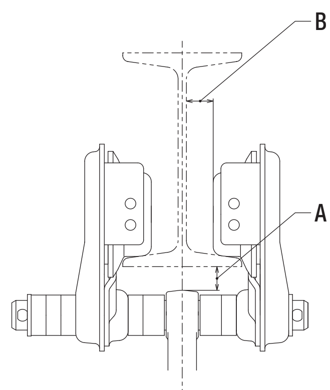
I-beam size			Clearance between trolley and rail									
			~1t		~2t		~3t			~5t	
							Single	Double			
H	B	t	A	B	A	B	A	A	B	A	B
100	75	5	×	×	×	×	×	×	×	×	×
125	75	5.5	13.8	9.75	×	×	×	×	×	×	×
150	75	5.5	13.8	9.75	×	×	×	×	×	×	×
180	100	6	14.2	22	18.6	19.5	×	×	×	×	×
200	100	7	14.1	21.5	18.6	19	×	×	×	×	×
150	125	8.5	11	33.25	15.4	30.75	×	×	×	×	×
250	125	7.5	12.5	33.75	16.9	31.25	10.6	11.8	28.75	32.4	18.25
250	125	10	5.9	32.5	10.3	30	17.2	18.4	27.5	25.8	17
200	150	9	9.8	45.5	14.3	43	14.5	15.7	40.5	29.7	30
300	150	8	12.9	46	17.3	43.5	17.6	18.8	41	32.8	30.5
300	150	10	7.3	45	11.7	42.5	12.0	13.2	40	27.2	29.5
300	150	11.5	3.7	44.25	8.2	41.75	8.5	9.7	39.25	23.7	28.75
350	150	9	10.8	45.5	15.4	43	15.5	16.7	40.5	30.7	30
350	150	12	1.7	44	6.2	41.5	6.4	7.6	39	21.6	28.5
400	150	10	7.8	45	12.2	42.5	12.5	13.7	40	27.7	29.5
400	150	12.5	0.7	43.75	5.1	41.25	5.4	6.6	38.75	20.6	28.25
450	175	11	×	×	11.1	54.5	11.4	12.6	52	19.5	41.5
450	175	13	×	×	4.5	53.5	4.3	5.5	51	26.6	40.5
600	190	13	×	×	6.5	61	6.8	8	58.5	22.0	48
600	190	16	×	×	×	×	×	×	×	11.9	46.5



Manual Trolley

(Unit:mm)

I-beam size			Clearance between trolley and rail										
			TSP		TSP/TSG								
			~500kg		~1t		~2t		~3t		~5t	
H	B	t	A	B	A	B	A	B	A	B	A	B
100	75	5	13.3	12.5	21.1	11.0	×	×	×	×	×	×
125	75	5.5	10.8	12.25	19.5	10.75	×	×	×	×	×	×
150	75	5.5	10.8	12.25	19.5	10.75	×	×	×	×	×	×
180	100	6	11.2	24.5	19.9	23	25.6	18.5	×	×	×	×
200	100	7	11.1	24	19.9	22.5	25.6	18	×	×	×	×
150	125	8.5	7.9	35.75	16.7	34.25	22.4	29.75	24.1	27.25	×	×
250	125	7.5	9.4	36.25	18.2	34.75	23.9	30.25	25.6	27.75	35.2	20.25
250	125	10	2.9	35	11.6	33.5	17.3	29	19	26.5	28.6	19
200	150	9	6.8	48	15.6	46.5	21.2	42	22.9	39.5	32.5	32
300	150	8	9.8	48.5	18.6	47	24.3	42.5	26	40	35.6	32.5
300	150	10	4.2	47.5	13	46	18.7	41.5	20.4	39	30.5	31.5
300	150	11.5	0.7	46.75	9.5	45.25	15.2	40.75	16.9	38.25	26.4	30.75
350	150	9	7.8	48	16.6	46.5	22.2	42	23.9	39.5	33.5	32
350	150	12	×	×	7.5	45	13.1	40.5	14.8	38	24.4	30.5
400	150	10	4.7	47.5	13.5	46	19.2	41.5	20.9	39	30.5	31.5
400	150	12.5	×	×	6.4	44.75	12.1	40.25	13.8	37.75	23.4	30.25
450	175	11	3.6	59.5	12.4	58	18.1	53.5	19.7	51	29.3	43.5
450	175	13	×	×	5.3	57	11	52.5	12.7	50	22.3	42.5
600	190	13	×	×	7.8	64.5	13.5	60	15.2	57.5	24.8	50
600	190	16	×	×	×	×	3.4	58.5	5.1	56	14.7	48.5

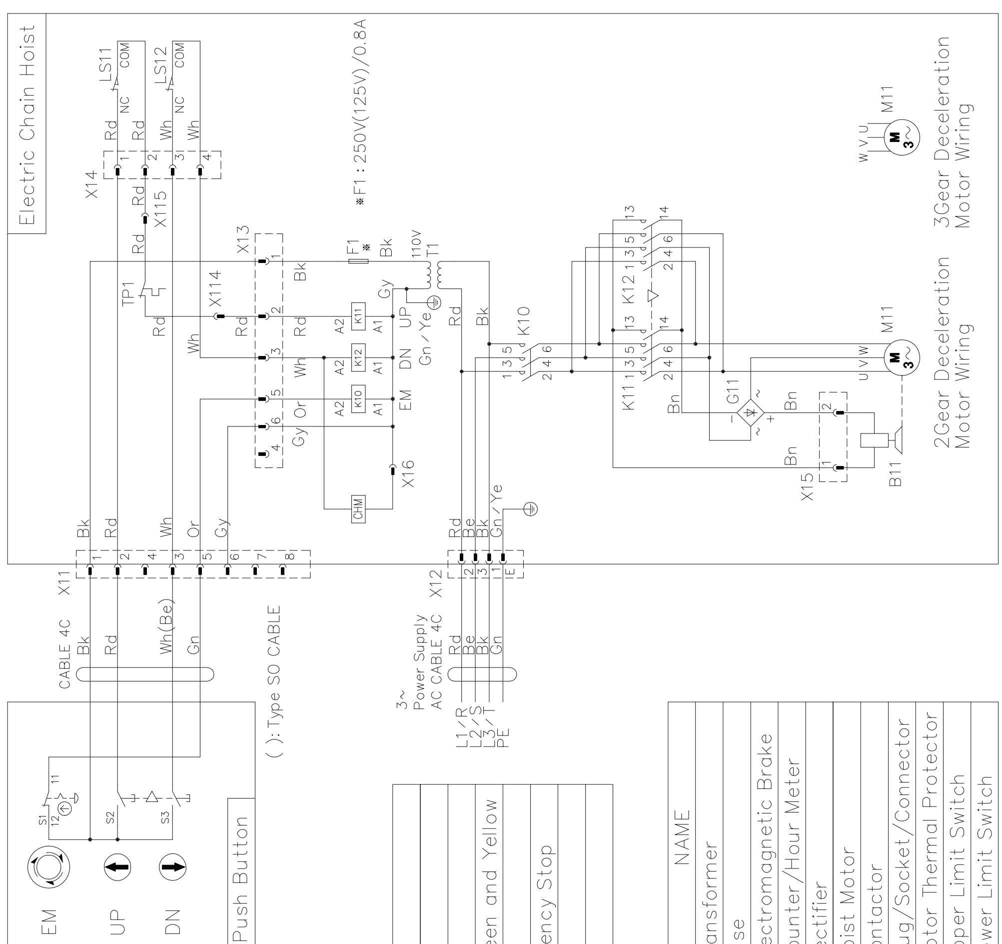


Technical Material
A

(to be continued)

Wiring Diagram of Single Speed ER2/ER2SP/ER2SG

575V (Plug Connection)



Note

1.

Body Size	Chain Hoist (ER) 2Gear Deceleration	3Gear Deceleration
B	003S/001H	—
C	005L Friction Clutch	005L Mechanical Friction Clutch
	003H/005S	—
D	010S	010L
E	020S/030S	015S/020L
F	—	025S/050S

2. Operation Type
   Hoist: Single Speed
3. Power Supply
   575V,60Hz,3Phase
4. Push Button Connection
   Plug Connection

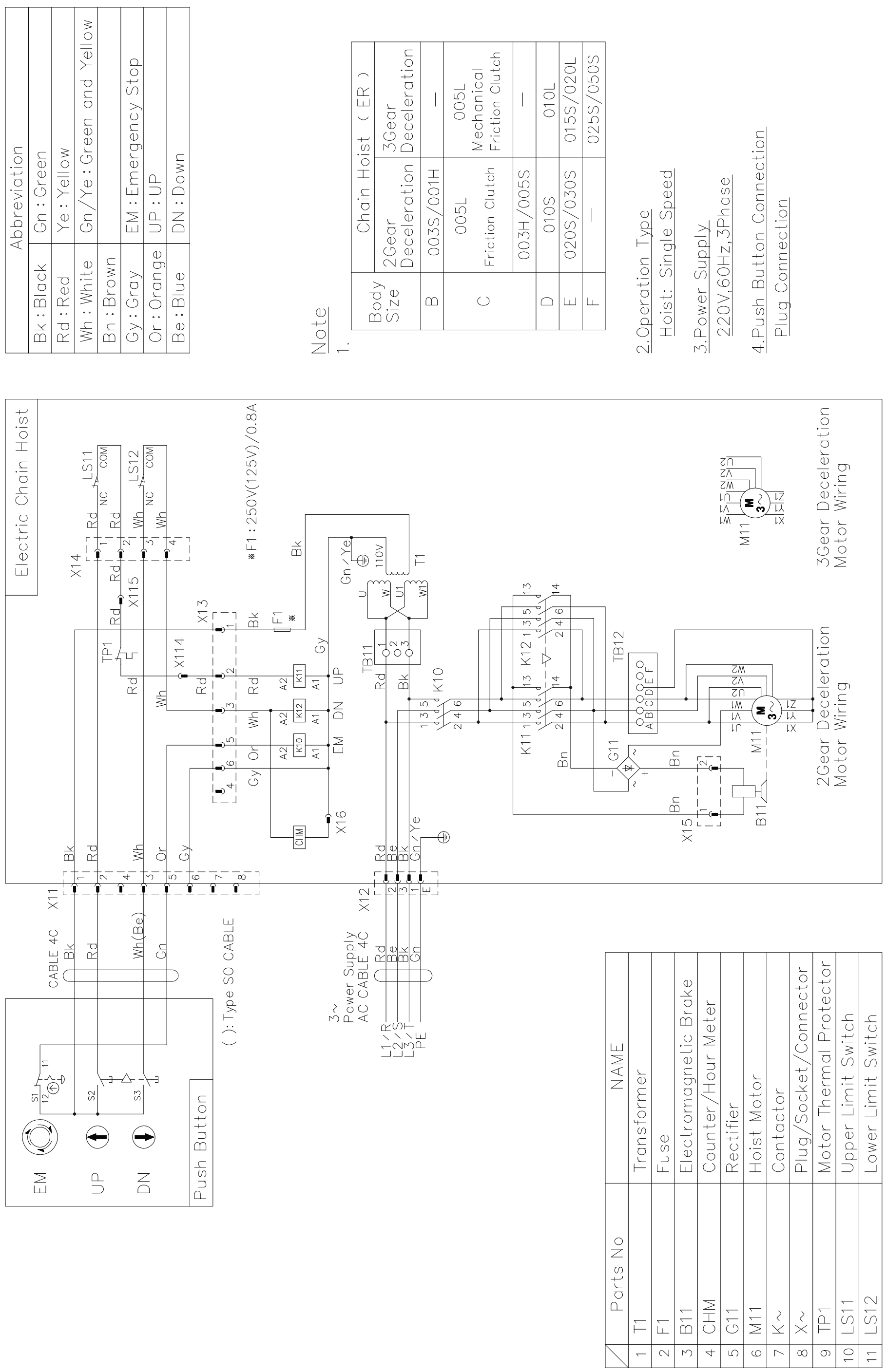
Abbreviation	
Bk : Black	Gn : Green
Rd : Red	Ye : Yellow
Wh : White	Gn/Ye : Green and Yellow
Bn : Brown	EM : Emergency Stop
Gy : Gray	UP : UP
Or : Orange	DN : Down
Be : Blue	

	Parts No	NAME
1	T1	Transformer
2	F1	Fuse
3	B11	Electromagnetic Brake
4	CHM	Counter/Hour Meter
5	G11	Rectifier
6	M11	Hoist Motor
7	K~	Contactor
8	X~	Plug/Socket/Connector
9	TP1	Motor Thermal Protector
10	LS11	Upper Limit Switch
11	LS12	Lower Limit Switch

Technical Material

A

220/440V class (220V) (Plug Connection)



Abbreviation	
Bk : Black	Gn : Green
Rd : Red	Ye : Yellow
Wh : White	Gn/Ye : Green and Yellow
Bn : Brown	
Gy : Gray	EM : Emergency Stop
Or : Orange	UP : UP
Be : Blue	DN : Down

Note

1.

Body Size	Chain Hoist (ER) 2Gear Deceleration	3Gear Deceleration
B	003S/001H	—
C	005L Friction Clutch	005L Mechanical Friction Clutch
	003H/005S	—
D	010S	010L
E	020S/030S	015S/020L
F	—	025S/050S

2.Operation Type
Hoist: Single Speed

3.Power Supply
220V,60Hz,3Phase

4.Push Button Connection
Plug Connection

	Parts No	NAME
1	T1	Transformer
2	F1	Fuse
3	B11	Electromagnetic Brake
4	CHM	Counter/Hour Meter
5	G11	Rectifier
6	M11	Hoist Motor
7	K~	Contactor
8	X~	Plug/Socket/Connector
9	TP1	Motor Thermal Protector
10	LS11	Upper Limit Switch
11	LS12	Lower Limit Switch

(to be continued)

220/440V class (440V) (Plug Connection)

Abbreviation	
Bk : Black	Gn : Green
Rd : Red	Ye : Yellow
Wh : White	Gn/Ye : Green and Yellow
Bn : Brown	
Gy : Gray	EM : Emergency Stop
Or : Orange	UP : UP
Be : Blue	DN : Down

Note

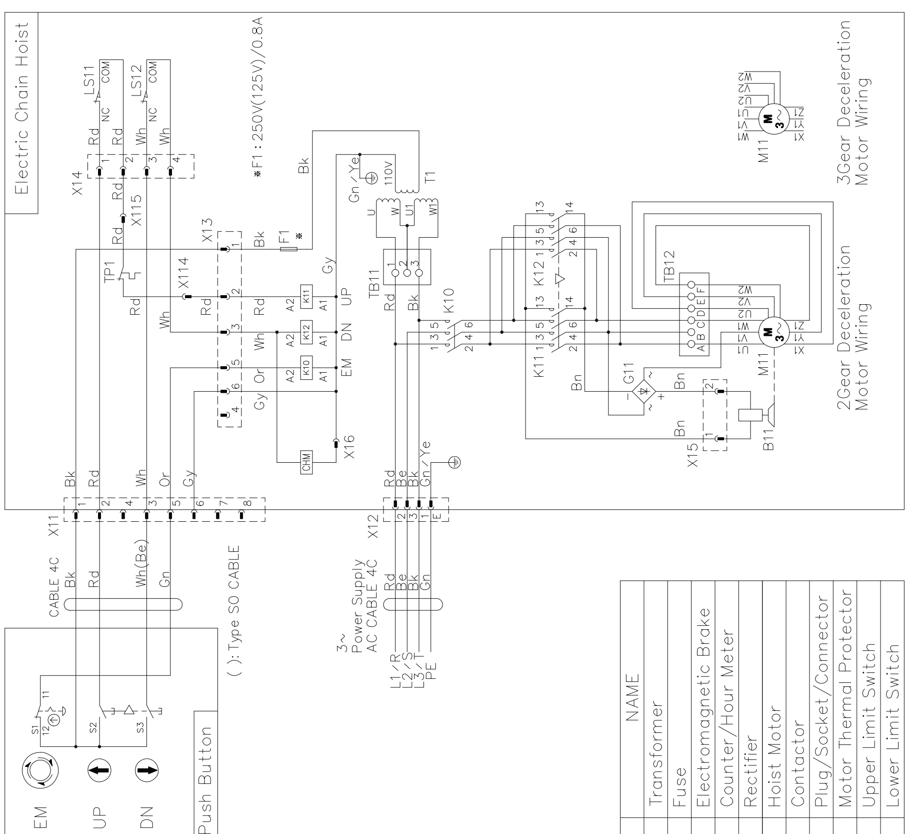
1.

Body Size	Chain Hoist (ER) 2Gear Deceleration	3Gear Deceleration
B	003S/001H	—
C	005L Friction Clutch	005L Mechanical Friction Clutch
	003H/005S	—
D	010S	010L
E	020S/030S	015S/020L
F	—	025S/050S

2. Operation Type
Hoist: Single Speed

3. Power Supply
440V,60Hz,3Phase

4. Push Button Connection
Plug Connection



	Parts No	NAME
1	T1	Transformer
2	F1	Fuse
3	B11	Electromagnetic Brake
4	CHM	Counter/Hour Meter
5	G11	Rectifier
6	M11	Hoist Motor
7	K~	Contactor
8	X~	Plug/Socket/Connector
9	TP1	Motor Thermal Protector
10	LS11	Upper Limit Switch
11	LS12	Lower Limit Switch

Wiring Diagram of Dual Speed ER2/ER2SP/ER2SG

220/440V class (220V) (Plug Connection)

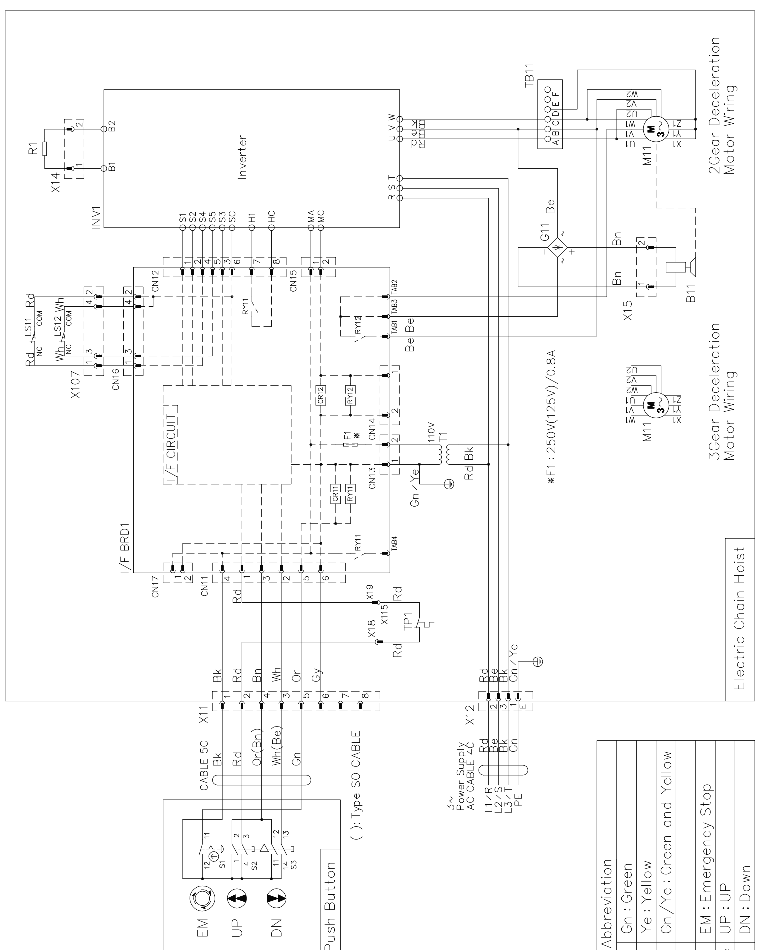
	Parts No	NAME
1	T1	Transformer
2	F1	Fuse
3	B11	Electromagnetic Brake
4	G11	Rectifier
5	M11	Hoist Motor
6	RY~	Relay
7	CR~	Surge Absorber
8	X~	Plug/Socket/Connector
9	TP1	Motor Thermal Protector
10	LS11	Upper Limit Switch
11	LS12	Lower Limit Switch
12	I/F BRD1	Interface Boad
13	INV1	Inverter
14	R1	Resistance

Note

1.

Body Size	Chain Hoist (ER) 2Gear Deceleration	3Gear Deceleration
B	001IH/003IS	—
C	005IL Friction Clutch	005IL Mechanical Friction Clutch
	003IH/005IS	—
D	010IS	010IL
E	020IS/030IS	015IS/020IL
F	—	025IS/050IS

2. Operation Type
   Hoist: Dual Speed
3. Power Supply
   220V,60Hz,3Phase
4. Push Button Connection
   Plug Connection



Abbreviation	
Bk : Black	Gn : Green
Rd : Red	Ye : Yellow
Wh : White	Gn/Ye : Green and Yellow
Bn : Brown	EM : Emergency Stop
Gy : Gray	UP : UP
Or : Orange	DN : Down
Be : Blue	

(to be continued)

220/440V class (440V) (Plug Connection)

	Parts No	NAME
1	T1	Transformer
2	F1	Fuse
3	B11	Electromagnetic Brake
4	G11	Rectifier
5	M11	Hoist Motor
6	RY~	Relay
7	CR~	Surge Absorber
8	X~	Plug/Socket/Connector
9	TP1	Motor Thermal Protector
10	LS11	Upper Limit Switch
11	LS12	Lower Limit Switch
12	I/F BRD1	Interface Boad
13	INV1	Inverter
14	R1	Resistance

Note

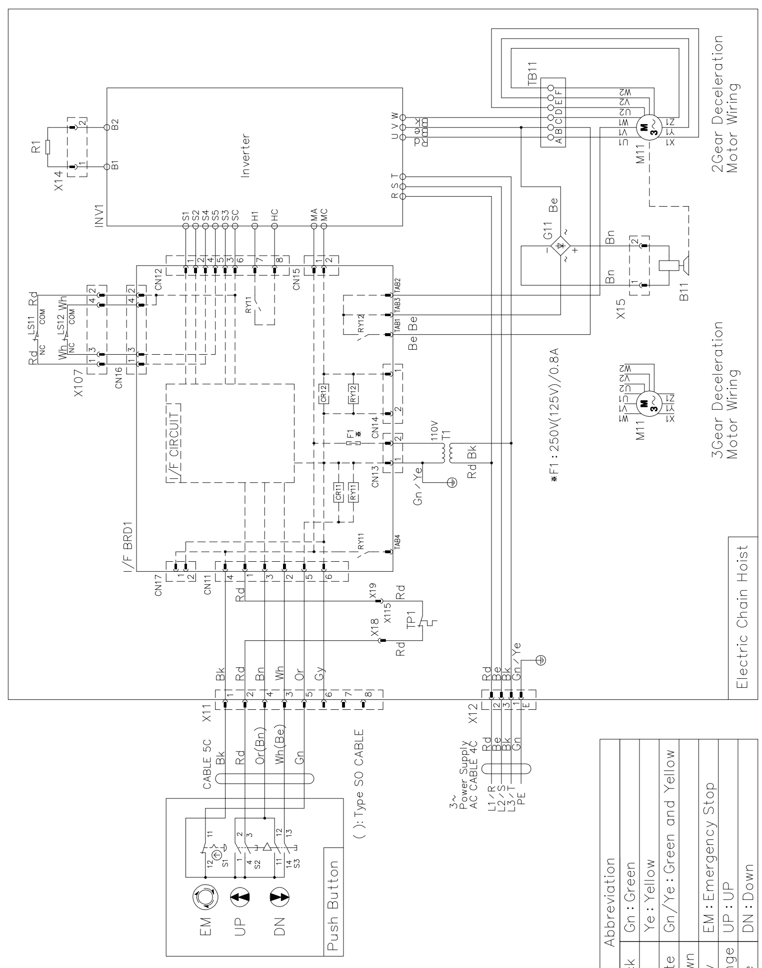
1.

Body Size	Chain Hoist (ER) 2Gear Deceleration	3Gear Deceleration
B	001IH/003IS	—
C	005IL Friction Clutch	005IL Mechanical Friction Clutch
	003IH/005IS	—
D	010IS	010IL
E	020IS/030IS	015IS/020IL
F	—	025IS/050IS

2.Operation Type
Hoist: Dual Speed

3.Power Supply
440V,60Hz,3Phase

4.Push Button Connection
Plug Connection



Abbreviation	
Bk : Black	Gn : Green
Rd : Red	Ye : Yellow
Wh : White	Gn/Ye : Green and Yellow
Bn : Brown	
Gy : Gray	EM : Emergency Stop
Or : Orange	UP : UP
Be : Blue	DN : Down

Technical Material

A

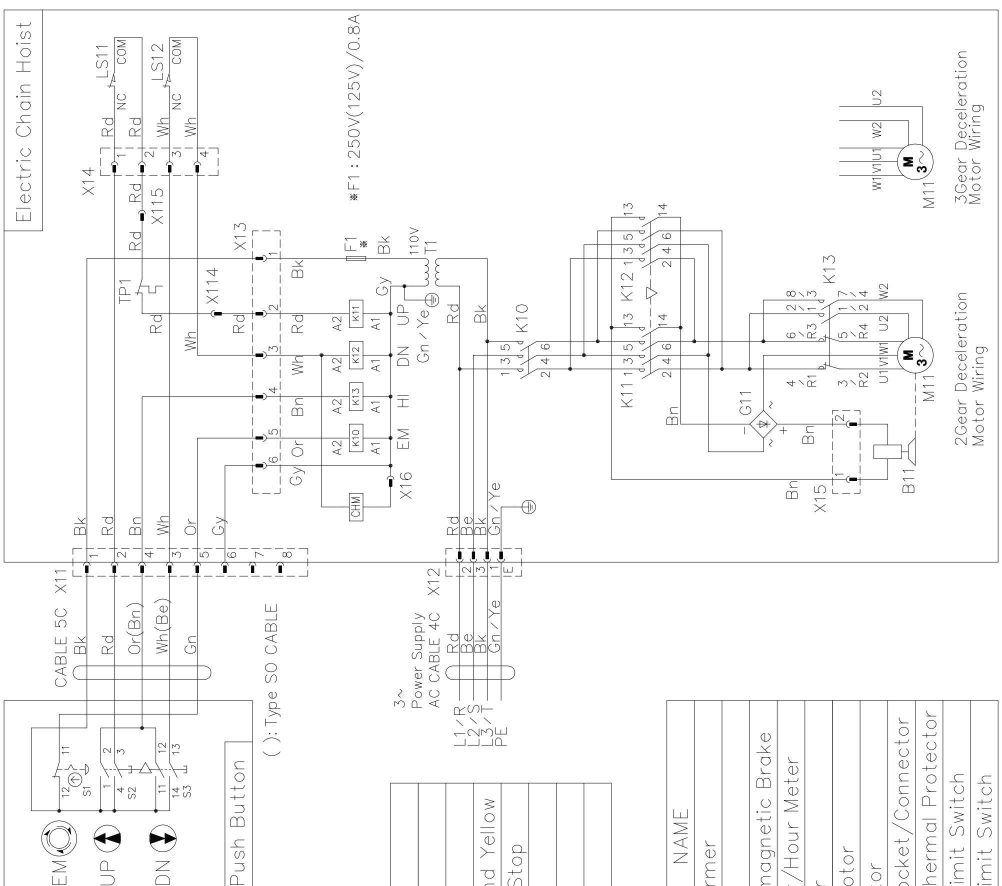
575V class (Plug Connection)

Note

1.

Body Size	Chain Hoist (ER) 2Gear Deceleration	Chain Hoist (ER) 3Gear Deceleration
B	003SD/001HD	—
C	—	005SD/005LD
D	—	010SD/010LD
E	—	015SD
	—	020LD/020SD
	—	030SD
F	—	025SD/050SD

2. Operation Type
   Hoist: Dual Speed
3. Power Supply
   575V,60Hz,3Phase
4. Push Button Connection
   Plug Connection



Abbreviation	
Bk : Black	Gn : Green
Rd : Red	Ye : Yellow
Wh : White	Gn/Ye : Green and Yellow
Bn : Brown	EM : Emergency Stop
Gy : Gray	UP : UP
Or : Orange	DN : Down
Be : Blue	HI : High Speed

	Parts No	NAME
1	T1	Transformer
2	F1	Fuse
3	B11	Electromagnetic Brake
4	CHM	Counter/Hour Meter
5	G11	Rectifier
6	M11	Hoist Motor
7	K~	Contactor
8	X~	Plug/Socket/Connector
9	TP1	Motor Thermal Protector
10	LS11	Upper Limit Switch
11	LS12	Lower Limit Switch

(to be continued)

■Wiring Diagram of Single Speed ER2M

575V (Plug Connection)

	Parts No	NAME
1	T1	Transformer
2	F1	Fuse
3	B11	Electromagnetic Brake
4	CHM	Counter/Hour Meter
5	G11	Rectifier
6	M11	Hoist Motor
7	M21	Trolley Motor
8	K~	Contactor
9	X~	Plug/Socket/Connector
10	TP~	Motor Thermal Protector
11	LS11	Upper Limit Switch
12	LS12	Lower Limit Switch
13	TB~	Terminal

Abbreviation	
Bk : Black	Gn : Green
Rd : Red	Ye : Yellow
Wh : White	Gn/Ye : Green and Yellow
Bn : Brown	EM : Emergency Stop
Gy : Gray	UP : UP
Or : Orange	DN : Down
Be : Blue	

Note

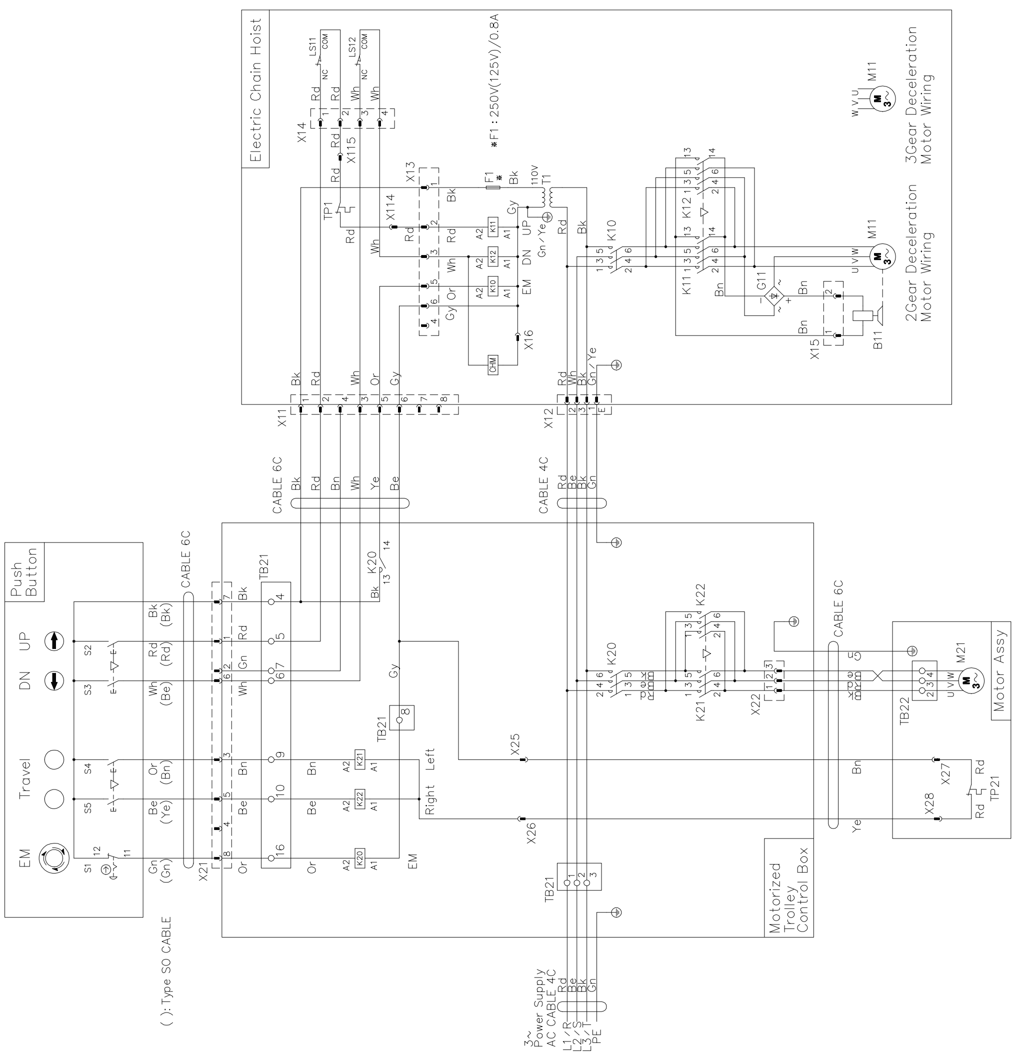
1.

Body Size	Chain Hoist (ER) 2Gear Deceleration	3Gear Deceleration
B	003S/001H	—
C	005L Friction Clutch	005L Mechanical Friction Clutch
	003H/005S	—
D	010S	010L
E	020S/030S	015S/020L
F	—	025S/050S

2.Operation Type
Hoist: Single Speed
Trolley: Single Speed

3.Power Supply
575V,60Hz,3Phase

4.Push Button Connection
Plug Connection



220/440V class (220V) (Plug Connection)

	Parts No	NAME
1	T1	Transformer
2	F1	Fuse
3	B11	Electromagnetic Brake
4	CHM	Counter/Hour Meter
5	G11	Rectifier
6	M11	Hoist Motor
7	M21	Trolley Motor
8	K~	Contactor
9	X~	Plug/Socket/Connector
10	TP~	Motor Thermal Protector
11	LS11	Upper Limit Switch
12	LS12	Lower Limit Switch
13	TB~	Terminal

Abbreviation	
Bk : Black	Gn : Green
Rd : Red	Ye : Yellow
Wh : White	Gn/Ye : Green and Yellow
Bn : Brown	EM : Emergency Stop
Gy : Gray	UP : UP
Or : Orange	DN : Down
Be : Blue	

Note

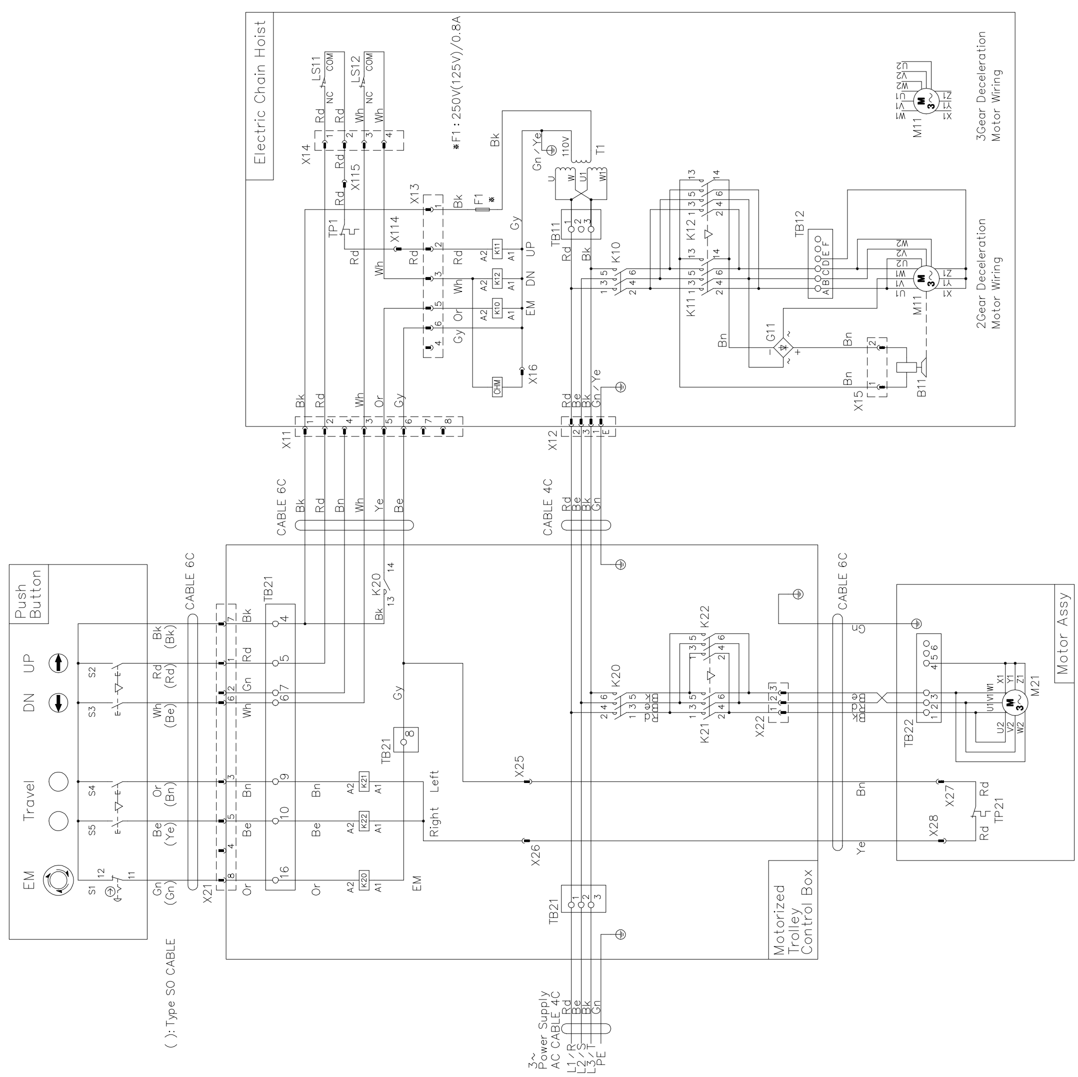
1.

Body Size	Chain Hoist (ER) 2Gear Deceleration	3Gear Deceleration
B	003S/001H	—
C	005L Friction Clutch	005L Mechanical Friction Clutch
	003H/005S	—
D	010S	010L
E	020S/030S	015S/020L
F	—	025S/050S

2. Operation Type
Hoist: Single Speed
Trolley: Single Speed

3. Power Supply
220V,60Hz,3Phase

4. Push Button Connection
Plug Connection



(to be continued)

Technical Material

A

220/440V class (440V) (Plug Connection)

	Parts No	NAME
1	T1	Transformer
2	F1	Fuse
3	B11	Electromagnetic Brake
4	CHM	Counter/Hour Meter
5	G11	Rectifier
6	M11	Hoist Motor
7	M21	Trolley Motor
8	K~	Contactor
9	X~	Plug/Socket/Connector
10	TP~	Motor Thermal Protector
11	LS11	Upper Limit Switch
12	LS12	Lower Limit Switch
13	TB~	Terminal

Abbreviation	
Bk : Black	Gn : Green
Rd : Red	Ye : Yellow
Wh : White	Gn/Ye : Green and Yellow
Bn : Brown	
Gy : Gray	EM : Emergency Stop
Or : Orange	UP : UP
Be : Blue	DN : Down

Note

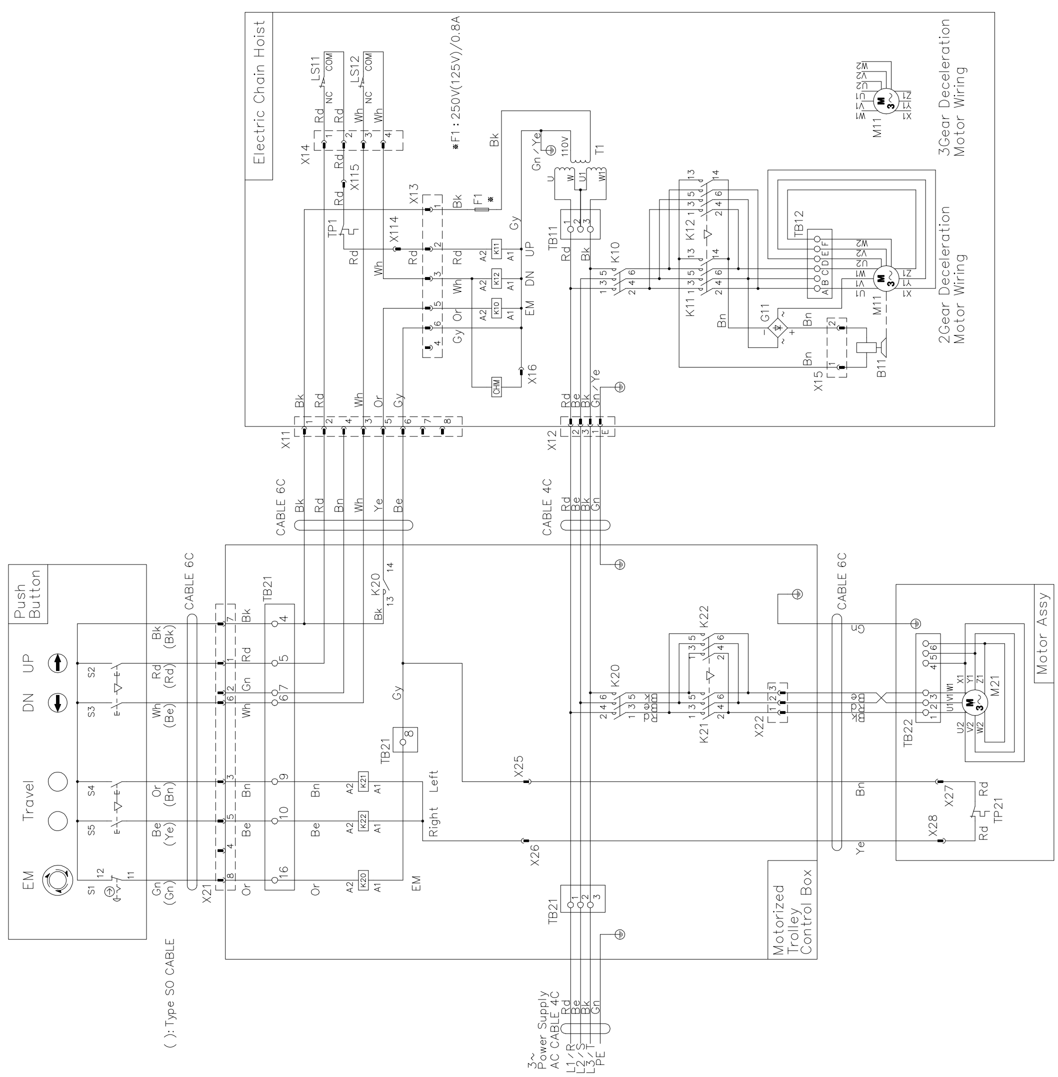
1.

Body Size	Chain Hoist (ER) 2Gear Deceleration	3Gear Deceleration
B	003S/001H	—
C	005L Friction Clutch	005L Mechanical Friction Clutch
D	003H/005S	—
	010S	010L
E	020S/030S	015S/020L
F	—	025S/050S

2.Operation Type
Hoist: Single Speed
Trolley: Single Speed

3.Power Supply
440V,60Hz,3Phase

4.Push Button Connection
Plug Connection



■Wiring Diagram of Dual Speed ER2M

220/440V class (220V) (Plug Connection)

	Parts No	NAME
1	T1	Transformer
2	F1	Fuse
3	B11	Electromagnetic Brake
4	G11	Rectifier
5	M11	Hoist Motor
6	M21	Trolley Motor
7	RY~	Relay
8	CR~	Surge Absorber
9	X~	Plug/Socket/Connector
10	TP~	Motor Thermal Protector
11	LS11	Upper Limit Switch
12	LS12	Lower Limit Switch
13	I/F BRD~	Interface Boad
14	TB~	Terminal
15	INV~	Inverter
16	R~	Resistance

Abbreviation	
Bk : Black	Gn : Green
Rd : Red	Ye : Yellow
Wh : White	Gn/Ye : Green and Yellow
Bn : Brown	
Gy : Gray	EM : Emergency Stop
Or : Orange	UP : UP
Be : Blue	DN : Down

Note

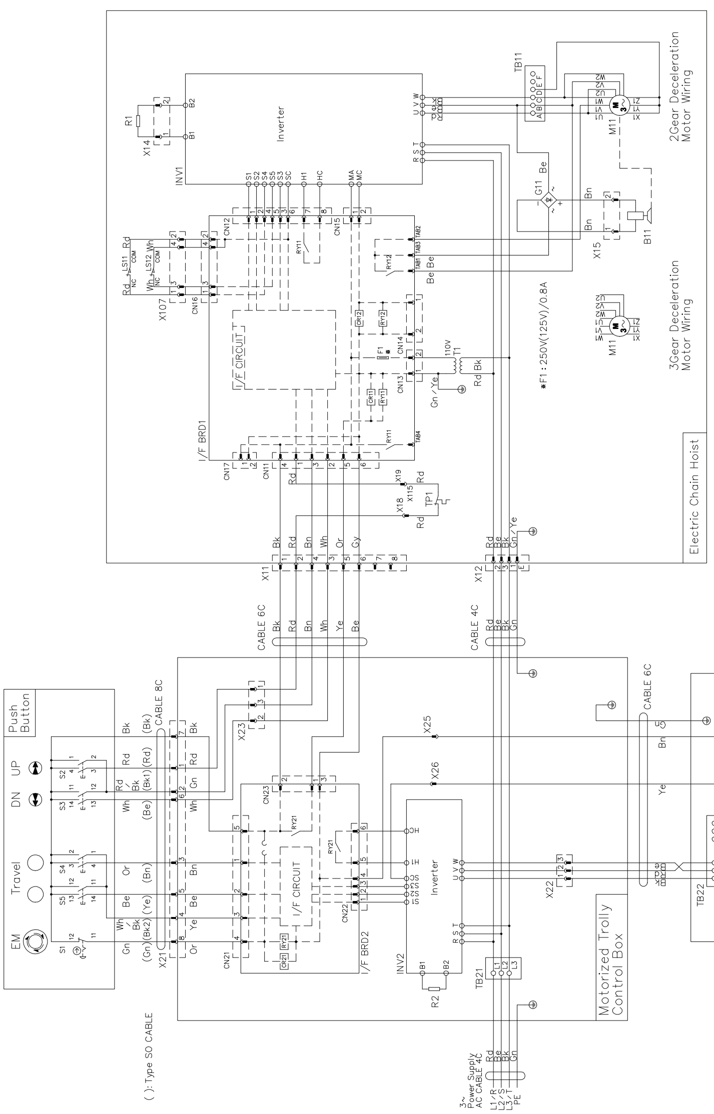
1.

Body Size	Chain Hoist (ER) 2Gear Deceleration	3Gear Deceleration
B	001IH/003IS	—
C	005IL Friction Clutch	005IL Mechanical Friction Clutch
	003IH/005IS	—
D	010IS	010IL
E	020IS/030IS	015IS/020IL
F	—	025IS/050IS

2.Operation Type
Hoist: Dual Speed
Trolley: Dual Speed

3.Power Supply
220V,60Hz,3Phase

4.Push Button Connection
Plug Connection



Technical Material

A

(to be continued)

220/440V class (440V) (Plug Connection)

	Parts No	NAME
1	T1	Transformer
2	F1	Fuse
3	B11	Electromagnetic Brake
4	G11	Rectifier
5	M11	Hoist Motor
6	M21	Trolley Motor
7	RY~	Relay
8	CR~	Surge Absorber
9	X~	Plug/Socket/Connector
10	TP~	Motor Thermal Protector
11	LS11	Upper Limit Switch
12	LS12	Lower Limit Switch
13	I/F BRD~	Interface Boad
14	TB~	Terminal
15	INV~	Inverter
16	R~	Resistance

Abbreviation	
Bk : Black	Gn : Green
Rd : Red	Ye : Yellow
Wh : White	Gn/Ye : Green and Yellow
Bn : Brown	
Gy : Gray	EM : Emergency Stop
Or : Orange	UP : UP
Be : Blue	DN : Down

Note

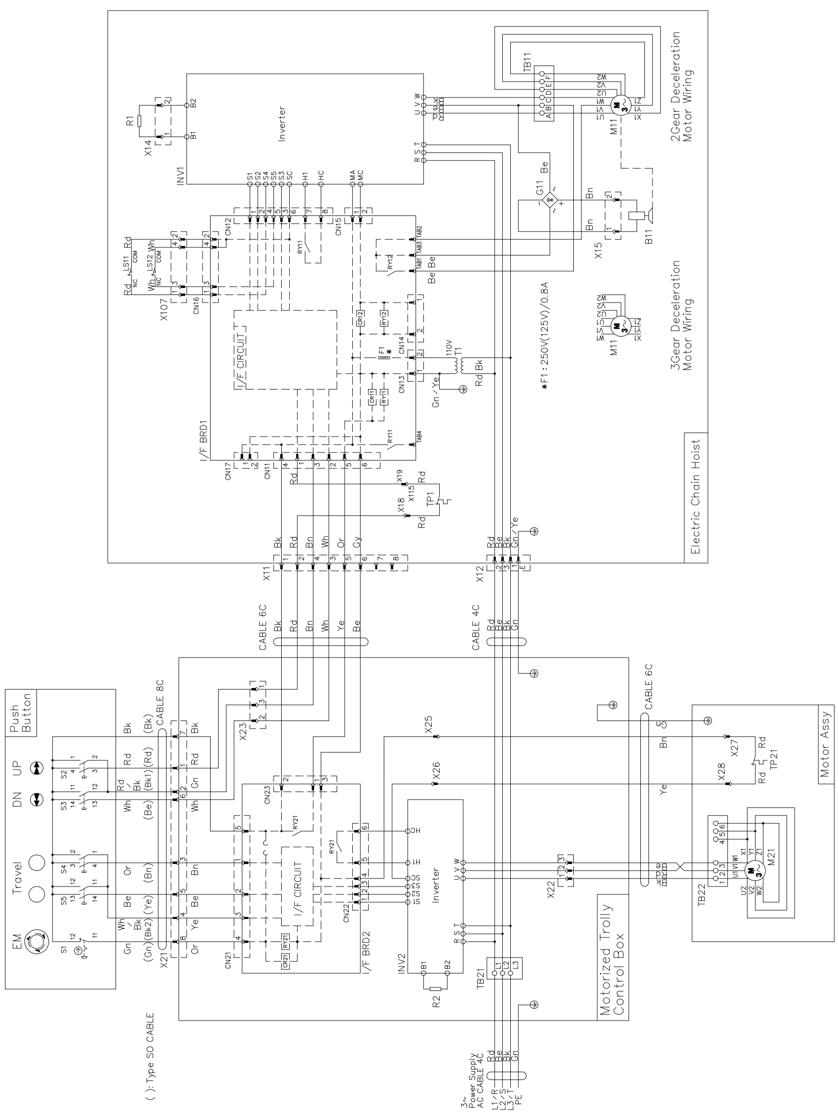
1.

Body Size	Chain Hoist (ER) 2Gear Deceleration	Chain Hoist (ER) 3Gear Deceleration
B	001IH/003IS	—
C	005IL Friction Clutch	005IL Mechanical Friction Clutch
C	003IH/005IS	—
D	010IS	010IL
E	020IS/030IS	015IS/020IL
F	—	025IS/050IS

2. Operation Type
   Hoist: Dual Speed
   Trolley: Dual Speed

3. Power Supply
   440V,60Hz,3Phase

4. Push Button Connection
   Plug Connection



575V class (Plug Connection)

	Parts No	NAME
1	T1	Transformer
2	F1	Fuse
3	B11	Electromagnetic Brake
4	CHM	Counter/Hour Meter
5	G11	Rectifier
6	M11	Hoist Motor
7	M21	Trolley Motor
8	K~	Contactor
9	X~	Plug/Socket/Connector
10	TP~	Motor Thermal Protector
11	LS11	Upper Limit Switch
12	LS12	Lower Limit Switch
13	TB~	Terminal

Abbreviation	
Bk : Black	Gn : Green
Rd : Red	Ye : Yellow
Wh : White	Gn/Ye : Green and Yellow
Bn : Brown	EM : Emergency Stop
Gy : Gray	UP : UP
Or : Orange	DN : Down
Be : Blue	HI : High Speed

Note

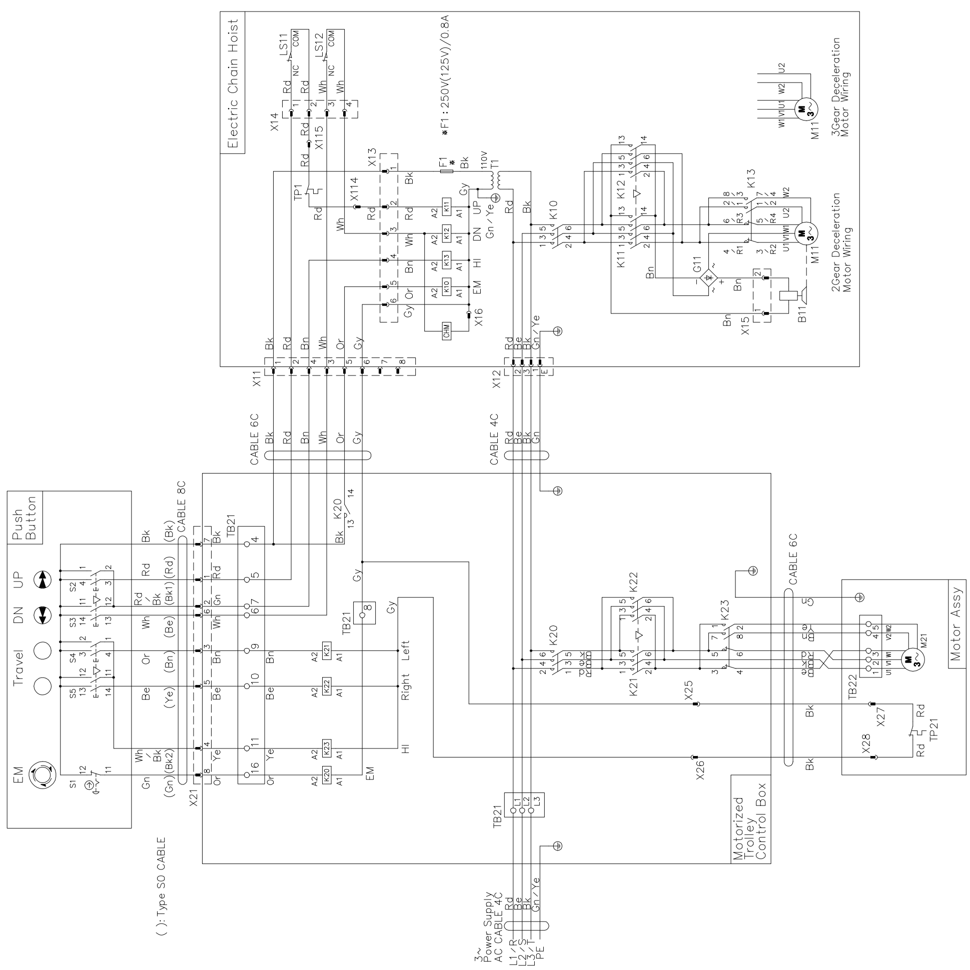
1.

Body Size	Chain Hoist (ER) 2Gear Deceleration	3Gear Deceleration
B	003SD/001HD	—
C	—	005SD/005LD
D	—	010SD/010LD
E	—	015SD
	—	020LD/020SD
	—	030SD
F	—	025SD/050SD

2.Operation Type
Hoist: Dual Speed
Trolley: Dual Speed

3.Power Supply
575V,60Hz,3Phase

4.Push Button Connection
Plug Connection



Check Sheet for ER2 Series Electric Chain Hoist Daily Inspection

Code		Capacity	Lot No.	Your CTRL No.	Installation date	Location	Inspection Certification valid thru
Electric Chain Hoist	ER2						
Motorized Trolley	MR2						
Geared Trolley	TS2 (TSG)						
Plain Trolley	TS2 (TSP)						

■Electric Chain Hoist ER2 Daily Inspection

■Check result : ○ Good, △To be replaced (adjusted) next inspection, ×Bad, Needs replacement (adjustment)

Category	Check item	Check method	Criteria	Inspection date/result					
				/	/	/	/	/	/
Appearance	Indication of nameplates and labels	Visual inspection	To have no peeled off. To be legible clearly.						
	Deformation and damage of each part of body size	Visual inspection	To have no apparent deformation or corrosion						
	Bolts, nut, split pins	Visual inspection	To have no loosened bolts, nuts, and split pins that can be seen from exterior. To have no come-off.						
Load Chain	Elongation of pitch	Visual inspection	To have no apparent elongation						
	Abrasion of wire diameter	Visual inspection	To have no apparent abrasion						
	Deformation, flaw, entanglement	Visual inspection	To have no apparent deformation, harmful flaw and entanglement						
	Rust, corrosion	Visual inspection	To have no apparent rust and corrosion						
	Twist	Visual inspection	To have no twisting due to capsized Bottom Hook of double type						
	Oiling	Visual inspection	To be oiled adequately						
	Check of mark	Visual inspection	To have no error in indication and marked pitch						
Top Hook, Bottom Hook	Stretched opening	Visual inspection	To have no stretched opening						
	Abrasion	Visual inspection	To have no apparent abrasion						
	Deformation, flaw, corrosion	Visual inspection	To have no apparent deformation, harmful flaw and corrosion						
	Hook Latch motion	Visual inspection/inspection by operation	To open/close smoothly						
	Hook motion (swivel)	Visual inspection/ inspection by operation	To have no apparent gap between Hook and Bottom Yoke						
	Idle Sheave motion	Visual inspection/ inspection by operation	Load Chain to move smoothly						
	Bottom Yoke	Visual inspection	To have no loosened bolt and nut						
Body size peripheral part	Chain spring	Visual inspection	To have no apparent permanent set						
	Cushion rubber	Visual inspection	• To have no apparent permanent set • To have no crack and peel off of rubber and steel plate						
Push Button Switch	Switch body size	Visual inspection	• To have no deformation, damage and loosened screw • Indication to be legible clearly						
Function/performance	Operational check	Press the push buttons to check the operation	• Load Chain to be wound smoothly • Electric Chain Hoist operates in the same direction as that of the push button operation • Motor to stop immediately when stopping the operation • All operations to stop when Emergency Stop is pressed • Electric Chain Hoist not to operate when pressing the push button while Emergency Stop is pressed • Electric Chain Hoist to operate normally when canceling Emergency Stop						
	Brake	Lifting/lowering operation with no load	Brake to operate securely and Bottom Hook to stop immediately (Guideline: Travel of the load chain is within 2 to 3 links.)						
	Friction Clutch with Mechanical Brake	Lifting/lowering operation with no load	To sound clicking noise of pawl when lifting						
	Limit switch	Lifting/lowering operation with no load	Motor to stop automatically when operating the electric chain hoist to upper/lower limit						
	Strange noise	Lifting/lowering operation with no load	To have no strange sound or vibration						

Executed by	Inspector						
Checked by	Maintenance Engineer						

DANGER

Mandatory

- When any abnormality is observed during inspection, stop the use of electric chain hoist, indicate "FAILURE", and contact the maintenance engineer or KITO for repair.

Use of the product with abnormality may result in death or serious injury.

NOTE

Decide the check items appropriate to the environment and operating conditions of the customer.

Motorized Trolley MR2 Daily Inspection

■Check result : ○ Good, △ To be replaced (adjusted) next inspection, ×Bad, Needs replacement (adjustment)

Category	Check item	Check method	Criteria	Inspection date/result					
				/	/	/	/	/	/
Appearance	Indication of nameplates and labels	Visual inspection	To have no peeled off. To be legible clearly.						
	Deformation and damage of each part	Visual inspection	To have no apparent deformation and corrosion Frame to have no apparent deformation						
	Bolts, nut, split pins	Visual inspection or inspection with tools	To have no loosened bolts, nuts, and split pins that can be seen from exterior. To have no come-off.						
Function/performance	Operational check	Traveling operation with no load	• To travel smoothly. To have no serpentine motion and vibration. • Electric Chain Hoist operates in the same direction as that of the push button operation • Motor to stop immediately when stopping the operation • All operations to stop when Emergency Stop is pressed • Electric Chain Hoist not to operate when pressing the push button while Emergency Stop is pressed • Electric Chain Hoist to operate normally when canceling Emergency Stop						
	Brake	Traveling operation with no load	When stopping the operation, brake to operate securely and motor to stop immediately.						

Executed by	Inspector						
Checked by	Maintenance Engineer						

Manual Trolley TS2 (TSG/TSP) Daily Inspection

■Check result : ○ Good, △ To be replaced (adjusted) next inspection, ×Bad, Needs replacement (adjustment)

Category	Check item	Check method	Criteria	Inspection date/result					
				/	/	/	/	/	/
Appearance	Indication of nameplates and labels	Visual inspection	To have no peeled off. To be legible clearly.						
	Deformation and damage of each part	Visual inspection	• To have no apparent deformation and corrosion • Frame to have no apparent deformation						
	Bolts, nut, split pins	Visual inspection	To have no loosened bolts, nuts, and split pins that can be seen from exterior. To have no come-off.						
Function/performance	Operational check	Traveling operation with no load	• To travel smoothly. To have no serpentine motion and vibration.						

Executed by	Inspector						
Checked by	Maintenance Engineer						

Check Sheet for ER2 Series Electric Chain Hoist Frequent Inspection

Code		Capacity	Lot No.	Your CTRL No.	Installation date	Location	Inspection Certification valid thru
Electric Chain Hoist	ER2						
Motorized Trolley	MR2						
Geared Trolley	TS2 (TSG)						
Plain Trolley	TS2 (TSP)						

■Electric Chain Hoist ER2 Frequent Inspection

■Check result : ○ Good, △ To be replaced (adjusted) next inspection, ×Bad, Needs replacement (adjustment)

Category	Check item	Check method	Criteria	Inspection date/result					
				/	/	/	/	/	/
Preceding inspection	Daily inspection	Check the execution	When performing frequent inspection, also perform the daily inspection.						
Load Chain	Elongation of pitch	Pitch measurement	Sum of pitches for 5 links must not exceed the limit value.						
	Abrasion of wire diameter	Diameter measurement	Not to exceed the limit value						
Top Hook, Bottom Hook	Stretched opening	Measurement	Interval between embossed marks not to exceed the limit value						
	Abrasion	Measurement	To have no abrasion exceeding the limit value (5 %)						
	Deformation, flaw, corrosion	Visual inspection	• To have no bending and twist • To have no attached foreign matter such as sputter						
Body size peripheral part	Chain container	Visual inspection	• To be mounted securely • To have no breakage, deformation and foreign matter • Lift must be shorter than the length of the permissible capacity of the chain container						
Electromagnetic brake	Number of start	Check CH Meter	Gap not to exceed the limit value (estimate the time to arrive at one million times)						
Push Button Switch	Switch body size	Visual inspection/ inspection by operation	• Operation buttons to move smoothly • Emergency Stop button to be enabled to operate and cancel						
	Push Button Switch cord	Visual inspection	• To be tied securely • Protection wire to prevent external force to be applied on the cord when being pulled • To have no damage						
Power feeding	Power cable	Visual inspection	• To have slack • To have no damage • To be connected securely						
	Cable hanger	Visual inspection	• To have no damage • To move with a small force • To be mounted at equal spacing						
	Messenger wire	Visual inspection	• To have no slack						
Function/ performance	Strange noise	Lifting/lowering operation with no load	• To have no humming noise from motor and scraping sound of the brake • To have no popping sound of load chain from the chain guide						

Executed by	Inspector						
Checked by	Maintenance Engineer						

DANGER

Mandatory

- When any abnormality is observed during inspection, stop the use of electric chain hoist, indicate "FAILURE", and contact the maintenance engineer or KITO for repair.

Use of the product with abnormality may result in death or serious injury.

NOTE

Decide the check items appropriate to the environment and operating conditions of the customer.

■Motorized Trolley MR2 Frequent Inspection

■Check result : ○ Good, △ To be replaced (adjusted) next inspection, ×Bad, Needs replacement (adjustment)

Category	Check item	Check method	Criteria	Inspection date/result					
				/	/	/	/	/	/
Preceding inspection	Daily inspection	Check the execution	When performing frequent inspection, also perform the daily inspection.						
Appearance	Combination	Shake the hoist	Electric chain hoist to swing right and left swiftly						
	Travel rail (guider)	Visual inspection	To have apparent deformation and damage						
	Oiling	Visual inspection	To be oiled adequately						
Refer to check table of electric chain hoist ER2 for electrical parts, push button switch, power feeding and electrical characteristics.									

Executed by	Inspector						
Checked by	Maintenance Engineer						

■Manual Trolley TS2 (TSG/TSP) Frequent Inspection

■Check result : ○ Good, △ To be replaced (adjusted) next inspection, ×Bad, Needs replacement (adjustment)

Category	Check item	Check method	Criteria	Inspection date/result					
				/	/	/	/	/	/
Appearance	Combination	Shake the hoist	Electric chain hoist to swing right and left swiftly						
	Travel rail (guider)	Visual inspection	To have apparent deformation and damage						
	Oiling	Visual inspection	To be oiled adequately						

Executed by	Inspector						
Checked by	Maintenance Engineer						

Check Sheet for ER2 Series Electric Chain Hoist Periodic Inspection

Code		Capacity	Lot No.	Your CTRL No.	Installation date	Location	Inspection Certification valid thru
Electric Chain Hoist	ER2						
Motorized Trolley	MR2						
Geared Trolley	TS2 (TSG)						
Plain Trolley	TS2 (TSP)						

■Electric Chain Hoist ER2 Periodic Inspection (1/2)

■Check result : ○ Good, △To be replaced (adjusted) next inspection, ×Bad, Needs replacement (adjustment)

Category	Check item	Check method	Criteria	Inspection date/result					
				/	/	/	/	/	/
Preceding inspection	Daily inspection	Check the execution	When performing periodic inspection, also perform the daily inspection.						
	Frequent inspection	Check the execution	When performing periodic inspection, also perform the frequent inspection.						
Top Hook, Bottom Hook	Number of start	Check CH Meter	Number of start not to exceed the guidelines for replacement						
Body size peripheral part	Chain guide A	Visual inspection	• To have no apparent abrasion and damage • To have no flaw due to hitting by Load Chain						
	Chain spring	Visual inspection/ inspection by measurement	• To have no apparent permanent setting (deformation) • Length of the chain spring to be longer than the criteria						
	Stopper	Visual inspection	Stopper must be mounted securely at the third link from the load chain end at no load side						
	Limit lever	Visual inspection/ inspection by operation	• To have no deformation, damage and abrasion • To move smoothly • To be clean						
	Chain pin	Visual inspection/ inspection by measurement	• To have no apparent deformation and flaw • Not to lower the criteria						
	Connection Yoke	Visual inspection/ inspection by measurement	• To have no apparent deformation, abrasion and damage • The difference between the hole diameter in vertical and lateral to be within 0.5 mm						
	Shaft retainer clip	Visual inspection	• To have no deformation, damage and abrasion • To be mounted securely without looseness						
Oil	Oil leakage	Visual inspection	To have no oil leakage at packing, oil seal and oil plug						
	Oil amount and stain	Visual inspection	• Oil is filled enough close to the oil check hole. • Gear oil has viscosity but not stained. • Check the operating hours with CH Meter. Operating hours not to exceed the guidelines for oil change.						
Electromagnetic brake	Appearance	Visual inspection	• To have no loosened bolts and screws • To have no flaw and damage						
	Gap	Measurement	The gap not to exceed the limit value						
	Hub and joint	Visual inspection	• To have no deformation and abrasion • Hub spring not to come off						
	Number of start	Check the CH Meter	Check the gap at the number of start arrives at one million times. Check the gap regularly after that and replace the electromagnetic brake when the gap arrives at the limit gap or the number of start arrives at two million times.						

⚠ DANGER

Mandatory

- When any abnormality is observed during inspection, stop the use of electric chain hoist, indicate "FAILURE", and contact the maintenance engineer or KITO for repair.

Use of the product with abnormality may result in death or serious injury.

NOTE

Decide the check items appropriate to the environment and operating conditions of the customer.

■Electric Chain Hoist ER2 Periodic Inspection (2/2)

■Check result : ○ Good, △ To be replaced (adjusted) next inspection, ×Bad, Needs replacement (adjustment)

Category	Check item	Check method	Criteria	Inspection date/result					
				/	/	/	/	/	/
Driving unit	Bearing	Visual inspection, Check CH Meter	• To have no apparent abrasion, flaw and damage • To move smoothly • Operating hours not to exceed the guidelines for replacement of bearing						
	Load gear, Gear B, Pinion	Visual inspection, Check CH Meter	• To have no apparent abrasion, deformation and damage • Operating hours not to exceed the guidelines for replacement of bearing						
	Friction clutch	Visual inspection, Check CH Meter	• To have no apparent abrasion, deformation and flaw • Operating hours not to exceed the guidelines for replacement of gears						
	Friction Clutch with Mechanical Brake	Visual inspection, Check CH Meter	• To have no apparent abrasion, deformation and flaw • Operating hours not to exceed the guidelines for replacement of gears						
	Load sheave	Visual inspection/ inspection by measurement	• To have no apparent abrasion, deformation and damage • To have no flaw on sheave pocket due to defective engagement • The thickness of sheave pocket must not lower the criteria.						
	Idle sheave	Visual inspection/ inspection by measurement	• To have no apparent abrasion, deformation and damage • To have no flaw on sheave pocket due to defective engagement • The thickness of sheave pocket must not lower the criteria.						
	V ring	Visual inspection, Check CH Meter	• To have no deformation and crack • Apply grease MOLITHERM No.2 on the V ring at brake cover side at 200 hours of operating hours						
Electrical parts	Electrical parts	Visual inspection	• To have no damaged or burnt part • To be mounted securely • Number of start no to exceed the guidelines for replacement						
	Wiring	Visual inspection	• Wiring to be fixed to electrical parts securely • Connector to be inserted securely • To have no damaged or burnt part						
	Intrusion or attachment of foreign matter	Visual inspection	• To have no water drop or foreign matter such as dust inside						
	VFD	Check the CH Meter (check of service life)	• Electrolytic capacitors 3000 hours (depending on the operating conditions) • Refer to "VFD Manual" for other items.						
Electric characteristics	Source voltage	Measurement	To be supplied power within rated voltage ± 10 %						
	Insulation resistance	Measurement	Insulation resistance to be higher than 5 MΩ						
	Grounding resistance	Measurement	To be grounded with grounding resistance 100 Ω or less						
Function/performance	Operational check	Lifting/lowering operation with a capacity	Perform inspection of the items on function/performance of daily inspection and frequent inspection with no load, and then perform the inspection of the same items with a capacity.						
	Brake	Lifting/lowering operation with a capacity Visual inspection/ inspection by measurement	Stopping distance of lifting/lowering to be within 1 % of the lifting distance						

Executed by	Inspector						
Checked by	Maintenance Engineer						

(to be continued)

Check Sheet for ER2 Series Electric Chain Hoist Periodic Inspection (continued)

Code		Capacity	Lot No.	Your CTRL No.	Installation date	Location	Inspection Certification valid thru
Electric Chain Hoist	ER2						
Motorized Trolley	MR2						
Geared Trolley	TS2 (TSG)						
Plain Trolley	TS2 (TSP)						

■Motorized Trolley MR2 Periodic Inspection

■Check result : ○ Good, △To be replaced (adjusted) next inspection, ×Bad, Needs replacement (adjustment)

Category	Check item	Check method	Criteria	Inspection date/result					
				/	/	/	/	/	/
Preceding inspection	Daily inspection	Check the execution	When performing periodic inspection, also perform the daily inspection.						
	Frequent inspection	Check the execution	When performing periodic inspection, also perform the frequent inspection.						
Brake	Appearance	Visual inspection	• To have no deformation, flaw and damage on the brake drum and motor cover • To have no deformation, flaw and damage on brake spring						
	Brake Pad	Measurement	Abrasion to be less than limit value						
Body size component	Wheel	Visual inspection/ inspection by measurement	• To have apparent deformation and damage • Abrasion of outer diameter to be less than limit value						
	Side roller	Visual inspection/ inspection by measurement	• To have no apparent deformation and damage • Abrasion of outer diameter to be less than limit value						
	Lifting shaft	Visual inspection/ inspection by measurement	• To have no apparent deformation and damage • Abrasion of outer diameter to be less than limit value						
	Suspender	Visual inspection/ inspection by measurement	• To have no apparent deformation and damage • Abrasion of outer diameter to be less than limit value						
	Gear frame packing	Visual inspection	• To have no damage, breakage and grease leakage.						
	Gears, motor shaft	Visual inspection	• To have no apparent abrasion, deformation and damage						
Travel Rail	Rail surface	Visual inspection	• To have no attachment of paint, oil and foreign matter • To have no dust and powder due to abrasion						
	Deformation, abrasion	Visual inspection/ inspection by measurement	• To have no deformation of beam flange such as twist and shear drop • To have no exceeding abrasion of rail surface						
	Rail fixing bolt	Visual inspection	To be mounted securely without looseness and come-off						
	Stopper	Visual inspection	To be mounted securely without looseness and come-off at the rail end						
Relay cable	Appearance	Visual inspection	To be connected securely without deformation and damage						
Refer to check table of electric chain hoist ER2 for electrical parts, push button switch, power feeding and electrical characteristics.									
Function/performance	Operational check	Traveling operation with a capacity Visual inspection/inspection by measurement	Perform inspection of the items on function/performance of daily inspection with no load, and then perform the inspection of the same items with a capacity. • To travel smoothly without serpentine motion and vibration						
	Brake	Traveling operation with a capacity Visual inspection/inspection by measurement	• Stopping distance of traveling to be within 10 % of the traveling distance, when no swinging of a load						
	Strange noise	Traveling operation with a capacity Visual inspection/inspection by measurement	• To have no irregular rotating noise • To have no motor hamming or scraping noise of a brake						

Executed by	Inspector						
Checked by	Maintenance Engineer						

DANGER

Mandatory

- When any abnormality is observed during inspection, stop the use of electric chain hoist, indicate “FAILURE”, and contact the maintenance engineer or KITO for repair.

Use of the product with abnormality may result in death or serious injury.

NOTE

Decide the check items appropriate to the environment and operating conditions of the customer.

■Manual Trolley TS2 (TSG/TSP) Periodic Inspection

■Check result : ○ Good, △ To be replaced (adjusted) next inspection, ×Bad, Needs replacement (adjustment)

Category	Check item	Check method	Criteria	Inspection date/result					
				/	/	/	/	/	/
Body size component	Wheel	Visual inspection/ inspection by measurement	• To have no apparent deformation and damage • Abrasion of outer diameter to be less than limit value						
	Lifting shaft	Visual inspection/ inspection by measurement	• To have no apparent deformation and damage • Abrasion of outer diameter to be less than limit value						
	Suspender	Visual inspection/ inspection by measurement	• To have no apparent deformation and damage • Abrasion of outer diameter to be less than limit value						
Travel rail	Rail surface	Visual inspection	• To have no attachment of paint, oil and foreign matter • To have no dust and powder due to abrasion						
	Deformation, abrasion	Visual inspection/ inspection by measurement	• To have no deformation of beam flange such as twist and shear drop • To have no exceeding abrasion of rail surface						
	Rail fixing bolt	Visual inspection	To be mounted securely without looseness and come-off						
	Stopper	Visual inspection	To be mounted securely without looseness and come-off at the rail end						
Function/performance	Operational check	Traveling operation with a capacity Visual inspection/ inspection by measurement	Perform inspection of the items on function/ performance of daily inspection with no load, and then perform the inspection of the same items with a capacity.						
	Strange noise	Traveling operation with a capacity Visual inspection/ inspection by measurement	Perform inspection of the items on function/ performance of daily inspection with no load, and then perform the inspection of the same items with a capacity.						

Executed by	Inspector						
Checked by	Maintenance Engineer						

WARRANTY

KITO Corporation (“KITO”) extends the following warranty to the original purchaser (“Purchaser”) of new products manufactured by KITO (KITO’s Products).

1) KITO warrants that KITO's Products, when shipped, shall be free from defects in workmanship and/or materials under normal use and service and KITO shall, at the election of KITO, repair or replace free of charge any parts or items which are proven to have said defects, provided that all claims for defects under this warranty shall be made in writing immediately upon discovery and, if there is anything within **a warranty period stated by your dealer from whom you purchased the products** from the date of purchase of KITO's Products by Purchaser and provided, further, that defective parts or items shall be kept for examination by KITO or its authorized agents or returned to KITO's factory or authorized service center upon request by KITO.

2) KITO does not warrant components of products provided by other manufacturers. However to the extent possible, KITO will assign to Purchaser applicable warranties of such other manufacturers.

3) Except for the repair or replacement mentioned in (1) above which is KITO's sole liability and purchaser’s exclusive remedy under this warranty, KITO shall not be responsible for any other claims arising out of the purchase and use of KITO’s Products, regardless of whether Purchaser’s claims are based on breach of contract, tort or other theories, including claims for any damages whether direct, incidental or consequential.

4) This warranty is conditional upon the installation, maintenance and use of KITO’s Products pursuant to the product manuals prepared in accordance with content instructions by KITO. This warranty shall not apply to KITO’s Products which have been subject to negligence, misuse, abuse, misapplication or any improper use or combination or improper fittings, alignment or maintenance.

5) KITO shall not be responsible for any loss or damage caused by transportation, prolonged or improper storage or normal wear and tear of KITO’s Products for loss of operating time.

6) This warranty shall not apply to KITO’s Products which have been fitted with or repaired with parts, components or items not supplied or approved by KITO or which have been modified or altered.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES. EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.

BULLETIN NO. SER-0310-PC-01

Owner's Manual

ELECTRIC CHAIN HOIST SER SERIES

¼ tonne through 3 tonne Capacity

Model, Lot and Serial Number

WARNING

This equipment should not be installed, operated or maintained by any person who has not read and understood all the contents of this manual. Failure to read and comply with the contents of this manual can result in serious bodily injury or death, and/or property damage.

KITO
HOISTS & CRANES

Table of Contents

Section	Page Number

1.0 Important Information and Warnings

1.1 Terms and Summary

This manual provides important information for personnel involved with the installation, operation and maintenance of this product. Although you may be familiar with this or similar equipment, it is strongly recommended that you read this manual before installing, operating or maintaining the product.

Danger, Warning, Caution and Notice

Throughout this manual there are steps and procedures that can present hazardous situations. The following signal words are used to identify the degree or level of hazard seriousness.

⚠ DANGER Danger indicates an imminently hazardous situation which, if not avoided, ***will*** result in ***death or serious injury***, and property damage.

⚠ WARNING Warning indicates an imminently hazardous situation which, if not avoided, ***could*** result in ***death or serious injury***, and property damage.

⚠ CAUTION Caution indicates a potentially hazardous situation which, if not avoided, ***may*** result in ***minor or moderate injury*** or property damage.

NOTICE Notice is used to notify people of installation, operation, or maintenance information which is important but not directly hazard-related.

⚠ CAUTION

These general instructions deal with the normal installation, operation, and maintenance situations encountered with the equipment described herein. The instructions should not be interpreted to anticipate every possible contingency or to anticipate the final system, crane, or configuration that uses this equipment. For systems using the equipment covered by this manual, the supplier and owner of the system are responsible for the system's compliance with all applicable industry standards, and with all applicable federal, provincial and local regulations/codes.

This manual includes instructions and parts information for a variety of hoist types. Therefore, all instructions and parts information may not apply to any one type or size of specific hoist. Disregard those portions of the instructions that do not apply.

Record your hoist's Model, Lot and Serial Number (see section 8) on the front cover of this manual for identification and future reference to avoid referring to the wrong manual for information or instructions on installation, operation, inspection, maintenance, or parts.

Use only Kito authorized replacement parts in the service and maintenance of this hoist.

WARNING

Equipment described herein is not designed for and **MUST NOT** be used for lifting, supporting, or transporting people, or for lifting or supporting loads over people.

Equipment described herein should not be used in conjunction with other equipment unless necessary and/or required safety devices applicable to the system, crane, or application are installed by the system designer, system manufacturer, crane manufacturer, installer, or user.

Modifications to upgrade, rerate, or otherwise alter this equipment shall be authorized only by the original equipment manufacturer.

Equipment described herein may be used in the design and manufacture of cranes or monorails. Additional equipment or devices may be required for the crane and monorail to comply with applicable crane design and safety standards. The crane designer, crane manufacturer, or user is responsible to furnish these additional items for compliance. Refer to ANSI/ASME B30.17, "Safety Standard for Top-Running Single Girder Cranes"; ANSI/ASME B30.2 "Safety Standard for Top-Running Double-Girder Cranes"; and ANSI/ASME B30.11 "Safety Standard for Underhung Cranes and Monorails".

If a below-the-hook lifting device or sling is used with a hoist, refer to ANSI/ASME B30.9, "Safety Standard for Slings" or ANSI/ASME B30.20, "Safety Standard for Below-the-Hook Lifting Devices".

Hoists and cranes, used to handle hot molten material may require additional equipment or devices. Refer to ANSI Z241.2, "Safety Requirements for Melting and Pouring of Metals in the Metalcasting Industry".

The system designer, system manufacturer, crane designer, crane manufacturer, installer, or user is responsible to ensure that the installation and associated wiring of these electrical components is in compliance with the Canadian Electrical Code, and all applicable Federal, Provincial and Local Codes.

Failure to read and comply with any one of the limitations noted herein can result in serious bodily injury or death, and/or property damage.

⚠ DANGER

HAZARDOUS VOLTAGES ARE PRESENT IN THE CONTROL BOX, OTHER ELECTRICAL COMPONENTS, AND CONNECTIONS BETWEEN THESE COMPONENTS.

Before performing ANY mechanical or electrical maintenance on the equipment, de-energize (disconnect) the main switch supplying power to the equipment; and lock and tag the main switch in the de-energized position. Refer to ANSI Z244.1, "Personnel Protection – Lockout/Tagout of Energy Sources".

Only trained and competent personnel should inspect and repair this equipment.

NOTICE

It is the responsibility of the owner/user to install, inspect, test, maintain, and operate a hoist in accordance with ANSI/ASME B30.16, "Safety Standard for Overhead Hoists". If the hoist is installed as part of a total lifting system, such as an overhead crane or monorail, it is also the responsibility of the owner/user to comply with the applicable volume of ANSI/ASME B30 that addresses that type of equipment and CSA B167-08.

It is the responsibility of the owner/user to have all personnel that will install, inspect, test, maintain, and operate a hoist read the contents of this manual and applicable portions of ANSI/ASME B30.16, "Safety Standard for Overhead Hoists". If the hoist is installed as part of a total lifting system, such as an overhead crane, the applicable ANSI/ASME B30 volume that addresses that type of equipment and CSA B167-08 must also be read by all personnel.

If the hoist owner/user requires additional information, or if any information in the manual is not clear, contact Kito or the distributor of the hoist. Do not install, inspect, test, maintain, or operate this hoist unless this information is fully understood.

A regular schedule of inspection of the hoist in accordance with the requirements of ANSI/ASME B30.16 should be established and records maintained.

1.2 Warning Tags and Labels

The warning tag illustrated below in Figure 1-1 is supplied with each hoist shipped from the factory. If the tag is not attached to your hoist's pendant cord, order a tag from your dealer and install it. Read and obey all warnings attached to this hoist. Tag is not shown actual size.

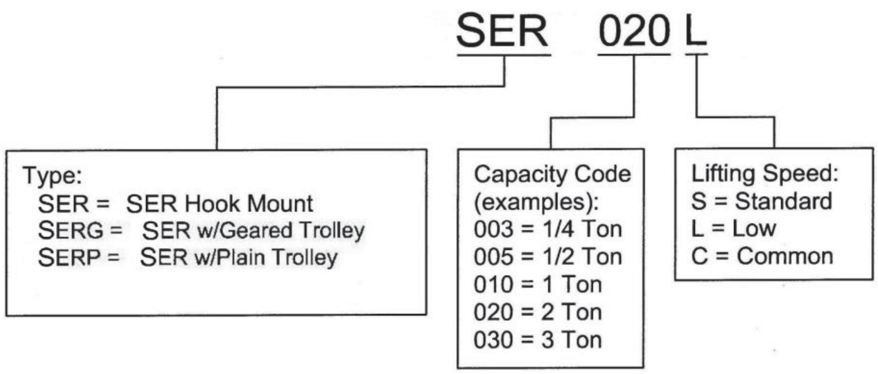
front back

Figure 1-1 Warning Tag Attached to Hoist

2.0 Technical Information

2.1 Specifications

2.1.1 Product Code



2.1.2 SER Models – Kito SER series hoists have a friction clutch mechanism that provides over winding protection.

2.1.3 Operating Conditions and Environment

Temperature range:	-20° to +40°C (-4° to +104°F)
Relative Humidity:	85% or less
Enclosure Rating:	Hoist Meets IP 55, Pendant Meets IP65
Supply Voltage:	Standard 115/230V-1-60 (Single Phase)
Speed:	Single
ASME Duty Classification:	H4
Intermittent Duty Rating:	60% ED
Maximum Number Starts per Hour:	360
Short Time Duty Rating:	60 min.

<table>
<tr><th colspan="10">Table 2-1 Hoist Specifications</th></tr>
<tr><th rowspan="3">Capacity
(tonne)</th><th rowspan="3">Code</th><th rowspan="3">Lifting Speed
(ft/min)</th><th colspan="3">Motor</th><th rowspan="3">Load Chain Wire Diameter (mm) x Chain Fall Lines</th><th rowspan="3">Load Sheave Pockets</th><th rowspan="3">Net Weight
(lbs)</th><th rowspan="3">Weight for One Addnl. FT. of Lift
(lbs)</th></tr>
<tr><th rowspan="2">Output
(Hp)</th><th colspan="2">Current Draw
(amps)</th></tr>
<tr><th>115V</th><th>230V</th></tr>
<tr><td>1/4</td><td>SER003S</td><td>14</td><td rowspan="2">0.34</td><td rowspan="2">7.7</td><td rowspan="2">3.9</td><td>5.0 x 1</td><td>5</td><td>82</td><td>0.37</td></tr>
<tr><td>1/2</td><td>SER005L</td><td>7</td><td rowspan="2">6.3 x 1</td><td>4</td><td>84</td><td rowspan="2">0.57</td></tr>
<tr><td>1/2</td><td>SER005S</td><td>15</td><td rowspan="2">0.6</td><td rowspan="2">16.9</td><td rowspan="2">8.5</td><td>5</td><td>104</td></tr>
<tr><td>1</td><td>SER010L</td><td>7</td><td rowspan="2">8.0 x 1</td><td>4</td><td>110</td><td rowspan="2">0.93</td></tr>
<tr><td>1</td><td>SER010S</td><td>14</td><td rowspan="3">1.2</td><td rowspan="3">23.9</td><td rowspan="3">12.0</td><td>5</td><td>159</td></tr>
<tr><td>2</td><td>SER020L</td><td>7</td><td>10.0 x 1</td><td>4</td><td>174</td><td>1.5</td></tr>
<tr><td>3</td><td>SER030C</td><td>3.5</td><td>10.0 x 2</td><td>4</td><td>207</td><td>3.1</td></tr>
</table>

2.2 Dimensions

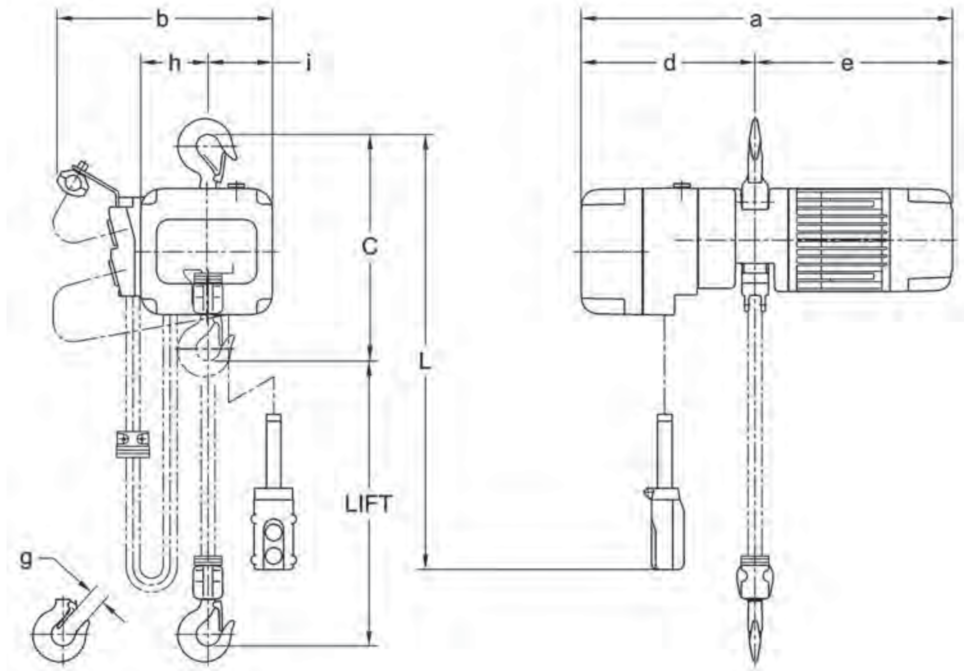
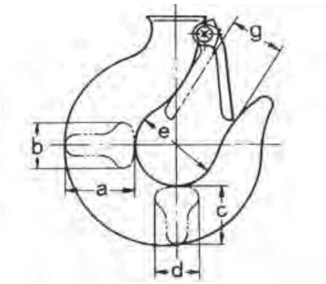


Figure 2-1 Hoist Dimensions (See Table 2-2)

<table>
<tr><th colspan="10">Table 2-2 Hoist Dimensions</th></tr>
<tr><th>Hoist Code</th><th>Minimum Headroom: C (in)</th><th>L* (ft)</th><th>a (in)</th><th>b (in)</th><th>d (in)</th><th>e (in)</th><th>g (in)</th><th>h (in)</th><th>i (in)</th></tr>
<tr><td>SER003S</td><td>13.8</td><td>8.2</td><td rowspan="2">22.2</td><td rowspan="2">13.0</td><td rowspan="2">10.4</td><td rowspan="2">11.9</td><td rowspan="3">0.9</td><td rowspan="2">4.0</td><td rowspan="2">3.9</td></tr>
<tr><td>SER005L</td><td>14.0</td><td>8.2</td></tr>
<tr><td>SER005S</td><td>14.6</td><td>8.2</td><td rowspan="2">23.2</td><td rowspan="2">13.8</td><td rowspan="2">10.8</td><td rowspan="2">12.6</td><td rowspan="2">4.7</td><td rowspan="2">4.1</td></tr>
<tr><td>SER010L</td><td>16.1</td><td>8.2</td><td rowspan="2">1.2</td></tr>
<tr><td>SER010S</td><td>17.3</td><td>8.2</td><td rowspan="3">26.9</td><td rowspan="3">16.5</td><td rowspan="3">12.6</td><td rowspan="3">14.4</td><td rowspan="2">6.1</td><td rowspan="2">5.2</td></tr>
<tr><td>SER020L</td><td>22.6</td><td>8.2</td><td>1.5</td></tr>
<tr><td>SER030C</td><td>29.5</td><td>9.2</td><td>1.7</td><td>8.2</td><td>3.0</td></tr>
</table>

*The "L" dimensions are based on the standard lift of 10 feet.

Table 2-3 Hook Dimension*



T = Top Hook

B = Bottom Hook

Units = inch

Capacity Code	Hook	a	b	c	d	e	g
003S, 005L, 005S	T	1.1	0.7	0.9	0.7	1.4	1.1
	B	1.1	0.7	0.9	0.7	1.4	0.9
010L, 010S	T & B	1.4	0.9	1.2	0.9	1.7	1.2
020L	T & B	1.9	1.1	1.6	1.1	2.0	1.5
030C	T & B	2.2	1.4	1.9	1.4	2.4	1.7

*Refer to Section 5.7 for inspection dimensions and limits.

3.0 Preoperational Procedures

3.1 Fill Gear Box with Oil

3.1.1 **⚠ CAUTION** DO NOT use any oil or quantity other than that listed below.

3.1.2 For a new hoist the correct quantity and type of oil is supplied with the hoist .

3.1.3 Refer to Section 6.2 when replacing the gear oil or checking the gear oil level.

Table 3-1 Amount of Gear Oil

Capacity Code	litres
003S, 005L	0.7
005S, 010L	1.0
010S, 020L, 030C	1.7

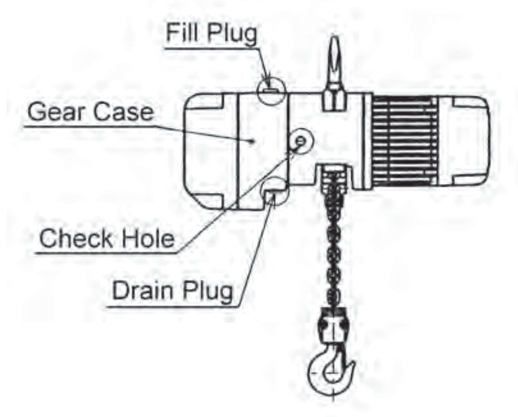


Figure 3-1 Oil Plug Locations

SER Gear Oil:

- Kito standard: Bonnoc M260 (NIPPON OIL)
- Acceptable equivalent: Meropa 320 (TEXACO)
- Acceptable equivalent: Meropa 320 (CALTEX)

3.2 Chain

3.2.1 The quantity and location of the chain components including cushion rubbers, chain springs and striker plates depend on the hoist model, capacity and limit switches. Never operate the hoist with incorrect, missing or damaged chain components. Refer to the hoist's nameplate, Table 3-2, and Figures 3-2, 3-3, and 3-4 and ensure that all chain components are in the correct location and properly installed.

3.2.2 When the hoist is used without a chain container, the free end of the chain is attached to the hoist body as shown in Figure 3-4. Connect the no load end of the chain to Chain Guide A with the End Wire or End Suspender provided. Make sure the chain remains free of twists and the chain Stopper is installed on the correct link. Refer to Table 3-2 for proper placement of Stopper.

Table 3-2 Chain Stopper Placement

Capacity Code	Without Chain Container	With Chain Container
003S, 005L, 005S, 010L, 010S, 020L, 030C	15th link from the free end	3rd link from the free end

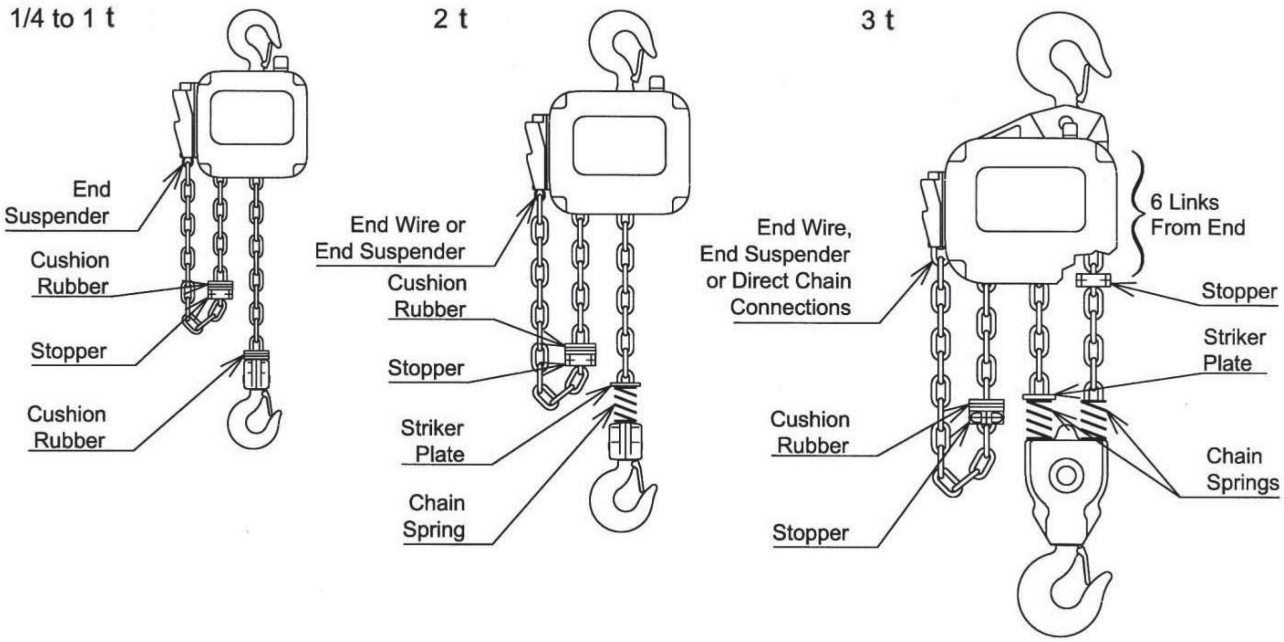


Figure 3-2 Chain Component Arrangement for Hoists with Upper Limit Switch Only.

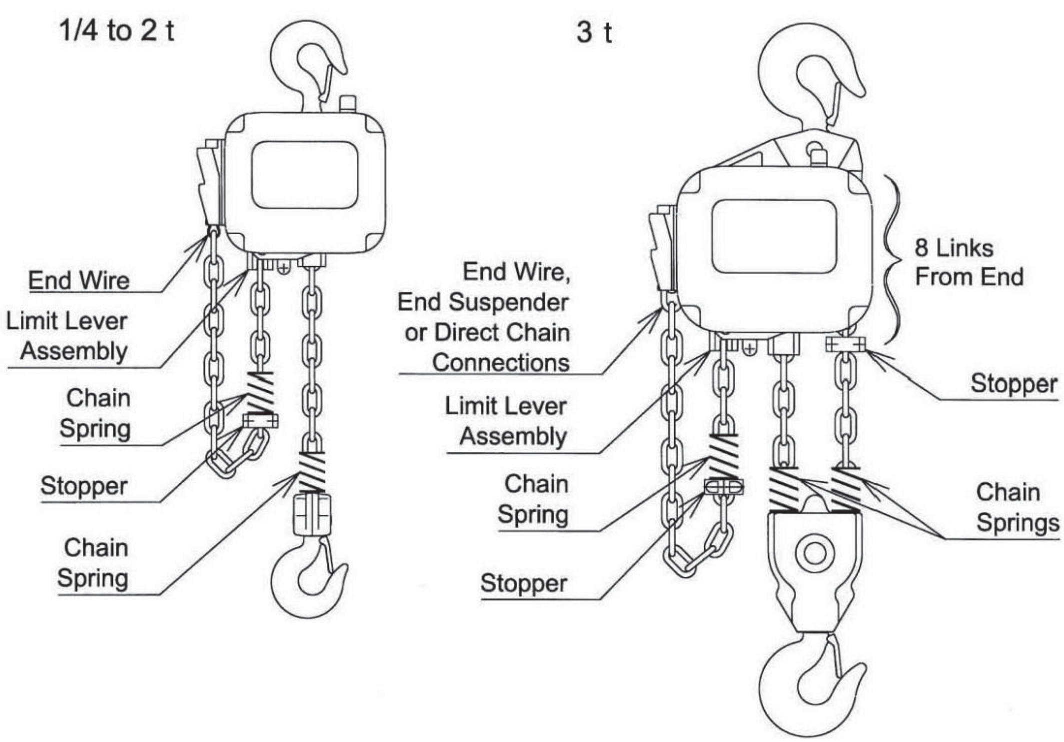


Figure 3-3 Chain Component Arrangement for Hoists with Optional Upper and Lower Limit Switch.

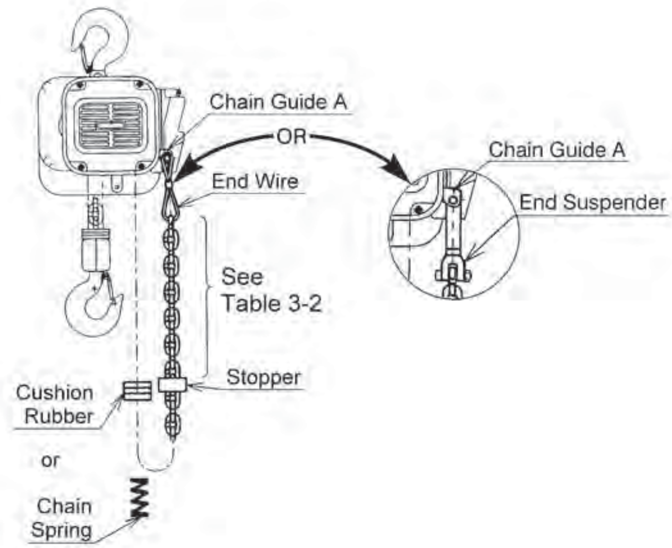


Figure 3-4 Attachment of Chain to Hoist Body – No Chain Container

3.2.3 When the optional canvas chain container is used, unfold it fully and install it on the hoist body as shown in Figure 3-5. In this case the free end of the chain is not attached to the hoist body and the chain stopper is installed on the third link from the free end. To place the chain into the chain container, feed the chain into the chain container beginning with the free end. Take care to avoid twisting or tangling the chain. NEVER put all the chain into the container at once. Lumped or twisted chain may:

- Upper Limit Switch Only - jam against the hoist body activating the friction clutch and potentially damaging the chain.
- Upper and Lower Limit Switch (Optional) - activate the down limit switch and stop the hoist during lowering.

3.2.4 **⚠ CAUTION** Each chain container indicates the maximum length of the load chain that can be stored in the container. The amount of chain the container must hold is equal to the lift on the hoist. DO NOT use a chain container with a storage capacity less than the lift length on the hoist. If all of the chain can not be stored in the container, the limit switch will not operate properly.

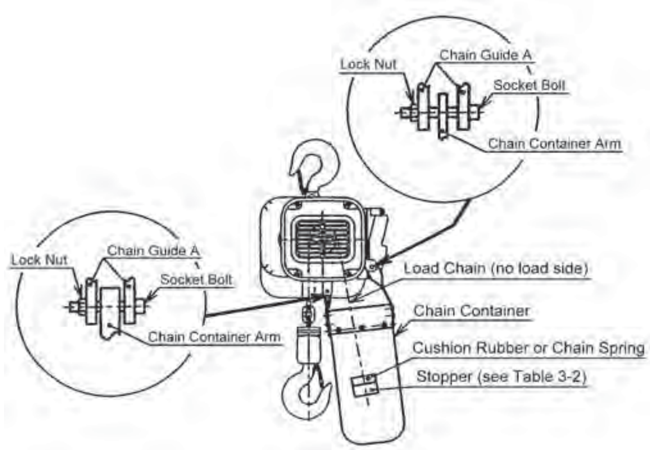


Figure 3-5 Attachment of Chain Container to Hoist Body

3.2.5 When using an optional steel chain container, refer to the assembly drawing and instructions provided with the container for correct assembly and attachment.

3.2.6 **⚠WARNING** Verify that the load chain is not twisted or tangled prior to operating the hoist. Make sure the bottom hook on 3 tonne double fall model is not capsized. See Figures 3-6 and 3-7. Correct all chain irregularities before conducting the first hoist operation.

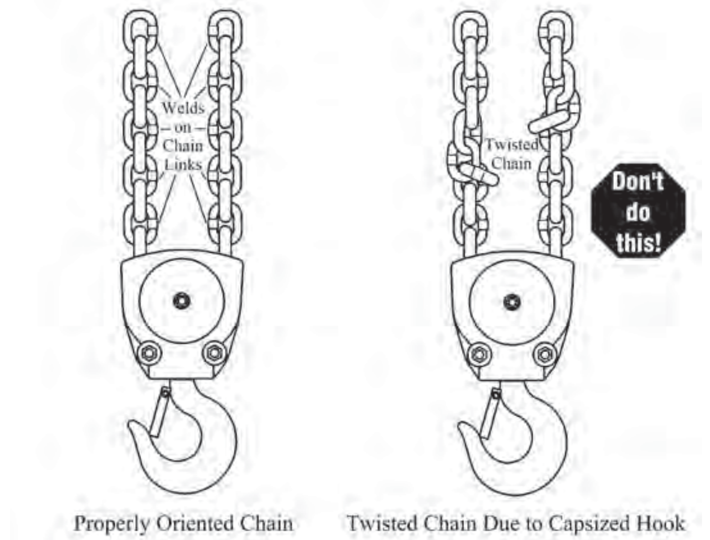


Figure 3-6 Twist in Load Chain – 3 tonne Double Fall Model

Figure 3-7 Capsized Hook and Chain – 3 tonne Double Fall Model

3.3 Mounting Location

3.3.1 **⚠WARNING** Prior to mounting the hoist ensure that the suspension and its supporting structure are adequate to support the hoist and its loads. If necessary consult a professional that is qualified to evaluate the adequacy of the suspension location and its supporting structure.

3.3.2 **NOTICE** See Section 6.6 for outdoor installation considerations.

3.4 Mounting the Hoist

3.4.1 Manual Trolley - Follow instructions in Owner's Manual provided with the trolley.

3.4.2 Motorized Trolley - Follow instructions in Owner's Manual provided with the trolley.

3.4.3 Hook Mounted to a Fixed Location - Attach the hoist's top hook to the fixed suspension point.

3.4.4 **⚠WARNING** Ensure that the fixed suspension point rests on the center of the hook's saddle and that the hook's latch is engaged.

3.5 Electrical Connections

3.5.1 **⚠ CAUTION** Ensure that the voltage of the electric power supply is proper for the hoist or trolley.

3.5.2 **⚠ CAUTION** Do not apply variable speed control to the SER model hoist.

3.5.3 **⚠ DANGER** Before proceeding, ensure that the electrical supply for the hoist or trolley has been de-energized (disconnected). Lock out and tag out in accordance with ANSI Z244.1 "Personnel Protection -Lockout/Tagout of Energy Sources".

3.5.4 **⚠WARNING** Make sure all power supply components (plugs, wires, breakers, fuses etc.) are adequately rated for the voltage and amperage draw of the hoist.

3.5.5 This instruction applies to installations where the hoist is installed hook mounted to a fixed suspension point or installed on a manual trolley. In this case the hoist is controlled by a pendant with two push buttons – one for raising and one for lowering. Refer to the appropriate trolley Owner's Manual if the hoist is installed on a motorized trolley.

Pendant Cord

The Pendant Cord connects to the hoist via a hard wire connection. Make the hardwire connection as follows:

- Refer to Figure 3-8.
- Attach the UP pendant wire to terminal number 12 (Red hoist pendant wire).
- Attach the DOWN pendant wire to terminal number 11 (White hoist pendant wire).
- Attach the pendant COMMON wire to the upper most terminal number 14 (Black hoist pendant wire).
- Install the Cord Strain Relief Cable to the Cord Support on the bottom of the hoist as shown in Figure 3-9.

Power Supply Cable

The Power Supply Cable connects to the hoist via a hard wire connection. Make the hard wire connection as follows:

- Refer to Figure 3-8.
- Attach the Black power supply cable wire to terminal number 10 (Black hoist power supply wire).
- Attach the White power supply cable wire to terminal number 9 (White hoist power supply wire).
- Attach the Yellow/Green power supply cable wire to the ground screw on the hoist back panel.
- Install the Cable Support Arm (pre-installed on the Power Supply Cable) on to the Socket Holder using the pre-installed Machine Screws and Lock Washers as shown in Figure 3-9.
- Use care to avoid twisting or kinking the Power Supply Cable.

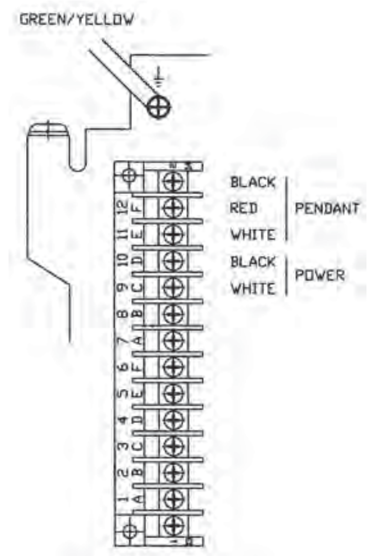


Figure 3-8 Pendant and Power Supply Cable Hardwire Connections

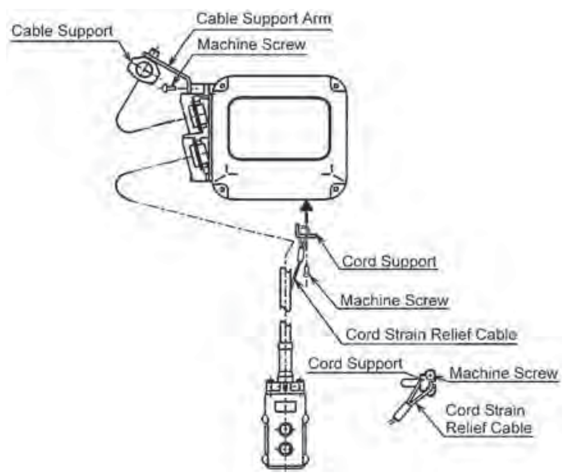


Figure 3-9 Pendant and Power Supply Cable Connections

Power Supply Cable - Installation

If the hoist is hook mounted to a fixed support ensure that the Power Supply Cable is properly installed and supported between the hoist and the electrical power supply.

If the host is installed on a manual trolley, then the Power Supply Cable must be installed along the beam that the trolley runs on. For curved beams a special cable suspension system will be needed, and this instruction does not apply. For straight beams install the Power Supply Cable as follows:

- Install a guide wire system parallel to the beam.
- For a manual trolley the guide wire should be positioned slightly outside the hoist's Cable Support as shown in Figure 3-9.
- Use the Cable Trolleys supplied with the hoist to suspend the Power Supply Cable from the guide wire. Space the Cable Trolleys every 5 feet.

3.5.6 Connection to Electrical Power Source - The white and black wires of the Power Supply Cable should be connected to an Electric Power Disconnect Switch or Circuit Breaker. This connection should be made so that the hoist is phased properly. Refer to Section 3.6.11 for instructions on how to check for correct power supply phase connection.

3.5.7 Fuse/Breaker Capacity -The hoist's power supply should be equipped with overcurrent protection such as fuses, which should be selected for 110% to 120% of total listed full load amperage, and should be dual element time-delay fuses. Refer to the motor nameplate for the full load amperage draw.

3.5.8 **DANGER** Grounding - An improper or insufficient ground connection creates an electrical shock hazard when touching any part of the hoist or trolley. In the Power Supply Cable the ground wire will be either Green with Yellow stripe or solid Green. It should always be connected to a suitable ground connection. Do not paint the trolley wheel running surfaces of the beam as this can affect grounding.

3.6 Preoperational Checks and Trial Operation

3.6.1 **⚠WARNING** Confirm the adequacy of the rated capacity for all slings, chains, wire ropes and all other lifting attachments before use. Inspect all load suspension members for damage prior to use and replace or repair all damaged parts.

3.6.2 **⚠WARNING** Verify and correct all chain irregularities prior to operating the hoist. Refer to Section 3.2.

3.6.3 Measure and record the “k” dimension of all hooks on hoist. See Table 5-4 under Section 5, “Inspection”.

3.6.4 Record the hoist's Model, Lot and Serial Number in the space provided on the cover of this manual.

3.6.5 Ensure that the hoist is properly installed to either a fixed point, or trolley, whichever applies.

3.6.6 If hoist is installed on a trolley, ensure that

- trolley is properly installed on the beam, and
- stops for the trolley are correctly positioned and securely installed on the beam.

3.6.7 Ensure that all nuts, bolts and split pins (cotter pins) are sufficiently fastened.

3.6.8 Pull down on the Pendant and ensure that the Cord Strain Relief Cable takes the force, not the Pendant Cord.

3.6.9 **⚠CAUTION** Check supply voltage before everyday use. If the voltage varies more than 10% of the rated value, electrical devices may not function normally.

3.6.10 Confirm proper operation.

- Before operating read and become familiar with Section 4 - Operation.
- Before operating ensure that the hoist (and trolley) meets the Inspection, Testing and Maintenance requirements of ANSI/ASME B30.16.
- Before operating ensure that nothing will interfere with the full range of the hoist’s (and trolley’s) operation.

3.6.11 **⚠WARNING** The hoist must be connected to the power source such that its direction of operation corresponds to the up-and-down commands issued from the pendant control; i.e. pushing the up button must cause the hoist to raise. If the hoist does not operate correctly, shut off and lockout /tagout the main power source to the hoist. Disconnect and switch the black and white input power leads at the power source to correct the hoist’s motor phasing.

4.0 Operation

4.1 Introduction

DANGER

DO NOT WALK UNDER A SUSPENDED LOAD

WARNING

HOIST OPERATORS SHALL BE REQUIRED TO READ THE OPERATION SECTION OF THIS MANUAL, THE WARNINGS CONTAINED IN THIS MANUAL, INSTRUCTION AND WARNING LABELS ON THE HOIST OR LIFTING SYSTEM, AND THE OPERATION SECTIONS OF ANSI/ASME B30.16 and ANSI/ASME B30.10. THE OPERATOR SHALL ALSO BE REQUIRED TO BE FAMILIAR WITH THE HOIST AND HOIST CONTROLS BEFORE BEING AUTHORIZED TO OPERATE THE HOIST OR LIFTING SYSTEM.

HOIST OPERATORS SHOULD BE TRAINED IN PROPER RIGGING PROCEDURES FOR THE ATTACHMENT OF LOADS TO THE HOIST HOOK.

HOIST OPERATORS SHOULD BE TRAINED TO BE AWARE OF POTENTIAL MALFUNCTIONS OF THE EQUIPMENT THAT REQUIRE ADJUSTMENT OR REPAIR, AND TO BE INSTRUCTED TO STOP OPERATION IF SUCH MALFUNCTIONS OCCUR, AND TO IMMEDIATELY ADVISE THEIR SUPERVISOR SO CORRECTIVE ACTION CAN BE TAKEN.

HOIST OPERATORS SHOULD HAVE NORMAL DEPTH PERCEPTION, FIELD OF VISION, REACTION TIME, MANUAL DEXTERITY, AND COORDINATION.

HOIST OPERATORS SHOULD **NOT** HAVE A HISTORY OF OR BE PRONE TO SEIZURES, LOSS OF PHYSICAL CONTROL, PHYSICAL DEFECTS, OR EMOTIONAL INSTABILITY THAT COULD RESULT IN ACTIONS OF THE OPERATOR BEING A HAZARD TO THE OPERATOR OR TO OTHERS.

HOIST OPERATORS SHOULD **NOT** OPERATE A HOIST OR LIFTING SYSTEM WHEN UNDER THE INFLUENCE OF ALCOHOL, DRUGS, OR MEDICATION.

OVERHEAD HOISTS ARE INTENDED ONLY FOR VERTICAL LIFTING SERVICE OF FREELY SUSPENDED UNGUIDED LOADS. DO **NOT** USE HOIST FOR LOADS THAT ARE NOT LIFTED VERTICALLY, LOADS THAT ARE NOT FREELY SUSPENDED, OR LOADS THAT ARE GUIDED.

NOTICE

- Read ANSI/ASME B30.16 and ANSI/ASME B30.10.
- Read the hoist manufacturer's Operating and Maintenance Instructions.
- Read all labels attached to equipment.

The operation of an overhead hoist involves more than activating the hoist's controls. Per the ANSI/ASME B30 standards, the use of an overhead hoist is subject to certain hazards that cannot be mitigated by engineered features, but only by the exercise of intelligence, care, common sense, and experience in anticipating the effects and results of activating the hoist's controls. Use this guidance in conjunction with other warnings, cautions, and notices in this manual to govern the operation and use of your overhead hoist.

4.2 Shall's and Shall Not's for Operation

WARNING

Improper operation of a hoist can create a potentially hazardous situation which, if not avoided, could result in death or serious injury, and substantial property damage. To avoid such a potentially hazardous situation **THE OPERATOR SHALL:**

- **NOT** lift more than rated load for the hoist.
- **NOT** operate unless load is centered under hoist.
- **NOT** use damaged hoist or hoist that is not working properly.
- **NOT** use hoist with twisted, kinked, damaged, or worn chain.
- **NOT** use hoist if the bottom hook is capsized (double fall hoists - see **Section 3.2**).
- **NOT** use the hoist to lift, support, or transport people.
- **NOT** lift loads over people.
- **NOT** apply load unless load chain is properly seated in the load sheave (and idle sheave for hoist with two chain falls).
- **NOT** use the hoist in such a way that could result in shock or impact loads being applied to the hoist.
- **NOT** attempt to lengthen the load chain or repair damaged load chain.
- **NOT** operate hoist when it is restricted from forming a straight line from hook to hook in the direction of loading.
- **NOT** use load chain as a sling or wrap load chain around load.
- **NOT** apply the load to the tip of the hook or to the hook latch.
- **NOT** apply load if binding prevents equal loading on all load-supporting chains.
- **NOT** operate beyond the limits of the load chain travel.
- **NOT** operate hoist with missing/damaged chain springs, cushion rubbers, stoppers or striker plates.
- **NOT** leave load supported by the hoist unattended unless specific precautions have been taken.
- **NOT** allow the chain, or hook to be used as an electrical or welding ground.
- **NOT** allow the chain, or hook to be touched by a live welding electrode.
- **NOT** remove or obscure the warnings on the hoist.
- **NOT** operate a hoist on which the safety placards or decals are missing or illegible.
- Be familiar with operating controls, procedures, and warnings.
- Make sure the unit is securely attached to a suitable support before applying load.
- Make sure load slings or other approved single attachments are properly sized, rigged, and seated in the hook saddle.
- Take up slack carefully - make sure load is balanced and load-holding action is secure before continuing.
- Make sure all persons stay clear of the supported load.
- Protect the hoist's load chain from weld splatter or other damaging contaminants.
- Report malfunctions or unusual performances (including unusual noises) of the hoist and remove the hoist from service until the malfunction or unusual performance is resolved.
- Make sure hoist limit switches function properly.
- Warn personnel before lifting or moving a load.
- Warn personnel of an approaching load.

⚠ CAUTION

Improper operation of a hoist can create a potentially hazardous situation which, if not avoided, could result in minor or moderate injury, or property damage. To avoid such a potentially hazardous situation **THE OPERATOR SHALL:**

- Maintain a firm footing or be otherwise secured when operating the hoist.
- Check brake function by tensioning the hoist prior to each lift operation.
- Use hook latches. Latches are to retain slings, chains, etc. under slack conditions only.
- Make sure the hook latches are closed and not supporting any parts of the load.
- Make sure the load is free to move and will clear all obstructions.
- Avoid swinging the load or hook.
- Make sure hook travel is in the same direction as shown on controls.
- Inspect the hoist regularly, replace damaged or worn parts, and keep appropriate records of maintenance.
- Use the hoist manufacturers recommended parts when repairing the unit.
- Lubricate load chain per hoist manufacturer's recommendations.
- **NOT** use the hoist load limiting or warning device to measure load.
- **NOT** use limit switches as routine operating stops. They are emergency devices only.
- **NOT** allow your attention to be diverted from operating the hoist.
- **NOT** allow the hoist to be subjected to sharp contact with other hoists, structures, or objects through misuse.
- **NOT** adjust or repair the hoist unless qualified to perform such adjustments or repairs.

4.3 Hoist Controls

4.3.1 For hoists mounted to motorized trolleys follow the control instruction included in the trolley's Owner's Manual.

4.3.2 Pendant Control – When using the pendant control depress the up button to raise the hoist or the down button to lower the hoist as shown in Figure 4-1 below. To stop motion release the buttons.

4.3.3 **⚠ CAUTION** Make sure the motor completely stops before reversing direction.

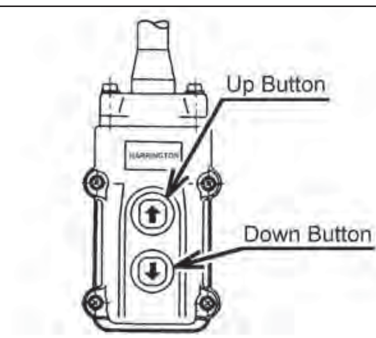


Figure 4-1 Push Button Pendant Control

5.0 Inspection

5.1 General

5.1.1 The inspection procedure herein is based on ANSI/ASME B30.16. The following definitions are from ANSI/ASME B30.16 and pertain to the inspection procedure below.

- **Designated Person** – a person selected or assigned as being competent to perform the specific duties to which he/she is assigned.
- **Qualified Person** – a person who, by possession of a recognized degree or certificate of professional standing, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.
- **Normal Service** – that distributed service which involves operation with randomly distributed loads within the rated load limit, or uniform loads less than 65% of rated load for not more than 25% of the time.
- **Heavy Service** – that service which involves operation within the rated load limit which exceeds normal service.
- **Severe Service** – that service which involves normal or heavy service with abnormal operating conditions.

5.2 Inspection Classification

5.2.1 Initial Inspection – prior to initial use, all new, altered, or modified hoists shall be inspected by a designated person to ensure compliance with the applicable provisions of this manual.

5.2.2 Inspection Classification – the inspection procedure for hoists in regular service is divided into two general classifications based upon the intervals at which inspection should be performed. The intervals in turn are dependent upon the nature of the critical components of the hoist and the degree of their exposure to wear, deterioration, or malfunction. The two general classifications are herein designated as FREQUENT and PERIODIC, with respective intervals between inspections as defined below.

5.2.3 FREQUENT Inspection – visual examinations by the operator or other designated personnel with intervals per the following criteria:

- Normal service – monthly
- Heavy service – weekly to monthly
- Severe service – daily to weekly
- Special or infrequent service – as recommended by a qualified person before and after each occurrence.

5.2.4 PERIODIC Inspection – visual inspection by a designated person with intervals per the following criteria:

- Normal service – yearly
- Heavy service – semiannually
- Severe service – quarterly
- Special or infrequent service – as recommended by a qualified person before the first such occurrence and as directed by the qualified person for any subsequent occurrences.

5.3 Frequent Inspection

5.3.1 Inspections should be made on a FREQUENT basis in accordance with Table 5-1, "Frequent Inspection." Included in these FREQUENT Inspections are observations made during operation for any defects or damage that might appear between Periodic Inspections. Evaluation and resolution of the results of FREQUENT Inspections shall be made by a designated person such that the hoist is maintained in safe working condition.

Table 5-1 Frequent Inspection
All functional operating mechanisms for maladjustment and unusual sounds.
Operation of limit switch and associated components
Hoist braking system for proper operation
Hooks in accordance with ANSI/ASME B30.10
Hook latch operation
Load chain in accordance with Section 5.7
Load chain reeving for compliance with Section 3.2 and 6.4

5.4 Periodic Inspection

5.4.1 Inspections should be made on a PERIODIC basis in accordance with Table 5-2, "Periodic Inspection." Evaluation and resolution of the results of PERIODIC Inspections shall be made by a designated person such that the hoist is maintained in safe working condition.

5.4.2 For inspections where load suspension parts of the hoist are disassembled, a load test per ANSI/ASME B30.16 must be performed on the hoist after it is re-assembled and prior to its return to service.

Table 5-2 Periodic Inspection
Requirements of frequent inspection.
Evidence of loose bolts, nuts, or rivets.
Evidence of worn, corroded, cracked, or distorted parts such as load blocks, suspension housing, chain attachments, clevises, yokes, suspension bolts, shafts, gears, bearings, pins and rollers.
Evidence of damage to hook retaining nuts or collars and pins, and welds or rivets used to secure the retaining members.
Evidence of damage or excessive wear of load and idler sheaves.
Evidence of excessive wear on motor or load brake.
Electrical apparatus for signs of pitting or any deterioration of visible controller contacts.
Evidence of damage of supporting structure or trolley, if used.
Function labels on pendant control stations for legibility.
Warning label properly attached to the hoist and legible (see Section 1.2).
End connections of load chain.

5.5 Occasionally Used Hoists

5.5.1 Hoists that are used infrequently shall be inspected as follows prior to placing in service:

- Hoist Idle More Than 1 Month, Less Than 1 Year: Inspect per FREQUENT Inspection criteria in Section 5.3.
- Hoist Idle More Than 1 Year: Inspect per PERIODIC Inspection criteria in Section 5.4.

5.6 Inspection Records

5.6.1 Dated inspection reports and records should be maintained at time intervals corresponding to those that apply for the hoist's PERIODIC interval per Section 5.2.4. These records should be stored where they are available to personnel involved with the inspection, maintenance, or operation of the hoist.

5.6.2 A long range chain inspection program should be established and should include records of examination of chains removed from service so a relationship can be established between visual observation and actual condition of the chain.

5.7 Inspection Methods and Criteria

5.7.1 This section covers the inspection of specific items. The list of items in this section is based on those listed in ANSI/ASME B30.16 for the Frequent and Periodic Inspection. In accordance with ANSI/ASME B30.16, these inspections are not intended to involve disassembly of the hoist. Rather, disassembly for further inspection would be required if frequent or periodic inspection results so indicate. Such disassembly and further inspection should only be performed by a qualified person trained in the disassembly and re-assembly of the hoist.

Table 5-3 Hoist Inspection Methods and Criteria

Item	Method	Criteria	Action
Functional operating mechanisms.	Visual, Auditory	Mechanisms should be properly adjusted and should not produce unusual sounds when operated.	Repair or replace as required.
Limit Switch	Function	Proper operation. Actuation of limit switch should stop hoist.	Repair or replace as required.
Limit Lever Assembly	Visual, Function	Lever should not be bent or significantly worn and should be able to move freely.	Replace.
Braking System Operation	Function	Braking distance with rated capacity should not exceed 3% of the lifting speed (approximately two chain links).	Repair or replace as required.
Hooks - Surface Condition	Visual	Should be free of significant rust, weld splatter, deep nicks, or gouges.	Replace.
Hooks - Fretting wear	Measure	The "u" and "t" dimensions should not be less than discard value listed in **Table 5-4**	Replace.
Hooks - Stretch	Measure	The "k" dimension should not be greater than 1.15 times that measured and recorded at the time of purchase (See **Section 3.6**). If recorded "k" values are not available for hooks when new, use nominal "k" values from **Table 5-4.**	Replace.
Hooks - Bent Shank or Neck	Visual	Shank and neck portions of hook should be free of deformations.	Replace.

Table 5-3 Hoist Inspection Methods and Criteria			
Item	**Method**	**Criteria**	**Action**
Hooks - Yoke Assembly	Visual	Should be free of significant rust, weld splatter, nicks, gouges. Holes should not be elongated, fasteners should not be loose, and there should be no gap between mating parts.	Tighten or replace as required.
Hooks - Swivel Bearing	Visual, Function	Bearing parts and surfaces should not show significant wear, and should be free of dirt, grime and deformations. Hook should rotate freely with no roughness.	Clean/lubricate, or replace as required.
Hooks - Idle Sheave and Axle (Bottom Hook on Double Fall Hoist)	Visual, Function	Pockets of Idle Sheave should be free of significant wear. Idle Sheave surfaces should be free of nicks, gouges, dirt and grime. Bearing parts and surfaces of Idle Sheave and Axle should not show significant wear. Idle Sheave should rotate freely with no roughness or significant free play.	Clean/lubricate, or replace as required.
Hooks - Hook Latches	Visual, Function	Latch should not be deformed. Attachment of latch to hook should not be loose. Latch spring should not be missing and should not be weak. Latch movement should not be stiff - when depressed and released latch should snap smartly to its closed position.	Replace.
Load Chain - Surface Condition	Visual	Should be free of rust, nicks, gouges, dents and weld splatter. Links should not be deformed, and should not show signs of abrasion. Surfaces where links bear on one another should be free of significant wear.	Replace.
Load Chain - Pitch and Wire Diameter	Measure	The "P" dimension should not be greater than maximum value listed in **Table 5-5.** The "d" dimension should not be less than minimum value listed in **Table 5-5.**	Replace. Inspect Load Sheave (and Idle Sheave for double fall hoist).
Load Chain - Lubrication	Visual, Auditory	Entire surface of each chain link should be coated with lubricant and should be free of dirt and grime. Chain should not emit cracking noise when hoisting a load.	Clean/lubricate (see **Section 6.0**).
Load Chain - Reeving	Visual	Chain should be reeved properly through Load Sheave (and Idle Sheave for double fall hoist) - refer to **Section 6.3**. Chain, Chain Springs, Cushion Rubbers, Striker Plates, and Stoppers should be installed properly - refer to **Section 3.2**.	Reeve/Install chain properly.
Chain Container (optional)	Visual	Container should not be damaged. Brackets should not be deformed or missing.	Replace.
Housing and Mechanical Components	Visual, Auditory, Vibration, Function	Hoist components including load blocks, suspension housing, chain attachments, clevises, yokes, suspension bolts, shafts, gears, bearings, pins and rollers should be free of cracks, distortion, significant wear and corrosion. Evidence of same can be detected visually or via detection of unusual sounds or vibration during operation.	Replace.

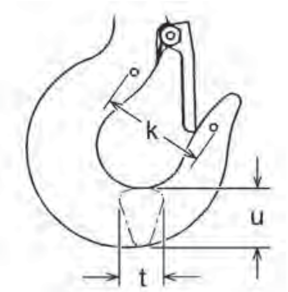
Table 5-3 Hoist Inspection Methods and Criteria			
Item	**Method**	**Criteria**	**Action**
Bolts, Nuts and Rivets	Visual, Check with Proper Tool	Bolts, nuts and rivets should not be loose.	Tighten or replace as required.
Motor Brake	Measure, Visual	Motor brake gap should be adjusted to the distance shown in **Table 6-2** before measuring the brake wear. Brake lining dimension "A" should not be less than discard value listed in **Table 5-6**. Refer to **Section 6.2** for gaining access to motor brake and for adjustment and inspection procedures. Braking surfaces should be clean, free of grease/oil and should not be glazed.	Adjust, Repair or Replace as required.
Contactor Contacts	Visual	Contacts should be free of significant pitting or deterioration.	Replace.
Load Sheave	Visual	Pockets of Load Sheave should be free of significant wear.	Replace.
Cushion Rubber	Visual	Should be free of significant deformation.	Replace.
Chain Springs	Visual	Chain springs should be not be deformed or compressed.	Replace.
Pendant - Switches	Function	Depressing and releasing push-buttons should make and break contacts in switch contact block and result in corresponding electrical continuity or open circuit. Push-buttons should be interlocked either mechanically or electrically to prevent simultaneous energization of circuits for opposing motions (e.g. up and down).	Repair or replace as necessary.
Pendant - Housing	Visual	Pendant housing should be free of cracks and mating surfaces of parts should seal without gaps.	Replace.
Pendant - Wiring	Visual	Wire connections to switches in pendant should not be loose or damaged.	Tighten or repair
Pendant - Cord	Visual, Electrical Continuity	Surface of cord should be free from nicks, gouges, and abrasions. Each conductor in cord should have 100% electrical continuity even when cord is flexed back-and-forth. Pendant Cord Strain Relief Cable should absorb all of the load associated with forces applied to the pendant.	Replace.
Pendant - Labels	Visual	Labels denoting functions should be legible.	Replace.
Warning Labels	Visual	Warning Labels should be affixed to the hoist (see **Section 1.2**) and they should be legible.	Replace.
Hoist Capacity Label	Visual	The label that indicates the capacity of the hoist should be legible and securely attached to the hoist.	Replace.

Table 5-4 Top Hook & Bottom Hook Dimensions

"k" Measured When New:

Top: ______________________

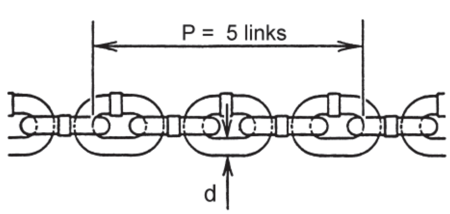
Bottom: ____________________



Capacity Code	Nominal "k" Dimension* inch (mm)	"u" Dimension inch (mm)		"t" Dimension inch (mm)	
		Standard	Discard	Standard	Discard
003S, 005L, 005S	1.65 (42)	0.93 (23.5)	0.83 (21)	0.69 (17.5)	0.63 (16)
010L, 010S	1.97 (50)	1.22 (31)	1.10 (28)	0.89 (22.5)	0.79 (20)
020L	2.46 (62.5)	1.57 (40)	1.42 (36)	1.14 (29)	1.02 (26)
030C	2.95 (75)	1.87 (47.5)	1.69 (43)	1.36 (34.5)	1.22 (31)

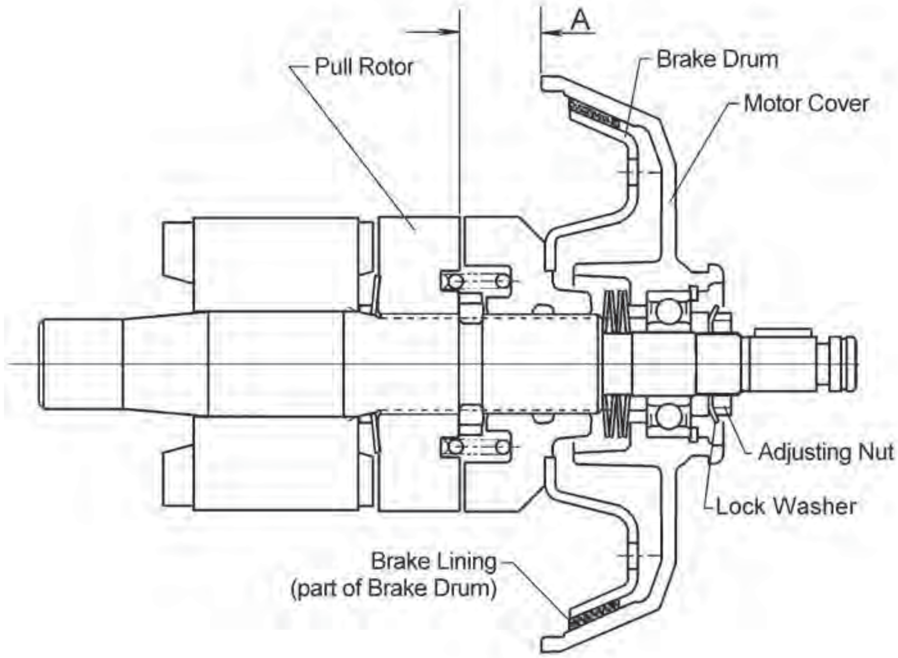
*These values are nominal since the dimension is not controlled to a tolerance. The **"k"** dimension should be measured when the hook is new - this becomes a reference measurement. Subsequent measurements are compared to this reference to make determinations about hook deformation/stretch. See Section 5.7, "Hooks - Stretch".

Table 5-5 Chain Wear Dimensions



Capacity Code	"P" Dimension inch (mm)		"d" Dimension inch (mm)	
	Standard	Discard	Standard	Discard
003S	2.97 (75.5)	3.02 (76.6)	0.22 (5.0)	0.18 (4.5)
005L, 005S	3.76 (95.5)	3.82 (96.9)	0.25 (6.3)	0.22 (5.7)
010L, 010S	4.76 (121.0)	4.91 (124.6)	0.31 (8.0)	0.28 (7.2)
020L, 030C	5.96 (151.5)	6.05 (153.8)	0.39 (10.0)	0.35 (9.0)

Table 5-6 Motor Brake Wear Dimensions



NOTICE Brake must be properly adjusted before measuring "A". See Section 6.2

Capacity Code	"A" Dimension - inch (mm)	
	Standard	**Discard**
003S, 005L	0.67 (17)	0.61 (15.5)
005S, 010L	0.85 (21.5)	0.79 (20)
010S, 020L, 030C	0.89 (22.5)	0.83 (21)

6.0 Maintenance and Handling

6.1 Lubrication

6.1.1 Load Chain

- For longer life, the load chain should be lubricated.
- The load chain lubrication should be accomplished after cleaning the load chain with an acid free cleaning solution.
- Apply Kito lubricating grease (Part No. E2R1951-001H) or an equivalent to industrial general lithium grease, NLGI No. 0, to the bearing surfaces of the load chain links as indicated by the shaded areas in Figure 6-1. Also apply the grease to the areas of the load chain (shaded areas in Figure 6-1) that contact the load sheave. Insure that the grease is applied to the contact areas in the load sheave pockets.
- Machine or gear oil (grade ISO VG 46 or 68 oil or equivalent) may be used as an alternative lubricant but must be applied more frequently.

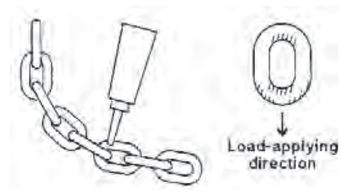


Figure 6-1 Chain Grease Application

- The chain should be lubricated every 3 months (more frequently for heavier usage or severe conditions).
- For dusty environments, it is acceptable to substitute a dry lubricant.

6.1.2 Hooks and Suspension Components:

- Hooks - Bearings should be cleaned and lubricated at least once per year for normal usage. Clean and lubricate more frequently for heavier usage or severe conditions.
- Suspension Pins - Lubricate at least twice per year for normal usage; more frequently for heavier usage or severe conditions.

6.1.3 Gear Box:

- **⚠WARNING** Using an incorrect type/grade of gearbox oil or the wrong quantity of oil may prevent the friction clutch from working properly and may affect the ability of the hoist to hold the load. Refer to Section 3.1 for the correct oil and quantity.
- The oil level can be checked using the oil check hole on the side of the hoist body shown in Figure 3-1. The oil level should be in accordance with Table 6-1 below.

Table 6-1 Criteria for Checking Hoist Gear Oil Level

Capacity Code	Oil Level (Hoist at level position)	
	Min	Max
Up to and including 010L	½ " below bottom edge of check hole	Even with bottom edge of check hole.
010S and Up	1" below bottom edge of check hole	Even with bottom edge of check hole.

- Change gear oil at least once every 5 years. The oil should be changed more frequently depending on the hoist's usage and operating environment.
- Refer to Figure 3-1 and Table 3-1 to change the gear oil, remove both fill and drain plugs and allow the old oil to drain completely. Replace the drain plug and refill the gear case with the correct quantity of new oil or until the oil level is within the range shown in Table 6-1.
- **NOTICE** Dispose of the used oil in accordance with local regulations.

6.2 Motor Brake

6.2.1 To keep your hoist working in optimum condition and prevent possible down time, it is recommended to check your motor brake lining and adjustment at regular intervals.

6.2.2 Motor Brake Unit Removal - Adjustment and inspection of the motor brake requires removal of the motor brake unit from the hoist as an assembly.

1) **⚠ CAUTION** Before proceeding disconnect the power supply and make sure the hoist is unloaded. To keep the load chain from moving, secure it by tying together the load and no-load sides directly under the hoist using a cord or wire.

2) Refer to Figure 6-2.

3) Remove the four Fan Cover bolts (A), Fan Cover (B), Fan snap ring (C), and Fan washer (D).

4) Pull the Fan (E) off the motor shaft using a wheel puller if necessary.

5) Remove the four Motor Cover Assembly bolts (F) and carefully pull the motor brake unit (G) out of the hoist.

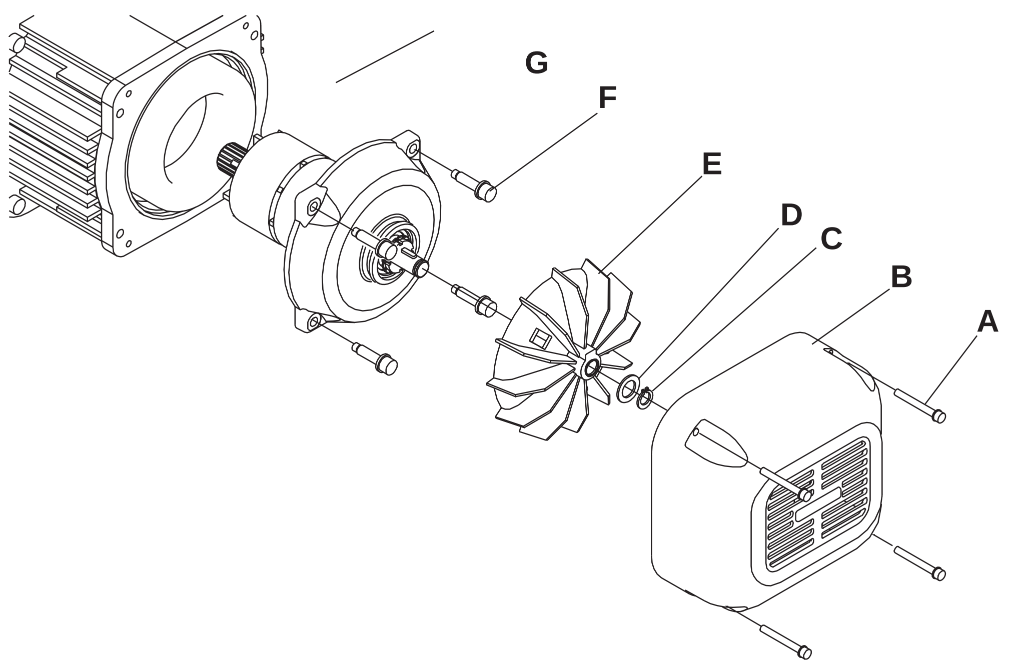


Figure 6-2 Motor Brake

6.2.3 Brake Gap (G) - The Brake Gap should be measured between the Brake Drum and Pull Rotor. Adjustment of the Brake Gap is accomplished by turning the Adjustment Nut in the center of the Motor Cover as shown in the figure with Table 6-2. Do this as follows:

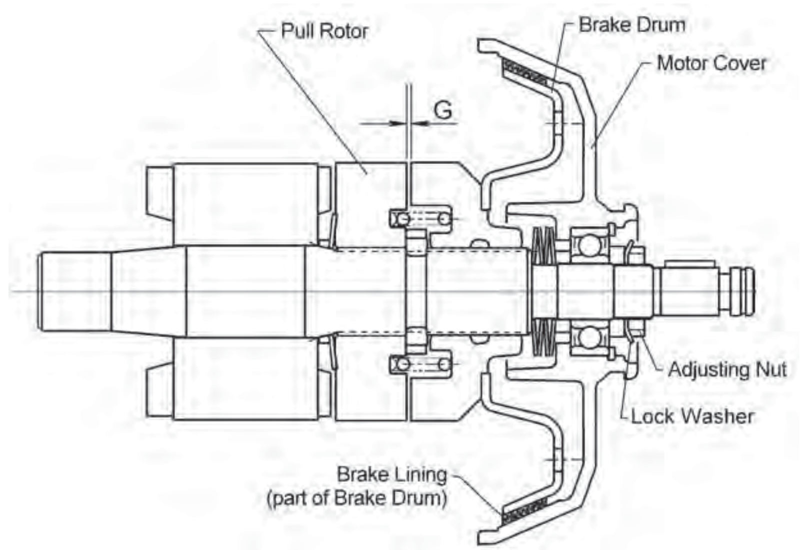
1) Bend the tab of the Lock Washer away from the Adjusting Nut so that the Adjusting Nut can be rotated.

2) Using a spanner wrench and a feeler gauge, rotate the Adjusting Nut to attain the proper Brake Gap per Table 6-2.

3) After the Brake Gap is set, secure the Adjusting Nut by bending one of the tabs of the Lock Washer into a slot in the Adjusting Nut. If necessary rotate the Adjusting Nut clockwise (tightening) to line up the tab with the slot.

4) If the proper brake adjustment cannot be achieved, disassemble the motor brake and inspect all motor brake parts. Replace the Brake Drum and/or Motor Cover if necessary.

Table 6-2 Motor Brake Gap



Capacity Code	Brake Gap (G) inch (mm)
003S, 005L, 005S, 010L, 010S, 020L, 030C	0.020 (0.5)

6.2.4 Brake Lining Inspection –The brake lining is designed for a long life and should provide years of trouble-free service. If the brake lining is being inspected due to excessive load chain drift during operation (see Section 5.7), disassemble the motor brake and inspect all motor brake parts. Braking surfaces should be clean, free of grease/oil and should not be glazed. Replace the Brake Drum and/or Motor Cover if necessary. For normal inspections, the Brake Lining and Motor Cover wear should be measured as follows.

1) Adjust the Brake Gap per Section 6.2.3 before measuring the Brake Lining and Motor Cover wear.

2) Refer to Table 5-6.

3) Measure the distance "A" using calipers and a straight edge. Place the straight edge across the edge of the motor cover and measure from the straight edge to the face of the Pull Rotor.

4) Compare the measurement with the values listed in Table 5-6. Replace the Brake Drum and/or Motor Cover if the "A" measurement is smaller than the discard limit.

6.2.5 Motor Brake Unit Installation - After the brake is properly adjusted and inspected, carefully replace the motor brake unit back into the hoist. Be sure to reseal the Motor Cover to motor frame surface using a small bead of liquid (hi-temperature) sealant. Refer to Section 6.2.2 and reassemble the parts in reverse order of removal.

6.3 Load Chain

6.3.1 Lubrication and Cleaning – refer to Section 6.1.

6.3.2 Load Chain Replacement:

1) **⚠ CAUTION** The hoist must be properly powered and operational in order to perform the following procedures.

2) **⚠ WARNING** Be certain that the replacement chain is obtained from Kito and is the exact size, grade and construction as the original chain. The new load chain must have an odd number of links so that both its end links have the same orientation. If the load chain is being replaced due to damage or wear out, destroy the old chain to prevent its reuse.

3) **⚠ CAUTION** When replacing load chain, check for wear on mating parts, i.e. Load Sheave, Chain Guides and Idle Sheaves, and replace parts if necessary.

4) Remove all chain components including the Bottom Hook Set Assembly, Stoppers, Cushion Rubbers, Chain Springs, Striker Plates, Chain Pin and End Wire (or End Suspender) from the chain for reuse on new chain. Inspect and replace any damaged or worn parts.

5) Using a C-link, attach the new chain to the end link of the old chain on the no-load side. The end link of the new load chain should be connected so that the welded portions of the load chain's standing links are oriented to the outside as they pass over the sheave. Refer to Figure 6-3.

6) Operate the hoist down to move the chain though the hoist body. Stop when a sufficient amount of new chain is accumulated on the load side.

7) Single fall hoists - Attach the chain components (step 4 above) to the chain. Refer to Section 3.2 for the proper locations.

8) Double falls (030C) - Feed the end link on the load side of the new chain through the required chain components (step 4 above) and the bottom hook's Idle Sheave. Attach the remaining chain components to the chain referring to Section 3.2 for the proper locations. Connect the end link to the top connection yoke with the chain pin, slotted nut and cotter pin. Ensure that chain remains free of twists. Refer to Figures 3-6 and 3-7.

9) **⚠ WARNING** Make sure Stoppers, Cushion Rubbers, Chain Springs and Striker Plates are properly installed. Refer to Section 3.2.

10) After installation has been completed, perform steps outlined in Section 3.6 "Preoperational Checks and Trial Operation".

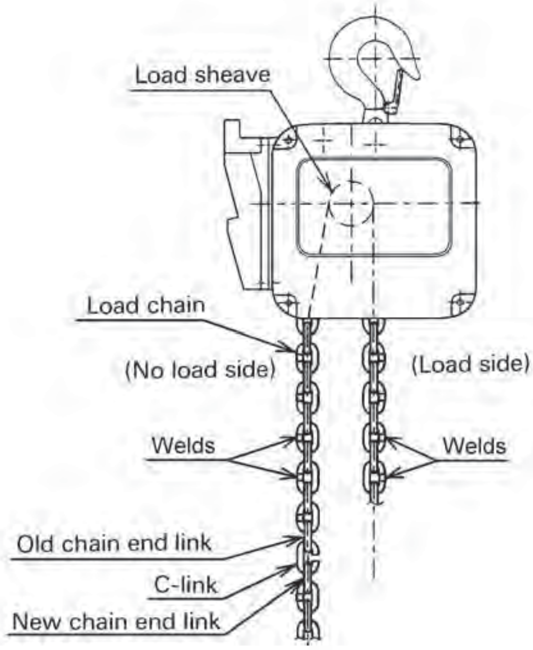


Figure 6-3 Chain Replacement

6.4 Friction Clutch

6.4.1 Friction Clutch – If abnormal operation or slippage occurs DO NOT attempt to disassemble or adjust the Friction Clutch. Replace the worn or malfunctioning Friction Clutch as an assembly with a new, factory adjusted part.

6.5 Storage

6.5.1 The storage location should be clean and dry.

6.6 Outdoor Installation

6.6.1 For hoist installations that are outdoors, the hoist should be covered when not in use.

6.6.2 Possibility of corrosion on components of the hoist increases for installations where salt air and high humidity are present. Make frequent and regular inspections of the unit's condition and operation.

7.0 Troubleshooting

⚠WARNING

HAZARDOUS VOLTAGES ARE PRESENT IN THE HOIST AND IN CONNECTIONS BETWEEN COMPONENTS.

Before performing ANY troubleshooting on the equipment, de-energize the supply of electricity to the equipment, and lock and tag the supply device in the de-energized position. Refer to ANSI Z244.1, "Personnel Protection - Lockout/Tagout of Energy Sources."

Only Trained and competent personnel should inspect and repair this equipment.

Table 7-1 Troubleshooting Guide

Symptom	Cause	Remedy
Hoist moving in wrong direction	Power supply reversed phased	Switch the 2 power supply cord wires at the power source.
	Improper electrical connections	Refer to wiring diagram and check all connections.
Hoist will not operate	Loss of power	Check circuit breakers, switches, fuses and connections on power lines/cable.
	Wrong voltage or frequency	Check voltage and frequency of power supply against the rating on the nameplate of the motor.
	Hoist overload	Reduce load to within rated capacity of hoist.
	Motor overheated and optional thermal overload protector has tripped	See Trouble Shooting Problem "Motor or brake overheating".
	Improper, loose, or broken wire in hoist electrical system	Shut off power supply, check wiring connections on hoist control panel and inside push-button pendant.
	Brake does not release	Check motor brake adjustment for proper clearance.
	Faulty magnetic contactor	Check coil for open or short circuit. Check all connections in the control circuit. Check for open contactors. Replace as needed.
	Defect in control transformer	Check transformer coil for signs of overheating. Disconnect transformer and check for open winding.
	Motor burned out	Replace motor frame/stator, shaft/rotor, and any other damaged parts.

Table 7-1 Troubleshooting Guide		
Symptom	**Cause**	**Remedy**
Hoist will not operate (continued)	Faulty Start Switch	Disconnect Start Switch from motor. The resistance between the Start Switch terminals 2 and 3 should be greater than 500K ohms. If not, consult factory.
	Faulty Start Capacitor(s)	Check capacitor(s) for open or short circuit. Check connections. Replace as needed.
Hoist lifts but will not lower	Down circuit open	Check circuit for loose connections. Check down side of limit switch for malfunction.
	Broken conductor in pendant cord	Check the continuity for each conductor in the cable. If one is broken, replace entire cable.
	Faulty magnetic contactors	Check coils for open or short circuit. Check all connections on motor circuit. Check for burned contacts. Replace as needed.
	Faulty switch in pendant	Check electrical continuity. Check electrical connections. Replace or repair as needed.
Hoist lowers but will not lift	Hoist overloaded	Reduce load to within rated capacity of hoist.
	Low voltage in hoist's power supply	Determine cause of low voltage and bring to within plus or minus 10% of the voltage specified on the motor nameplate. The voltage should be measure at the hoist contactor.
	Up circuit open	Check circuit for loose connections. Check up side of limit switch for malfunction.
	Broken conductor in pendant cord	Check the continuity of each conductor in the cable. If one is broken, replace entire cable.
	Faulty magnetic contactor	Check coils for open or short circuit. Check all connections on motor circuit. Check for burned contacts. Replace as needed.
	Faulty switch in pendant	Check electrical continuity. Check electrical connections. Replace or repair as needed.
	Faulty friction clutch	If abnormal operation or slippage occurs do NOT attempt to disassemble or adjust the Friction Clutch. Replace the worn or malfunctioning Friction Clutch as an assembly with a new, factory adjusted part.
Hoist will not lift rated load or does not have the proper lifting speed	Hoist overloaded	Reduce load to within rated capacity.
	Low voltage in hoist's power supply	Determine cause of low voltage and bring to within plus or minus 10% of voltage specified on the motor nameplate. The voltage should be measured at the hoist contactor.
	Brake drags	Check motor brake adjustment for proper clearance.
	Faulty friction clutch	If abnormal operation or slippage occurs do NOT attempt to disassemble or adjust the Friction Clutch. Replace the worn or malfunctioning Friction Clutch as an assembly with a new, factory adjusted part.
Load drifts excessively when hoist is stopped	Motor brake not holding	Clean and inspect brake lining. Check brake adjustment for proper clearance.

Table 7-1 Troubleshooting Guide

Symptom	Cause	Remedy
Motor or brake overheating	Excessive load	Reduce load to within rated capacity of hoist.
	Excessive duty cycle	Reduce frequency of lifts.
	Wrong voltage or frequency	Check voltage and frequency of power supply against the rating on the nameplate on the motor.
	Brake drags	Check brake adjustment for proper clearance.
	Extreme external heating	Above an ambient temperature of 40°C, the frequency of hoist operation must be reduced to avoid overheating of the motor. Special provisions should be made to ventilate the hoist or otherwise shield it from the heat.
Hoist operates intermittently	Collectors making poor contact	Check movement of spring loaded arm, weak spring, connections, and shoe. Replace as needed.
	Contactor contacts arcing	Check for burned contacts. Replace as needed.
	Loose connection in circuit	Check all wires and terminals for bad connections. Replace as needed.
	Broken conductor in Pendant Cord	Check for intermittent continuity in each conductor the Pendant Cord. Replace entire Pendant Cord if continuity is not constant.

8.0 Parts List

When ordering Parts, please provide the Hoist model number, lot number and serial number located on the Hoist nameplate.

Reminder: Per sections 1.1 and 3.6.4 to aid in ordering Parts and Product Support, record the Hoist model number, lot number and serial number in the space provided on the cover of this manual.

The parts list is arranged into the following sections:

In the column "Parts Per Hoist" a designator is used for parts that apply only to a particular model or option. Refer to Section 2 for hoist model numbers and additional descriptions. The designators are:

U = Upper Limit Switch only (standard)

U/L = Upper/Lower Limit Switch (optional)

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8.1 Housing and Motor Parts

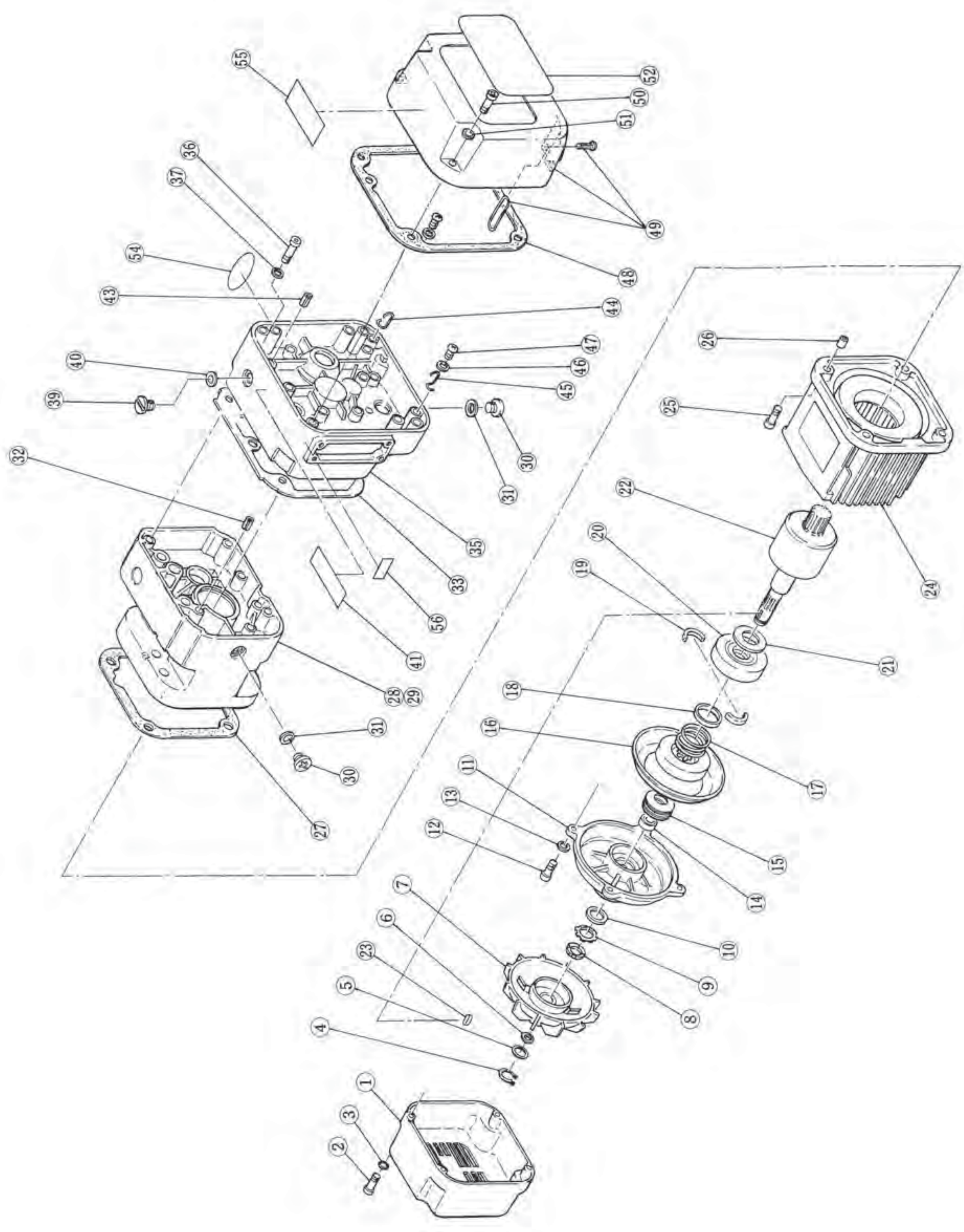

FIGURE 8-1 HOUSING AND MOTOR PARTS

8.1 Housing and Motor Parts

Figure No.	Part Name	Parts Per Hoist	003S	005L	005S	010L	010S	020L	030C
1	Fan Cover	1	ER1BS9107		ER1CS9107		ER1DS9107		
2	Socket Bolt	4	J1BE1-0504022				J1BE1-0604524		
3	Toothed Lock Washer	4	J1WH012-10050				J1WH012-10060		
4	Snap Ring	1	J1SS000-00015				J1SS000-00018		
5	Fan Washer	1	ER1BS9322				ER1DS9322		
6	O Ring	1	J1OP011-00110				J1OP011-00140		
7	Fan	1	ER1BS9108		ER1CS9108		ER1DS9108		
8	Nut	1	ES217005S				ES217010S		
9	Lock Washer	1	ES218005S				ES218010S		
10	Spacer	1	ES216S005				ES216S010		
11	Motor Cover Assembly	1	ER1BS2106		ER1CS2106		ER1DS2106		
12	Socket Bolt	4	J1BE1-0602525		J1BE1-0802525		J1BE1-1003030		
13	Spring Washer	4	J1WS011-20060		J1WS011-20080		J1WS011-20100		
14	Collar M	1	ES192005S				ES192010S		
15	Coned Disc Spring M	4	E3S191005S				ES191010S		
16	Brake Drum Assembly	1	ER1BS5212		EP1CS5212		ER1DS5212		
17	Brake Spring	1	ER1BB9214		EP1CS9214		EP1DS9214		
18	Thrust Collar	1	ES506003		ES506005S		ES506010S		
19	Thrust Disc	2	ES505003				ES505010S		
20	Pull Rotor	1	ES503003				ES503010S		
21	Coned Disc Spring	1	ES504003				ES504010S		
22	Motor Shaft with Rotor	1	EP1BS5502		EP1CS5502		EP1DS5502		
23	Key	1	ER1BS9320				ER1DS9320		
24	Motor Frame with Stator 115/230V-1-60	1	A1CAF03S5A1		A1CAF05S5A1		A1CAF10S5A1		
	Motor Frame with Stator – optional thermal protection 115/230V-1-60		A1CAF03S5TP		A1CAF05S5TP		A1CAF10S5TP		
25	Socket Bolt	4	J1BE1-0603030		J1BE1-0803535		J1BE1-1004040		
26	Set Pin S	2	ES120003		ES120010S		ER1DS9138		
27	Packing M	1	ER1BS9118		ER1CS9118		ER1DS9118		
28	Body A	1	ER1BS9100						
29	Body B	1		ER1BS9101	ER1CS9101		ER1DS9101		
30	Oil Plug	2	E3S111003						
31	Plug Packing	2	E3S112003						
32	Set Pin S	2	ES120003				ES120010S		
33	Packing G	1	ER1BS9116		ER1CS9116		ER1DS9116		
35	Gear Case F	1	ER1BS9103		ER1CS9103		ER1DS9103		
36	Socket Bolt	4	J1BE1-0606524				J1BE1-0809028		

8.1 Housing and Motor Parts

Figure No.	Part Name	Parts Per Hoist	003S	005L	005S	010L	010S	020L	030C
37	Toothed Lock Washer	4	J1WHH012-10060				J1WH012-10080		
39	Oil Plug B	1	ER1BS9135						
40	Eyebolt Packing	1	ES127005S						
41	Name Plate OF	1	ER2CS98471						
43	Spring Pin	1	E3S129005S						
44	Cover Suspender A	1	ER1BS9431						
45	Cover Suspender B	1	ER1BS9432						
46	Washer	2	ER1BS9436						
47	Machine Screw with Lock Washer	2	ES650005S						
48	Packing C	1	ER1BS9117		ER1CS9117		ER1DS9117		
49	Controller Cover Assembly	1	ER1BB2104		ER1CB2104		ER1DB2104		
50	Socket Bolt	4	J1BE1-0504022				J1BE1-0604024		
51	Spring Washer	4	J1WS011-20050				J1WS011-20060		
52	Name Plate B	1	A1CAF03S9A3	A1CAF05L9A3	A1CAF05S9A3	A1CAF10L9A3	A1CAF10S9A3	A1CAF20L9A3	A1CAF30R9A3
54	Name Plate AD	1	ER1BS9868	ER1BL9868	ER1BS9868	ER1BL9868	ER1BS9868	ER1BL9868	ER1DR9868
55	Warning Label E	1	ER2CS99362						
56	Name Plate AE	1	EP1BS9896						

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8.2 Gearing Parts

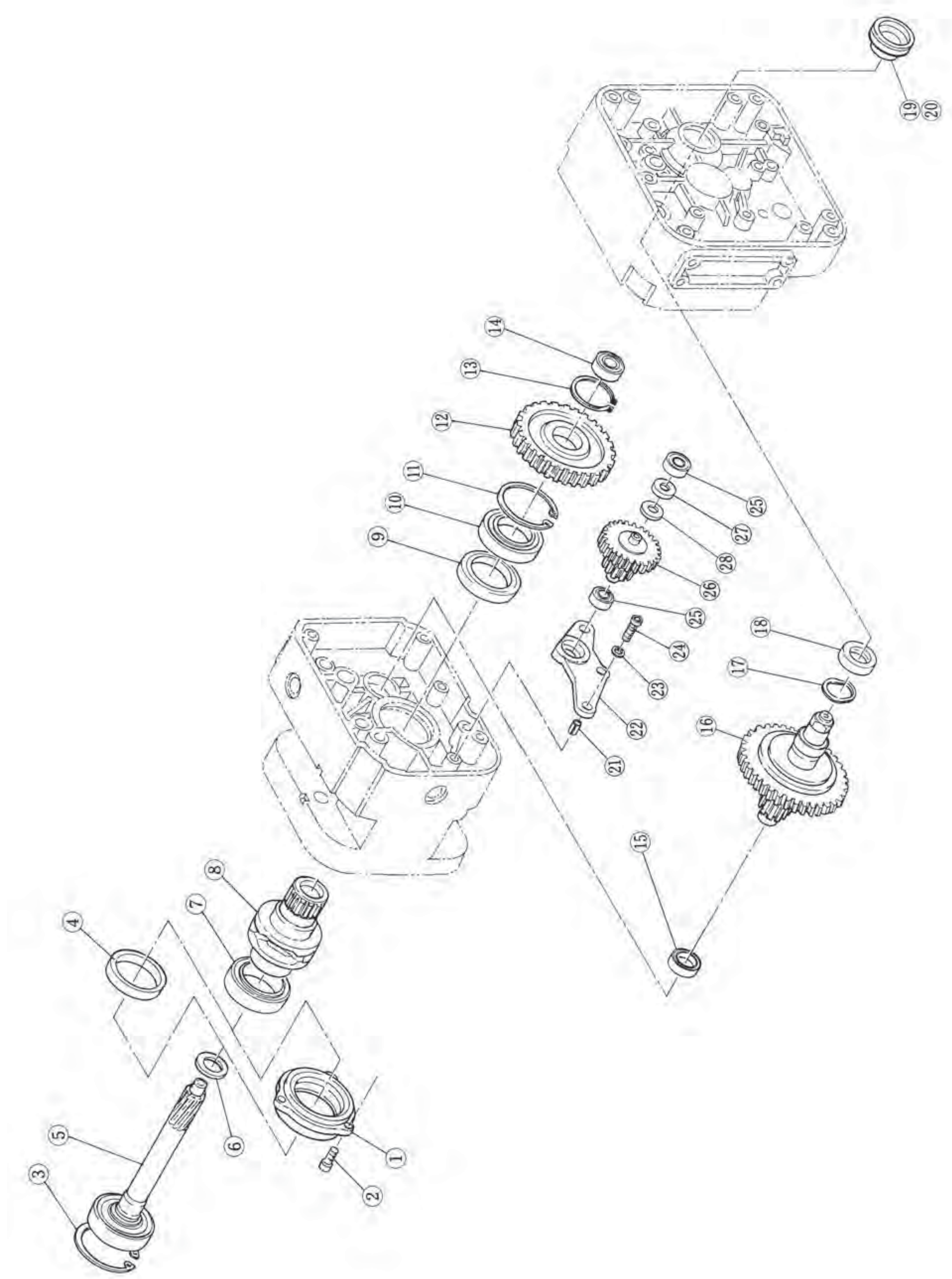

FIGURE 8-2 GEARING PARTS

<table>
<tr><th>Figure No.</th><th>Part Name</th><th>Parts Per Hoist</th><th>003S</th><th>005L</th><th>005S</th><th>010L</th><th>010S</th><th>020L</th><th>030C</th></tr>
<tr><td>1</td><td>Bearing Holder</td><td>1</td><td colspan="2"></td><td colspan="2">ER1CS9110</td><td colspan="3">ER1DS9110</td></tr>
<tr><td>2</td><td>Socket Bolt</td><td>3</td><td colspan="2"></td><td colspan="2">J1BE1-0501818</td><td colspan="3">J1BE1-0602020</td></tr>
<tr><td>3</td><td>Snap Ring</td><td>1</td><td colspan="4">J1SR000-00062</td><td colspan="3">J1SR000-00075</td></tr>
<tr><td>4</td><td>Collar B</td><td>1</td><td colspan="2">ER1BS9111</td><td colspan="5"></td></tr>
<tr><td>5</td><td>Pinion Assembly</td><td>1</td><td colspan="2">ER1BS5220</td><td colspan="2">ER1CS5220</td><td colspan="3">ER1DS5220</td></tr>
<tr><td>6</td><td>Oil Seal</td><td>1</td><td colspan="2">ES221003</td><td colspan="5">ES221010S</td></tr>
<tr><td>7</td><td>Ball Bearing</td><td>1</td><td colspan="2">J1GR020-06007</td><td colspan="2">J1GR020-06009</td><td colspan="3">J1GR020-06209</td></tr>
<tr><td>8</td><td>Load Sheave</td><td>1</td><td>ER1BS9241</td><td>ER1BL9241</td><td>ER1CS9241</td><td>ER1CL9241</td><td>ER1DS9241</td><td colspan="2">ER1DL9241</td></tr>
<tr><td>9</td><td>Oil Seal</td><td>1</td><td colspan="4">ES232005S</td><td colspan="3">ER1DS9244</td></tr>
<tr><td>10</td><td>Ball Bearing</td><td>1</td><td colspan="4">J1GR000-06007</td><td colspan="3">J1GR000-06009</td></tr>
<tr><td>11</td><td>Snap Ring</td><td>1</td><td colspan="4">J1SR000-00062</td><td colspan="3">J1SR000-00075</td></tr>
<tr><td>12</td><td>Load Gear</td><td>1</td><td colspan="2">ER1BL9240</td><td colspan="2">ER1CS9240</td><td colspan="2">ER1DS9240</td><td>ER1DE9240</td></tr>
<tr><td>13</td><td>Snap Ring</td><td>1</td><td colspan="2">J1SS000-00030</td><td colspan="2">J1SS000-00035</td><td colspan="3">J1SS000-00045</td></tr>
<tr><td>14</td><td>Ball Bearing</td><td>1</td><td colspan="2">J1GR000-06201</td><td colspan="2">J1GR000-06301</td><td colspan="3">J1GR000-06303</td></tr>
<tr><td>15</td><td>Ball Bearing</td><td>1</td><td colspan="2">J1GR000-06301</td><td colspan="2">J1GR000-06204</td><td colspan="3">J1GR000-06404</td></tr>
<tr><td>16</td><td>Friction Clutch Set</td><td>1</td><td>ER1BB1223</td><td>ER1BC1223</td><td>ER1CB1223</td><td>ER1CC1223</td><td>ER1DB1223</td><td>ER1DC1223</td><td>ER1DE1223</td></tr>
<tr><td>17</td><td>Wavy Washer</td><td>1</td><td colspan="2">ER1BS9234</td><td colspan="2">ER1CS9234</td><td colspan="3">ER1DS9234</td></tr>
<tr><td>18</td><td>Oil Seal</td><td>1</td><td colspan="2">ES221005S</td><td colspan="2">E6F235003S</td><td colspan="3">ER1DS9233</td></tr>
<tr><td>19</td><td>Friction Plug</td><td>1</td><td colspan="2">ER1BS9235</td><td colspan="2">ER1CS9235</td><td colspan="3">ER1DS9235</td></tr>
<tr><td>20</td><td>Nameplate FP</td><td>1</td><td colspan="7">ER1BS9892</td></tr>
<tr><td>21</td><td>Set Pin S</td><td>2</td><td></td><td colspan="3">ES120003</td><td colspan="3">ES120010S</td></tr>
<tr><td>22</td><td>Gear Plate</td><td>1</td><td></td><td>ER1BC9261</td><td colspan="2">ER1CL9261</td><td colspan="3">ER1DL9261</td></tr>
<tr><td>23</td><td>Spring Washer</td><td>3</td><td></td><td colspan="3">J1WS011-20060</td><td colspan="3">J1WS011-20080</td></tr>
<tr><td>24</td><td>Socket Bolt</td><td>3</td><td></td><td colspan="3">J1BE1-0603030</td><td colspan="3">J1BE1-0803535</td></tr>
<tr><td>25</td><td>Ball Bearing
(Needle Bearing for 005L)</td><td>2</td><td></td><td>ER1BC9265</td><td colspan="2">J1GR000-06000</td><td colspan="3">J1GR000-06201</td></tr>
<tr><td>26</td><td>Gear B Assembly</td><td>1</td><td></td><td>ER1BC5262</td><td>ER1CL5262</td><td>ER1CC5262</td><td>ER1DL5262</td><td colspan="2">ER1DC5262</td></tr>
<tr><td>27</td><td>Thrust Needle Bearing</td><td>1</td><td></td><td>ER1BC9268</td><td colspan="5"></td></tr>
<tr><td>28</td><td>Thrust Plate</td><td>1</td><td></td><td>ER1BC9269</td><td colspan="5"></td></tr>
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8.3 Hook Parts

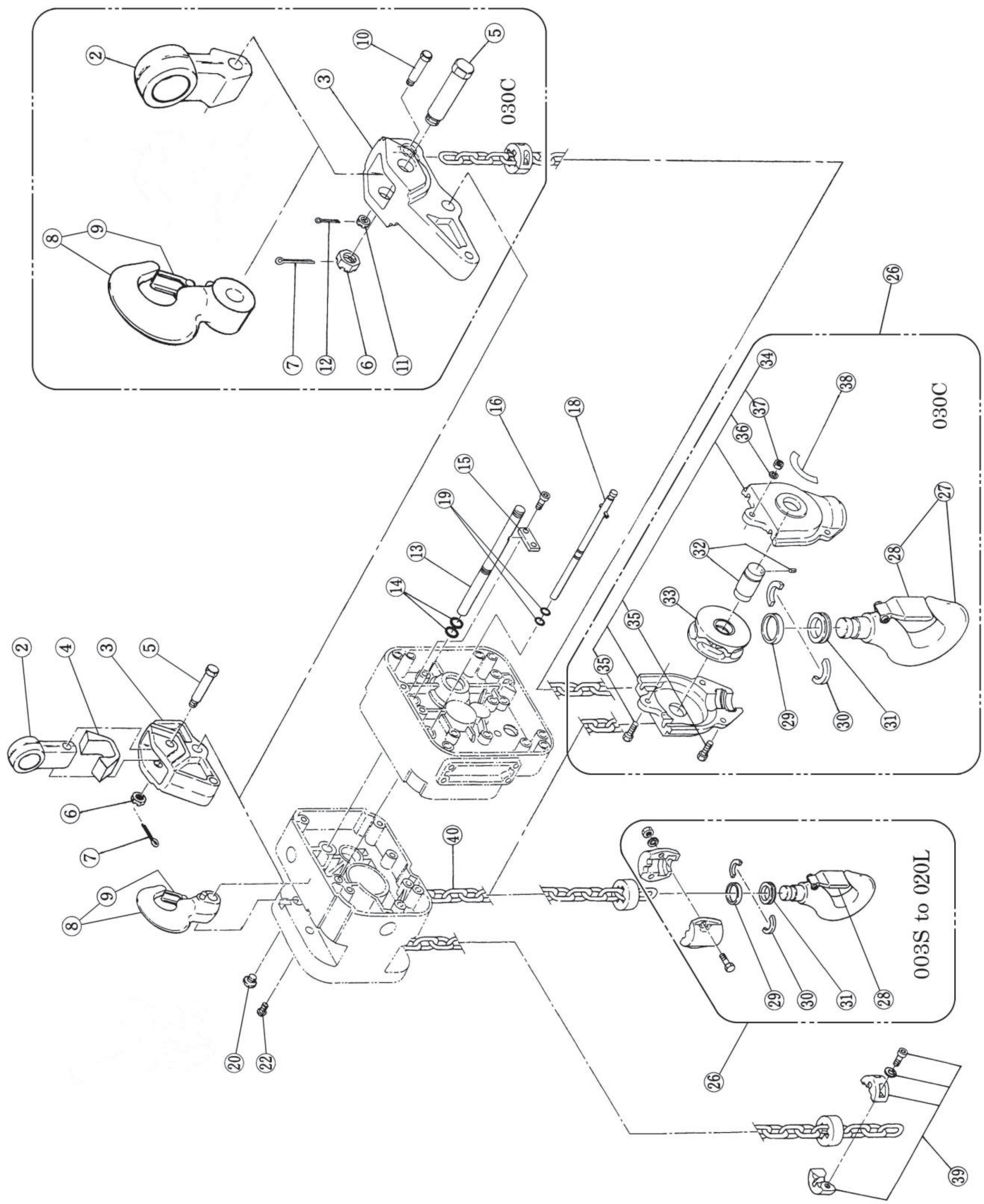

FIGURE 8-3 HOOK PARTS

8.3 Hook Parts

Figure No.	Part Name	Parts Per Hoist	003S	005L	005S	010L	010S	020L	030C
2	Suspender E (for Geared Trolley)	1	T7GB010-90041					T7GB020-90041	T7GB030-90041
	Suspender E (for Push Trolley)	1	T7PB005-90042			T7GB010-90041		T7GB020-90041	T7GB030-90041
3	Connection Yoke	1	ER1BS9029		ER1CS9029		ER1DS9029	ER1DL9029	ER1DR9030
4	Connection Yoke Rubber	1	ER1BS9028					ER1DL9028	
5	Yoke Bolt	1	ER1CS9032					ER1ES9032	
6	Slotted Nut	1	J1NL001-10100					J1NL001-20160	
7	Split Pin	1	J1PW01-025018					J1PW01-040030	
8	Top Hook Assembly	1	ER1BS1001	ER1BL1001	ER1CS1001	ER1CL1001	ER1DS1001	ER1DL1001	ER1DR1001
9	Hook Latch Assembly	1	ER1BS1002			ER1DS1002		ER1ES1002	ER1FS1002
10	Chain Pin	1							ES041030
11	Slotted Nut	1							M2049020
12	Split Pin	1							J1PW01-020016
13	Connection Shaft	1	ER1BS9121		ER1CS9121		ER1DS9121		
14	O Ring	2	J1OP011-00080		J1OP011-0010A		J1OP011-00125		
15	Plate A	1	ER1BS9123				ER1DS9123		
16	Machine Screw with Spring Washer	2	M6F554010						
18	Fixing Shaft Assembly	1	ER1BS1122		ER1CS1122		ER1DS1122		
19	O Ring	2	J1OP011-00070				J1OP011-00090		
20	Shaft Plug	1	ER1BS9128		ER1CS9128		ER1DS9128		
22	Machine Screw	1	J1AK2-6000808						

8.3 Hook Parts

<table>
<tr><th>Figure No.</th><th>Part Name</th><th>Parts Per Hoist</th><th>003S</th><th>005L</th><th>005S</th><th>010L</th><th>010S</th><th>020L</th><th>030C</th></tr>
<tr><td>26</td><td>Bottom Hook Complete Set</td><td>1</td><td>ER1BS1011</td><td colspan="2">ER1CS1011</td><td colspan="2">ER1DS1011</td><td>ER1ES1011</td><td>ER1DR1011</td></tr>
<tr><td>27</td><td>Bottom Hook Assembly</td><td>1</td><td colspan="6"></td><td>ER1FS2011</td></tr>
<tr><td>28</td><td>Hook Latch Assembly</td><td>1</td><td colspan="3">ER1BS1002</td><td colspan="2">ER1DS1002</td><td>ER1ES1002</td><td>ER1FS1002</td></tr>
<tr><td>29</td><td>Thrust Collar A</td><td>1</td><td colspan="3">ES026003</td><td colspan="2">ES026010L</td><td>ES026015</td><td>ES026025</td></tr>
<tr><td>30</td><td>Hook Stopper</td><td>2</td><td colspan="3">ES027003</td><td colspan="2">ES027010L</td><td>ES027015</td><td>ES027025</td></tr>
<tr><td>31</td><td>Thrust Bearing</td><td>1</td><td colspan="3">ES022003</td><td colspan="2">ES022010L</td><td>ES022015</td><td>ES022025</td></tr>
<tr><td>32</td><td>Bottom Shaft Assembly</td><td>1</td><td colspan="6"></td><td>ES5054030</td></tr>
<tr><td>33</td><td>Idle Sheave Assembly</td><td>1</td><td colspan="6"></td><td>ES1051030</td></tr>
<tr><td>38</td><td>Name Plate C</td><td>1</td><td colspan="6"></td><td>M3805-030</td></tr>
<tr><td rowspan="2">39</td><td rowspan="2">Stopper Assembly</td><td>1</td><td colspan="3">ER1CS10411</td><td colspan="2">ER1DS10412</td><td>ER1ES10411</td><td></td></tr>
<tr><td>2</td><td colspan="6"></td><td>ER1ES10411</td></tr>
<tr><td>40</td><td>Load Chain (Nickel Plated)</td><td>1</td><td>KER050</td><td colspan="2">KER063</td><td colspan="2">KER080</td><td colspan="2">KER100</td></tr>
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8.4 Chaining Parts

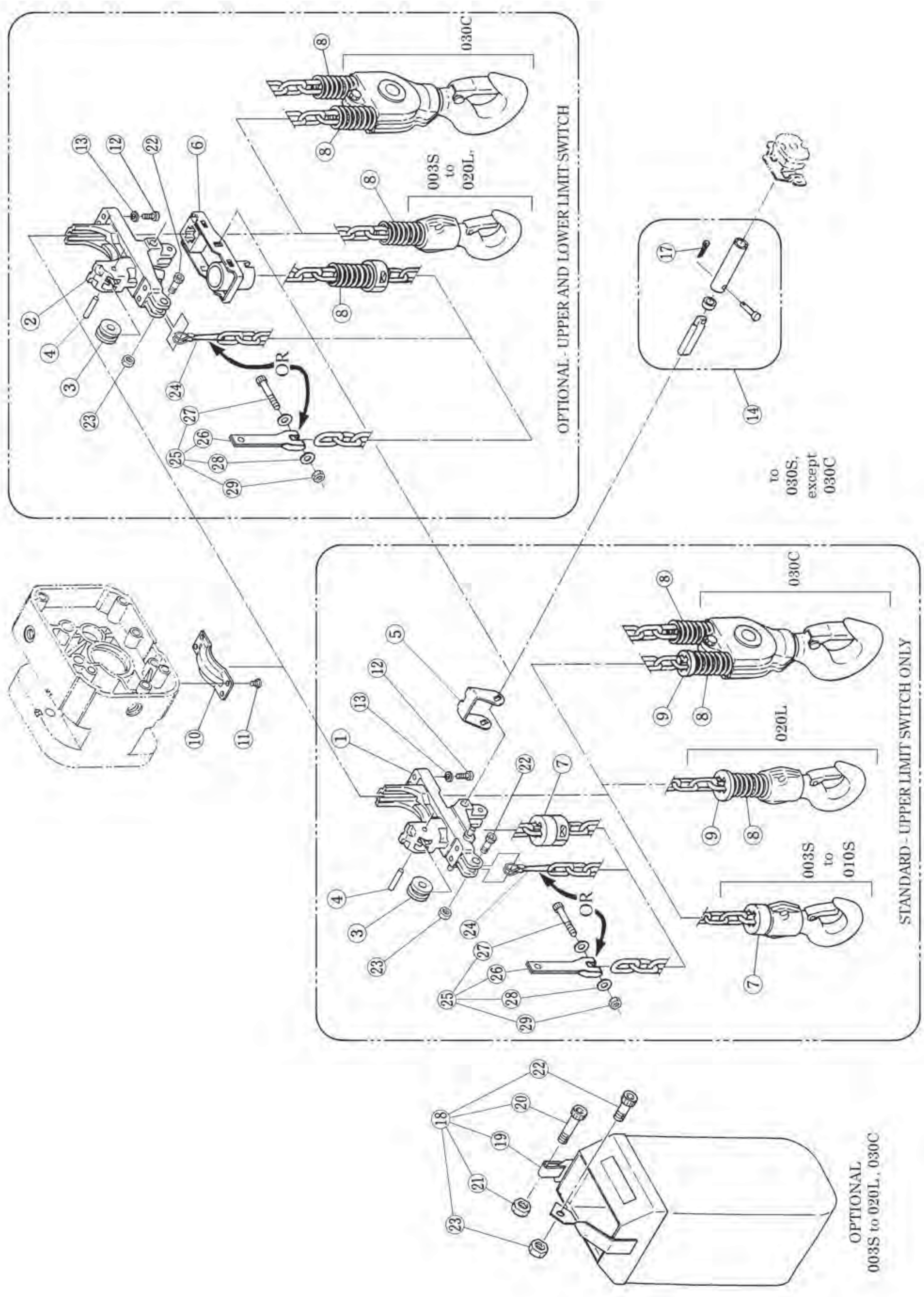

FIGURE 8-4 CHAINING PARTS

8.4 Chaining Parts

<table>
<tr><th>Fig No</th><th>Part Name</th><th colspan="2">Parts Per Hoist</th><th>003S</th><th>005L</th><th>005S</th><th>010L</th><th>010S</th><th>020L</th><th>030C</th></tr>
<tr><td>1</td><td>Chain Guide A</td><td>U</td><td>1</td><td>ER1BS9331</td><td>ER1BL9331</td><td>ER1CS1331</td><td>ER1CL1331</td><td>ER1DS1331</td><td colspan="2">ER1DL1331</td></tr>
<tr><td>2</td><td>Chain Guide AL</td><td>U/L</td><td>1</td><td>ER1BS9330</td><td>ER1BL9330</td><td>ER1CS9330</td><td>ER1CL9330</td><td>ER1DS9330</td><td colspan="2">ER1DL9330</td></tr>
<tr><td>3</td><td>Guide Roller</td><td></td><td>1</td><td colspan="2"></td><td>ES403005S</td><td colspan="2">ER1DS9333</td><td colspan="2">ER1DL9333</td></tr>
<tr><td>4</td><td>Roller Pin</td><td></td><td>1</td><td colspan="2"></td><td colspan="2">ER1CS9334</td><td>ER1DS9334</td><td colspan="2">ER1DL9334</td></tr>
<tr><td>5</td><td>Limit Lever S</td><td>U</td><td>1</td><td colspan="2">ER1BS9337</td><td colspan="2">ER1CS9337</td><td colspan="3">ER1DS9337</td></tr>
<tr><td>6</td><td>Limit Lever Assembly</td><td>U/L</td><td>1</td><td>ER1BS5335</td><td>ER1BL5335</td><td>ER1CS5335</td><td>ER1CL5335</td><td>ER1DS5335</td><td colspan="2">ER1DL5335</td></tr>
<tr><td>7</td><td>Cushion Rubber</td><td>U</td><td>(x)</td><td>ER1BS9053 (2)</td><td colspan="2">ER1CS9053 (2)</td><td colspan="2">ER1DS9053 (2)</td><td colspan="2">ER1ES9053 (1)</td></tr>
<tr><td rowspan="2">8</td><td rowspan="2">Chain Spring</td><td>U</td><td>(x)</td><td colspan="5"></td><td>ES047015 (1)</td><td>ER1DL9051 (2)</td></tr>
<tr><td>U/L</td><td>(x)</td><td>ES047D003 (2)</td><td colspan="2">ES047A005 (2)</td><td colspan="2">ER1DS9051 (2)</td><td>ES047015 (2)</td><td>ER1DL9051 (3)</td></tr>
<tr><td>9</td><td>Limit Lever Striker</td><td>U</td><td>1</td><td colspan="5"></td><td colspan="2">ER1ES9054</td></tr>
<tr><td>10</td><td>Chain Guide B</td><td></td><td>1</td><td>ER1BS9332</td><td>ER1BL9332</td><td>ER1CS9332</td><td>ER1CL9332</td><td>ER1DS9332</td><td colspan="2">ER1DL9332</td></tr>
<tr><td>11</td><td>Mach. Screw w/Spring Washer</td><td></td><td>4</td><td colspan="2"></td><td colspan="5">M6F554010</td></tr>
<tr><td>12</td><td>Socket Bolt</td><td></td><td>4</td><td colspan="2">J1BE1-0603030</td><td colspan="2">J1BE1-0604024</td><td colspan="3">J1BE1-0804528</td></tr>
<tr><td>13</td><td>Spring Washer</td><td></td><td>4</td><td colspan="4">J1WS011-20060</td><td colspan="3">J1WS011-20080</td></tr>
<tr><td>14</td><td>Limit Lever Pin Assembly</td><td></td><td>1</td><td colspan="2">ER1BS1338</td><td colspan="2">ER1CS1338</td><td colspan="3">ER1DS1338</td></tr>
<tr><td>17</td><td>Split Pin</td><td></td><td>1</td><td colspan="7">J1PW01-02008</td></tr>
<tr><td>18</td><td>Chain Container Kit</td><td></td><td>1</td><td colspan="7">BC-D1</td></tr>
<tr><td>20</td><td>Socket Bolt</td><td></td><td>1</td><td colspan="7">ER419001</td></tr>
<tr><td>21</td><td>Lever Nut</td><td></td><td>1</td><td colspan="7">ES855003</td></tr>
<tr><td>22</td><td>Socket Bolt</td><td></td><td>1</td><td colspan="7">ER414001</td></tr>
<tr><td>23</td><td>Lever Nut</td><td></td><td>1</td><td colspan="7">ES857005S</td></tr>
<tr><td>24</td><td>End Wire</td><td></td><td>1</td><td colspan="4">ER1BS9408</td><td colspan="3">ER1DS9408</td></tr>
<tr><td>25</td><td>End Suspender Assembly</td><td></td><td>1</td><td colspan="2">ENDSUSB</td><td colspan="4">ENDSUSCD</td><td>ENDSUSDR</td></tr>
<tr><td>26</td><td>End Suspender</td><td></td><td>1</td><td colspan="6">ER1BS9408R2</td><td>ER1DR9408</td></tr>
<tr><td>27</td><td>Socket Bolt</td><td></td><td>1</td><td colspan="2">J1BE1-0604524</td><td colspan="4">ER414001</td><td>J1BE0803518</td></tr>
<tr><td>28</td><td>Flat Washer</td><td></td><td>2</td><td colspan="2">J1WD01100060</td><td colspan="5"></td></tr>
<tr><td>29</td><td>Lever Nut</td><td></td><td>1</td><td colspan="2">ES855003</td><td colspan="5">ES857005S</td></tr>
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8.5 Electric Parts

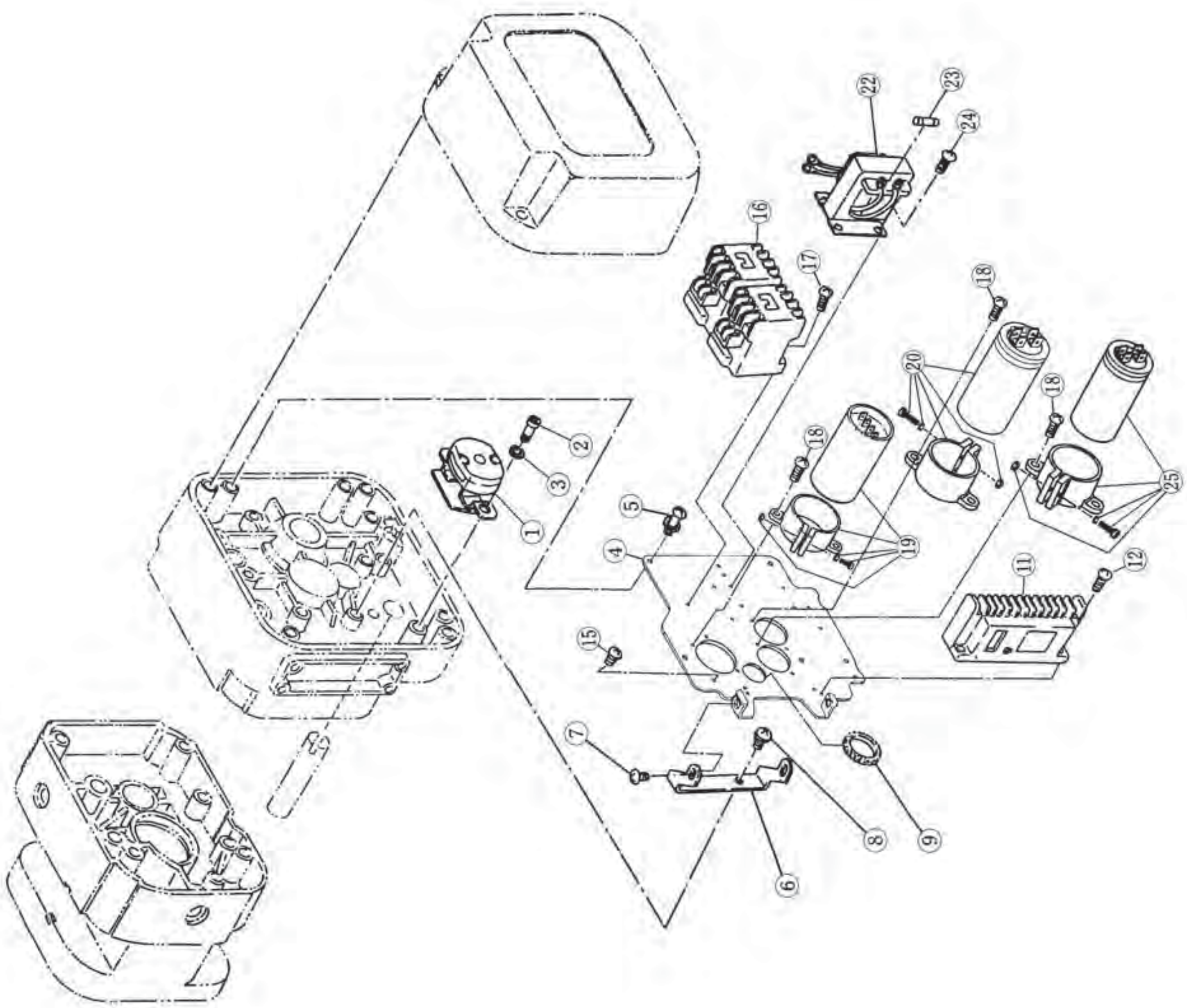

FIGURE 8-5 ELECTRIC PARTS

8.5 Electric Parts

<table>
<tr><th>Fig No</th><th>Part Name</th><th colspan="2">Parts Per Hoist</th><th>003S</th><th>005L</th><th>005S</th><th>010L</th><th>010S</th><th>020L</th><th>030C</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Limit Switch Assembly</td><td>U</td><td>1</td><td colspan="7">ER1BS1551</td></tr>
<tr><td>U/L</td><td>1</td><td colspan="7">ER1BS2551</td></tr>
<tr><td>2</td><td>Socket Bolt</td><td></td><td>3</td><td colspan="7">J1BE1-0601212</td></tr>
<tr><td>3</td><td>Spring Washer</td><td></td><td>3</td><td colspan="7">J1WS011-20060</td></tr>
<tr><td>4</td><td>Plate</td><td></td><td>1</td><td colspan="2">EP1BS9441</td><td colspan="2">EP1CS9441</td><td colspan="3">EP1DS9441</td></tr>
<tr><td>5</td><td>Plate Screw</td><td></td><td>3</td><td colspan="7">ER1BS9445</td></tr>
<tr><td>6</td><td>Hinge</td><td></td><td>1</td><td colspan="2">ER1BS9442</td><td colspan="2">ER1CS9442</td><td colspan="3">ER1DS9442</td></tr>
<tr><td>7</td><td>Hinge Screw</td><td></td><td>2</td><td colspan="7">ER1BS9443</td></tr>
<tr><td>8</td><td>Mach. Screw w/Spring Washer</td><td></td><td>2</td><td colspan="7">E6F151003</td></tr>
<tr><td>9</td><td>Bushing</td><td></td><td>1</td><td colspan="4">ECP99JBAA</td><td colspan="3">ECP99JBAB</td></tr>
<tr><td>11</td><td>Terminal Plate, 14P</td><td></td><td>1</td><td colspan="7">ECP1314AA</td></tr>
<tr><td>12</td><td>Mach. Screw w/Spring Washer</td><td></td><td>2</td><td colspan="7">MS555010</td></tr>
<tr><td>15</td><td>Mach. Screw w/Spring Washer</td><td></td><td>3</td><td colspan="7">MS555010</td></tr>
<tr><td>16</td><td>Electromagnetic Contactor</td><td></td><td>1</td><td colspan="2">MGC23306D</td><td colspan="5">MGC23306B</td></tr>
<tr><td>17</td><td>Mach. Screw w/Spring Washer</td><td></td><td>(x)</td><td colspan="2">MS556010 (2)</td><td colspan="5">MS556010 (4)</td></tr>
<tr><td>18</td><td>Mach. Screw w/Spring Washer</td><td></td><td>(x)</td><td colspan="4">J1AW24001010 (4)</td><td colspan="3">J1AW24001010 (6)</td></tr>
<tr><td>19</td><td>Starter Switch Assembly</td><td></td><td>1</td><td colspan="2">EP1BS2472</td><td colspan="5">EP1CS2472</td></tr>
<tr><td>20</td><td>Capacitor Assembly w/ Resistor</td><td></td><td>1</td><td colspan="2">EP1BS2473</td><td colspan="2">EP1CS2473</td><td colspan="3">EP1BS2473</td></tr>
<tr><td>22</td><td>Transformer
- Primary = 115/230V
- Secondary = 110V</td><td></td><td>1</td><td colspan="7">TRF62F601</td></tr>
<tr><td>23</td><td>Fuse
- Trans. Secondary = 110V</td><td></td><td>1</td><td colspan="7">9006271</td></tr>
<tr><td>24</td><td>Mach. Screw w/Spring Washer</td><td></td><td>4</td><td colspan="7">MS555010</td></tr>
<tr><td>25</td><td>Capacitor Assembly</td><td></td><td>1</td><td colspan="4"></td><td colspan="3">EP1DS5480</td></tr>
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8.6 Power Supply and Pendant Parts

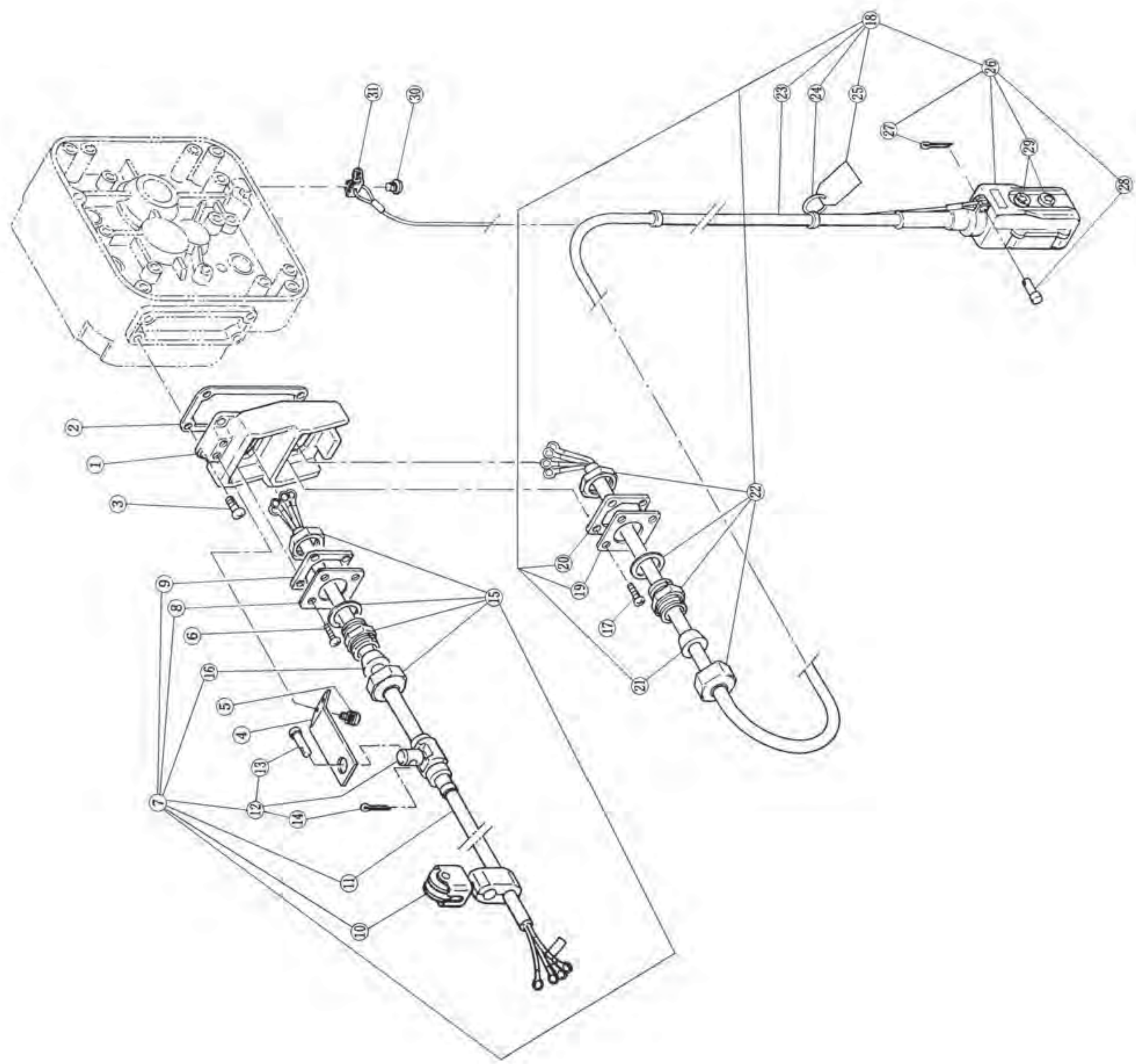


FIGURE 8-6 POWER SUPPLY AND PENDANT PARTS

8.6 Power Supply and Pendant Parts

<table>
<tr><th>Fig No</th><th>Part Name</th><th>Parts Per Hoist</th><th>003S</th><th>005L</th><th>005S</th><th>010L</th><th>010S</th><th>020L</th><th>030C</th></tr>
<tr><td>1</td><td>Socket Holder</td><td>1</td><td colspan="7">ER1BS9513</td></tr>
<tr><td>2</td><td>Socket Holder Packing</td><td>1</td><td colspan="7">ER1BS9512</td></tr>
<tr><td>3</td><td>Machine Screw with Spring Washer</td><td>4</td><td colspan="7">ES656003</td></tr>
<tr><td>4</td><td>Cable Support Arm</td><td>1</td><td colspan="7">ER1BS9541</td></tr>
<tr><td>5</td><td>Machine Screw with Spring Washer</td><td>2</td><td colspan="7">ES650005S</td></tr>
<tr><td>6</td><td>Tapping Machine Screw</td><td>4</td><td colspan="7">ER1BS9517</td></tr>
<tr><td>7</td><td>Power Supply Cable 3C Complete Set</td><td>1</td><td colspan="2">EP1BS1521</td><td colspan="5">EP1CS1521</td></tr>
<tr><td>8</td><td>Holder Plate</td><td>1</td><td colspan="7">ECP5924AI</td></tr>
<tr><td>9</td><td>Plate Packing</td><td>1</td><td colspan="7">ECP5924AJ</td></tr>
<tr><td>10</td><td>Cable Hanger 14 Assembly</td><td>2</td><td colspan="7">ES1527003</td></tr>
<tr><td>11</td><td>Power Supply Cable</td><td>1</td><td colspan="2">Z2CC402</td><td colspan="5">Z1CC403</td></tr>
<tr><td>12</td><td>Cable Support Assembly</td><td>1</td><td colspan="2">E4YS005-2822</td><td colspan="5">M3ES010-1724</td></tr>
<tr><td>13</td><td>Cable Support Pin B</td><td>1</td><td colspan="7">ESES002-9541</td></tr>
<tr><td>14</td><td>Split Pin</td><td>1</td><td colspan="7">J1PW01-016010</td></tr>
<tr><td>15</td><td>Cable Holder A Assembly</td><td>1</td><td colspan="7">M1R1341-010S</td></tr>
<tr><td>16</td><td>Cord Packing</td><td>1</td><td colspan="2">ECP6914AA</td><td colspan="5">ECP6916AA</td></tr>
<tr><td>17</td><td>Tapping Machine Screw</td><td>4</td><td colspan="7">ER1BS9517</td></tr>
<tr><td>18</td><td>Push Button Cord Assembly</td><td>1</td><td colspan="6">EP1BS1557</td><td>EP1DR1557</td></tr>
<tr><td>19</td><td>Holder Plate</td><td>1</td><td colspan="7">ECP5924AI</td></tr>
<tr><td>20</td><td>Plate Packing</td><td>1</td><td colspan="7">ECP5924AJ</td></tr>
<tr><td>21</td><td>Cord Packing</td><td>1</td><td colspan="7">ECP6912AA</td></tr>
<tr><td>22</td><td>Cable Holder A Assembly</td><td>1</td><td colspan="7">M1R1341-010S</td></tr>
<tr><td>23</td><td>Push Button Cord</td><td>1</td><td colspan="7">Z1CK401</td></tr>
<tr><td>24</td><td>Tag Holder</td><td>1</td><td colspan="7">E3S787003</td></tr>
<tr><td>25</td><td>Warning Tag</td><td>1</td><td colspan="7">E2R567-001H</td></tr>
<tr><td>26</td><td>2 Push Button Switch</td><td>1</td><td colspan="7">E1R1561</td></tr>
<tr><td>27</td><td>Split Pin</td><td>1</td><td colspan="7">J1PW01-016010</td></tr>
<tr><td>28</td><td>Cord chain Pin B</td><td>1</td><td colspan="7">ES628003</td></tr>
<tr><td>29</td><td>Arrow Set</td><td>1</td><td colspan="7">ARROWS</td></tr>
<tr><td>30</td><td>Machine Screw with Spring Washer</td><td>1</td><td colspan="7">M6F5541010</td></tr>
<tr><td>31</td><td>Cord Support Wire Stopper</td><td>1</td><td colspan="7">ER1BS95341</td></tr>
</table>

9.0 Warranty

Warranty explanation and terms.

All products sold by Kito Canada Inc. are warranted to be free from defects in material and workmanship from date of purchase for the following periods:

Hoists, Trolleys and Parts: 1 year

ER2 Electric Hoists and MR2 Motorized Trolleys: 3 years

ER2 DC Current Brake: 10 years/ 2,000,000 cycles

The product must be used in accordance with manufacturer's recommendations and must not have been subject to abuse, lack of maintenance, misuse, negligence, or unauthorized repairs or alterations.

Should any defect in material or workmanship occur during the above time period in any product, as determined by Kito Canada's inspection of the product, Kito agrees, at its discretion, either to replace (not including installation) or repair the part or product free of charge and deliver said item F.O.B. Kito Canada Inc. place of business to customer.

Customer must obtain a Return Goods Authorization (RGA) as directed by Kito Canada Inc. prior to shipping product for warranty evaluation. An explanation of the complaint must accompany the product. Product must be returned freight prepaid. Upon repair, the product will be covered for the remainder of the original warranty period. If it is determined there is no defect, or that the defect resulted from causes not within the scope of Kito's warranty, the customer will be responsible for the costs of returning the product.

Kito Canada Inc. disclaims any and all other warranties of any kind expressed or implied as to the product's merchantability or fitness for a particular application. Kito will not be liable for death, injuries to persons or property or for incidental, contingent, special or consequential damages, loss or expense arising in connection with the use or inability whatever, regardless of whether damage, loss or expense results from any act or failure to act by Kito, whether negligent or willful, or from any other reason.

WEBSITE: www.kito.ca

E-MAIL: info@kito.ca

TOLL FREE: 1-888-322-KITO (5486)

Kito Canada Inc. West
309 – 3815 1st Ave
Burnaby, BC, V5C 3V6
Phone: 604-291-9955
Fax: 604-294-8855

Kito Canada Inc. East
36 – 2400 Lucknow Drive
Mississauga, ON, L5S 1T9
Phone: 905-405-0905
Fax: 905-405-0906

APPENDIX X

Available Maintenance Contractors

Appendix X
Available Maintenance Contractors

RTL Robinsons Enterprises Ltd.

PO Box 1807, 350 Old Airport Road
Yellowknife, NT, X1A 2P4
T: 867-873-6271

Camco Construction Ltd.

4 Nuttall Court
Yellowknife, NT, X1A 3M3
T: 867-873-8522

APPENDIX XI

Inspection Forms

Dam Safety Inspection Notes - Bluefish

Outside temperature…………………………..Name of the Operator:…………………………..
Inspection Date: ……………………………Fore bay water level:………………

1. **DAM CREST**
   1.1 Depression / settlement visible Yes ( ) / No ( )
   If yes Size (depth, width, length) …………………………………………………
   1.2 Sinkhole visible Yes ( ) / No ( )
   If yes Size (depth, width, length) ……………………………………………………
   1.3 Longitudinal cracks visible Yes ( ) / No ( )
   If yes Size (depth, width, length)……………………………………………………
   1.4 Cracks perpendicular to dam axis Yes ( ) / No ( )
   If yes Size (width, length)………………………………………………………
   1.5 Animal burrows visible Yes ( ) / No ( )
   If yes size (width, depth, length)……………………………………………………
   1.6 Excessive Vegetation Yes ( ) / No ( )
   If yes; trees taller than 3m Yes ( ) / No ( )

2. **UPSTREAM SLOPE**
   2.1 Depression on the rip rap visible Yes ( ) / No ( )
   If yes Size (depth, width, length) …………………………………….. …………
   2.2 Sinkhole visible Yes ( ) / No ( )
   If yes Size (depth, width, length) …………………………………………………
   2.3 Longitudinal cracks visible Yes ( ) / No ( )
   If yes Size (depth, width, length)……………………………………………………
   2.4 Cracks perpendicular to dam axis Yes ( ) / No ( )
   If yes Size (width, length)……………………………………………………….
   2.5 Animal burrows visible Yes ( ) / No ( )
   If yes size (width, depth, length)……………………………………………………
   2.6 Excessive Vegetation Yes ( ) / No ( )
   If yes; trees taller than 3m Yes ( ) / No ( )

3. **DOWNSTREAM SLOPE**
   3.1 Depression visible Yes ( ) / No ( )
   If yes Size (depth, width, length) ………………………………………………….
   3.2 Sinkhole visible Yes ( ) / No ( )
   If yes Size (depth, width, length) ……………………………………………………
   3.3 Longitudinal cracks visible Yes ( ) / No ( )
   If yes Size (depth, width, length)……………………………………………………
   3.4 Cracks perpendicular to dam axis Yes ( ) / No ( )
   If yes Size (width, length)………………………………………………………
   3.5 Animal burrows visible Yes ( ) / No ( )
   If yes size (width, depth, length)……………………………………………………
   3.6 Any bulging visible Yes ( ) / No ( )
   If yes size (width, depth, length)……………………………………………………
   3.7 Excessive Vegetation Yes ( ) / No ( )
   If yes; trees taller than 3m Yes ( ) / No ( )

4. DOWNSTREAM TOE

4.1 From the toe width of the strip free of vegetation (0 m / 1 m /2 m /3 m /…..m)
4.2 Visible seepage Yes ( ) / No ( )
If yes roughly flow rate ………l/s Turbidity (clear / dirty)
4.3 Seepage water exiting as a sand or water boil Yes ( ) / No ( )
4.4 Material erosion visible Yes ( ) / No ( )

5. ABETMENT Right Bank

5.1 Any seepages visible Yes ( ) / No ( )
If yes flow rate roughly (liters /minute)……………………………………….
Turbidity of seepage water Clear ( ) dirty ( )
5.2 Sinkhole visible Yes ( ) / No ( )
If yes Size (depth, width, length) …………………………………………………
5.3 Animal burrows visible Yes ( ) / No ( )
If yes size (width, depth, length)……………………………………………………
5.4 Any bulging visible Yes ( ) / No ( )
If yes size (width, depth, length)……………………………………………………
5.5 Excessive Vegetation Yes ( ) / No ( )
If yes; trees taller than 3m Yes ( ) / No ( )

6. ABETMENT Left Bank

6.1 Any seepages visible Yes ( ) / No ( )
If yes flow rate roughly (liters /minute)……………………………………….
Turbidity of seepage water Clear ( ) dirty ( )
6.2 Sinkhole visible Yes ( ) / No ( )
If yes Size (depth, width, length) …………………………………………………
6.3 Animal burrows visible Yes ( ) / No ( )
If yes size (width, depth, length)……………………………………………………
6.4 Any bulging visible Yes ( ) / No ( )
If yes size (width, depth, length)……………………………………………………
6.5 Excessive Vegetation Yes ( ) / No ( )
If yes; trees taller than 3m Yes ( ) / No ( )

7. SEEPAGE READING (If weir is existing)

7.1 Approximate flow rate ………………………litters/ minute
7.2 Turbidity of water (clear / dirty)
7.3 Weir reading (if available)………………………

Signature of the operator ……………………………………

*** *If you need any clarification please contact* ***Gamini***, *(Senior Hydro Engineer)*
Email ghettiarachchige@ntpc.com
Tel 867 669 3312

Reviewed: Sep 18, 2014

Piezometer Monitoring Sheet

Location: Bluefish Dam

Date (YY/MM/DD) / / / Time:

Reservoir pond level:

Weather:

Air temperature:

Operator:

Piezometer No.	Depth to water level from top of PVC pipe (m)	Depth to bottom of PVC pipe from top of PVC pipe (m)	Comments
SPO1 - 25mm			
SPO1 - 50mm			
SPO2 - 25mm			
SPO2 - 50mm			
SPO3 - 25mm			
SPO3 - 50mm			
SPO4 - 25mm			
SPO4 - 50mm			
SPO5 - 25mm			
SPO5 -50mm			
SPO6 - 25mm			
SPO6 - 50mm			
SPO7 - 25mm			
SPO7 - 50mm			
SPO8 - 25mm			
SPO8 - 50mm			
SPO9 - 25mm			
SPO9 - 50mm			
SPO10 - 25mm			
SPO10 - 50mm			

If the instrument hits the bottom of the PVC pipe before sensing water level (the beep), please mark (X) in comments column.

Readings taken by ……………………………………. Signature ……………………………

Ground-Temperature Cable / Thermistor Monitoring Sheet

Location: Bluefish Dam

Reservoir level (m):
Date (YY/MM/DD):
Name of Operator:

Weather:
Air Temperature (°C):
Signature:

GTC 1	Temp Reading (C^0)	Remarks
1		
2		
3		
4		
5		
6		
7		

GTC 2	Temp Reading (C^0)	Remarks
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

GTC 3	Temp Reading (C^0)	Remarks
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

GTC 4	Temp Reading (C^0)	Remarks
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

GTC 5	Temp Reading (C^0)	Remarks
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

GTC 6	Temp Reading (C^0)	Remarks
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Note: If no reading please mark "X"

APPENDIX XII

RST Water-Level Meter Manual

innovation in
geotechnical
instrumentation

RST INSTRUMENTS LTD.
11545 Kingston St.,
Maple Ridge, BC
CANADA V2X 0Z5

SALES + SERVICE + MANUFACTURING:
604 540 1100 | info@rstinstruments.com
TOLL FREE (USA & Canada) | 1-800-665-5599

www.rstinstruments.com

Using the Water Level Meter

Turning the unit on:

Press the button briefly. The LED will flash and the horn may operate briefly depending on mode. The system will power down after 5 minutes.

Measuring depth to water:

With the unit on, lower the probe toward the water. When the water is reached, the LED will turn on, and the horn may operate depending on function.

Battery status:

When the unit is turned on, the LED will flash 3 times to indicate good battery status. A single flash indicates that the battery is getting low.

Changing the horn function:

The horn can be loud, very loud, or silent. To enter or leave silent mode on the horn, press the button briefly. To enter or leave very loud mode, press the button twice in rapid succession.

Changing to high sensitivity mode:

If the water being measured is ultra-pure, the normal setting may not detect the water surface. To enter high sensitivity mode, press and hold the button for 5 seconds. The LED will flash briefly. To exit high sensitivity mode, remove the battery briefly and press and hold the button while re-inserting the battery.

rst INSTRUMENTS
innovation in geotechnical instrumentation

TEL 604 540 1100
info@rstinstruments.com
www.rstinstruments.com

RST Instruments Ltd.
11545 Kingston St.,
Maple Ridge, BC V2X 0Z5 Canada

Certified System ISO 9001

PRODUCT CATEGORY:
ENVIRONMENTAL

Water Level Meters

RST Water Level Meters are used for convenient and accurate measurement of elevation of groundwater in boreholes, standpipes, and wells. They employ a high accuracy, NIST traceable, non-stretch, flat tape, permanently marked in 1 mm or 1/100 ft. graduations.

The RST Water Level Meter is supplied on a sturdy winding reel complete with a brake and carrying handle. Features include a shrouded stainless steel probe (allows accurate level determinations under cascading water conditions), a graduated LED light scale corresponding to high and low, a buzzer, and sensitivity control as standard. An optional tape guide/datum acts as a reference point and also prevents tape abrasion from the casing edge. The moisture resistant electronics and standard 9V battery are housed in the front for quick and easy access.

> APPLICATIONS

Measuring the elevation of groundwater in standpipes, boreholes, and wells.

> FEATURES

An ultra-wide conductivity range allows for use in different liquids ranging from pure water to neat cement grout.	
Programmable, multi-functional button acts as the control interface.	
Frontal battery (standard 9 V) compartment needs no tools for removal/battery replacement.	
Auto buzzer and battery level check at start up.	
Rugged design for the most adverse conditions.	
Resolution 1 mm or 1/100 ft.	Sensitivity adjustment.
Auto OFF	Thermistor option also available.
NIST traceable, non-stretch steel tape, Tefzel® or polyethylene coated.	
7 strand, 24 gauge stainless steel conductors.	
13 mm / 0.5 in. O.D. stainless steel probe. (16 mm / 0.625 in. O.D. on dual scale tapes).	
Graduated LED light scale corresponding to high and low.	
Sensing point at bottom of probe causes negligible water displacement ensuring high accuracy readings.	
Available with either a polyethylene or Tefzel® coating for corrosive fluids.	
Tape markings will not fade or wear away.	

> BENEFITS

✓ **High Reliability**	✓ **High Accuracy**
✓ **Custom Options**	✓ **Upgradable**

Available for **CUSTOMIZATION** Info on reverse.

Available for **IMMEDIATE DELIVERY** Info on reverse.

Water Level Meter reels come in various sizes to accommodate different tape lengths - see ordering on back.

Tefzel® is a registered trademark of E.I. duPont de Nemours and Company or its affiliates.
RST Instruments Ltd. reserves the right to change specifications without notice. WLB0002I

rst INSTRUMENTS
innovation in geotechnical instrumentation

TEL 604 540 1100
info@rstinstruments.com
www.rstinstruments.com

RST Instruments Ltd.
11545 Kingston St.,
Maple Ridge, BC V2X 0Z5 Canada

Certified System ISO 9001

Water Level Meters

PRODUCT CATEGORY:
ENVIRONMENTAL

SPECIFICATIONS + ORDERING

SPECIFICATIONS

TAPE LENGTH *CONTACT RST FOR ADDITIONAL LENGTHS*	PART #	
	POLY TAPE	TEFZEL® TAPE
15 m	WL1015	WL3015
30 m	WL1030	WL3030
50 m	WL1050	WL3050
75 m	WL1075	WL3075
100 m	WL1100	WL3100
150 m*	WL1150	WL3150
200 m*	WL1200	WL3200
250 m*	WL1250	N/A
300 m**	WL1300	WL3300
400 m***	WL1400	N/A
500 m***	WL1500	N/A
600 m***	WL1600	N/A
50 ft	WL2005	WL4005
60 ft	WL2060	N/A
100 ft	WL2010	WL4010
150 ft	WL2015	WL4015
200 ft	WL2020	WL4020
250 ft	WL2025	N/A
300 ft	WL2030	N/A
400 ft*	WL2040	WL4040
500 ft*	WL2050	WL4050
600 ft*	WL2060	N/A
750 ft*	WL2075	N/A
1000 ft**	WL2100	WL4100
1200 ft***	WL2120	N/A
1500 ft***	WL2150	N/A
Alternate tape lengths available upon request.		
* Mounted on a medium sized reel.		
** Mounted on a large sized reel.		
*** Mounted on an extra large sized reel.		

ORDERING INFO

Part number / tape length.
Temperature option, if required.
Accessories required.

Available for IMMEDIATE DELIVERY
Contact RST for Details

Available for CUSTOM OPTIONS
Contact RST for Details

ACCESSORIES

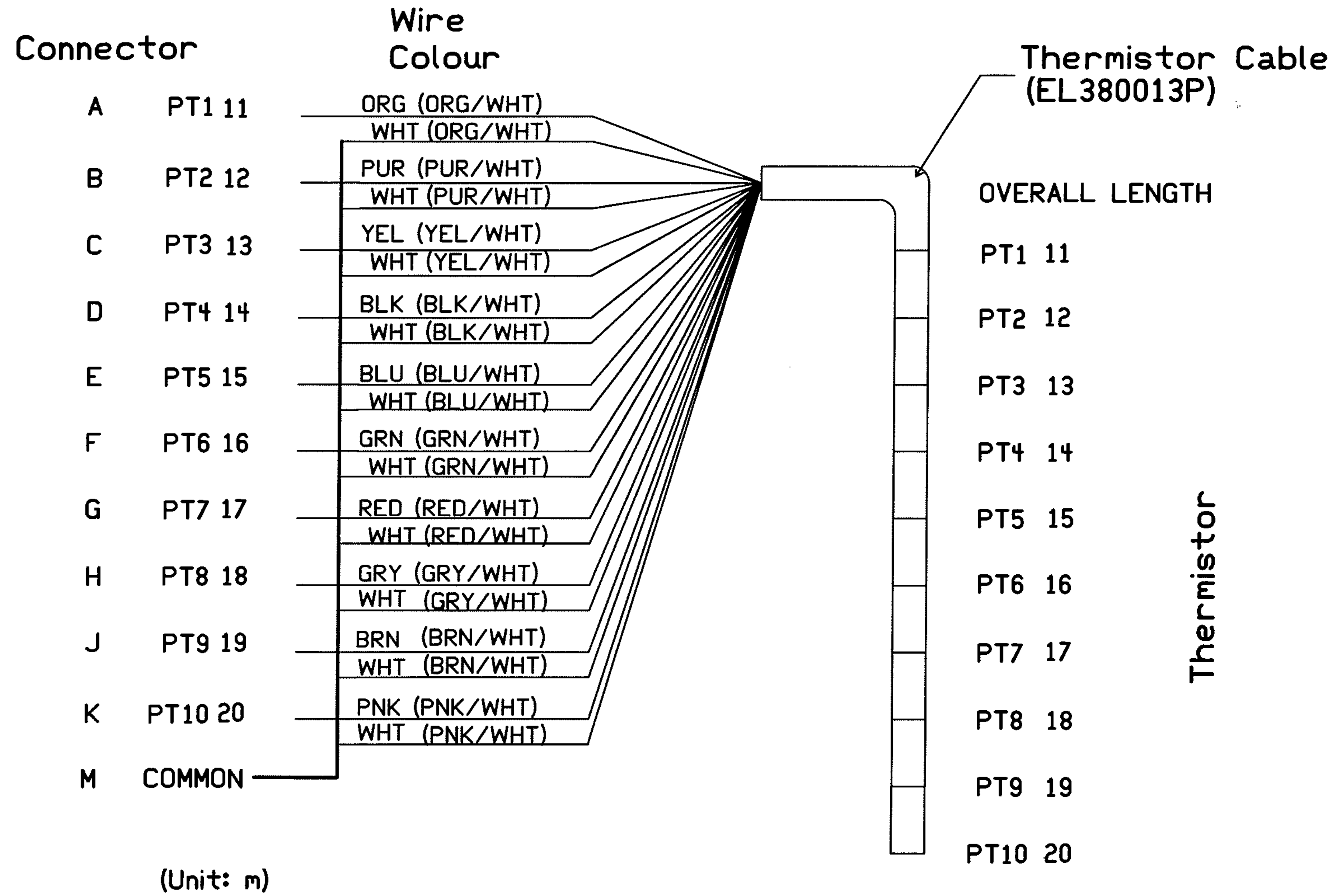
ITEM	PART #
Aluminum carrying/shipping cases: - up to 100 m / 300 ft - 150-250 m / 400-750 ft - 300 m / 1000 ft and larger	 WL6505 WL6504 IC3031C
Soft vinyl carrying cases: - up to 250 m / 750 ft - 300 m / 1000 ft	 WL6506 IC6508
Tape guide/datum	WL6500
Electronic module replacement	WL6541
Power reel.	WL1500P
Replacement tapes with probe	Contact RST for more information
Digital temperature readout.	

Water Level Meter shown on optional Power Reel with carrying/shipping case. Contact RST for more details.

Optional for permanent installation: A Water Level Probe with electronics and battery housed in a waterproof box. Contact RST for more details.

APPENDIX XIII

Ground Temperature Cable Wiring and Calibration Sheets



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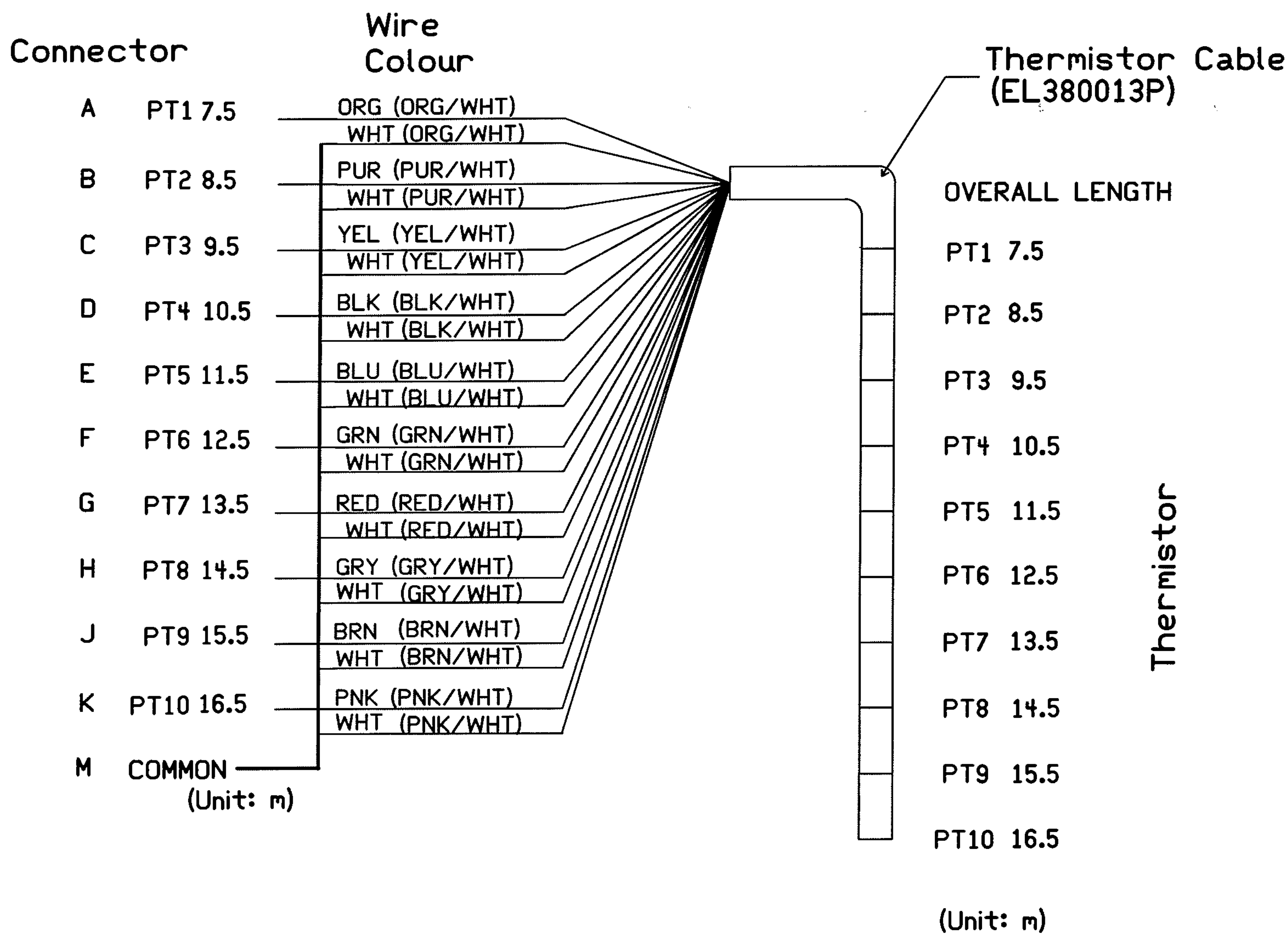

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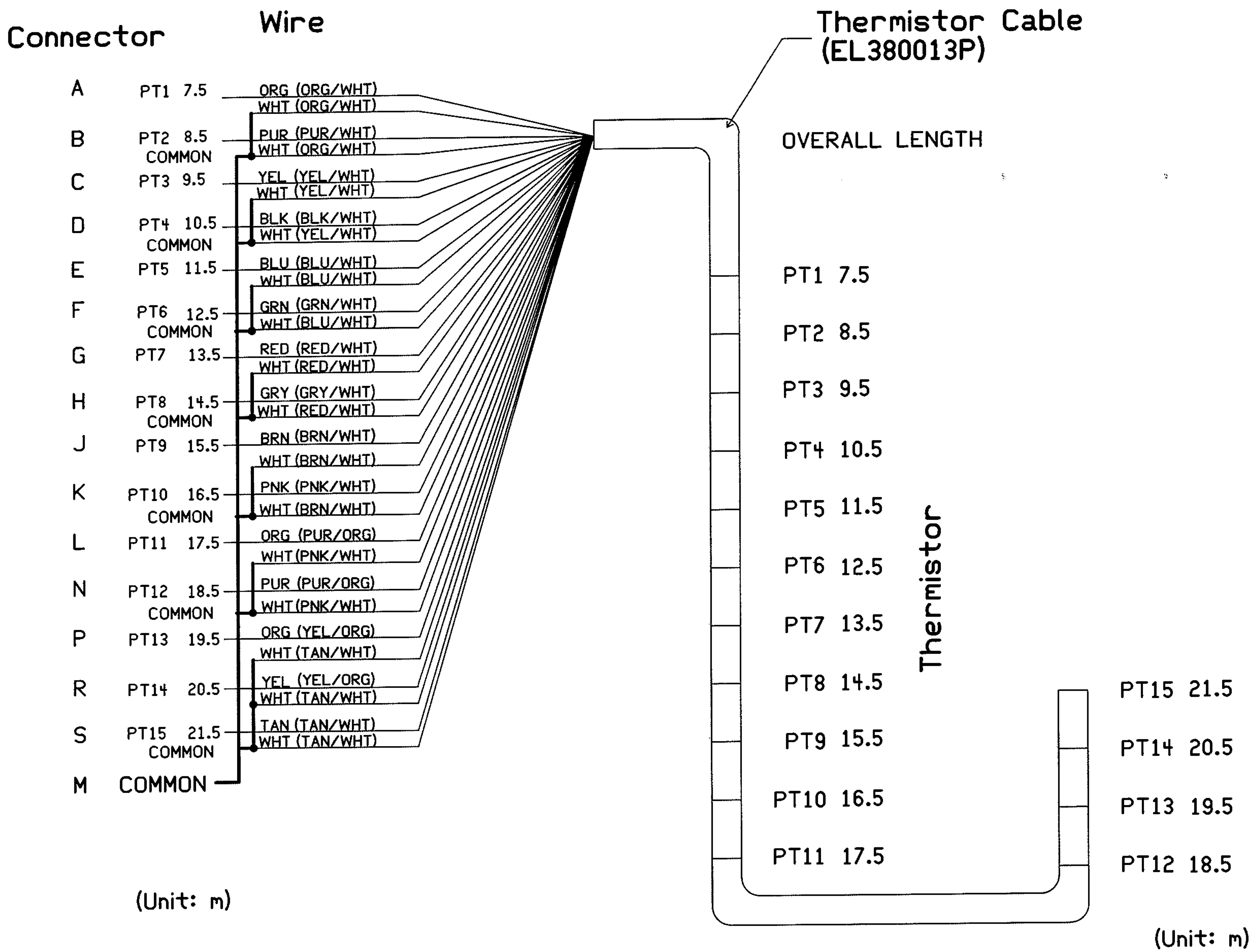

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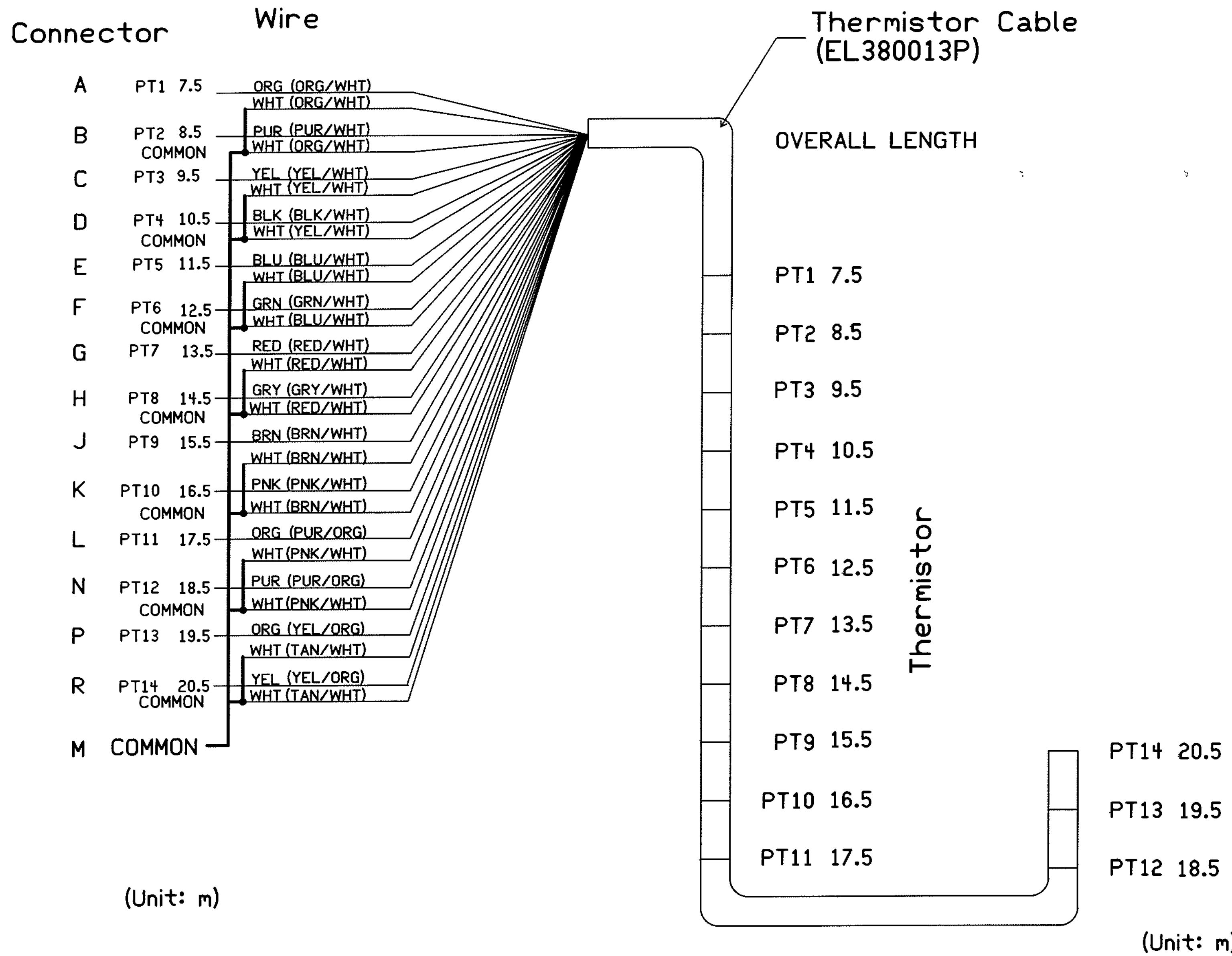
TS3417



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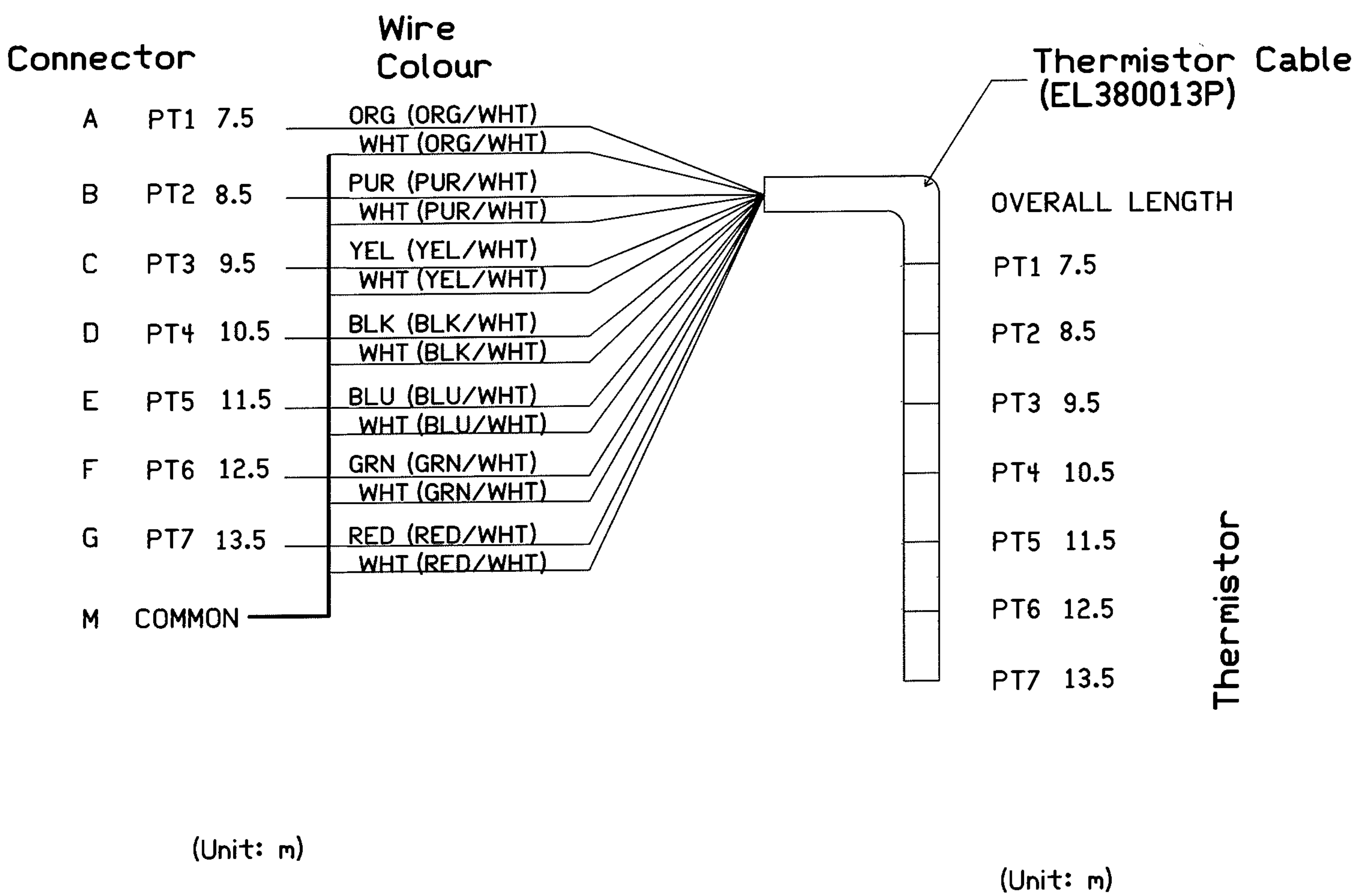
Author:	WY Size: A
Date:	2012/10/26 Sheet 3 of 5

TS3418 - TS3419



S/N: TS3420

Co:	RST INSTRUMENTS LTD		
Title:	THERMISTOR CABLE		
J/N:	THW0123/WOQ024782	Revision:	A
Author:	WY	Size:	A
Date:	2012/10/26	Sheet	5 of 5

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Tel: 604 540 1100 • Fax: 604 540 1005 • Toll Free: 1 800 665 5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

Thermistor Strings

Customer:	McCAW NORTH DRILLING & BLASTING	Number of Points:	10
Work Order:	Q024782	Length:	20 m
Thermistor Type:	3 kΩ		

This is to certify that Thermistor String S/N: TS3415 meets the RST Instruments specifications for the product.

Technician: Joshua Chung Date: 7 Nov 12

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Thermistor Strings

Customer:	McCAW NORTH DRILLING & BLASTING	Number of Points:	10
Work Order:	Q024782	Length:	16.5 m
Thermistor Type:	3 kΩ		

This is to certify that Thermistor String S/N: TS3416 meets the RST Instruments specifications for the product.

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Thermistor Strings

Customer:	McCAW NORTH DRILLING & BLASTING	Number of Points:	15
Work Order:	Q024782	Length:	21.5 m
Thermistor Type:	3 kΩ		

This is to certify that Thermistor String S/N: TS3417 meets the RST Instruments specifications for the product.

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Thermistor Strings

Customer:	McCAW NORTH DRILLING & BLASTING	Number of Points:	14
Work Order:	Q024782	Length:	20.5 m
Thermistor Type:	3 kΩ		

This is to certify that Thermistor String S/N: TS3418 meets the RST Instruments specifications for the product.

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Thermistor Strings

Customer:	McCAW NORTH DRILLING & BLASTING	Number of Points:	14
Work Order:	Q024782	Length:	20.5 m
Thermistor Type:	3 kΩ		

This is to certify that Thermistor String S/N: TS3419 meets the RST Instruments specifications for the product.

Technician: Joshua Chung CL Date: 7 Nov 12

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Thermistor Strings

Customer:	McCAW NORTH DRILLING & BLASTING	Number of Points:	7
Work Order:	Q024782	Length:	13.5 m
Thermistor Type:	3 kΩ		

This is to certify that Thermistor String S/N: TS3420 meets the RST Instruments specifications for the product.

Technician: Joshua Chung ____________ Date: 7 Nov 12

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APPENDIX XIV

RST Ground Temperature Cable Readout Box Manual

RST INSTRUMENTS LTD.

TH2016B
Thermistor Readout

Instruction Manual

RST Instruments Ltd.
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Maple Ridge, BC Canada V2X 0Z5
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TH2016B Thermistor Readout Instruction Manual

Product:	TH2016B Thermistor Readout Instruction Manual Installation Manual
Document number:	ELM0064A TH2016B Thermistor Readout Instruction Manual.doc
Revision:	A
Date:	March 19, 2013

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1 OVERVIEW

The RST TH2016B Thermistor Readout represents the next generation in thermistor readout devices. It's lightweight, yet extremely rugged design is perfectly suited for harsh environmental conditions often encountered in the field. Furthermore the TH2016B is extremely easy to use with a USB interface for downloading data. The readout uses 3 standard AA alkaline batteries which are field replaceable, negating the need to return the readout to the factory for battery replacement. The use of standard AA batteries eliminates the need for a charger.

Figure 1 – TH2016B Readout

1. USB Connector
2. Large Character LCD display
3. Backlight
4. ESC (navigates back a menu)
5. Scroll Up
6. Scroll Down
7. Enter
8. Terminal Strip (for single sensor connection)
9. Expansion Port (16 sensor connection)

2 QUICK START INSTRUCTIONS

The instructions for performing a manual reading on a Thermistor (i.e. not storing to memory) are simple and straightforward:

1. Connect the Thermistor to the terminal block (Figure 1)
2. Turn display on (press any key)
3. Wait a few moments for unit to startup
4. Record the displayed reading.

Note
Step 4 (above) is assuming the Monitor Settings are set to *default*. The TH2016B has the ability to custom configure the readout settings so Celsius or Fahrenheit units can be displayed, as well as sensor resistance.

3 POWERING ON/OFF

The TH2016B readout can be powered on anytime by pressing any key. The unit can be powered off manually or automatically. To power off manually, use the up/down arrows to scroll to the following screen:

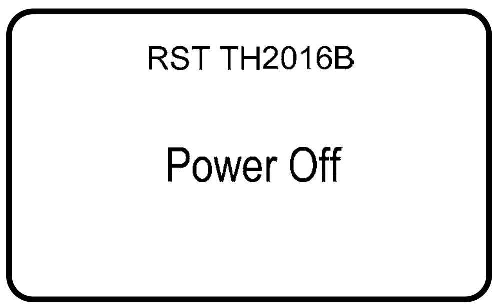

Figure 2 – Manual Power Off

- Press *Enter* and the unit will turn off.
- To adjust the automatic power off settings, navigate to the *Auto Off* screen as shown below:

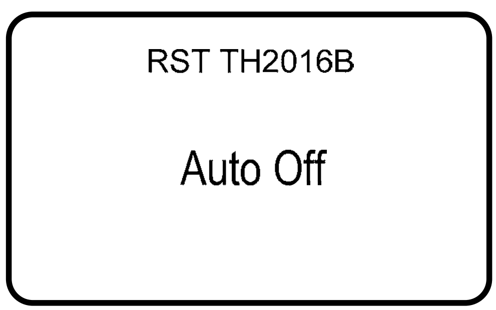

Figure 3 – Auto Off Screen

- Press *Enter* and the following screen will appear:

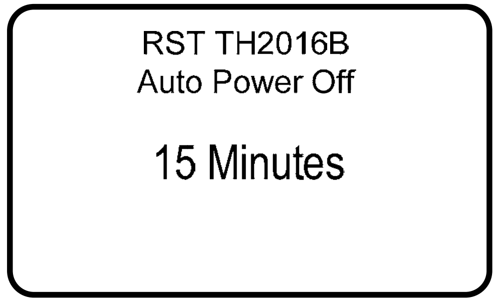

Figure 4 – Auto Power Off Time

Use the arrow keys to scroll to the desired auto power off time. Please note that the auto power off feature is always active and cannot be disabled. This is to conserve battery life. The default is 5 minutes. The next screen prompts to set the Auto Backlight Off:

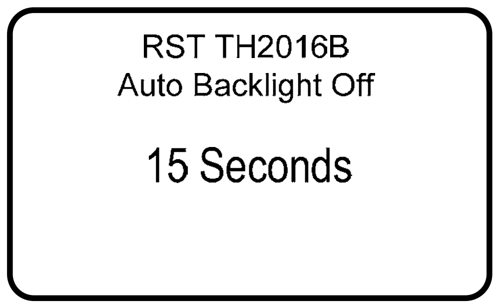

Figure 5 – Auto Backlight Off

Use the up/down scroll buttons to adjust. Press *Enter* and you will be returned to the previous menu.

4 TH2016B FRONT PANEL CONTROLS

4.1 Startup

Upon powering on the unit (by pressing any key), an opening screen will appear showing the RST Instruments logo. If the user wishes to view the details of the readout *press any key* immediately and the following will appear:

RST Instruments
Readout TH2016B

Version: 2.00
Serial#: 156456
2013/03/18 17:04:05

Figure 6 – TH2016B Readout Details

This displays the model, version number, serial number and the current date/time settings. It is always a good idea to ensure that the date and time are correct, as this may affect any readings being stored in memory on the unit. Refer to section 0 for setting the date and time.

If no keys are pressed after power on, the unit will default to readings screen as shown below.

	RST TH2016B	ºC
23.52	23.52	23.52
24.56	24.56	24.56
21.56 >	21.56	
23.43	23.43	
24.76	24.76	
24.67	24.67	

Figure 7 – Readings Screen

The readings screen displays the current reading on the thermistor (assuming an instrument is connected). The default units are degrees Celsius. Temperature units can be changed if desired (section 5). The time interval between subsequent sensor readings can be changed using Multireadout Host Software shipped with TH2016B readout. The default sampling delay is 0.2 seconds.

Note

In Monitor mode, press the Enter key on keypad to skip the sampling delay and move on to read next sensor.

Note

Hold down both arrow keys to toffle between reading units: ºC, F, Ohms.

4.2 Setting the Date & Time

Keeping the date and time current ensures that you have accurate historical records of your temperature data. Whenever a reading is taken and stored in the units' memory, an associated date/time stamp is always included.

- Turn on the readout by pressing any key.
- Using the arrow keys, scroll down to the *Set Time* screen and press *Enter:*

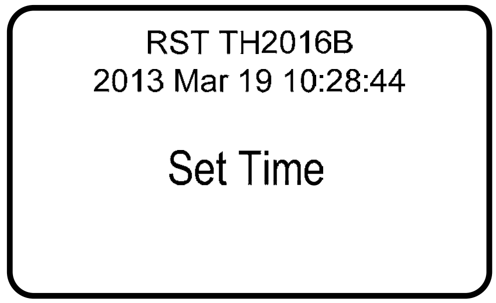

Figure 8 – Set Time

- The current editable data field will have an underline, use the arrow keys to modify the field and press enter when complete (pressing enter cycles through each field).

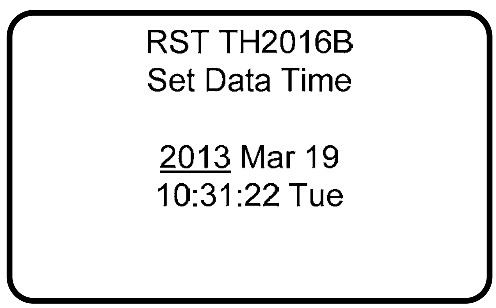

Figure 9 – Date/Time Set

- When complete the program will exit to the main menu screen.

4.3 Connecting Single Field Instruments

The standard wiring for an individual thermistor consists of one pair of wires plus an additional shield. The following table outlines the color codes:

Green	Therm +
White	Therm -
Bare	Shield

Flip up the gates on the quick connect terminal strip (Figure 1) and insert the stripped ends of the cable matching color for color. Close each gate to secure the wire. If needed, RST can supply a cable with alligator clips for instrument connection.

> **Note**
>
> Applying solder to the bare ends of the cable aids in reducing fraying over time. All RST sensors are pre-tinned from the factory.

4.4 Multi-Channel Connection

The TH2016B contains an internal multiplexer allowing it to be connected to multi-channel instruments through its *Expansion* connector. Appendix B – Expansion Connector Pin-out provides the pin-out of this connector. Mating halves of the connectors are available through RST if your current sensors are not equipped with the appropriate connector.

During location setup, the number of sensors can be specified. Please refer to sections 5 & 7.

5 MONITOR SETTINGS

Various parameters of the TH2016B readout can be adjusted by selecting the *Monitor Settings* menu as shown below:

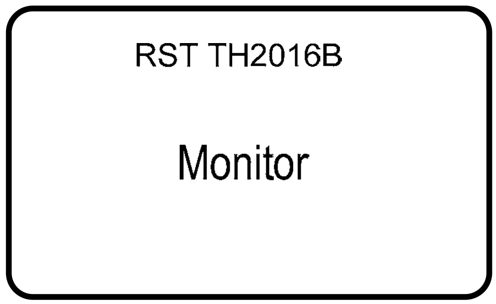

Figure 10 – Monitor Settings

- Press *Enter* to choose whether a custom or predefined setting is required.

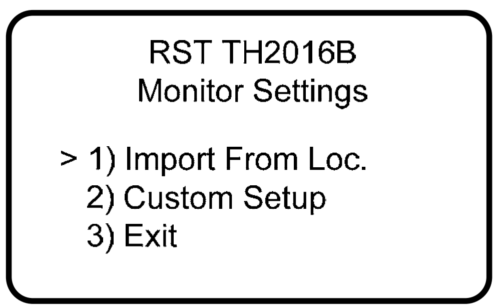

Figure 11 – Monitor Settings Options

5.1 Import From Loc. Option

If the *Import From Loc.* option is chosen (selecting option 2 and pressing *enter*), the screen will advance to the location screen (i.e. Figure 21), assuming at least one location was defined. If no memory locations currently exist in the readout's memory, a screen will appear stating "No Locations". Each location has its own specific settings such as: number of sensors; thermistor type and temperature correction parameters. Use the arrow keys to scroll to the location which you would like to set the monitor settings to. Press *enter* when complete. The location label will appear at the top of the screen indicating location settings currently in use.

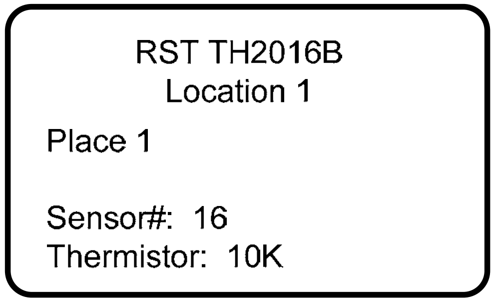

Figure 12 – Predefined Monitor Options

- Use the up/down arrows to select the location to copy the settings from and press *Enter.* The unit will display the Correction Parameters for chosen location.

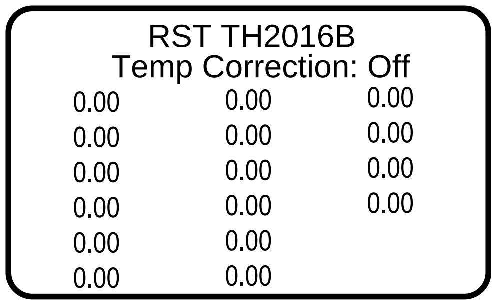

Figure 13 – Predefined Correction Parameters

- Press the up/down arrow keys to turn temperature correction feature on or off. Press *Enter* when complete. The unit will return to the previous menu.

5.2 Custom Setup

If the *Custom Setup* is chosen (option 1 and pressing *enter*), the screen will advance and prompt for the number of sensors.

- Press *Enter* to select the number of sensors connected. This will be set to 1 if using terminal strip connector or any number between 1 and 16 if connecting sensors to expansion connector.

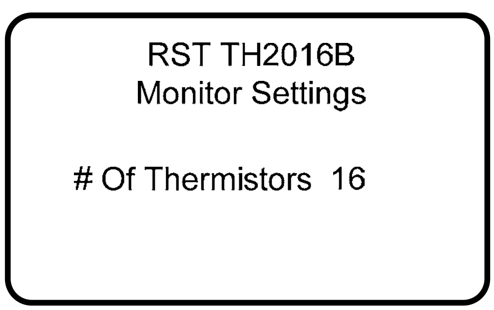

Figure 14 – Sensor Number

- Press *Enter* choose the *Thermistor Type*:

RST VW2106
Monitor Settings

Thermistor Type
3K

Figure 15 – Thermistor Type

- Use the up/down arrows to select the appropriate thermistor. Options include 2252, 3K, 10K and RTD. For most cases, the default “5K” thermistor should be chosen. Press *Enter* when complete.
- Select the desired display units (Centigrade/Fahrenheit):

RST TH2016B
Monitor Settings

Temperature Units
Centigrade

Figure 16 – Thermistor Units

- Press the up/down arrow keys to select and press *Enter* when complete. The unit will return to the previous menu.

6 MANUAL READINGS

The following instructions outline the basic steps needed to take a manual reading with the TH2016B readout:

- Connect the Thermistor leads to the quick-connect terminals. Match the wires color for color.
- Turn on the readout by pressing any key.
- The readout will go through its startup procedure, and automatically default to the reading screen.
- The temperature reading will appear (^{o}C/^{o}F).
- Record the reading and move onto the next instrument.
- Manual readings on sensors which contain multiple thermistors are performed by connecting the instrument to the *Expansion* port with the appropriate connector (section 4.4).

> **Note**
>
> In Monitor mode, press the Enter key on keypad to skip the sampling delay and move on to read next sensor..

For memory functions, please refer to section 7.

7 STORING READINGS IN MEMORY

The TH2016B has 128k of internal memory allowing it to store over 3018 time-stamped thermistor readings. The current memory usage is displayed on *Memory* screen, as shown in Figure 17. Data can be reviewed either on-board or downloaded to a host computer via the USB connector. Individual locations can be preconfigured in the office via the Multireadout Host Software or by creating locations on the unit itself (section 7.1).

7.1 Creating Memory Locations in the Field

The TH2016B Readout has the ability to be either pre-configured in the office (through Host Software), or taken directly to the field. If taken directly to the field, each location will be assigned a generic name which is editable once back in the office and connected to a host computer. In most cases it is recommended that the TH2016B be pre-configured in the office prior to taking readings in the field. In this manner, site location names can be setup ahead of time allowing the field personnel to be able to arrive at instrument locations, and store readings without needing to create a location in the units' memory.

If the TH2016B has not been pre-configured in the office, the following instructions explain how to create new locations. Please refer to Figure 36 (flow chart) for a graphical representation of the steps outlined below:

- Turn on the readout by pressing any key.
- Using the arrow keys, scroll to *Memory* and press *Enter*.

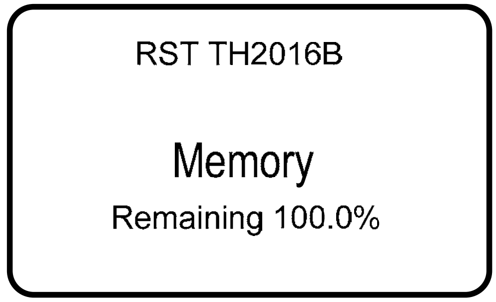

Figure 17 – Memory Screen

- Press *Enter* to advance to the next screen.
- Using the arrow keys, scroll to *Create Location* and press *Enter*.

Note

The maximum number of predefined locations is 254.

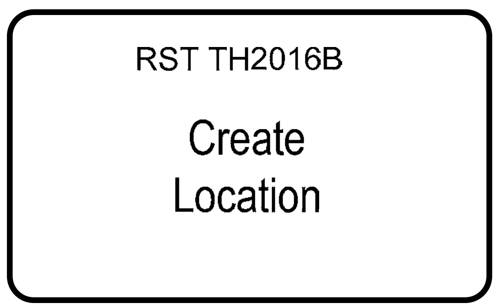

Figure 18 – Create Location

- The readout unit will automatically create a site called *Location X* where '*X*' is the next storage location available in the units' memory. Please note that when creating new sites in the field, you can only name them *Location X*. Make note of the real location name in your field notebook and its relation to the *Location* number. When connecting to the Host Software back in the office, a custom name can be entered at that time. This replaces the site name assigned by the readout.

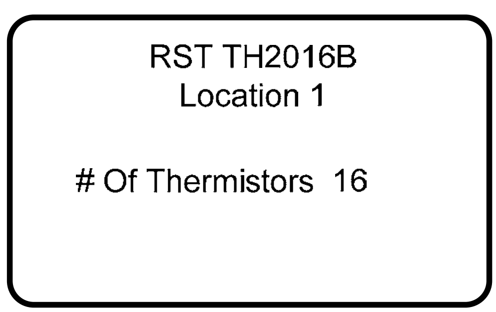

Figure 19 – New Location

- The TH2016B automatically increments the new location to the next number available.

- Use the arrow keys to select the number of thermistors associated with that location. Valid entries are between 1 and 16 thermistors.
- Next, choose the type of Thermistor. The default is “5K”. Press Enter when complete.

RST TH2016B
Location 1

Thermistor Type
3K

Figure 20 – Thermistor Type

- Once the thermistor type has been chosen, press *Enter* and the unit will return to the previous menu. Use the arrow keys to scroll to *Store Data* and press *Enter.* The following screen will appear:

RST TH2016B
Location 1
Location 1

Sensor#: 16
Thermistor: 3K

Figure 21 – Select Location

- Use the arrow keys to select the location you just created. When the desired location is found, press *Enter* to select it. The following will appear:

2013/03/18 17:25:48		°C
23.52	23.52	23.52
24.56	24.56	24.56
21.56 >	21.56	
23.43	23.43	
24.76	24.76	
24.67	24.67	

Figure 22 – Storing a Reading

Note

In Store Data mode, press the Down Arrow key on keypad to skip the sampling delay and move on to read next sensor..

> **Note**
>
> Hold down both arrow keys to toffle between reading units: °C, F, Ohms.

- Figure 22 illustrates a location that has 16 sensors associated with it. Press *Enter* to store the reading.
- The TH2016B will prompt you with the question: *Accept*?, press *Enter* to store the reading.

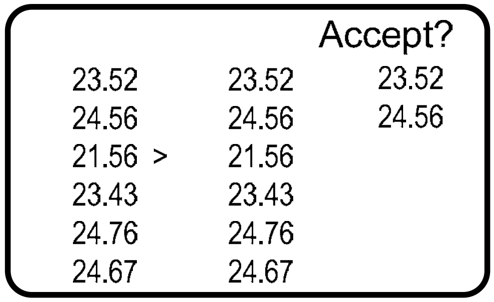

Figure 23 – Accepting Reading

- After storing the reading, the TH2016B will return the user to the previous screen.

7.2 Reviewing Data

To review any reading on the TH2016B unit itself, please follow these instructions:

- Power on the readout by pressing any key.
- Using the arrow keys, scroll down to *Memory*, press *Enter*.
- Scroll to *Review Data* and press *Enter*.
- Scroll to the desired location (using arrow keys) and press *Enter*.

RST TH2016B
Location 1

Location 1

Sensor#: 16
Thermistor: 3K

Figure 24 – Select a Location

- If the location contains more than one reading, these readings can be scrolled through using the arrow keys. The date and time of each reading will appear to differentiate each reading.

2013/03/18 17:25:48 ºC

23.52	23.52	23.52
24.56	24.56	24.56
21.56 >	21.56	
23.43	23.43	
24.76	24.76	
24.67	24.67	

Figure 25 – Reviewing Data

- Figure 25 illustrates 16 independent sensors associated with a single location.
-

Note

Hold down both arrow keys to toffle between reading units: ºC, F, Ohms.

7.3 Datalogging

The TH2016B has a basic datalogging function where the user is able to set the datalogging interval and the number of iterations. Datalogging can function on either the single or multiple channel features of the readout.

- From the TH2016B main reading screen scroll to *Memory* and press *Enter*.
- Use the arrows to scroll to the datalogging screen as shown below and press *Enter*.

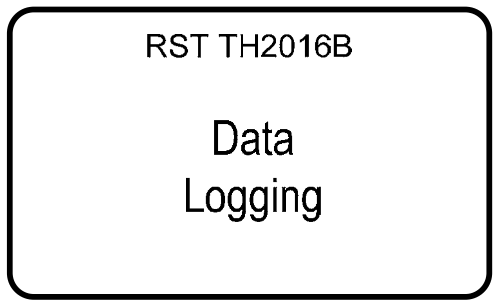

Figure 26 – Datalogging Screen

- Choose a location you wish to record data to by using the arrow keys. If no locations are currently set-up, the readout will respond with “No Locations”. Proceed to setup a location as described in section 7.1.

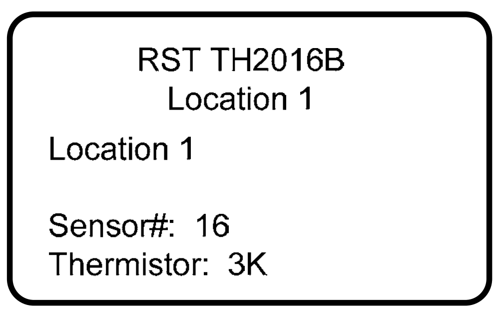

Figure 27 – Select a Location

- Then set the *Interval* using the arrow keys. Holding down the arrow keys make the digits scroll faster. Press *Enter* when complete.

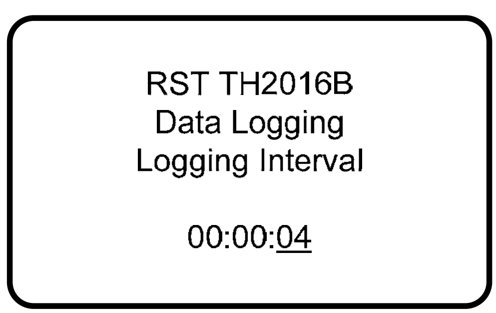

Figure 28 – Datalogging Interval

- Once the interval is set, press *Enter* and the following screen will appear:

RST TH2016B
Data Logging
Logging Number

4

Stop On Memory Full=0

Figure 29 – Datalogging Number

- Use the arrow keys to select the number of iterations you wish the readout to datalog (in the above case, it will take 4 readings at a 4 second interval). To continuously datalog until the memory is full, select 0. After pressing *enter* the readout will start the datalogging process and will end with "logging completed". ESC can be pressed at any time to abort the datalogging process.
- Datalogging can also be accessed through the *Store Data* screen (once the intervals have been created as described above). Scroll to *Store Data* and select the location were you would like to datalog. Press *Enter.*
- Press and HOLD the enter button to commence datalogging. The screen will appear as follows:

Logging 1		15:37:31
		ºC
24.81	24.81	24.81
24.81	24.81	24.81
24.81	24.81	24.81
24.81	24.81	24.81
24.81	24.81	
24.81	24.81	

Figure 30 – Logging Screen

- During datalogging, the logging number will increase with the corresponding time stamp being updated in the upper right-hand corner of the screen.

Note

In Data Logging mode, press the Down Arrow key on keypad to skip the sampling delay and move on to read next sensor..

- Once logging has finished, the following will appear:

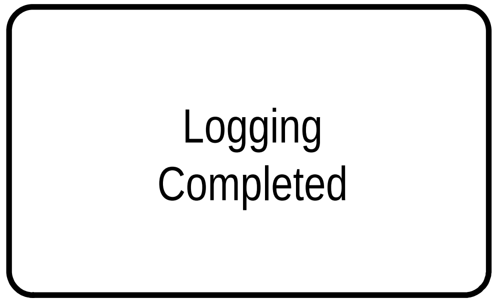

Figure 31 – Logging Completed

- Once datalogging is complete, the readout will automatically turn off according to the *Auto Off* setting (section 3).

7.4 Deleting

All location information can be deleted from the TH2016B readout or via the Host Software. This is done by the following:

- Power on the display by pressing any key.
- Using the arrow keys, scroll down to *Memory*, press *Enter*.
- Using the arrow keys, scroll to *Delete* and press *Enter*.

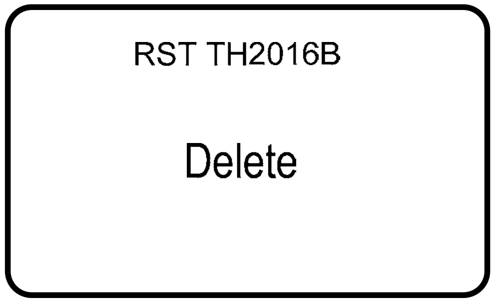

Figure 32 – Delete

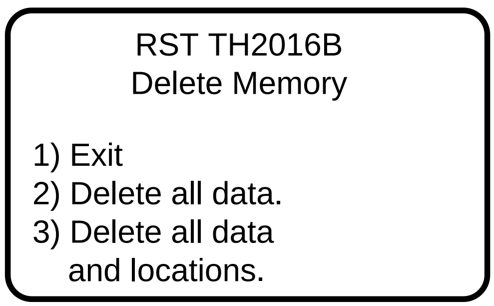

Figure 33 – Delete Options

Using the *arrow keys*, scroll to the desired delete option and press the *Enter* key to select. Press *Enter* to confirm, press *ESC* to exit back to the main menu.

8 TH2016B INTERNAL BATTERY

The RST TH2016B operates on 3 alkaline AA batteries. Access to the batteries is done through a port on the side of the unit. Use a flathead screwdriver or a coin to access the batteries (see Figure 34). The unit ships standard with regular AA batteries. If the unit is being used consistently in cold environments, the user may replace the alkaline batteries with lithium batteries which are also readily available.

Figure 34 – Battery Door

The status of the battery can be checked by:

- Turning on the readout by pressing any key.
- Using the arrow keys, scroll to the battery voltage screen.
- The readout will display the *battery voltage* as shown below:

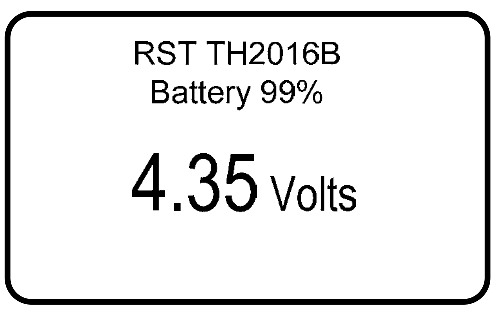

Figure 35 – Battery Voltage

Note
If the battery voltage drops below 3.5 volts a low battery warning will be displayed in the form of “BATT” in the upper right of each screen. Change the batteries at this time.

9 SOFTWARE & FIRMWARE UPDATES

The TH2016B readout is designed such that the unit's software and firmware can be easily updated by the customer through the USB port. Please regularly visit: http://www.rstinstruments.com for product updates.

10 CONTACT US

For sales information contact: sales@rstinstruments.com

For technical support contact: rst_support@rstinstruments.com

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Telephone:	604-540-1100
Facsimile:	604-540-1005
Toll Free:	1-800-665-5599
Website:	http://www.rstinstruments.com

11 APPENDIX A – TH2016B MENU FLOW CHART

The following flow chart outlines all functions of the TH2016B front panel controls:

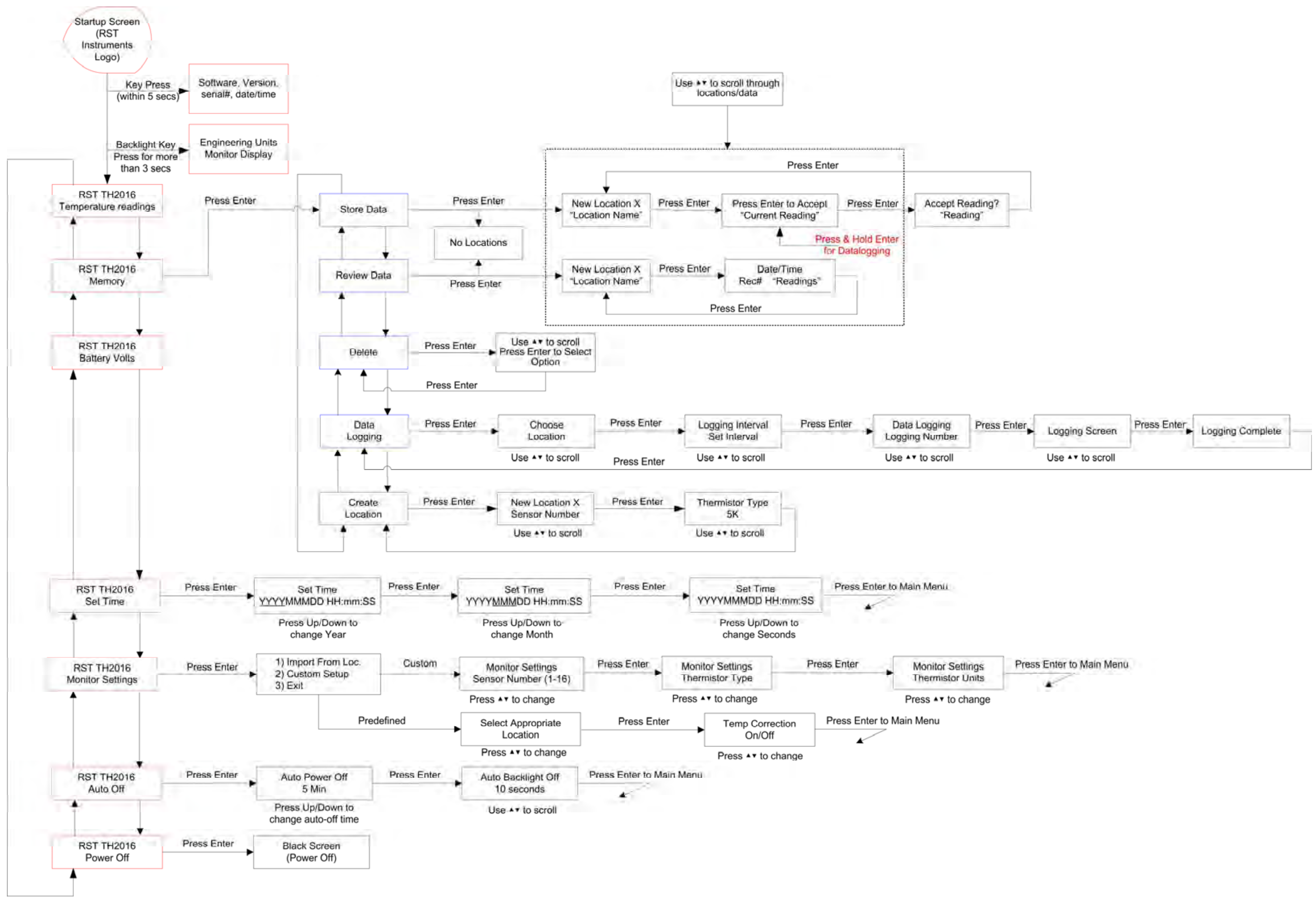

Figure 36 – TH2016B Menu Flow-Chart

12 APPENDIX B – EXPANSION CONNECTOR PIN-OUT

Trident Connector Pin	Signal
A	Therm 1 +
B	Therm 2 +
C	Therm 3 +
D	Therm 4 +
E	Therm 5 +
F	Therm 6 +
G	Therm 7 +
H	Therm 8 +
J	Therm 9 +
K	Therm 10 +
L	Therm 11 +
M	Thermistor -
N	Therm 12 +
P	Therm 13 +
R	Therm 14 +
S	Therm 15 +
T	Therm 16 +
U	NC
V	NC

TH2016B Connector ITT: **Trident Part No. = 192900-0039**

Mates with: **Trident Part No. = 192922-1280**

13 APPENDIX C – SPECIFICATIONS

Description	***Specification***
Supported Temperature Readout Sensors	NTC3000 (standard), NTC2252, NTC10K, RTD, NTC 5K
Thermistor Accuracy	±0.01 ^{o}C
Thermistor Range	-50 ^{o}C to 80 ^{o}C
Display	Graphic 128 x 64 pixels large character display
Display Backlight	High efficiency LCD with auto off
Memory	128 kB
Max Instrument Locations	254
Memory Capacity	3018 custom labeled points
Location Identification String	Up to 20 characters
Download Speed	15 seconds (full memory)
Battery	3 “AA” alkaline
Battery Indicator	On-screen low battery indicator
Operating Temperature	-20 ^{o}C to 60 ^{o}C
Dimensions	W 22cm x D 19cm x H9.5cm (8.75 x 7.5 x 3.75in.)
Weight	1.1 kg (2.4 lbs)

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Certified System ISO 9001

PRODUCT CATEGORY:
READOUTS + DATA LOGGERS

TH2016B Thermistor Readout

The portable TH2016B Thermistor Readout reads, displays, and logs up to 16 thermistor string points at the push of a button.

Unprecedented accuracy, flexible memory options and ease of use make the TH2016B invaluable for projects requiring temperature monitoring involving thermistor strings. Maximum download time is only 15 seconds.

Complementing its high level of accuracy, the TH2016B is also designed for maximum efficiency with the user in mind. Housed in a compact and rugged case, the complete readout operates with only 3 "AA" batteries and comes well-equipped with a large graphics display with backlight. A short cable with alligator clips for thermistors allows quick settling time in adverse cable conditions.

> APPLICATIONS

Reads, displays, and logs thermistors.

> FEATURES

- Readings in raw or engineering units.
- Large graphics display with a convenient backlight.
- Durable, compact design for excellent portability and field use.
- Field-replaceable "AA" alkaline batteries eliminate the need for a large, bulky 12 V battery and a charger.
- Stores up to 254 thermistor string locations per route, each with a text label, date stamp, previous data, and up to 3,000 arrays of 16 points.
- Data transfer to a host computer via USB in a compatible file format for Microsoft Excel® and other spreadsheets. User friendly host software for Microsoft Windows® included.

> BENEFITS

- ✓ **Increase Productivity**
- ✓ **High Accuracy**
- ✓ **High Reliability**

ORDERING

ITEM	PART #
TH2016B Thermistor Readout	TH2016B

SPECIFICATIONS

ITEM	DESCRIPTION
Supported Temperature Readout Sensors	NTC5K
Temperature Curve Conformance	±0.05°C
Resistance Accuracy	±0.02%
Temperature Readout Range	-50°C to 80°C
Display	Graphic 128 x 64 pixels large character display
Display Backlight	High efficiency LCD with auto off
Max Thermistor String Locations	254
Memory Capacity	3,000 custom labelled and date stamped arrays of 16 points
Location Identification String	Up to 20 characters
Download Speed	15 seconds (full memory)
Battery	3 "AA" alkaline
Battery Indicator	On-screen, low battery indicator
Operating Temperature	-20°C to 50°C
Dimensions	W 22 cm x D 19 cm x H 9.5 cm (8.75 x 7.5 x 3.75in.)
Weight	1.1 kg (2.4 lbs)