UNIVERSIDAD CATÓLICA DE SANTA MARÍA

FACULTAD DE CIENCIAS E INGENIERÍAS FÍSICAS Y FORMALES

PROGRAMA PROFESIONAL DE INGENIERÍA ELECTRÓNICA

"FILOSOFÍA DE CONTROL PARA MOLIENDA SAG EN PLANTA DE MOLIENDA DE TINTAYA – ANTAPACCAY Y DISEÑO DE ESTRATEGIA DE CONTROL UTILIZANDO SISTEMA DE CONTROL DISTRIBUIDO"

Tesis Presentada por el Bachiller:

ROQUE SALAS, Rene Erwin

Para optar el título Profesional
de Ingeniero Electrónico

AREQUIPA – PERÚ
2013

A dios que me guio desde mis primeros pasos, a mis padres Rene Roque Díaz y Zulma Salas Hinojosa que sin su apoyo incondicional nada de esto hubiera sido posible, a mi hermana Zulma que es el mejor ejemplo a seguir, a mis compañeros de trabajo del Proyecto Antapaccay son los que hicieron mi sueño posible, a mis amigos ustedes que siempre me apoyaron.

ÍNDICE GENERAL

CAPÍTULO I

CAPÍTULO II

CAPÍTULO V

ÍNDICE DE FIGURAS

CAPITULO I

CAPITULO II

CAPITULO III

CAPITULO IV

CAPITULO V

ÍNDICE DE TABLAS

CAPITULO II

CAPITULO IV

CAPITULO V

RESUMEN

El desarrollo de la presente tesis tiene por objetivo elaborar una filosofía de control para el proceso de molienda SAG y diseñar la estrategia de control más adecuada, utilizando el sistema de control distribuido Infusion de Invensys.

La ingeniería desarrollada por Bechtel Corporation será profundizado por la norma ISA en los P&ID (Diagrama de Tuberías e Instrumentación).

Analizar la filosofía de control del Proyecto Antapaccay propuesta por Bechtel Corporation, con el fin de verificar cada aspecto de Ingeniería no contemplada durante su diseño. Esto motivo a estudiar a fondo el tema y proponer soluciones de diseño, de construcción y de control que esté acorde a los objetivos de molienda que son: ahorro de energía, ahorro de agua, incremento de volumen de carga y obtención de la granulometría deseada

Otros puntos importantes son: la selección del molino para el proceso de Molienda SAG y el diseño de la etapa de comunicación entre el DCS de la Foxboro de la central y el controlador (PLC Siemens) del Molino SAG.

A lo largo de este trabajo se podrá apreciar los detalles que nos permitió alcanzar el objetivo propuesto. Donde el objetivo ha sido lograda al comisionar los lazos de control de los Apron Feeders, Faja de alimentación Molino SAG, Alimentación Agua de Proceso y descarga Molino SAG.

ABSTRACT

The development of this thesis aims to develop a control philosophy for SAG milling process and design the most appropriate control strategy, using the distributed control system of Invensys.

The engineering developed by Bechtel Corporation will be deepened by the ISA in the P & ID (Piping and Instrumentation Diagram).

Analyze control philosophy Antapaccay Project proposed by Bechtel Corporation, to verify every aspect of engineering not covered during design. This reason to thoroughly study the issue and propose solutions for design, construction and control that is consistent with the objectives of milling are: energy savings, water savings, increased cargo volume and obtain the desired particle size.

Other important points are: the selection of the mill for SAG milling process and the design of the stage of communication between the Foxboro DCS plant and controller (PLC Siemens) SAG mill.

Throughout this paper we will appreciate the details that allowed us to achieve the objective. The objectives have been achieved by commissioning the control loops of Apron Feeders, belt conveyor SAG Mill, Food Process Water and discharger SAG Mill.

CAPITULO I

PLANTAMIENTO METODOLOGICO

1.1 Identificación del problema

En los procesos de molienda Semiautógena (SAG) utilizan como medio de molienda los gruesos provenientes de la línea de alimentación del Stockpile y bolas de acero como elementos moledores adicionales para obtener una granulometría adecuada.
El proceso depende de la velocidad del alimentador, de los cambios de rotación del molino, de la carga de material y de los elementos moledores adicionales (bolas de acero).

La carga suministrada por el alimentador es mezclada con agua y la lechada de cal que posteriormente ingresa al molino SAG para ser elevado por las paredes internas del molino mediante elementos levantadores en rotación, hasta el punto en que la gravedad lo despega e impulsa en una caída parabólica, produciendo una ola continua que impacta con el material en la zona inferior del molino. El golpe con junto de las bolas de acero y el material aledaño, disminuyen continuamente el tamaño de las rocas, hasta el momento de su expulsión a través de las parrillas adosadas a la tapa hacia el harnero vibratorio en donde aquellas rocas que no han alcanzado la granulometría adecuada, vuelvan al proceso de molienda y completa el ciclo.

Se puede obtener una granulometría relativamente fina al seleccionar un molino Semiautógeno que sea capaz de asegurar una operación estable y segura; también desarrollando una filosofía de control para el proceso de molienda. Teniendo como variables de control el flujo, temperatura, presión, potencia y carga de alimentación.

La filosofía de control es implementada en la planta de molienda de Tintaya – Antapaccay bajo condiciones reales y adversas de trabajo y se utilizara el controlador ya instalado en campo que es un PLC S7200 de la marca Siemens.

1.2 Descripción del problema

El circuito de molienda Semiutógena de Tintaya – Antapaccay consiste en una alimentar de material, una línea del proceso de agua, lechada de cal, un molino SAG (*Gearlees*), un sistema controlador de carga, un controlador de rotación y un harnero vibratorio.

Para que el molino SAG trabaje de manera óptima, necesita que la carga de mineral y de las bolas no exceda el 50% su capacidad. El molino SAG tiene una dimensión de 40 ft x 25 ft y es accionado a través de un motor envolvente de 24.000kW. La capacidad de alimentación es del 35%, teniendo la granulometría de entrada típica de 8 a 10 pulgadas y en la salida del molino obteniendo granulometría entre 12 y 19 mm, dimensión que sigue siendo disminuida entapas posteriores a molienda.

Por este motivo se elaborada la filosofía de control y se escogerá la estrategia de control más adecuada utilizando el sistema de control distribuido del Proyecto Antapaccay que cumplan con los estándares del proyecto.

El diagrama Fig.1.1 muestra el proceso realizado por Ingeniería Bechtel del circuito de molienda.

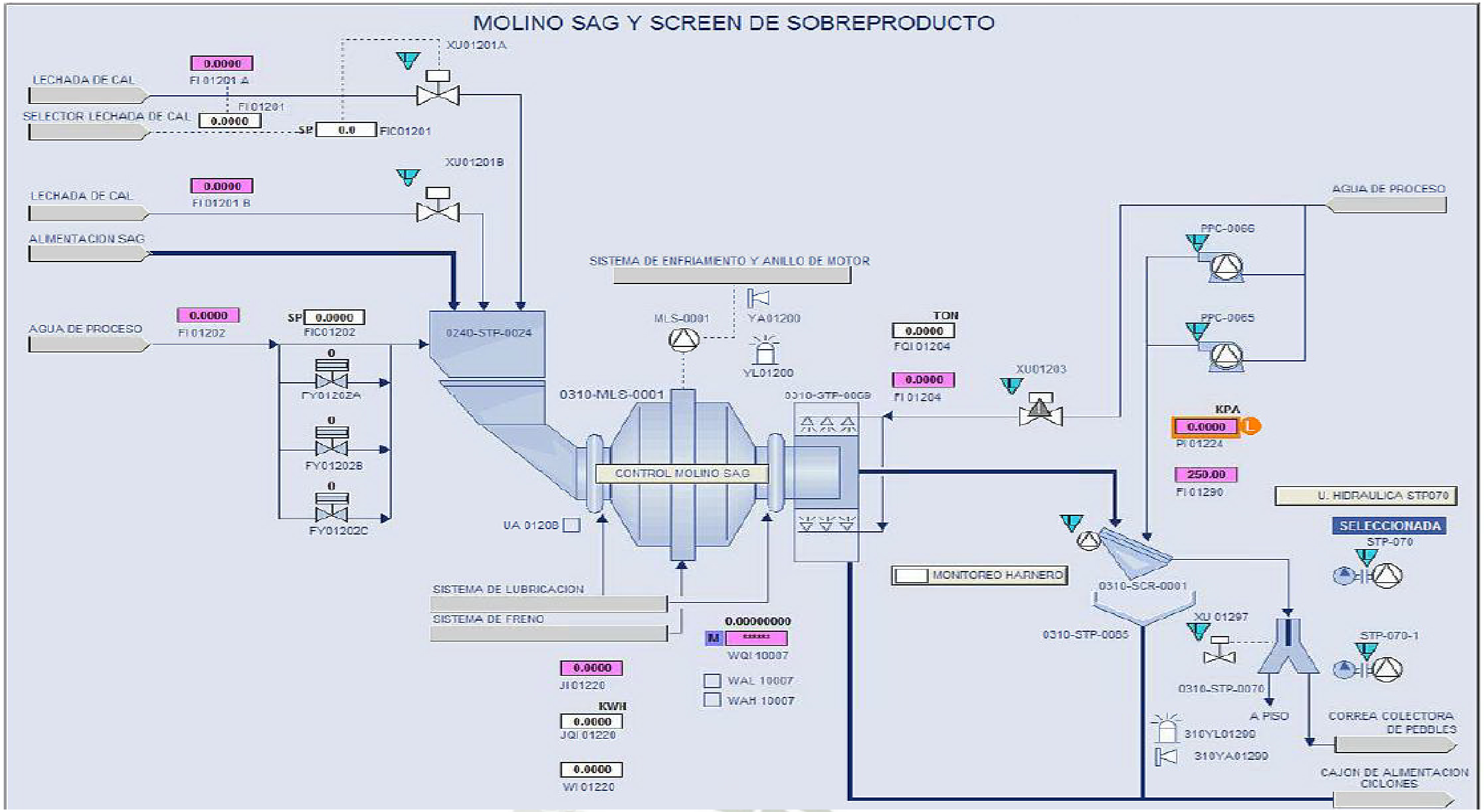


Fig.1.- Circuito de Molino SAG

Fuente: HMI EWS001. Tintaya – Antapaccay

1.3 Objetivos

1.3.1 General

Elaborar la filosofía y diseñar la estrategia de control usando un sistema de control distribuido para el proceso de molienda SAG.

1.3.2 Específicos

- Estudiar el tipo de arranque más eficiente para el proceso de Molienda SAG.
- Diseño del controlador de Alimentadores de Acopio (Apron Feeders).
- Diseño de Controlador de Línea de Proceso de agua.
- Diseño del Controlador – Alimentadores de Bolas.
- Diseño del Controlador Alimentación de Carga Fresca – Molino SAG.
- Diseño del Controlador Descarga de Mineral – Molino SAG.
- Diseño de la etapa de comunicación entre el DCS (Infusion - Invensys) de la central de control y el controlador de molienda SAG.

1.4 Hipótesis

Es posible realizar una filosofía de control, de acuerdo a los requerimientos para el molino SAG del proyecto Tintaya – Antapaccay y diseñar las estrategias de control para cada sistema que conforme el circuito de molienda.

1.5 Variables de Estudio

1.5.1 Dependientes

- Sistema de control para el circuito de molienda SAG.

1.5.2 Independientes

- Carga de material dentro del molino SAG.
- Potencia generada por el anillo de rotor del molino SAG.
- Flujo de agua para el centrifugado del material.
- Flujo de lechada de cal para el centrifugado del material.
- Carga de bolas dentro de molino SAG.
- Frecuencia de la correa de alimentación del molino SAG.

1.6 Alcances

La elaboración de la filosofía de control y el diseño de la estrategia de control utilizando sistema de control distribuido, plateando la correcta operación del Molino SAG en una planta de molienda.

La arquitectura propuesta por Bechtel Corporation, maximizara la producción y ahorrara energía, lo que mejorara la confiabilidad de los equipos y del proceso lo cual permitirá a los operadores de control un tarea más simple.

1.7 Área de Desarrollo

- Ingeniería y Precomisionado.

1.8 Línea de Desarrollo

- Instrumentación.
- Automatización y Control de Procesos.

1.9 Tipo de Desarrollo

- Diseño de Ingeniería de Control.
- Implementación en Campo.

1.10 Nivel de Desarrollo

- Aplicativa experimental.

CAPITULO II
MARCO TEÓRICO

2.1 Descripción del Proceso Planta Concentradora de Tintaya – Antapaccay

El yacimiento de cobre Antapaccay está ubicado a 10 kilómetros de la operación minera Tintaya de Xstrata Copper, en la provincia de Espinar, Región Cusco, a una altura de 4.200 msnm. La planta concentradora (línea única) tiene la capacidad para tratar 70.000 tpd [tonelada x día] de mineral sulfurado mediante trituración/flotación, con una producción inicial de 160.000 tpa [tonelada x año] de cobre en concentrados.

La concentradora presenta un recurso mineral de 720Mt con una ley de 0,56% de cobre más contenido de oro, considerando una ley de corte al 0,2% de cobre. Tiempo de vida útil inicial de 20 años.

El mineral es transportado de la mina (dos tajos abiertos) a la planta de Chancado Primario a través de camiones mineros. El mineral es descargado en una parrilla fija donde es conducida hacia triturador o chancador, posteriormente el material triturado fino es descargado al Apron Feeder (pista alimentadora) quien transportara el material hacia Sacrifical Conveyor (faja de sacrificio) donde se detectara la presencia de materiales no deseados o sobre cargas de mineral. Todo el mineral menor a ½” será transportada a través Overland Conveyor (faja transportadora) con longitud de 7 kilómetros hacia el Coarse Ore Stockpile (acopio de material grueso), el material será descargado en cuatro Reclaim Apron Feeder los cuales alimentaran al SAG Mill Feed Conveyor (faja alimentadora molino SAG).

La carga de mineral ingresa al Molino SAG junto a la lechada de cal y agua, donde el material será molido hasta obtener una granulometría fina, el material que no logre obtener la granulometría deseada, será descargada en Pebbles Conveyor (faja Pebbles) donde el material será acumulado en el Stockpile y descargara en los Pebbles Crusher a través de dos fajas transportadoras, donde el material será triturado para obtener una mejor granulometría, una vez que se complete el proceso en Pebbles Crusher, el mineral será transportado nuevamente al Molino SAG a través de la faja de descarga del circuito de Chancado Pebbles creando un circuito cerrado entre estas dos etapas. Paralelamente, el material que haya alcanzado una granulometría fina será descargado a través del harnero del molino SAG hacia un cajón distribuidor, donde el material será bombeado a través de dos bombas hacia dos hidrociclones los cuales separan la mena de la ganga y otras partículas compactas más pesadas que el agua, esta separación se produce a la velocidad de rotación generada al inyectarse agua en el interior del cuerpo de los hidrociclones, la pulpa obtenida sale a través de tubos y conducidas hacia los colectores de los molinos bolas. En los molinos se volverá a moler la pulpa para obtener un granulometría más fina y más pura la cual será descargada mediante rebose hacia el cajón distribuidor, creando un nuevo circuito cerrado para este proceso.

La pulpa acondicionada y clasificada es enviada hacia un cajón de distribución, que alimenta a las baterías de los hidrociclones, los cuales clasifican la pulpa separándolas en dos estados underflow y overflow, los cuales ingresaran a las Celdas de Flotación Rougher, con un agitador. El relave de flotación Rougher discurre por el canal hacia los espesadores de recuperación de agua, el concentrado ingresa a un cajón de distribución y mediante dos bombas, posteriormente es enviado al cajón distribuidor de alimentación de relomienda. La pulpa almacenada en el cajón de remolienda es bombeada hacia las baterías de hidrociclones, donde el overflow y el underflow ingresan a los cajones de alimentación de los molinos verticales (molinos ISA), posteriormente la pulpa de remolienda Rougher es bombeada hacia el segundo tanque de flotación Cleaner y la pulpa de remolienda Scavenger es bombeada hacia el primer tanque de flotación Cleaner, el producto del segundo tanque ingresa a la tercera etapa de limpieza, el concentrado obtenido será bombeado hacia el cajón de concentración final CU para completar el ciclo, mientras que el concentrado del primer tanque ingresa al Cleaner Scavenger Flotación donde se cumplirá el ciclo de proceso de Scavenger Regrind originando un circuito cerrado entre estas etapas, esta etapa transfiere las colas a través de una bomba hacia Tailings Thickening (relaves) los cuales serán enviados a los depósitos de residuos de Tintaya.El circuito de flotación tienes dos curier donde registran las leyes de alimentación, concentrado y colas en todo el sistema de flotación.

El concentrado final almacenado en cajón de concentración CU será bombeado hacia lo tanques de almacenamiento, donde el concentrado pasara por un tambor rotatorio que será bombeada hacia la planta de concentrado CU Final, el concentrado obtenido será transportada hacia la planta de filtros a través de una faja transportadora en donde el concentrado será almacenado y posteriormente transportado a través de camiones hacia el puerto de Matarani de la ciudad de Mollendo del departamento de Arequipa.

El diagrama completo del Proceso de la Planta Concentradora está representado por la Fig.2.1, también ver Anexos.

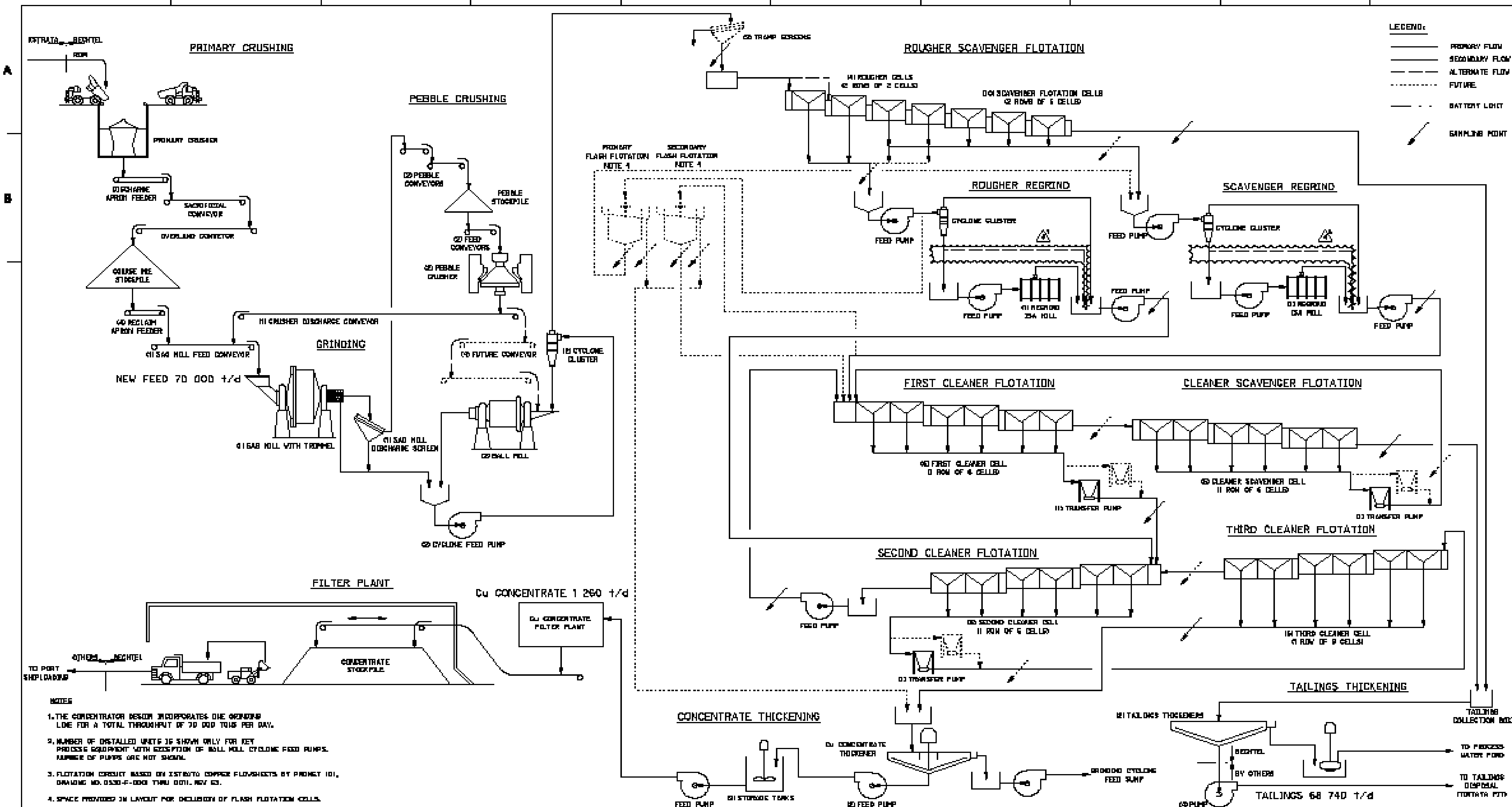


Fig.2.1.- Proceso Planta Concentradora de Tintaya – Antapaccay
Fuente: Proyecto Tintaya - Antapaccay - Bechtel

2.1.1 Circuito de Molienda de Tintaya – Antapaccay

La planta de molienda está conformado por dos circuitos: circuito de molienda semiautógena o SAG (Semi-Autogenous Grinding) y un circuito de molienda secundaria conformada por dos molinos bolas.

El propósito del circuito de molienda SAG es el de moler el mineral hasta dejarlo de un tamaño máximo definido por el harnero vibratorio. El propósito del circuito de molienda secundaria con bolas es el de entregar una pulpa de mineral de tamaño de partículas adecuado para su procesamiento en la planta de flotación. Estos dos circuitos están conectados en serie a través de un pozo.

El circuito SAG está conformado por una correa transportadora de alimentación de mineral, una línea de agua, una línea de lechada de cal, un molino SAG, un harnero vibratorio, un sistema de correas trasportadoras de retorno de mineral grueso a molienda y chancador Pebbles.

El mineral que ingresa a este circuito proviene del proceso del chancado primario. Al mineral se le agrega agua y lechada de cal al ingreso de la molienda SAG, al cual se denomina "alimentación fresca". Una vez procesada la alimentación fresca por el molino, entra en la etapa de clasificación por el harnero vibratorio, en donde aquellas partículas que no han alcanzado el tamaño especificado, vuelven al proceso de molienda.

Esto se pude realizar de dos maneras: pasando o no por el chancador Pebbles. El material ha alcanzado el tamaño adecuado, será descargado en el pozo, en donde será bombeado hacia el segundo circuito.

El circuito de molienda secundaria está conformado por un pozo, una línea de agua, una línea de lechada de cal, dos bombas centrifugas, dos molinos de bolas y dos baterías de hidrociclones. La configuración es de un circuito inverso dado que le mineral entra primero a una fase de clasificación en los hidrociclones y luego a molienda de bolas.

El pozo recibe el producto de la molienda SAG y las descargas de los molinos de bolas. En el pozo se agrega agua para formar una pulpa de mineral con una densidad adecuada para alimentar mediante bombas centrifugas hacia los hidrociclones. En los hidrociclones la pulpa de mineral que contiene las partículas de menor tamaño es enviada a los procesos de flotación y la pulpa con partículas de mayor tamaño es enviada a los molinos de bolas para una mayor conminución. Finalmente el producto de bolas vuelve al pozo de bombeo de mineral.

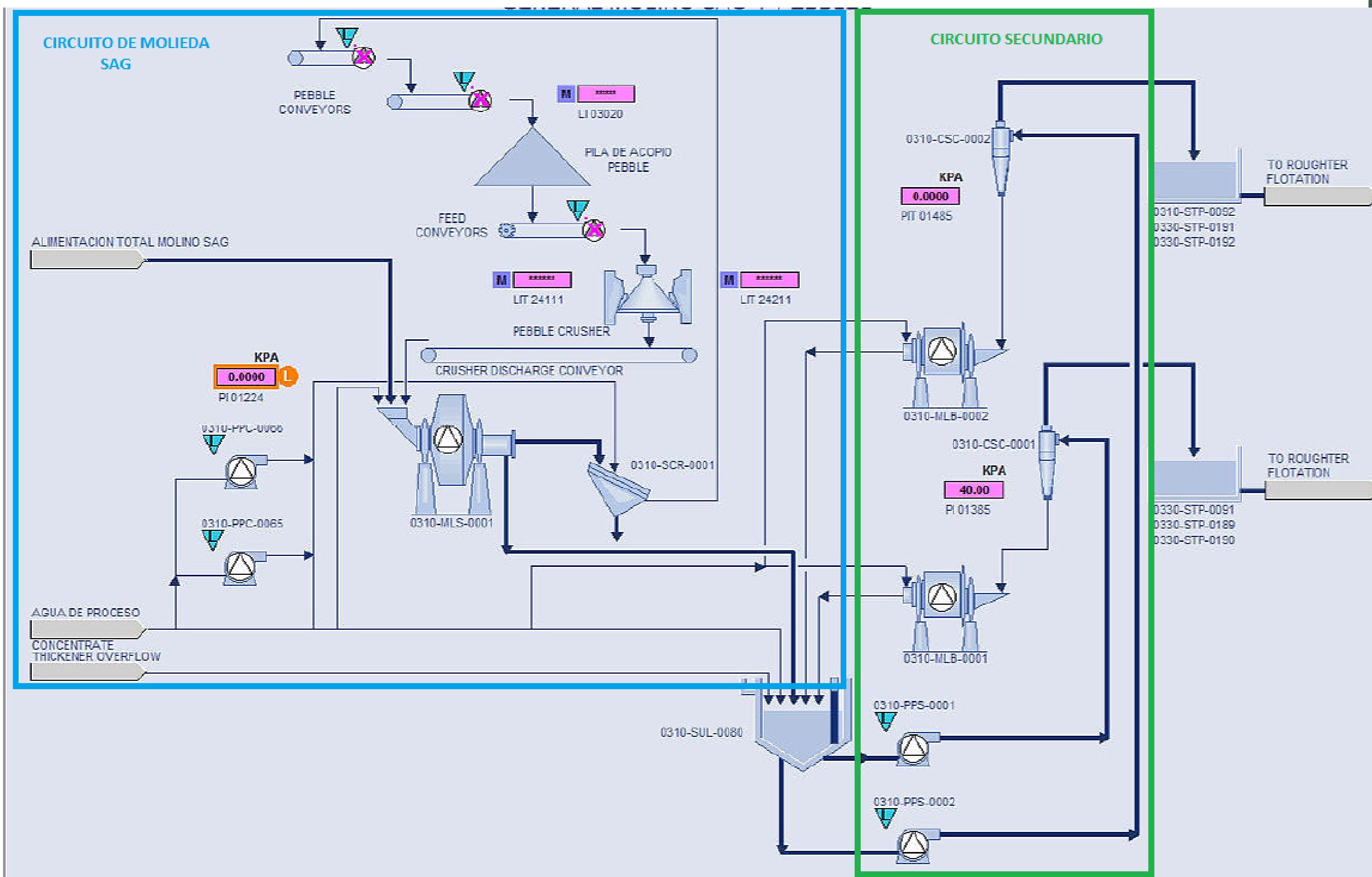


Fig.2.2.- Circuito de Molino SAG

Fuente: HMI EWS001. Tintaya – Antapaccay

2.2 Molienda Semiautógena y Autógena

A principios de los 80 se desarrolla la molienda semiautógena (SAG) y autógena (AG), buscando principalmente reducir los costos operativos al reducirse o eliminarse el consumo de los elementos de molienda, e igualmente la potencia absorbida por los molinos.

Molienda Autógena (AG): Es cuando el mineral se fragmenta en el interior del molino sin ayuda de otro tipo de medio moledor que no sea el propio mineral.

Molienda Semiautógena (SAG): Se provocará la fragmentación del mineral por el efecto combinado del propio mineral y de un pequeño porcentaje de bolas de acero.

Fig.2.2.- Molienda Semiautógena

Fuente: Zenith Mining and Construcción

Los molinos SAG utilizan una combinación de mineral y una pequeña cantidad de bolas de acero (entre el 4 y el 15% del volumen del molino). Los molinos AG trabajan mejor con materiales gruesos, que favorecen la rotura del material, en cambio los molinos SAG trabajan mejor con materiales finos, dado que la rotura la producen principalmente las bolas.

2.3 Tipos de molienda

La molienda se puede realizar con materiales secos o a suspensiones de sólidos en líquido según sea la calidad del material, para lo cual se desarrollaron dos tipos de tecnología:

- Tecnología por vía seca.
- Tecnología por vía húmeda.
-

La tecnología por vía seca se utiliza cuando se dispone de materias primas extremadamente puras o cuando se desea producir materiales de una calidad no muy elevada, por ejemplo en la fabricación de cemento.

La tecnología por vía húmeda viene caracterizada por una reducción rápida de los materiales componentes de la mezcla y para una mejor homogenización. Con la trituración en húmedo la materia primas se dispersa dé modo que permiten una posterior reducción de las partículas naturales, por ejemplo en la preparación de minerales para concentrado.

Ambas tecnologías utilizadas en procesos de molienda son factibles según el material que se desea procesar, por lo tanto, se considera los siguientes puntos de la Tabla 2.1:

Molienda Húmeda	Molienda Seca
Requiere menos potencia por tonelada tratada.	Requiere más potencia por tonelada tratada.
No requiere equipos adicionales para el tratamiento de polvos.	Si requiere equipos adicionales para tratamiento de polvos.
Consume más revestimiento (por corrosión).	Consume menos revestimientos.

Tabla.2.1.- Tipos de Molienda

Fuente: Elaboración propia

Considerando los puntos descritos en la Tabla 2.1 se optó por utilizar la tecnología por vía húmeda en el circuito de molienda de Tintaya – Antapaccay, considerando principalmente el ahorro de energía.

2.4 Tipos de Molinos

En esta sección solo se describirán los molinos que se utilizan en el Proyecto de Tintaya – Antapaccay.

2.4.1 Molino Bolas

En la Fig.2.3 se muestra el esquema con los principales elementos de un molino de bolas con motor de anillo. Está compuesto por un chute retráctil que es alimentado a través de una tolva de alimentación, un muñón giratorio de entrada que introduce el mineral hacia el interior del molino, un muñón para descarga del material hacia el harnero vibratorio. El ingreso de bolas también se realiza a través del chute retráctil.

En la parte frontal por donde ingresa el material, se aprecia que el rotor es precisamente el cilindro de conminución del material, soportado por descansos hidrostáticos que permiten su rotación.

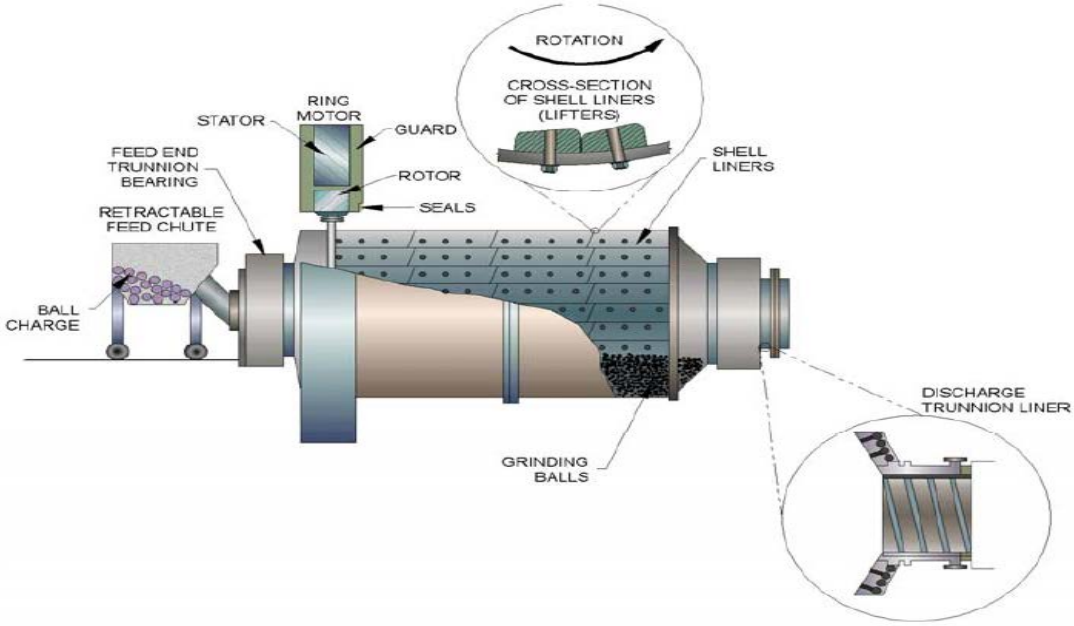


Fig.2.3.- Esquema General Molino de Bolas

Fuente: FLSmidth

El cuerpo del molino consiste en un cilindro de acero giratorio con extremos cónicos. Este cilindro esta soportado en cada extremo por muñones giratorios sobre cojinetes, presenta revestimientos lineales de metal atornillados en las paredes internas del molino tanto en la cabeza del molino como en la armazón (véase Fig.2.4)

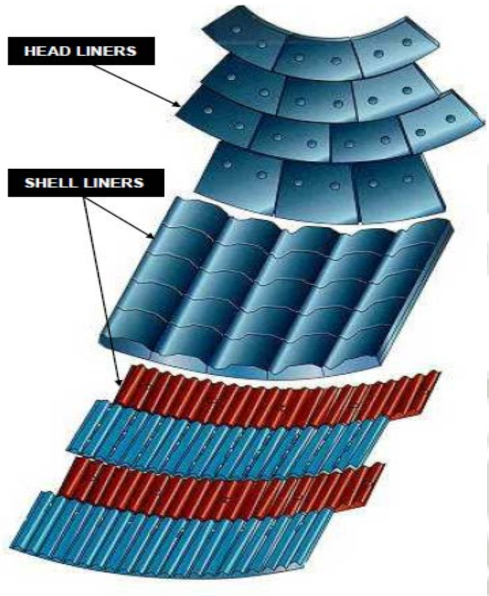


Fig.2.3.- Revestimientos Molino de Bolas

Fuente: FLSmidth

Perimetralmente en la cara frontal del molino, es rodeado por el estator (véase Fig.2.3) que es responsable de la generación del torque necesario para la operación que se transmite mediante un campo magnético en una interfaz de polos eléctricos, el detalle se observa en la Fig.2.4. Este sistema motriz se le denomina *Gearless.*

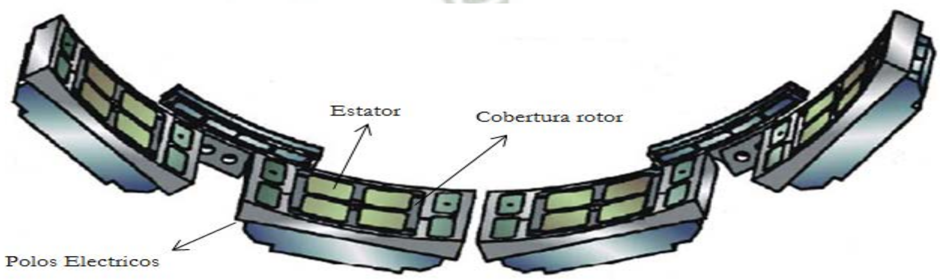


Fig.2.4.- Esquema General Molinos de Bolas

Fuente: FLSmidth

Principio de Funcionamiento:

La alimentación del molino se realiza mediante la tolva de alimentación que descarga el material dentro del chute retráctil, el material es introducido al molino a través del muñón de entrada, el ingreso de las bolas, ingreso de agua y lechada de cal también se realiza por ese medio. El ingreso de bolas dependerá del volumen total de la carga de agua y el mineral, formando un lodo líquido que llenara los espacios entre las bolas de acero. El volumen promedio será del 35% del volumen de carga total, permitiendo que el mineral se desborde a través del muñón de descarga.

El giro del molino genera en su interior, una combinación de fuerza centrífuga y fricción que mediante elementos levantadores elevan la carga hasta que la fuerza centrífuga llega a cero y por gravedad despega e impulsa en caída parabólica, generando una ola continua que impactara el material en la zona inferior del molino. El golpe en conjunto con las bolas de acero, disminuirán continuamente el tamaño de la carga. La velocidad crítica es la velocidad del molino en el que la fuerza centrífuga mantiene todo el material adherido en los levantadores evitando el efecto de cascada que requiere molienda. Los molinos de bolas operan entre el 72 a 76% de velocidad critica.

2.4.2 Molino SAG

El molino SAG (semiautogenous grinding mill) es un equipo creado para conminuir material mediante impacto. En términos generales, la molienda que utiliza como principio de conminución solamente el impacto del mismo material aledaño, se denomina molienda autógena (AG), sin embargo al incorporar una porción de bolas de acero (porcentualmente menor que un molino de bolas), se le denomina molienda semiautógena (SAG). *Ver referencia sección 2.2. Molienda SAG y AG.*

En la Fig.2.5 se muestra el esquema con los principales elementos de un molino SAG con motor de anillo. Está compuesto por un chute alimentador por donde ingresa le mineral hacia el molino, una cabeza alimentadora, armazones lineales en la cara frontal por donde ingresa la carga, el cilindro está revestido internamente por armazones elevadores, disco de frenos, sellos, elevadores de pulpa, cono de descarga, muñón de descarga y un trommel por donde solo pasa el material que haya alcanzado la granulometría deseada.

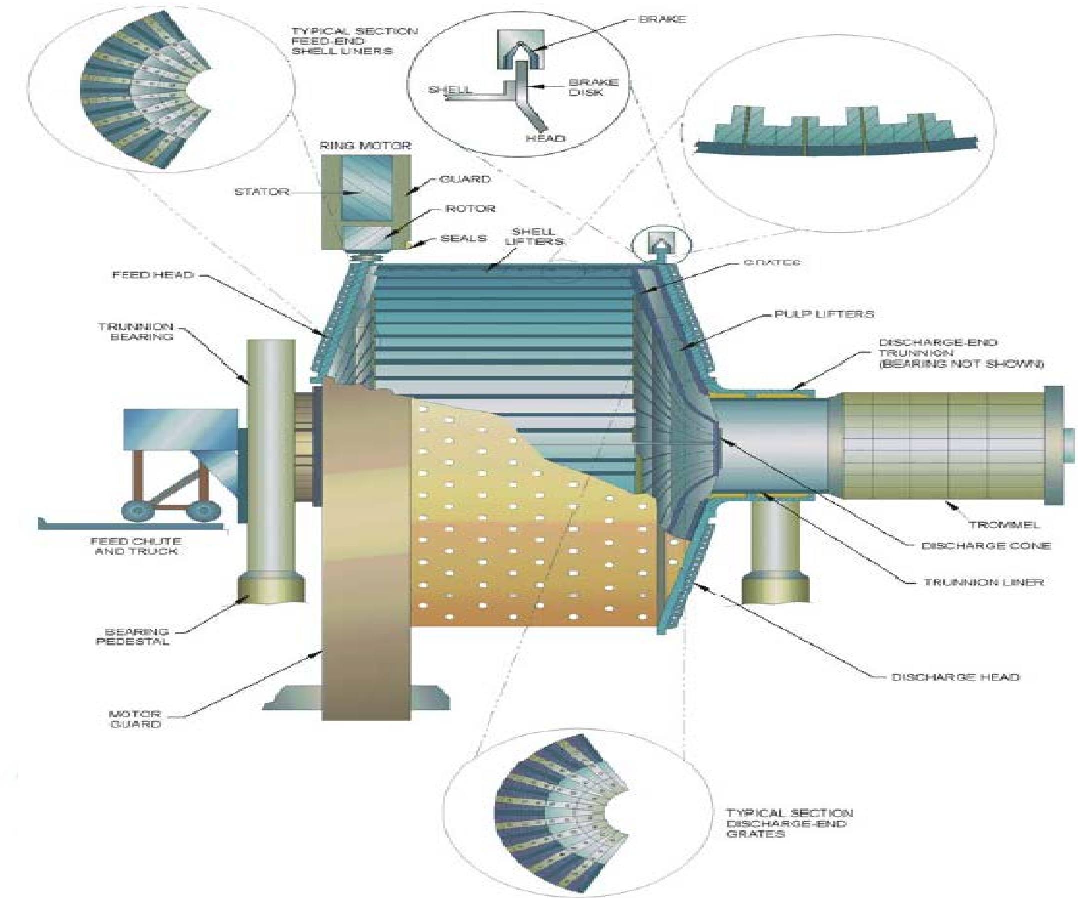


Fig.2.5.- Esquema General Molino SAG

Fuente: FLSmidth

Los componentes que conforman el motor de anillo del molino son, el rotor que es precisamente el cilindro de conminución del material, el estator que rodea perimetralmente al rotor. El principio de funcionamiento es similar al explicado en la sección *2.4.1 Molino de Bolas.*

Principio de Funcionamiento:

La carga del molino SAG se compone por materiales descargados en la tolva de alimentación, bolas de acero, lechada de cal y agua. La carga total del molino ocupa el 30 % del volumen del molino, donde las bolas solo suelen ocupar aproximadamente el 8 a 15 % del volumen del molino.

La velocidad del molino SAG se puede variar para regular el efecto cascada (tumbling) para el triturado del material utilizando los revestimientos elevadores que ayudan aumentar la carga durante la rotación del molino. La carga se eleva dos tercios de la altura del cilindro antes de caer a la punta de la carga. La acción de molienda dentro del cilindro es una combinación de rotura de mineral a través de la acción de caída, el golpe entre las bolas y la abrasión de la carga por el continuo frotamiento entre ellos, a esto se lo conoce acción cascada (véase Fig.2.6).

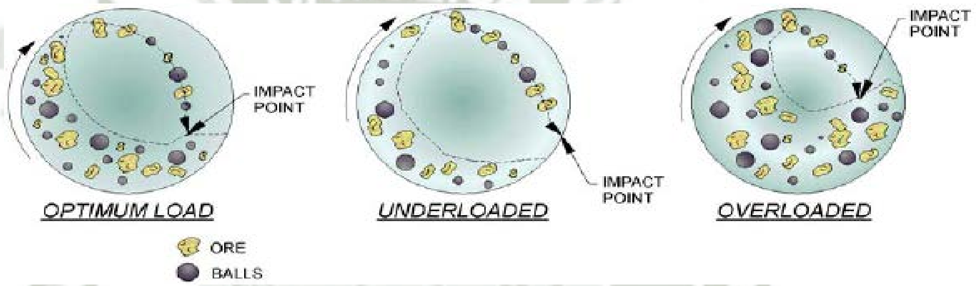


Fig.2.6.- Acción Cascada Molino SAG

Fuente: FLSmidth

La velocidad del molino genera gran parte de la acción de levamiento del material. El molino SAG es accionado por motor variable el cual funciona entre 10 a 85 % de su velocidad critica, esta velocidad es la que genera la fuerza centrífuga que mantiene el material adherido a la paredes internas del molino, si la velocidad excede su porcentaje de trabajo evitara la acción cascada que se requiere para el triturado del mineral.

Cuando la mena alcanza la granulometría ideal esta pasa hacia el cabezal de descarga, formado por rejillas metálicas y elevadores de pulpa, esto se realiza a través de los muñones de descarga que envían el material hacia las pantallas clasificadoras.

Sistema de Clasificación:

Este sistema es la etapa final del molino SAG, es donde la carga formada por el mineral, el agua y la lechada de cal son descargadas en las pantallas clasificadoras. Estas pantallas tienen ranuras por donde solo pasa el mineral que alcanzo la granulometría ideal, posteriormente es descargada a través de una canaleta hacia el sumidero del SAG que pasaran a la siguiente etapa de molienda. Las partículas que no pudieron pasar por las ranuras de las pantallas clasificadoras serán transportadas hacia el chancador Pebbles o recirculadas al molino SAG.

2.5 Tipos de Accionamientos

En esta sección se explicara los tipos de accionamientos que se implementan en los molinos de bolas y los molinos SAG, también se detallara el beneficio de cada accionamiento

2.5.1 Accionamiento mediante Engranajes

Tradicionalmente el accionamiento de los molinos de bolas es realizado por motores de inducción en Europa y motores sincrónicos en USA, la transmisión de potencia entre los motores y el cuerpo del molino es realizada por sistemas mecánicos, integrados por una variedad de arreglos de engranajes y/o embriagues.

En la Fig.2.7 se muestra la configuración europea con corona dentada, engranajes, piñones, reductor y motor de inducción, para una velocidad nominal de 1000 rpm. Esta configuración simple puede ser usada como un sistema de piñón simple o dual, es decir, utilizar uno o dos motores. El uso de motores de inducción de rotor bobinado asegura la entrega suficiente de torque para la partida del molino pero presentando una limitación en la corriente de partida; en otras palabras no es necesario la instalación de un embriague de aire para suministrar el torque en la partida.

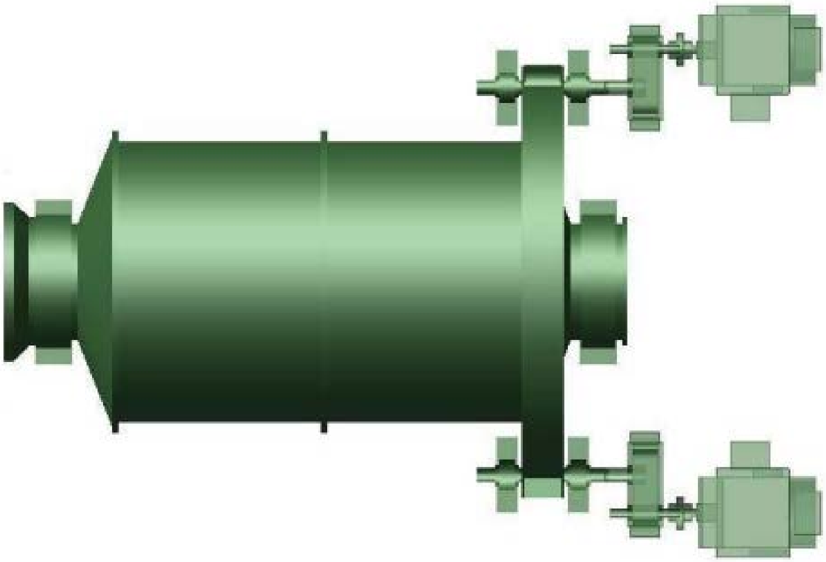


Fig.2.7.- Configuración Europea

Fuente: FLSmidth

En la Fig.2.8 se muestra el diseño americano típico, con una corona dentada y piñón, pero sin reductor y utilizando un motor sincrónico de baja velocidad, es decir un motor con gran cantidad de polos, por ejemplo con una velocidad nominal de 200 rpm. El uso de motores sincrónicos tiene la característica de un bajo torque de partido, el sistema de piñón equipado con un embriague de aire o hidráulico entre el motor y el piñón. El embriague permite al motor partir y alcanzar la velocidad nominal previa a la partida del molino.

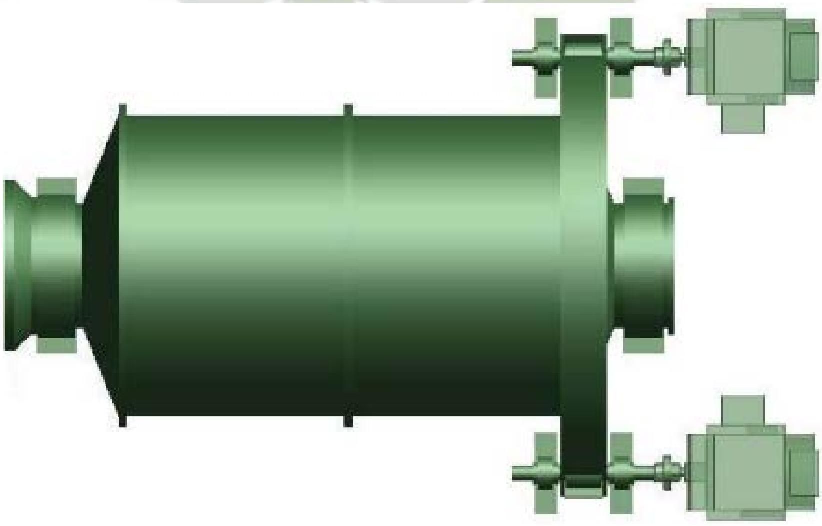


Fig.2.8.- Configuración Americana

Fuente: FLSmidth

2.5.2 Accionamiento por Motores Sincrónicos

Los motores sincrónicos son un tipo de motor eléctrico de corriente alterna, caracterizados principalmente por tener una velocidad de giro del eje en régimen permanente directamente proporcional a la frecuencia de suministro eléctrico e inversamente proporcional a los polos de la maquina; existen motores monofásicos y polifásicos, sin embargo en la industria se utiliza los motores sincrónicos trifásicos.

Un motor sincrónico trifásico está constituido por un estator y un rotor; el estator contiene un devanado trifásico que al ser alimentado por una fuente trifásica crea un “campo magnético rotatorio”, se denomina así a la resultante entre la interacción de las fuerzas magneto motrices de los tres enrollados del estator, cuando estos son alimentados desde una fuente trifásica de voltajes. Por otro lado el rotor contiene un devanado de corriente continua, denominado devanado de campo, y un devanado en cortocircuito, que impide el funcionamiento de la maquina a una velocidad distinta a la de sincronismo, denominado devanado amortiguador.

Existen dos tipos de rotores, el rotor de polos salientes es utilizado para aplicaciones donde es necesario una baja velocidad de giro del motor y el motor cilíndrico se utiliza para aplicaciones de alta velocidad.

Los accionamientos de motores sincrónicos que se utilizan actualmente tiene la característica de tener una velocidad variable y controlada. Las razones son las siguientes:

- Depende de la dureza del material, la velocidad del molino puede ser modificada reduciendo las perdidas enérgicas.
- Mayor posibilidad de eficiencia y confiabilidad.
- Posibilidad de controlar el motor a una velocidad reducida.
- Potencia que se desea generar.
- Tiempo de mantenimiento.

2.5.2.1 Cicloconversores

Es un control de velocidad denominado Cicloconversores, es un circuito de electrónica de potencia encargado de realizar una conversión AC-AC de forma directa, sin pasar por una etapa DC. El esquema utilizado consta de dos motores sincrónicos controlando dos piñones conectados a una corona dentada. Los motores utilizados son de pocos polos y son alimentados por Cicloconversores a una baja frecuencia (véase Fig.2.9).

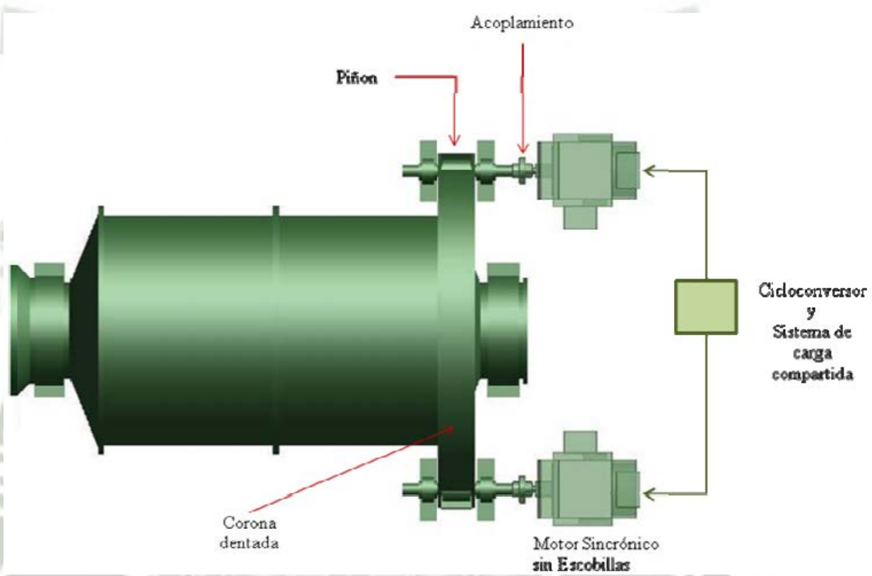


Fig.2.9.- Esquema de Accionamiento con Cicloconversores

Fuente: FLSmidth

Beneficios:

- Baja inversión inicial.
- Control de aceleración y desaceleración.
- Permite la operación sobre y bajo la velocidad nominal.
- Capacidad de posicionamiento del molino.
- No pull-out torque.

Desventajas:

- Transmisión mecánica debido a los engranajes.

- No le es inherente la característica de sobrecarga.
- No contribuye con la generación de reactivos.
- El estator y el rotor deben ser removidos para el mantenimiento.

2.5.2.2 Inversor Conmutado por Carga o Load Commutated Inverter (LCI)

Este esquema consta de dos motores sincrónicos de baja velocidad cada uno conectada a un piñón y estos a su vez controlando una corona dentada instalada alrededor del molino. Los motores son alimentados por dos variadores de frecuencia de frecuencia *"Load Commutated Inverter"* los cuales comparten la misma carga de dos motores DC, véase Fig.2.10.

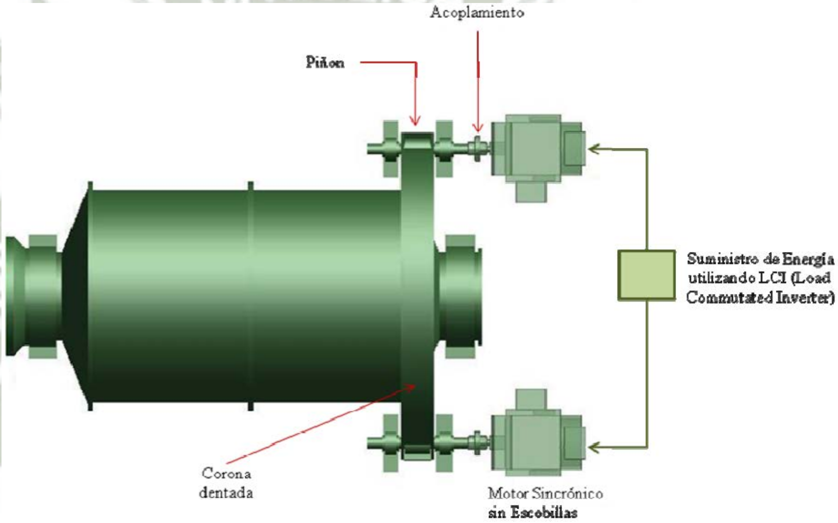


Fig.2.10.- Load Commutated Inverter

Fuente: FLSmidth

Beneficios:

- Controla la aceleración del 10% a la velocidad de operación.
- Bajo mantenimiento de motores.
- Operación sobre y debajo la velocidad base.

Desventajas:

- Transmisión mecánica mediante un arreglo de engranajes.

- Necesita un sistema de análisis de torsión en los ejes, debido a los peaks de torque.
- No presenta capacidad de sobrecarga.
- No contribuye con energía reactiva.

2.5.2.3 Accionamiento Quadramatic

Es la combinación de un control de torque y ajuste de posición mediante embriagues neumáticos es denominado el accionamiento Quadramatic, Fig.2.11. Este método utiliza dos embriagues de aire, configuración americana, permitiendo la utilización de dos motores sincrónicos de baja velocidad y torque reducido.
Los motores pueden ser arrancados uno a la vez, para producir la reducción en el sistema de potencia.

Maneja corrientes de partida, relativamente bajas en los motores sincrónicos lo que permite un arranque con voltaje nominal. Presenta una condición inicial de carga compartida, que se logra mediante ajustes en el embriague de aire.

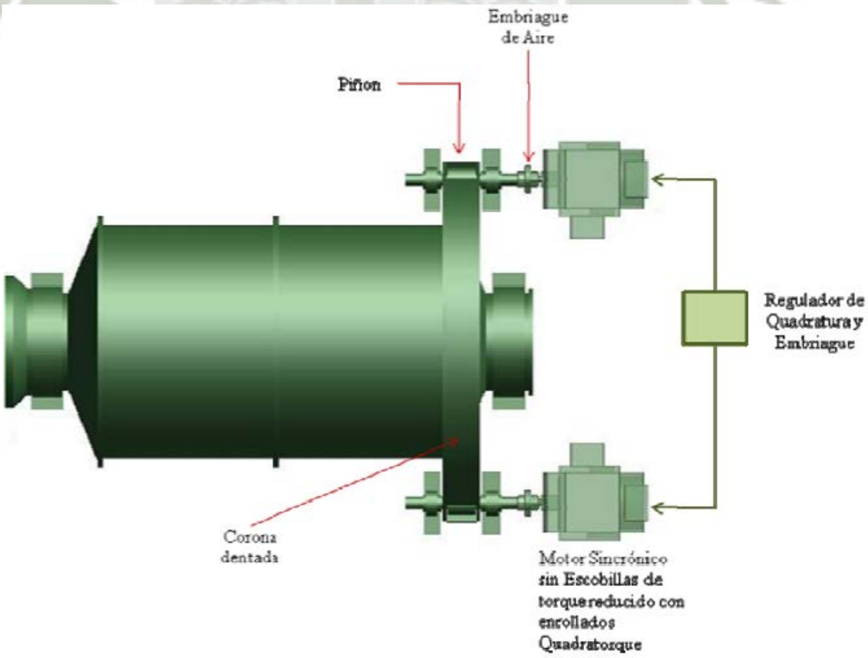


Fig.2.11.- Accionamiento Quadramatic

Fuente: FLSmidth

2.5.3 Accionamiento por Motores Asincrónicos

Las maquinas asincrónicas o de inducción son máquinas de corriente alterna, utilizadas principalmente como motores, en cuyo caso el funcionamiento básico consiste en alimentar el enrollado trifásico del estator desde una fuente trifásica para producir un campo magnético rotatorio, de la misma forma que una maquina sincrónica, este campo rotatorio induce corrientes alternas en el enrollado del rotor produciéndose así un toque motriz en el eje de la máquina.

Los motores de inducción son divididos en dos grupos dependiendo de la construcción del rotor: rotor bobinado y jaula de ardilla, siendo el primero un bobinado trifásico accesible mediante escobillas, en cambio el rotor de jaula de ardilla está constituido por una serie de conductores metálicos dispuestos paralelamente unos a otros, y cortocircuitados en sus extremos por unos anillos metálicos.

2.5.3.1 Motor Jaula de Ardilla

Estos motores de inducción se caracterizan por ser de alta velocidad, por lo cual es necesaria la instalación de reductores de velocidad a modo de reducir la velocidad del molino. El sistema consiste en un modelo europeo típico utilizando motores de inducción de este tipo, véase el detalle en la Fig.2.12.

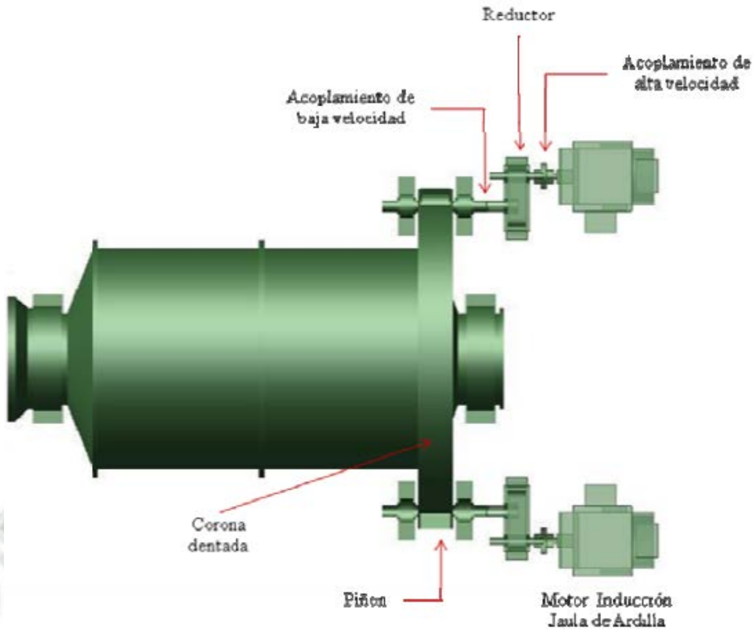


Fig.2.12.- Configuración motor Jaula de Ardilla

Fuente: FLSmidth

Beneficios:

- No es necesario la instalación de embriagues para el arranque.
- Fácil mantenimiento.
- Confiables.

Desventajas:

- Es necesario un arreglo de engranajes.
- Es necesario la instalación de reductores de velocidad
- Depende de condensadores para la regular el factor de potencia.

2.5.3.2 Motor Rotor Bobinado

Esta configuración consta de dos motores de inducción de rotor bobinado conectados a un reductor de velocidad mediante acoplamientos de alta velocidad, que a su vez el reductor es conectado a un piñón utilizando un acoplamiento de baja velocidad; los piñones son conectados a una corona dentada común. El arranque de los motores se realiza mediante un sistema de reóstatos líquidos que al alcanzar la velocidad sincrónica, cortocircuita las tres fases del rotor. El sistema para compartir la carga es similar al utilizado por dos motores DC, véase Fig.2.13.

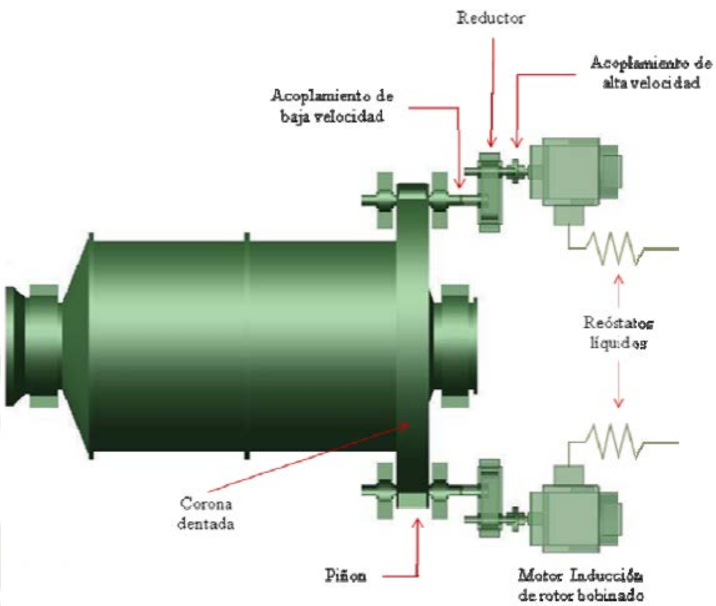


Fig.2.13.- Configuración motor de Rotor Bobinado

Fuente: FLSmidth

Beneficios:

- Bajo costo de inversión inicial.
- Fácil mantención
- Altamente confiables.

Desventajas:

- No utiliza control de velocidad.
- Necesita de un sistema de reóstatos líquidos para el arranque.

2.5.4 Accionamiento sin Engranajes o Gearless Mill Drive (GMD)

Es utilizado para satisfacer las crecientes demandas de procesamiento de minerales de alto rendimiento. Este tipo de accionamiento eléctrico sin engranajes (Gearless) mediante motores anillo son utilizando en molinos Semiautógenos (SAG) y de bolas de gran potencia.

Este método elimina toda componente mecánica en el sistema de accionamiento de los molinos mencionados, como la corona dentada, piñones, caja de engranajes, acoplamiento, eje de motores, descansos, entre otros.

El accionamiento Gearless consiste en un motor sincrónico diseñado para operar a bajas velocidades, las cuales serán variables, será controlado mediante una fuente de Cicloconversores (CCV). El rotor del motor es a su vez el molino, es decir, los polos del rotor son adosados alrededor de la estructura cilíndrica del molino. El estator es montado en la base del cilindro rodeando el rotor. De esta manera, toda la potencia del accionamiento del molino es transmitida magnéticamente en una interfaz de polos, observables en el detalle de la esquina superior izquierda de la Fig.2.14.

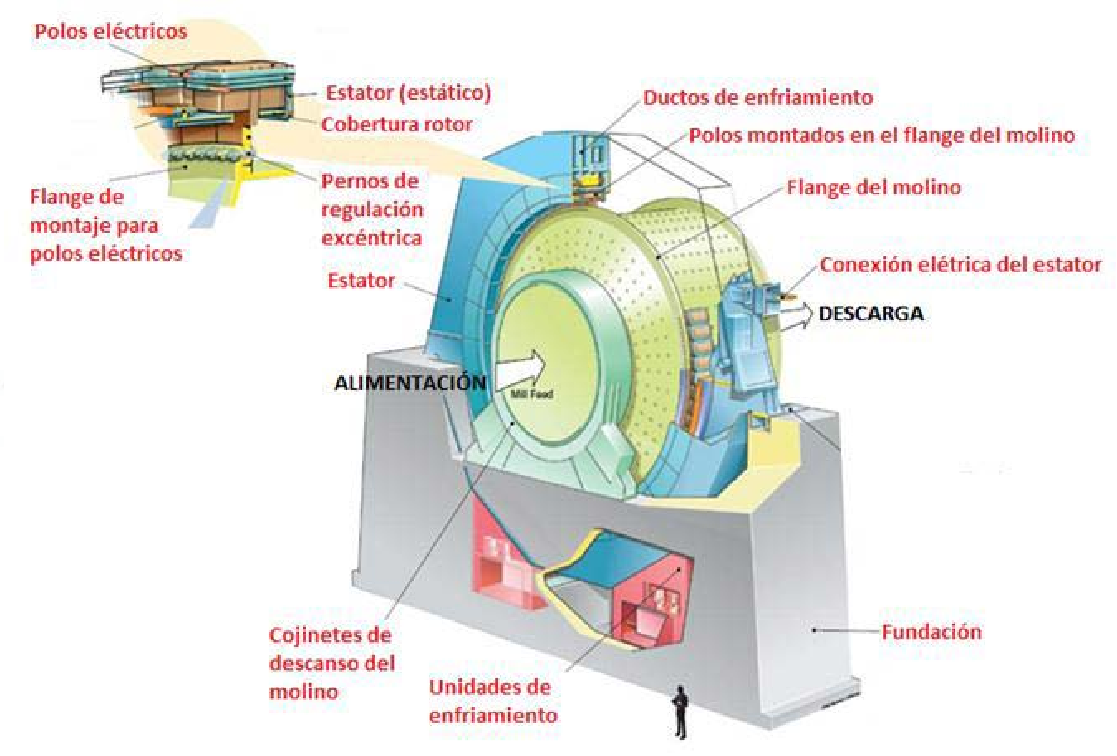


Fig.2.14.- Accionamiento Gearless

Fuente: FLSmidth

Este tipo de accionamiento es utilizado en los molinos SAG y molinos de Bolas del proyecto Antapaccay, debido que su potencia nominal se encuentra entre 15 - 30[MW].

2.6 Sistema de Control Distribuido (DCS)

Un sistema de control distribuido, es un sistema de control aplicado, a un sistema de fabricación, proceso o cualquier sistema dinámico, en el que los elementos del tratamiento no son centrales en la localización, sino que se distribuyen a lo largo de todo el sistema con cada componente o sub-sistema controlado por uno o más controladores. Todos los sistemas de control están conectados mediante redes de comunicación y de monitorización.

Es un sistema de control modular basado en microprocesadores, que es capaz de ejecutar cualquier tipo de control de un proceso determinado. A través de módulos configurables, módulos de comunicación y módulos de entrada/salida (I/O).

El sistema de control distribuido puede adquirir grandes volúmenes de información y producir señales en tiempo real que actúen sobre el proceso. También la inclusión de estaciones de trabajo basadas en video y controladores compartidos, capaces de manejar complejas estrategias de control, conteniendo información de elementos funcionales como controladores PID, totalizadores, temporizadores, circuitos lógicos, dispositivos de cálculo, etc.

Por lo tanto se define como un sistema abierto, que permite la integración de equipos de distintos fabricantes que realicen una función específica, donde realiza la función de canalizador de todos los datos recogidos para transmitirlos a todos los usuarios mediante líneas de comunicación de alta velocidad. Se establece una comunicación cliente – servidor.

En la Fig.2.15 se muestra la comparación entre un sistema de control centralizado y un Distribuido.

Este sistema incluye interfaces humano maquina (HMI) para la operación y ejecución de comandos del proceso.

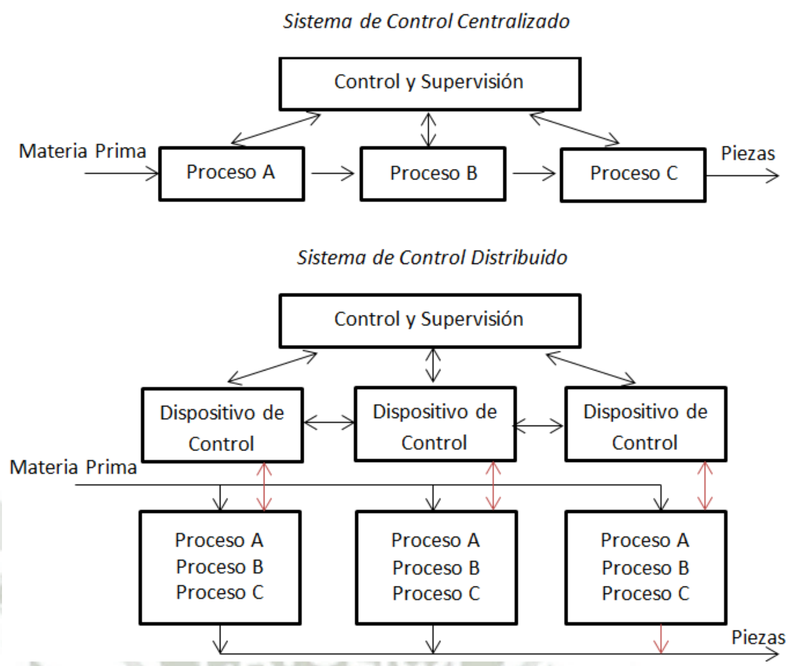


Fig.2.15.- Comparación de Sistemas de Control Centralizado y un Distribuido

Fuente: Propia

2.6.1 Arquitectura de un sistema de control distribuido

Los sistemas de control distribuido están formados por varios niveles de control, los cuales trabajan en conjunto a fin de ejecutar tareas complejas con la mayor efectividad posible y el máximo aprovechamiento en el uso de recursos. En la Fig.2.16 se representa la arquitectura de un sistema de control distribuido.

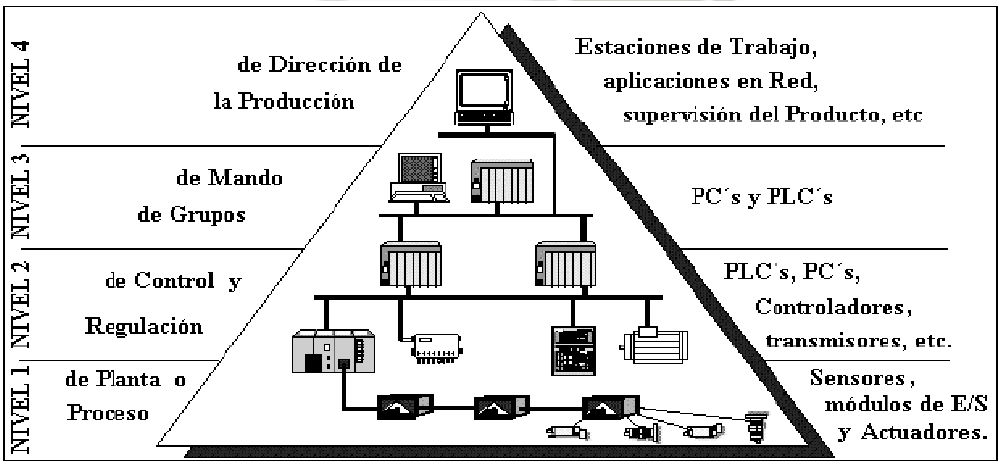


Fig.2.16.- Arquitectura de un sistema de control distribuido

Fuente: Internet

El nivel 1, o nivel de planta, es aquel que se encuentra físicamente en contacto con el entorno a controlar. Se utilizan sensores, actuadores y módulos I/O, los cuales transmiten y reciben información utilizando un bus de comunicaciones. Su función principal es comunicar al DCS las condiciones del proceso en todo momento y realizar ajustes de acuerdo a la lógica de control programada en niveles superiores de la arquitectura.

En el nivel 2, o nivel de control, se encuentran las interfaces de operaciones de cada uno de los procesos controlados en el nivel de planta. En este se encuentra los procesadores de control y las estaciones de trabajo donde los operadores pueden observar el proceso y tomar decisiones más vinculadas al mismo. En este nivel se encuentra también elementos como PLC y sistemas SCADA. Estos elementos se comunican con el DCS haciendo uso de puentes de comunicación adecuados, poniendo a disposición de los operadores toda la información adquirida del proceso.

En el nivel 3, llamado nivel de mando o de ingeniería, se encuentran las estaciones de trabajo y servidores con aplicaciones específicas que permiten controlar y supervisar la línea de producción. En este nivel se realizan las configuraciones y modificaciones a la lógica de control que regirán los procesos de los niveles inferiores. Se puede encontrar en este nivel, servidores históricos donde son almacenados todos los datos de control en planta.

En el nivel 4, llamado nivel de dirección de producción o nivel administrativo, se encuentran las estaciones de trabajo o Workstations con aplicaciones que permiten adquirir datos ubicados en los servidores del nivel 3 para analizarlos y enviarlos entre las Workstations que monitorean el proceso de producción.

Toda esta estructura de control debe estar soportada por una plataforma de comunicaciones lo suficientemente robusta como para brindar la eficiencia en la comunicación de los distintos niveles.

2.6.2 Comunicación entre los diferentes niveles en un DCS

La arquitectura de un DCS tiene forma piramidal (ver Fig.2.16). Las distintas redes de datos van desde los niveles inferiores de campo, hasta los niveles superiores de administración. Donde se puede definir en dos tipos de redes: redes de control y redes de datos. Las redes de control están ligadas a la parte baja de la pirámide, mientras que las redes de datos están ligadas a la parte alta de la pirámide.

Estas redes están basadas en tecnología Ethernet, referidas a redes de área local y dispositivos bajo el estándar IEEE 802.3, en los niveles inferiores de la arquitectura de un DCS. Esto quiere decir que existen equipos como los PLC que tienen interfaces físicas Ethernet las cuales permiten la comunicación con estaciones de trabajo encargadas de supervisión mediante un SCADA, o pueden estar conectadas directamente al nodo de control de un DCS a través de un interfaz Ethernet.

En los niveles de planta, control y mando de grupos de un DCS, se encuentran comunicaciones Profibus, Fieldbus, Hart, Modbus entre otros, que permiten la interconexión de los instrumentos con el sistema.

CAPITULO III
DISEÑO DE FILOSOFIA DE CONTROL

3.1 Circuito de Molienda SAG

La planta de molienda contempla un acopio abierto de 55,000 [t] de capacidad viva provista de cuatro alimentadores de placas (Apron Feeder 0240-FEA-0005 al 0008) para la recuperación de mineral desde la pila de acopio, tres en operación continua y un equipo en standby, indistintamente. El circuito de molienda está compuesto por un molino SAG de 12.2 m x 6.7m (40 x 22 pies) (0310.MLS-0001) de 24 [MW], provisto de un tromel corto, cuyo sobre tamaño alimenta al harnero vibratorio (0310-SCR-0001) de doble parilla de 3.7 x 7.3m (12 x 24 pies), para la clasificación.

La clasificación, el producto grueso es conducido mediante correas hacia la planta de chancado Pebbles, mientras que el producto fino es enviado al circuido de molienda secundaria, compuesto de dos molinos de bolas de 7.9m x 12.2m (26 x 40 pies) (0310.MLB-0001 & 0002) cada uno operando en circuito cerrado inverso con dos baterías de 12 ciclones (0310-CSC-0001 & 0002) de 823 mm (33 pulgadas) de diámetro. Cada batería de ciclones cuenta además con dos salidas adicionales (14 posiciones totales). La operación normal del proyecto Antapaccay contempla él envió de la totalidad de los Pebbles chancados a la alimentación del molino SAG.

El diseño de la planta ha considerado un tratamiento promedio de 70,000 t/d de mineral, con un esquema operacional de 365 días por año, 24 horas al día y 92 % de utilización efectiva. Se ha estimado un producto final de molienda que alimenta a flotación, con granulometría media de 80% bajo 160 micrones, y con 33 % de solidos de peso.

El diagrama completo del circuito molienda está representada con el Fig.3.1, en este capítulo solo se consideran los lazos de control del circuito1 (Molino SAG).

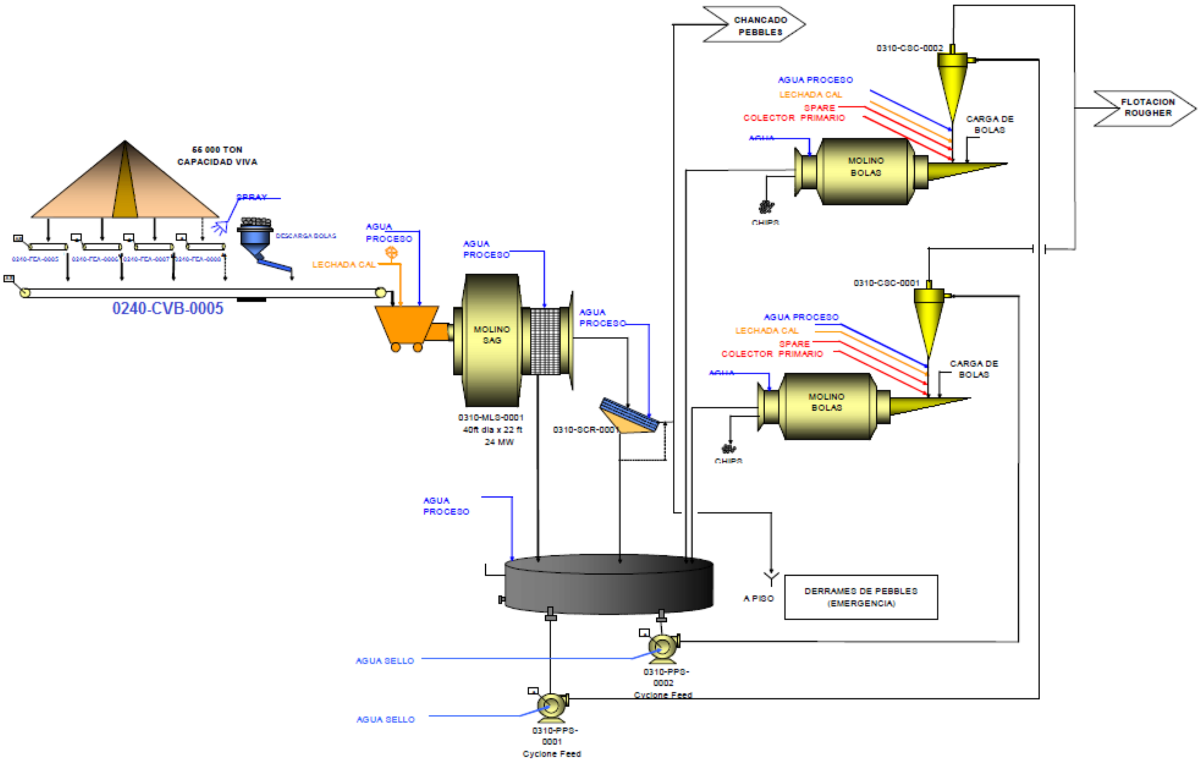


Fig.3.1.- Diagrama Esquemático de Molienda de Tintaya – Antapaccay

Fuente: Bechtel LTDA

Filosofía de Operación:

El acopio de mineral grueso es un recinto abierto con una carga viva de 55,000 [t], permitiendo una autonomía máxima cercana a 18 horas. La descarga del acopio a través de tres Apron Feeders bastara para proveer la totalidad del flujo demandado por molienda (3,170 t/h nominales y 3,646 t/h de diseño).

Alimentación molino SAG

El variador de frecuencia instalado en la correa transportadora (0240-CVB-0005) que alimenta al molino SAG tiene dos objetivos fundamentales, primero actuar como arrancador suave y segundo como herramienta de mantenimiento. La alimentación de mineral al molino SAG será controlada por medio de la variación de la velocidad de los alimentadores de placa (0240-FEA-0005 a 0008).

Carguío de Bolas molino SAG

La carga de bolas del molino SAG, el cual está provisto por dos tolvas de almacenamiento cubiertas 0240-BNC-0006 y 0007, de 400 [t] de capacidad cada una, provistas de sistemas de descarga y conteo. Estas tolvas abastecerán con bolas de 5” de diámetro, vía descarga directa del alimentador rotatorio sobre la correa de alimentación (0240-CVB-0005) del molino.

Descarga del molino SAG

El molino SAG cuenta, para su clasificación de su descarga, con un trommel corto y un harnero vibratorio 0310-SCR-0001. Ambos equipos requieren de la adición de agua de modo de efectuar una eficiente clasificación del material que será transportado a Pebbles y al Circuito Secundario. Se ha conceptuado dicha adición en forma manual, de modo que el operador de terreno debe ajustar el caudal en cada punto, siendo el objetivo la obtención de Pebbles lo más libre que sea posible sin restos de barro.

Agua de Proceso

Se contemplan tres líneas de ingreso de agua durante la alimentación del molino SAG y una línea de agua para la descarga a través del Trommel, de modo de efectuar una eficiente clasificación de los Pebbles. Se ha conceptuado dicha adición en forma manual, de modo que el operador de terreno debe ajustar el caudal en cada punto, siendo el objetivo la obtención de Pebbles más libre de barro para obtener mineral más fino.

Lechada de Cal

Cuenta con dos líneas de ingreso de cal durante la alimentación del molino SAG, cada una con un diámetro de 1 ½ “. El control es a través de una relación entre el peso vs flujo que determinara la actuación de cada una de las válvulas.

3.2 Lazos de Control Molienda SAG

3.2.1 Lazo de Control – Alimentación de Carga de Mineral Faja 5

Está compuesto por cuatro Apron Feeders o alimentadores de acopio que abastecerán de carga de mineral a la faja 0240-CVB-0005. Conformado por el transmisor 0240-WIT-01140 encargado de medir el peso de la carga de mineral, estas señales ingresan al controlador 0240-WIC-01140, donde la señal de salida controlara la variación de velocidad de cada motor 0240-FEA-0005-M1 a 0008-M1.

La filosofía de control contempla cuatro lazos de control.

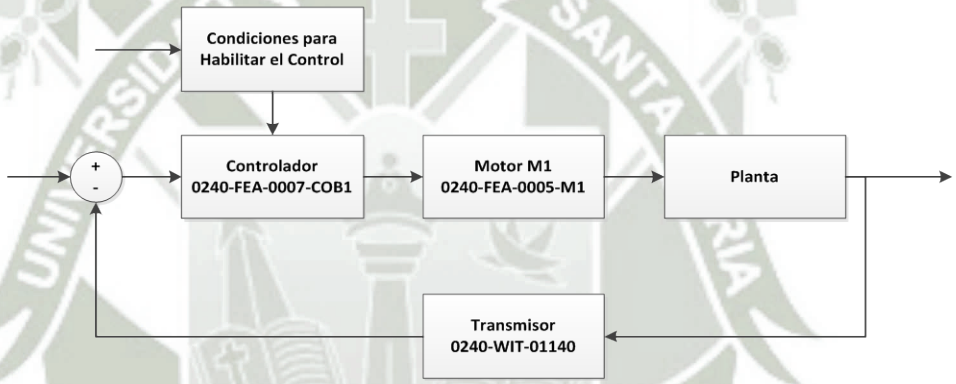


Fig.3.2.- Diagrama de Bloques Apron Feeder 0240-FEA-0005

Fuente: Elaboración Propia

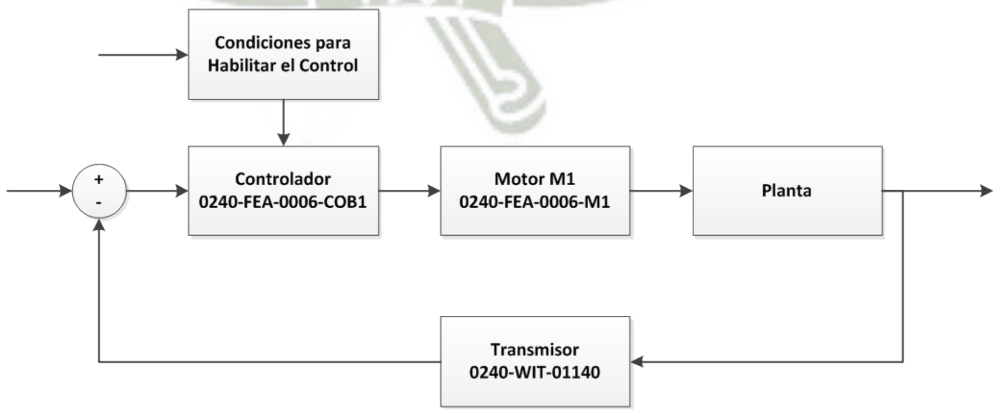


Fig.3.3.- Diagrama de Bloques Apron Feeder 0240-FEA-0006

Fuente: Elaboración Propia

Para que los controladores de los Apron Feeders estén habilitados es necesario cumplir las siguientes condiciones:

- Sensores de Atoro desbloqueados.
- Sensores de Velocidad deben medir una velocidad minina de 1000ppm.
- No detectar el desalineamiento a lo largo de la Faja 5 a través de los Pull-Cord.

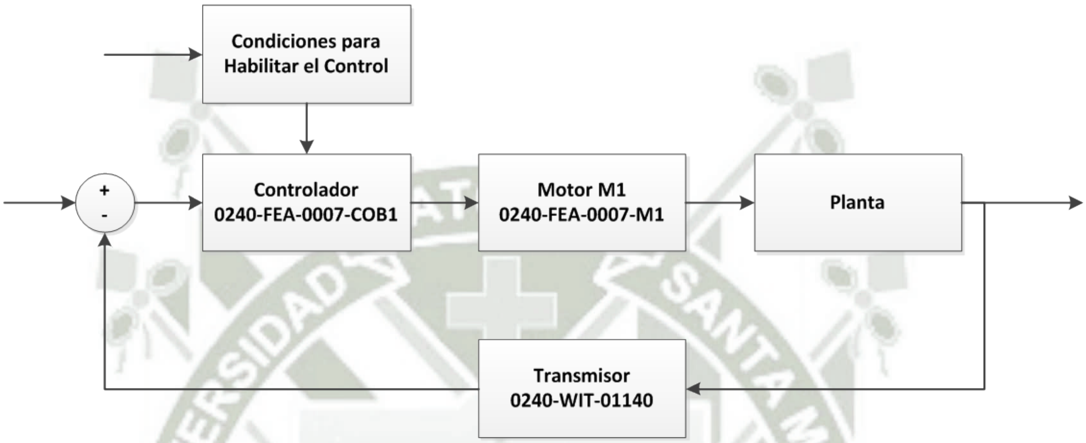


Fig.3.4.- Diagrama de Bloques Apron Feeder 0240-FEA-0007

Fuente: Elaboración Propia

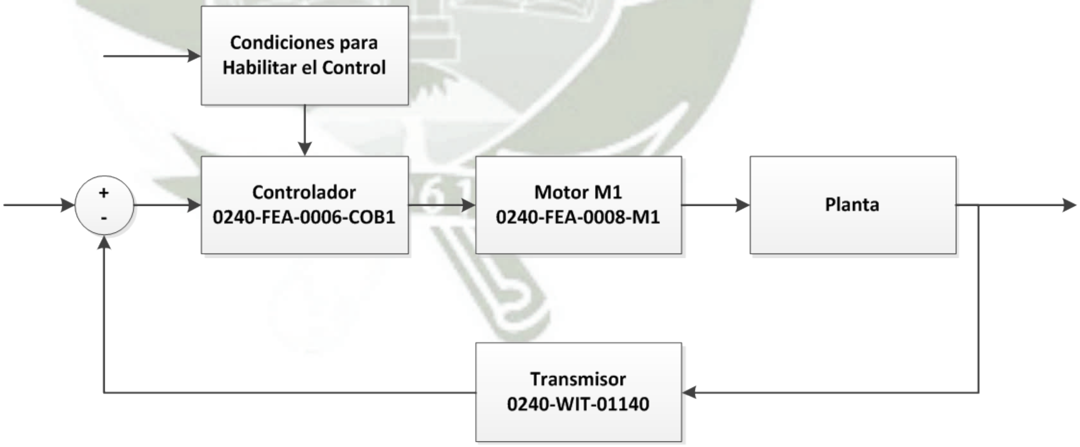


Fig.3.5.- Diagrama de Bloques Apron Feeder 0240-FEA-0008

Fuente: Elaboración Propia

3.2.2 Lazo de Control – Carguío de Bolas

Está compuesto por dos tolvas 0240-BNC-0006 y 0240-BNC-0007 que abastecerán bolas de 5” de diámetro hacia el molino SAG, vía descarga directa del alimentador rotatorio sobre la faja 0240-CVB-0005 por acción de los motores 0240-FET-0005-M1 y 0240-FET-0006-M1. La cantidad de bolas es controlada a través del transmisor de potencia 0310-JIT-01220, dentro del controlador existe una función que determina el porcentaje de bolas que debe tener el molino SAG el cual no puede exceder del 30% de la carga de mineral.
A esto se lo conoce como el método de inferencia en base a la potencia, donde se mide el nivel de llenado volumétrico de carga total versus el consumo de potencia.

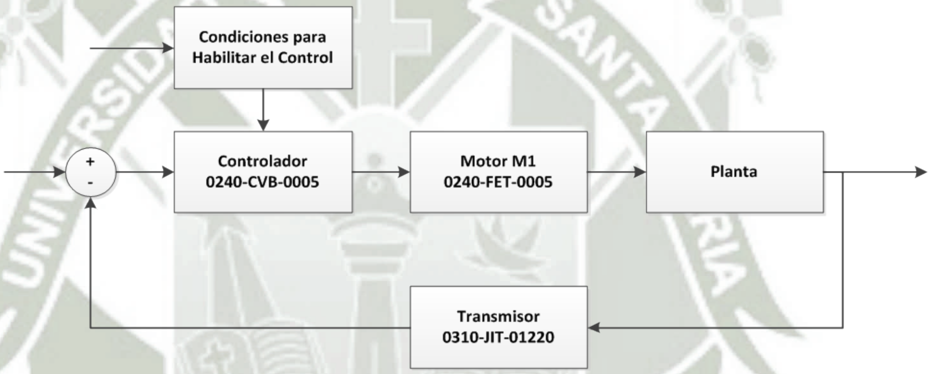


Fig.3.6.- Diagrama de Bloques Tolva alimentadora 0240-FET-0005

Fuente: Elaboración Propia

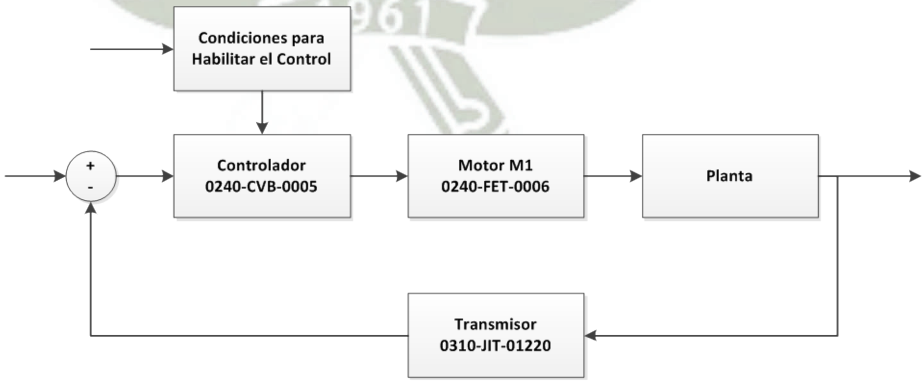


Fig.3.7.- Diagrama de Bloques Tolva alimentadora 0240-FET-0006

Fuente: Elaboración Propia

3.2.3 Lazo de Control – Agua de Proceso

Las válvulas 0310-FV-01202, 0310-FV-01202B y 0310-FV-01202C regularan el ingreso de agua al molino SAG para controlar el porcentaje de solidos a través del controlador 0310-FIC-01202.

Este lazo de control, utiliza un control en relación compuesto por el transmisor 0240-WIT-01140 encargado de medir el peso de la faja de alimentación del Molino SAG 0240-CVB-0005 y el transmisor 0310-FIT-01202 encargado de controlar el flujo de agua de Proceso. Mediante una relación del 0310-FY-01202 se obtiene una escala de peso vs flujo que determinara la apertura de las válvulas, los porcentajes de apertura están entre el 20% y 30%.

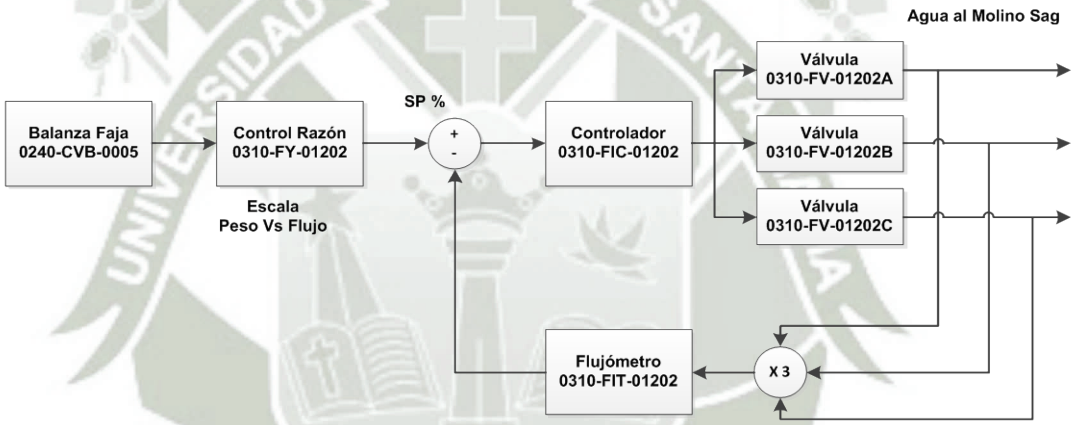


Fig.3.8.- Diagrama de Bloques Proceso de Agua de Alimentación Molino SAG

Fuente: Elaboración Propia

3.2.4 Lazo de Control – Lechada de Cal

Este control tiene como objetivo regular los flujos de Cal de ingreso al Molino SAG a través de dos líneas de alimentación:

El flujo de la línea 1 (tubería 221) es censada por el transmisor 0310-FIT-01201A, la señal será enviada al controlador 0310-FIC-01201A, que tiene como objetivo mantener un flujo constante para permitir un buen control del pH. La salida de controlador regula la apertura de la válvula 0310-FV-01201A permitiendo la descarga de lechada de cal hacia el Molino SAG.

La línea 2 trabaja de manera similar a la línea 1, pero ambas compuestas por controladores independientes. El flujo de línea 2 (tubería 226) es censada por el transmisor 0310-FIT-01201B, la señal será enviada al controlador 0310-FIC-01201B que tomara acción sobre la apertura de la válvula 0310-FV-01201B.

Este lazo de control, utiliza un control en relación, compuesto por el transmisor 0240-WIT-01140 encargado de medir el peso de la faja de alimentación del Molino SAG 0240-CVB-0005 y los transmisores 0310-FIT-01201A y 0310-FIT-01202B encargados de controlar el flujo de Lechada de Cal. Mediante una relación del 0310-FY-01201 se obtiene una escala de peso vs flujo que determinara la apertura de las válvulas, los porcentajes de apertura están entre el 35% y 45%.

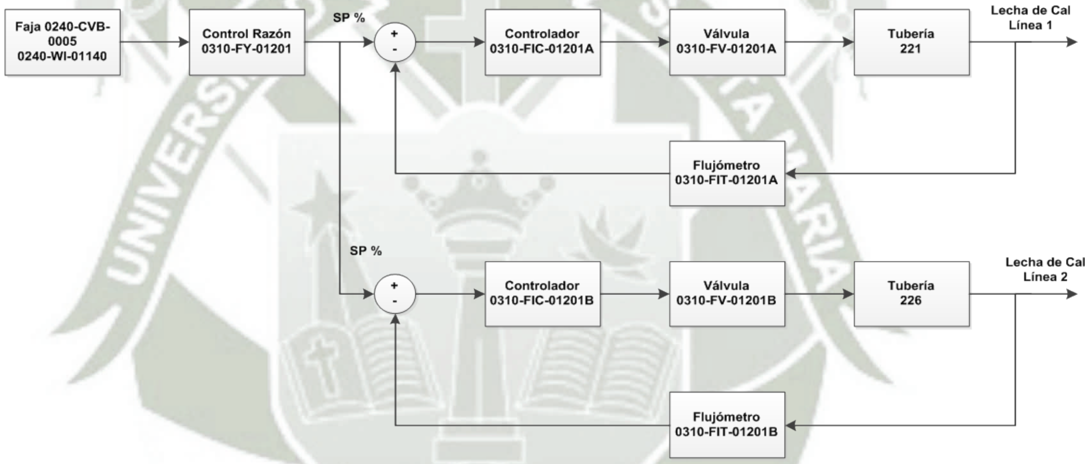


Fig.3.9.- Diagrama de Bloques Lechada de Cal

Fuente: Elaboración Propia

3.2.5 Lazo de Control – Alimentación de Carga Fresca Molino SAG

Este lazo de control en cascada tiene como objetivo regular la potencia del molino SAG según el ingreso de carga de mineral con el fin de ahorrar energía.

Está compuesto por dos lazos:

Lazo interno que regula la velocidad de la faja 5, donde la señal es censada por el transmisor 0240-WIT-01140, esta señal es enviada al controlador 0240-WIC-

01140. La señal de salida del controlador ajustara la velocidad del motor 0240-CVB-0005-M1.

Y el lazo externo que regula la potencia del molino SAG, la señal es censada por el transmisor 0310-JIT-01220, la señal es enviada al controlador Vendor SAG. La señal de salida del controlador ajustara la potencia del molino.

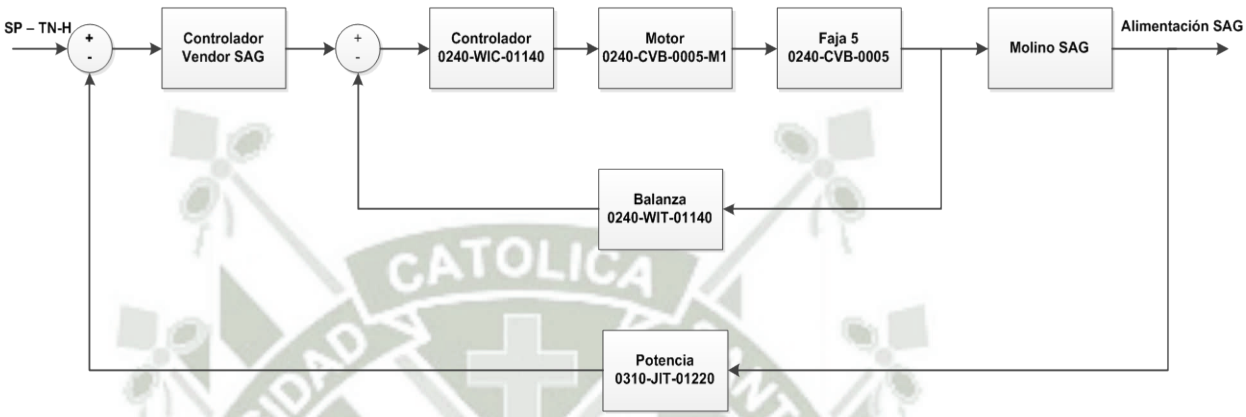


Fig.3.10.- Diagrama de Bloques Alimentación de Carga Fresca Molino SAG

Fuente: Elaboración Propia

3.2.6 Lazo de Control – Descarga de Mineral Molino SAG

Este lazo tiene como objetivo mantener la vibración una uniforme para la clasificación de mineral. La vibración es censada por los transmisores 0310-VT-01292 y 01293 y la señal enviada al controlador Vendor SCR-1.

La salida del controlador regulara la potencia del motor 0310-SCR-0001-M1.

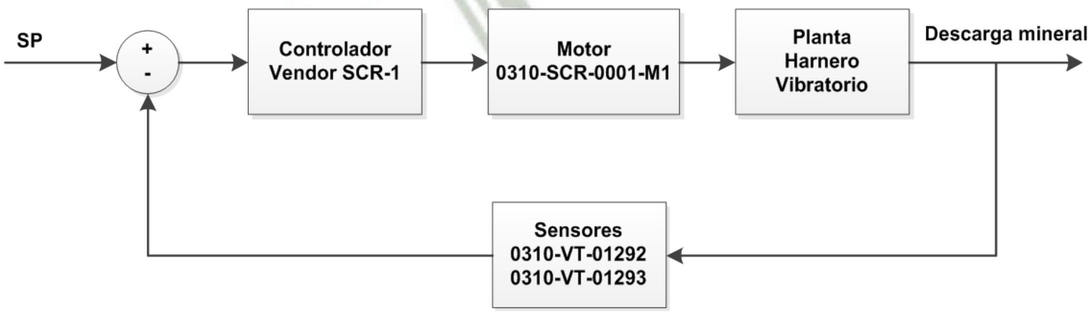


Fig.3.11.- Diagrama de Bloques Descarga de Mineral Molino SAG

Fuente: Elaboración Propia

CAPITULO IV

DISEÑO DE ESTRATEGIA DE CONTROL

4.1 Diagrama de Proceso e Instrumentación (P&ID)

Partiendo del Diagrama Esquemático Fig.3.1 identificamos los procesos que actúan sobre el molino SAG, como carguío de bolas, lechada de cal, agua de proceso, alimentadores de acopio y alimentación de carga.

Por lo tanto en este capítulo se mostraran los P&IDs de los procesos mencionados en los cuales se muestra a detalle de instrumentación, tanto en forma de monitoreo, como permisivos o funcionamiento como variables de proceso en lazos de control junto los elementos de control como las válvulas proporcionales.

También se especifica el diámetro de las tuberías para las diferentes líneas (lechada de cal y agua de proceso), instrumentos locales (manómetros, etc), elementos mecánicos (válvulas manuales, etc) y elementos de control (detalle de los Vendor).

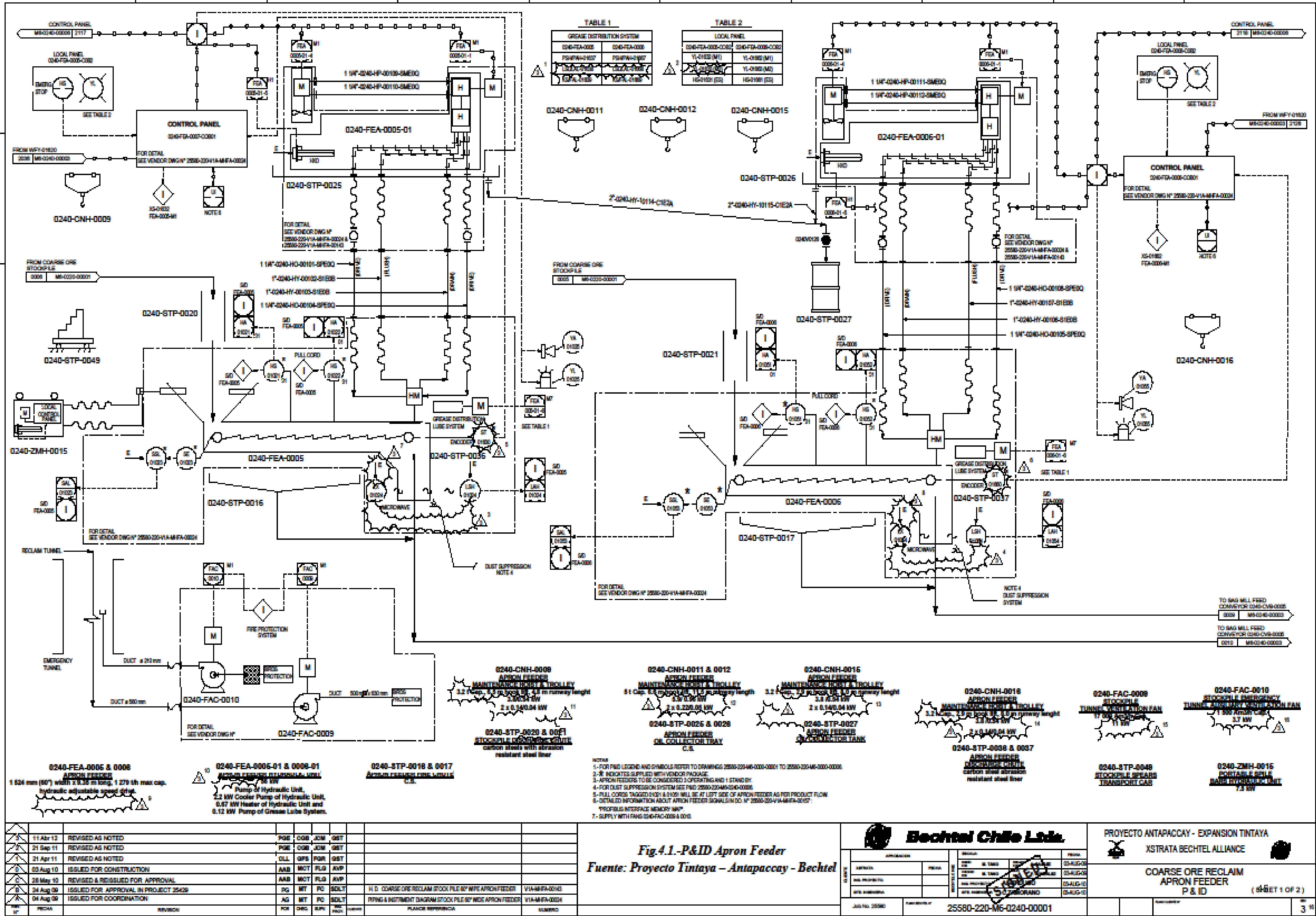


Fig.4.1.-P&ID Apron Feeder

Fuente: Proyecto Tintaya – Antapaccay - Bechtel

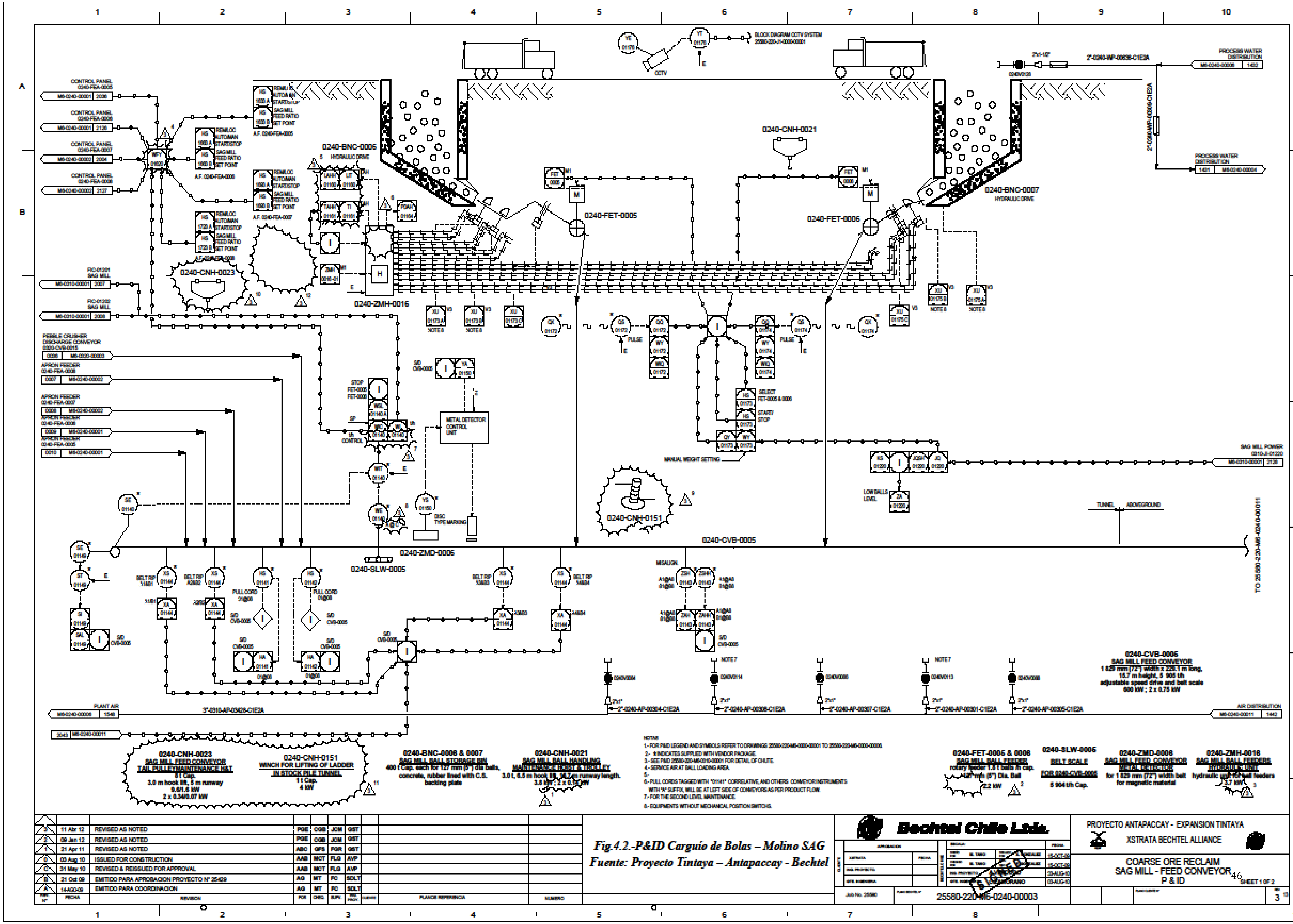


Fig.4.2.-P&ID Carguío de Bolas – Molino SAG
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

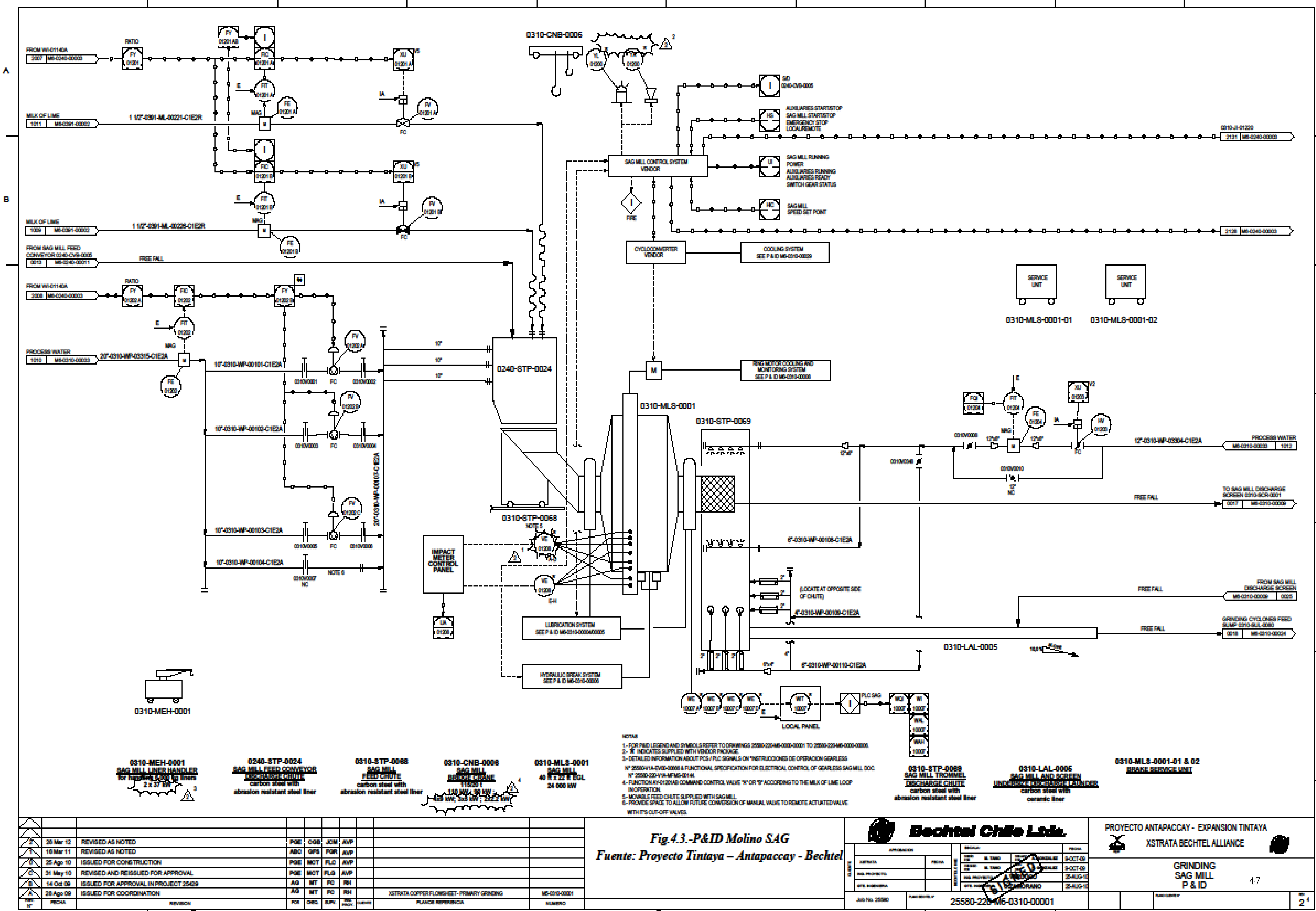
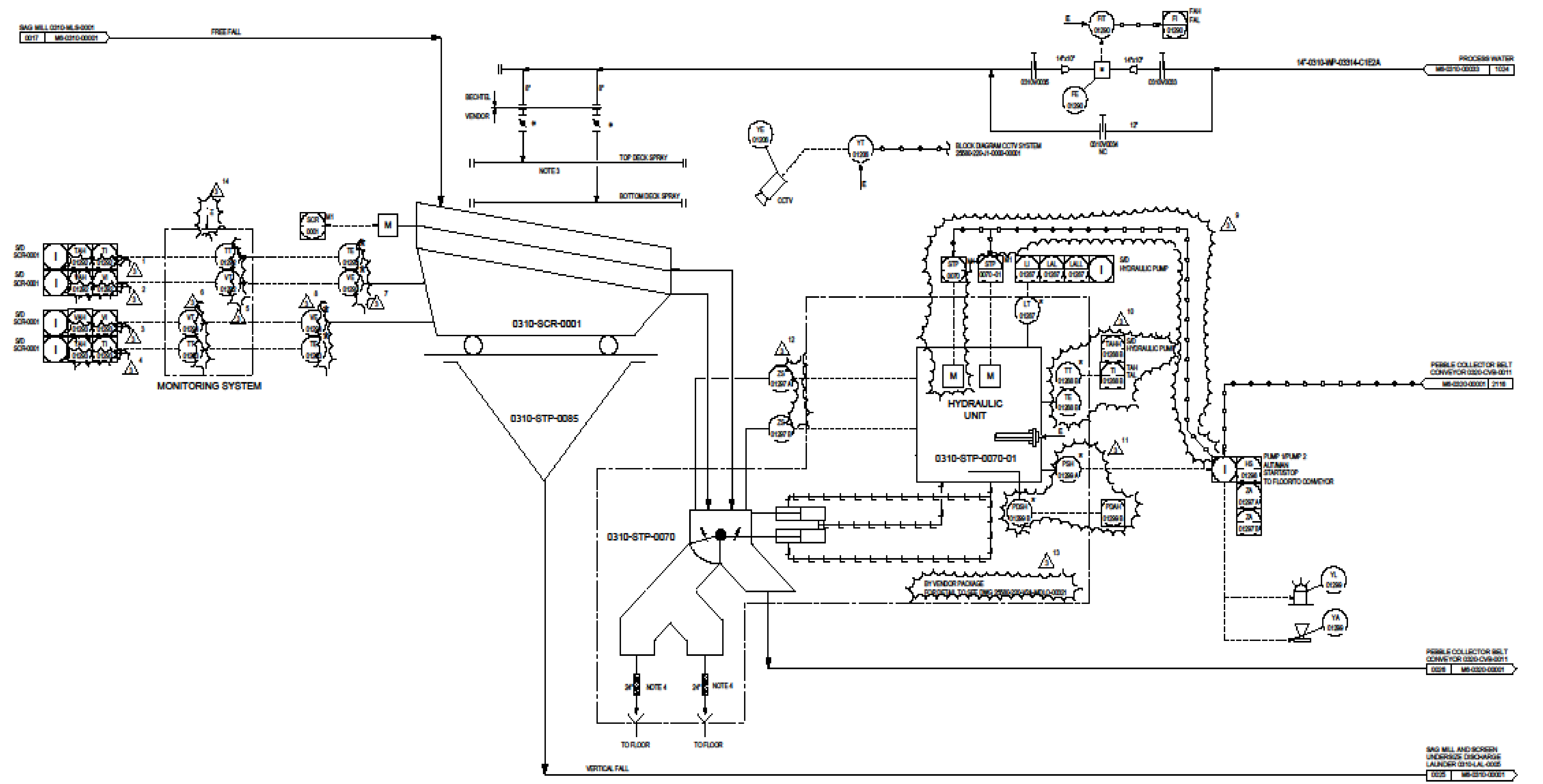


Fig.4.3.-P&ID Molino SAG

Fuente: Proyecto Tintaya – Antapaccay - Bechtel



0310-SCR-0001
SAG MILL
DISCHARGE SCREEN
3.7m x 7.3m Cap. 1 619 t/h
double deck vibration screen type
75 kW

0310-STP-0070
SCREEN OVERSIZE
DISCHARGE CHUTE
Carbon steel, rubber lined.

NOTAS

1.- FOR P&ID LEGEND AND SYMBOLS REFER TO DRAWINGS 25580-220-M6-0000-00001 TO 25580-220-M6-0000-00006.

2.- ★ INDICATES SUPPLIED WITH VENDOR PACKAGE.

3.- SEE VENDOR DRAWING 2654-4050180A (VP 25580-220-V1A-MFSS-00004) FOR DETAILS OF SPRAY BARS.

4.- HOSES INCLUDED IN THE SUPPLY OF CHUTE.

0310-STP-0070-01
GATE HYDRAULIC UNIT FOR SCREEN
OVERSIZE DISCHARGE CHUTE
1.5 kW

0310-STP-0085
SAG MILL SCREEN UNDERSIZE
DISCHARGE CHUTE
Carbon steel, rubber lined

REV. N°	FECHA	REVISION	POR	CHEQ.	SUPV.	ING. PROY.	CLIENTE
3	28 Mar 12	REVISED AS NOTED	PGE	OGB	JCM	GST	
2	20 Jun 11	REVISED AS NOTED	CLL	OGB	FGR	GST	
1	28 Mar 11	REVISED AS NOTED	ABC	GFS	FGR	GST	
0	08 Oct 10	ISSUED FOR CONSTRUCTION	ABC	MCT	FGR	AVP	
C	03 Sep 10	REVISED AND REISSUED FOR APPROVAL	VSM	MCT	FGR	AVP	
B	21 Oct 09	ISSUED FOR APPROVAL IN PROJECT N° 25409-220-M6-0310-10009	AG	MT	FC	SDLT	
A	28 Aug 09	ISSUED FOR COORDINATION	AG	MT	FC	SDLT	

PLANOS REFERENCIA	NUMERO
XSTRATA COPPER FLOWSHEET- PRIMARY GRINDING	M6-0310-00001

Fig.4.4.-P&ID Harnero Vibratorio
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

Bechtel Chile Ltda.

PROYECTO ANTAPACCAY - EXPANSION TINTAYA
XSTRATA BECHTEL ALLIANCE
GRINDING
SAG MILL OVERSIZE PRODUCT SCREEN
P & ID

Job No. 25580
25580-220-M6-0310-00009
3

4.2 Tabla de referencia

En las siguientes tablas de referencia se detallara los elementos que integran cada lazo de control a implementar y la descripción de cada uno.

CONTROL DE ALIMENTACIÓN DE MINERAL FAJA 5 – 0240-FEA-0005	
ELEMENTOS DE LAZO DE CONTROL	
TAG	**DESCRIPCIÓN**
0240-WIT-01140	Transmisor de Peso en faja 5
0240-WIC-01140	Control de Peso de faja 5
0240-FEA-0007-COB1	Controlador Vendor
0240-FEA-0005-M1	Motor de accionamiento Apron Feeder
0240-SE-01023	Detector de Velocidad Inductivo Apron Feeder
0240-ST-01630	Transmisor Encoder Apron Feeder
0240-LX/LSH-01024	Level Switch Alto Microwave Chute de Descarga Apron Feeder
0240-HS-01021	Pull-Cord - Switch Apron Feeder
0240-HS-01022	Pull-Cord - Switch Apron Feeder
DESCRIPCIÓN DEL LAZO	
El transmisor 0240-WIT-01140 mide el peso de carga de ingreso al Molino SAG y manda la señal de control al controlador 0240-WIC-01140 quien enviara los comandos de control hacia el controlador Vendor quien controla al motor 0240-FEA-0005-M1. Para que se habilite el control se necesita tener las condiciones iniciales del detector de velocidad 0240-SE-01023, el status del Encoder 0240-ST-01630 que debe mantener una velocidad mínima de 1000 ppm y los Pull-Cord 0240-HS-01021/01022 que determinan el alineamiento del Apron Feeder, sin estas condiciones el motor no será accionado. Observaciones: Diagrama P&ID Lógica de Control – Infusion Invensys	

Tabla.4.1.- Control de Alimentación de Mineral Faja 5 – 0240-FEA-0005

Fuente: Elaboración Propia

CONTROL DE ALIMENTACIÓN DE MINERAL FAJA 5 – 0240-FEA-0006	
ELEMENTOS DE LAZO DE CONTROL	
TAG	**DESCRIPCIÓN**
0240-WIT-01140	Transmisor de Peso en faja 5
0240-WIC-01140	Control de Peso de faja 5
0240-FEA-0006-COB1	Controlador Vendor
0240-FEA-0006-M1	Motor de accionamiento Apron Feeder
0240-SE-01053	Detector de Velocidad Inductivo Apron Feeder
0240-ST-01660	Transmisor Encoder Apron Feeder
0240-LX/LSH-01054	Level Switch Alto Microwave Chute de Descarga Apron Feeder
0240-HS-01051	Pull-Cord - Switch Apron Feeder
0240-HS-01052	Pull-Cord - Switch Apron Feeder
DESCRIPCIÓN DEL LAZO	
El transmisor 0240-WIT-01140 mide el peso de carga de ingreso al Molino SAG y manda la señal de control al controlador 0240-WIC-01140 quien enviara los comandos de control hacia el controlador Vendor quien controla al motor 0240-FEA-0006-M1. Para que se habilite el control se necesita tener las condiciones iniciales del detector de velocidad 0240-SE-01053, el status del Encoder 0240-ST-01660 que debe mantener una velocidad mínima de 1000 ppm y los Pull-Cord 0240-HS-01521/01052 que determinan el alineamiento del Apron Feeder, sin estas condiciones el motor no será accionado. Observaciones: Diagrama P&ID Lógica de Control – Infusion Invensys	

Tabla.4.2.- Control de Alimentación de Mineral Faja 5 – 0240-FEA-0006

Fuente: Elaboración Propia

CONTROL DE ALIMENTACIÓN DE MINERAL FAJA 5 – 0240-FEA-0007	
ELEMENTOS DE LAZO DE CONTROL	
TAG	**DESCRIPCIÓN**
0240-WIT-01140	Transmisor de Peso en faja 5
0240-WIC-01140	Control de Peso de faja 5
0240-FEA-0007-COB1	Controlador Vendor
0240-FEA-0007-M1	Motor de accionamiento Apron Feeder
0240-SE-01083	Detector de Velocidad Inductivo Apron Feeder
0240-ST-01690	Transmisor Encoder Apron Feeder
0240-LX/LSH-01084	Level Switch Alto Microwave Chute de Descarga Apron Feeder
0240-HS-01081	Pull-Cord - Switch Apron Feeder
0240-HS-01082	Pull-Cord - Switch Apron Feeder
DESCRIPCIÓN DEL LAZO	
El transmisor 0240-WIT-01140 mide el peso de carga de ingreso al Molino SAG y manda la señal de control al controlador 0240-WIC-01140 quien enviara los comandos de control hacia el controlador Vendor quien controla al motor 0240-FEA-0007-M1. Para que se habilite el control se necesita tener las condiciones iniciales del detector de velocidad 0240-SE-01083, el status del Encoder 0240-ST-01690 que debe mantener una velocidad mínima de 1000 ppm y los Pull-Cord 0240-HS-01581/01082 que determinan el alineamiento del Apron Feeder, sin estas condiciones el motor no será accionado. Observaciones: Diagrama P&ID Lógica de Control – Infusion Invensys	

Tabla.4.3.- Control de Alimentación de Mineral Faja 5 – 0240-FEA-0007

Fuente: Elaboración Propia

CONTROL DE ALIMENTACIÓN DE MINERAL FAJA 5 – 0240-FEA-0008	
ELEMENTOS DE LAZO DE CONTROL	
TAG	**DESCRIPCIÓN**
0240-WIT-01140	Transmisor de Peso en faja 5
0240-WIC-01140	Control de Peso de faja 5
0240-FEA-0008-COB1	Controlador Vendor
0240-FEA-0008-M1	Motor de accionamiento Apron Feeder
0240-SE-01113	Detector de Velocidad Inductivo Apron Feeder
0240-ST-01720	Transmisor Encoder Apron Feeder
0240-LX/LSH-01114	Level Switch Alto Microwave Chute de Descarga Apron Feeder
0240-HS-01111	Pull-Cord - Switch Apron Feeder
0240-HS-01112	Pull-Cord - Switch Apron Feeder
DESCRIPCIÓN DEL LAZO	
El transmisor 0240-WIT-01140 mide el peso de carga de ingreso al Molino SAG y manda la señal de control al controlador 0240-WIC-01140 quien enviara los comandos de control hacia el controlador Vendor quien controla al motor 0240-FEA-0008-M1. Para que se habilite el control se necesita tener las condiciones iniciales del detector de velocidad 0240-SE-01113, el status del Encoder 0240-ST-01720 que debe mantener una velocidad mínima de 1000 ppm y los Pull-Cord 0240-HS-01111/01112 que determinan el alineamiento del Apron Feeder, sin estas condiciones el motor no será accionado. Observaciones: Diagrama P&ID Lógica de Control – Infusion Invensys	

Tabla.4.4.- Control de Alimentación de Mineral Faja 5 – 0240-FEA-0008

Fuente: Elaboración Propia

CONTROL DE ALIMENTACIÓN DE BOLAS – 0240-FET-0005	
ELEMENTOS DE LAZO DE CONTROL	
TAG	**DESCRIPCIÓN**
0310-JIT-01220	Transmisor de Potencia Molino SAG – 0310-MLS-0001
0240-CVB-0005-COB	Controlador Vendor Faja 5
0240-QS-01172	Detector Contador de Bolas Alimentación de Bolas SAG
0240-QX-01172	Detector Espejo de Bolas Alimentación de Bolas SAG
0240-QQ-01172	Contador Totalizador de Bolas
0240-HS-01173	Selector de Tolva de alimentación en modo manual
0240-WY-01173	Conversor de Peso – según la potencia del Molino SAG
0240-QY-01173	Conversor de Cantidad – acción manual
0240-FET-0005-M1	Motor de accionamiento de tolva 5
DESCRIPCIÓN DEL LAZO	
A través del selector manual, definimos con que tolva se desea trabajar, esto es una condición inicial para que recibe el controlador Vendor 0240CVB-0005-COB. La señal del controlador actuara sobre el motor 0240-FET-0005-M1 quien suministrara bolas. El control trabaja a través del contador de bolas 0240-QQ-01172 y el transmisor de potencia 0310-JIT-01220, quienes determinan la cantidad de ingreso de bolas al Molino SAG, a través del conversor de peso 0240-WY-01173. Observaciones: Diagrama P&ID Lógica de Control – Infusion Invensys	

Tabla.4.5.- Control de Alimentación de Mineral Faja 5 – 0240-FET-0005

Fuente: Elaboración Propia

CONTROL DE ALIMENTACIÓN DE BOLAS – 0240-FET-0006	
ELEMENTOS DE LAZO DE CONTROL	
TAG	**DESCRIPCIÓN**
0310-JIT-01220	Transmisor de Potencia Molino SAG – 0310-MLS-0001
0240-CVB-0005-COB	Controlador Vendor Faja 5
0240-QS-01174	Detector Contador de Bolas Alimentación de Bolas SAG
0240-QX-01174	Detector Espejo de Bolas Alimentación de Bolas SAG
0240-QQ-01174	Contador Totalizador de Bolas
0240-HS-01173	Selector de Tolva de alimentación en modo manual
0240-WY-01173	Conversor de Peso – según la potencia del Molino SAG
0240-QY-01173	Conversor de Cantidad – acción manual
0240-FET-0006-M1	Motor de accionamiento de tolva 5
DESCRIPCIÓN DEL LAZO	
A través del selector manual, definimos con que tolva se desea trabajar, esto es una condición inicial para que recibe el controlador Vendor 0240-CVB-0005-COB. La señal del controlador actuara sobre el motor 0240-FET-0006-M1 quien suministrara bolas. El control trabaja a través del contador de bolas 0240-QQ-01174 y el transmisor de potencia 0310-JIT-01220, quienes determinan la cantidad de ingreso de bolas al Molino SAG, a través del conversor de peso 0240-WY-01173. Observaciones: Diagrama P&ID Lógica de Control – Infusion Invensys	

Tabla.4.6.- Control de Alimentación de Mineral Faja 5 – 0240-FET-0006

Fuente: Elaboración Propia

CONTROL DE FLUJO DE AGUA FRESCA – MOLINO SAG	
ELEMENTOS DE LAZO DE CONTROL	
TAG	**DESCRIPCIÓN**
0310-FIT-01202	Transmisor de Flujo – agua de proceso 0310-MLS-0001
0310-FIC-01202	Controlador de Flujo – agua de proceso 0310-MLS-0001
0310-FV-01202A	Válvula de Control por Segmento - agua de proceso
0310-FV-01202B	Válvula de Control por Segmento - agua de proceso
0310-FV-01202C	Válvula de Control por Segmento - agua de proceso
0310-FY-01202A	Escalamiento Peso vs Flujo – Control de Relación
0310-FY-01202B	Apertura de Válvulas – agua de proceso alimentación molino SAG
0320-DIC-01202	Control de Tonelaje de alimentación del molino SAG
0240-WIT-01140	Transmisor de Tonelaje de alimentación del molino SAG.
DESCRIPCIÓN DEL LAZO	
El objetivo de este lazo es controlador el porcentaje de solido del Molino SAG. La Salida de controlador 0310-DIC-01202 dará el setpoint de referencia para controlar la apertura de las válvulas 0310-FV-01202A, 0310-FV-01202B y 0310-FV-01202C, quienes regularan el flujo de agua. EL controlador 0310-DIC-01202 está determinado por el escalamiento de 0310-FY-01202A y 0310-FY-01202B. Datos de control serán obtenidos de los transmisores 0310-FIT-01202 y 0240-WIT-01140. Porcentaje de apertura de Válvulas no mayor a 40%. Observaciones: Diagrama P&ID Lógica de Control – Infusion Invensys	

Tabla.4.7.- Control de Flujo Agua de Proceso Molino SAG

Fuente: Elaboración Propia

CONTROL DE FLUJO DE LECHADA DE CAL – MOLINO SAG	
ELEMENTOS DE LAZO DE CONTROL	
TAG	**DESCRIPCIÓN**
0310-FIT-01201A	Transmisor de Flujo – lechada de cal 0310-MLS-0001
0310-FIT-01201B	Transmisor de Flujo – lechada de cal 0310-MLS-0001
0310-FIC-01201A	Controlador de Flujo – lechada de cal 0310-MLS-0001
0310-FIC-01201B	Controlador de Flujo – lechada de cal 0310-MLS-0001
0310-FV-01201A	Válvula de Control por Segmento – lechada de cal
0310-FV-01201B	Válvula de Control por Segmento – lechada de cal
0310-FY-01201	Escalamiento Peso vs Flujo – Control de Relación
0240-WIT-01140	Transmisor de Tonelaje de alimentación del molino SAG
0240-WIC-01140	Control de Tonelaje de alimentación del molino SAG
DESCRIPCIÓN DEL LAZO	
En este control solo se controla el accionamiento de la válvula 0310-FV-01201A en modo automático (petición de cliente Xstrata). El Accionamiento de la válvula 0310-FV-01201B será controlado en modo manual, a través de un selector. El transmisor 0310-FIT-01201A mide el flujo de ingreso de la lechada de cal y manda un señal al controlador 0310-FIC-01201A, quien controlara la posición de apertura de la válvula 0310-FV-01201A Observaciones: Diagrama P&ID Lógica de Control – Infusion Invensys	

Tabla.4.8.- Control de Flujo Lechada de Cal Molino SAG

Fuente: Elaboración Propia

CONTROL DE ALIMENTACIÓN DE CARGA FRESCA – MOLINO SAG	
ELEMENTOS DE LAZO DE CONTROL	
TAG	**DESCRIPCIÓN**
0240-WIT-01140	Transmisor de Tonelaje de alimentación del molino SAG
0240-CVB-0005-M1	Motor de Alimentación Molino SAG
0240-WIC-01140	Control de Tonelaje de alimentación del molino SAG
0310-JIT-01220	Transmisor de Potencia Molino SAG – 0310-MLS-0001
0310-MLS-0001-COB	Control Vendor Molino SAG
DESCRIPCIÓN DEL LAZO	
El lazo interno está compuesto por el transmisor 0240-WIT-01140 que mide la carga de mineral y manda una señal al controlador 0240-WIC-01140 quien controlara la velocidad de la faja 5 0240-CVB-0005-M1. El lazo externo está compuesto por el transmisor 0310-JIT-01220 que mide la potencia del Molino SAG y manda un señal al controlador Vendor SAG que es el set point del controlador 0240-WIC-01140, el cual modula la velocidad del motor de anillo de Molino SAG. Observaciones: Diagrama P&ID Lógica de Control – Infusion Invensys	

Tabla.4.9.- Control de Alimentación Carga Fresca Molino SAG

Fuente: Elaboración Propia

CONTROL DE DESCARGA DE MINERAL – MOLINO SAG	
ELEMENTOS DE LAZO DE CONTROL	
TAG	**DESCRIPCIÓN**
0310-VT-01292	Transmisor de Vibración – Harnero Vibratorio
0310-VT-01293	Transmisor de Vibración – Harnero Vibratorio
0310-TT-01292	Transmisor de Temperatura – condición de arranque
0310-TT-01293	Transmisor de Temperatura – condición de arranque
0310-SCR-0001-M1	Motor – Harnero Vibratorio
0310-SCR-0001-COB	Controlador Vendor – Harnero Vibratorio
DESCRIPCIÓN DEL LAZO	
Los transmisores 0310-VT-01292 y 0310-VT-01293 miden la vibración que genera el harnero vibratorio para la clasificación de mineral, una hacia los molinos Pebbles que recirculan hacia el molino SAG y los que alcanzan la granulometría deseada pasan hacia los hidrociclones. La señal de control de salida de transmisores irán al controlador Vendor 0310-SCR-0001-COB quien controlara la vibración ejercida por el motor 0310-SCR-0001-M1. Observaciones: Diagrama P&ID Lógica de Control – Infusion Invensys	

Tabla.4.10.- Control de Descarga de Mineral Molino SAG

Fuente: Elaboración Propia

4.3 Instrumentación

Los sensores y actuadores fueron seleccionados, revisados y aprobados por el Área de Ingeniería de Instrumentación & Control de Bechtel del Proyecto Antapaccay Expansión Tintaya.

En las siguientes tablas se resume las características de los equipos utilizados.

TRANSMISORES DE PROCESO DE MOLIENDA SAG

N°	TAG	SEÑAL	TIPO	SERVICIO	MARCA	MODELO	RANGO	AJUSTE
1	0240-WIT-01140	Profibus	Transmisor de Peso	Correa Alimentación Molino SAG	Merrick	475	0 - 6500 t/h	0 - 5905 t/h
2	0240-SE-01023	DI	Detector de Velocidad Inductivo	Apron Feeder 5	Milltronics	MSP-12	--	--
3	0240-ST-01630	Vendor	Transmisor Encoder	Apron Feeder 5	Hagglunds	SPDB3600	1000 - 3600 ppr	
4	0240-LX-01024	DI	Fuente Emisora Microwave	Chute Descarga Apron Feeder Stockpile	Hycontrol	HYC-MWS-SR-2-110V	--	--
5	0240-LSH-01024	DI	Switch de Nivel Alto Microwave	Chute Descarga Apron Feeder Stockpile	Hycontrol	HYC-MWS-SR-2-110V	--	--
6	0240-HS-01021	DI	Pull Cord - Switch de Mano	Apron Feeder 5	Conveyor Components	RS - 5D	--	--
7	0240-HS-01022	DI	Pull Cord - Switch de Mano	Apron Feeder 5	Conveyor Components	RS - 5D	--	--
8	0240-SE-01053	DI	Detector de Velocidad Inductivo	Apron Feeder 6	Milltronics	MSP-12	--	--
9	0240-ST-01660	Vendor	Transmisor Encoder	Apron Feeder 6	Hagglunds	SPDB3600	1000 - 3600 ppr	
10	0240-LX-01054	DI	Fuente Emisora Microwave	Chute Descarga Apron Feeder Stockpile	Hycontrol	HYC-MWS-SR-2-110V	--	--
11	0240-LSH-01054	DI	Switch de Nivel Alto Microwave	Chute Descarga Apron Feeder Stockpile	Hycontrol	HYC-MWS-SR-2-110V	--	--
12	0240-HS-01051	DI	Pull Cord - Switch de Mano	Apron Feeder 6	Conveyor Components	RS - 5D	--	--
13	0240-HS-01052	DI	Pull Cord - Switch de Mano	Apron Feeder 6	Conveyor Components	RS - 5D	--	--
14	0240-SE-01083	DI	Detector de Velocidad Inductivo	Apron Feeder 7	Milltronics	MSP-12	--	--
15	0240-ST-01690	Vendor	Transmisor Encoder	Apron Feeder 7	Hagglunds	SPDB3600	1000 - 3600 ppr	
16	0240-LX-01084	DI	Fuente Emisora Microwave	Chute Descarga Apron Feeder Stockpile	Hycontrol	HYC-MWS-SR-2-110V	--	--
17	0240-LSH-01084	DI	Switch de Nivel Alto Microwave	Chute Descarga Apron Feeder Stockpile	Hycontrol	HYC-MWS-SR-2-110V	--	--
18	0240-HS-01081	DI	Pull Cord - Switch de Mano	Apron Feeder 7	Conveyor Components	RS - 5D	--	--
19	0240-HS-01082	DI	Pull Cord - Switch de Mano	Apron Feeder 7	Conveyor Components	RS - 5D	--	--
20	0240-SE-01113	DI	Detector de Velocidad Inductivo	Apron Feeder 8	Milltronics	MSP-12	--	--
21	0240-ST-01720	Vendor	Transmisor Encoder	Apron Feeder 8	Hagglunds	SPDB3600	1000 - 3600 ppr	
22	0240-LX-01114	DI	Fuente Emisora Microwave	Chute Descarga Apron Feeder Stockpile	Hycontrol	HYC-MWS-SR-2-110V	--	--
23	0240-LSH-01114	DI	Switch de Nivel Alto Microwave	Chute Descarga Apron Feeder Stockpile	Hycontrol	HYC-MWS-SR-2-110V	--	--
24	0240-HS-01111	DI	Pull Cord - Switch de Mano	Apron Feeder 8	Conveyor Components	RS - 5D	--	--
25	0240-HS-01112	DI	Pull Cord - Switch de Mano	Apron Feeder 8	Conveyor Components	RS - 5D	--	--
26	0310-JIT-01220	FFieldbus	Transmisor de Potencia	Potencia Motor de Anillo Molino SAG	Siemens		--	--
27	0240-QS-01172	PI	Detector Contador de Bolas	Alimentación de Bolas Molino SAG	Allen - Bradley	Serie 9000	--	--

28	0240-QX-01172	--	Detector Espejo de Bolas	Alimentación de Bolas Molino SAG	Allen - Bradley	Serie 9000	--	--
29	0240-QQ-01172	--	Contador Totalizador de Bolas	Alimentación de Bolas Molino SAG	Allen - Bradley	Serie 9000	--	--
30	0240-HS-01173	DI	Selector de Equipo	Alimentación de Bolas Molino SAG	Allen - Bradley	Serie 9000	--	--
31	0240-QS-01174	PI	Detector Contador de Bolas	Alimentación de Bolas Molino SAG	Allen - Bradley	Serie 9000	--	--
32	0240-QX-01174	--	Detector Espejo de Bolas	Alimentación de Bolas Molino SAG	Allen - Bradley	Serie 9000	--	--
33	0240-QQ-01174	--	Contador Totalizador de Bolas	Alimentación de Bolas Molino SAG	Allen - Bradley	Serie 9000	--	--
34	0310-FIT-01202	FFieldbus	Transmisor de Flujo	Agua Proceso a Chute de Alim. Molino SAG	Rosemount	8732ESR1G4NAM5DTB6Q4	0 - 2000 m3/h	0 - 1800 m3/h
35	0310-FIT-01201A	FFieldbus	Transmisor de Flujo	Cal a chute de Alimentación Molino SAG	Rosemount	8732ESR1G4NAM5DTB6Q4	0 - 50 m3/h	0 - 6,5 m3/h
36	0310-FIT-01201B	FFieldbus	Transmisor de Flujo	Cal a chute de Alimentación Molino SAG	Rosemount	8732ESR1G4NAM5DTB6Q4	0 - 50 m3/h	0 - 6,5 m3/h
37	0310-VT-01292	AI	Transmisor de Vibración	Harnero Vibratorio Descarga Molino SAG	SKF	CMPT 2310T	0 - 75 mm/s	0 - 23,4 mm/s
38	0310-VT-01293	AI	Transmisor de Vibración	Harnero Vibratorio Descarga Molino SAG	SKF	CMPT 2310T	0 - 75 mm/s	0 - 23,4 mm/s
39	0310-TT-01292	AI	Transmisor de Temperatura	Harnero Vibratorio Descarga Molino SAG	SKF	CMPT 2310T	0 - 200 °C	0 - 120 °C
40	0310-TT-01293	AI	Transmisor de Temperatura	Harnero Vibratorio Descarga Molino SAG	SKF	CMPT 2310T	0 - 200 °C	0 - 120 °C

Tabla.4.11.- Características Transmisores de Molienda SAG

Fuente: Elaboración Propia

Actuadores de Proceso Molienda SAG								
N°	**Tag**	**Señal**	**Tipo**	**Servicio**	**Marca**	**Modelo**	**Rango**	**Ajuste**
1	0310-FV-01202A	FFieldbus	Válvula de Control por Segmento Bola	Agua de Proceso a Chute de Alim. Molino SAG	Neles	RECA10DSJT2T	0 - 1500 m3/h	0 - 900 m3/h
2	0310-FV-01202B	FFieldbus	Válvula de Control por Segmento Bola	Agua de Proceso a Chute de Alim. Molino SAG	Neles	RECA10DSJT2T	0 - 1500 m3/h	0 - 900 m3/h
3	0310-FV-01202C	FFieldbus	Válvula de Control por Segmento Bola	Agua de Proceso a Chute de Alim. Molino SAG	Neles	RECA10DSJT2T	0 - 1500 m3/h	0 - 900 m3/h
4	0310-FV-01201A	FFieldbus	Válvula de Control Diafragma On/Off	Cal a chute de Alimentación Molino SAG	Valam	KESC61	--	--
5	0310-FV-01201B	FFieldbus	Válvula de Control Diafragma On/Off	Cal a chute de Alimentación Molino SAG	Valam	KESC62	--	--

Tabla.4.12.- Características Actuadores de Proceso de Molienda SAG

Fuente: Elaboración Propia

Motores de Proceso Molienda SAG							
N°	**Tag**	**Equipo**	**Descripción**	**Marca**	**Características**	**Power (KW)**	**Motor (rpm)**
1	0240-FEA-0005	Apron Feeder	Motor Eléctrico	Metso	Motor eléctrico de 56 KW, Cooler 2,2 KW	56	1500
2	0240-FEA-0006	Apron Feeder	Motor Eléctrico	Metso	Motor eléctrico de 56 KW, Cooler 2,2 KW	56	1500
3	0240-FEA-0007	Apron Feeder	Motor Eléctrico	Metso	Motor eléctrico de 56 KW, Cooler 2,2 KW	56	1500
4	0240-FEA-0008	Apron Feeder	Motor eléctrico	Metso	Motor eléctrico de 56 KW, Cooler 2,2 KW	56	1500
5	0240-FET-0006	Alimentador de Bolas	Motor Rotatorio	Insesa	Feeder Rotatorio 1,8 tballs / h	2,2	1175
6	0240-FET-0007	Alimentador de Bolas	Motor Rotatorio	Insesa	Feeder Rotatorio 1,8 tballs / h	2,2	1175
7	0240-CVB-0005	Faja de Alimentación SAG	Motor eléctrico	STM	Carga 5905 t/h, max. Velocidad. 3,2 m/s	600	1800
8	0240-SLW-0005	Faja de Escala CVB-0005	Motor eléctrico	STM	Carga 5905 t/h	1,1	--
9	0310-MLS-0001	Molino SAG	Motor Anillo	Flsmidth	Motor sin Engranajes 32 200 HP	24	--
10	0310-SCR-0001	Descarga Molino SAG	Motor Vibratorio	Haber & Bocker	Capacidad 619 t/h, apertura de rejilla 35 mm	75	1785

Tabla.4.13.- Características Motores de Proceso de Molienda SAG

Fuente: Elaboración Propia

4.4 Sistema de Control Distribuido - DCS

El detalle del DCS para el Proyecto Antapaccay – Expansión Tintaya abarca los PCS (Sistema de Control de Procesos) para las áreas de proceso de acuerdo a las especificaciones técnicas requeridas por el cliente Xstrata Cooper.

El DCS es implementado con el software Infusion y con hardware de control de IA Foxboro, proveídos por Invensys. Esta plataforma ofrece la integración de los distintos protocolos de comunicación en la misma placa base como:

- Foundation Fieldbus.
- Profibus.
- Modbus.
- HART.
- Ethernet.
- FoxCom
- DeviceNet.
- Discretas.
- 4 – 20 mA.

Infusion ECS ofrece el manejo de equipos redundantes lo que asegura el funcionamiento de la plataforma. La utilización de múltiples módulos I/O que permitirán integrar cualquier sistemas de terceros (Vendor) sin problemas de conflicto de comunicación.

4.4.1 Arquitectura del Sistema

La plataforma Infusion ECS tiene la capacidad de realizar múltiples sesiones de Ingeniería de manera simultánea, para este propósito el ECS tiene una base de datos que permite un control eficaz y genera una copia de seguridad.

La ECS tiene la capacidad la integración de cualquier plataforma de control como PLC, DSC y SCADA; para más de 800 interfaces aplicadas en todos los sistemas, por esta razón la comunicación de equipos de terceros (Vendor) como PLCs han sido considerados de tipo nativo para propósitos de monitoreo exclusivamente integrada en la MESH Network.

La MESH Network ha sido diseñada para:

- Proporcionar la más alta disponibilidad de comunicación Peer to Peer entre cualquier tipo de procesador (Control, Comunicación y/o Aplicación) independiente del diseño de la topología como árbol invertida.

- Comunicación de Procesadores Unicast de manera simultánea.

- La MESH Network puede es compartida con sistemas de terceros, tales como PLCs y SCADA.

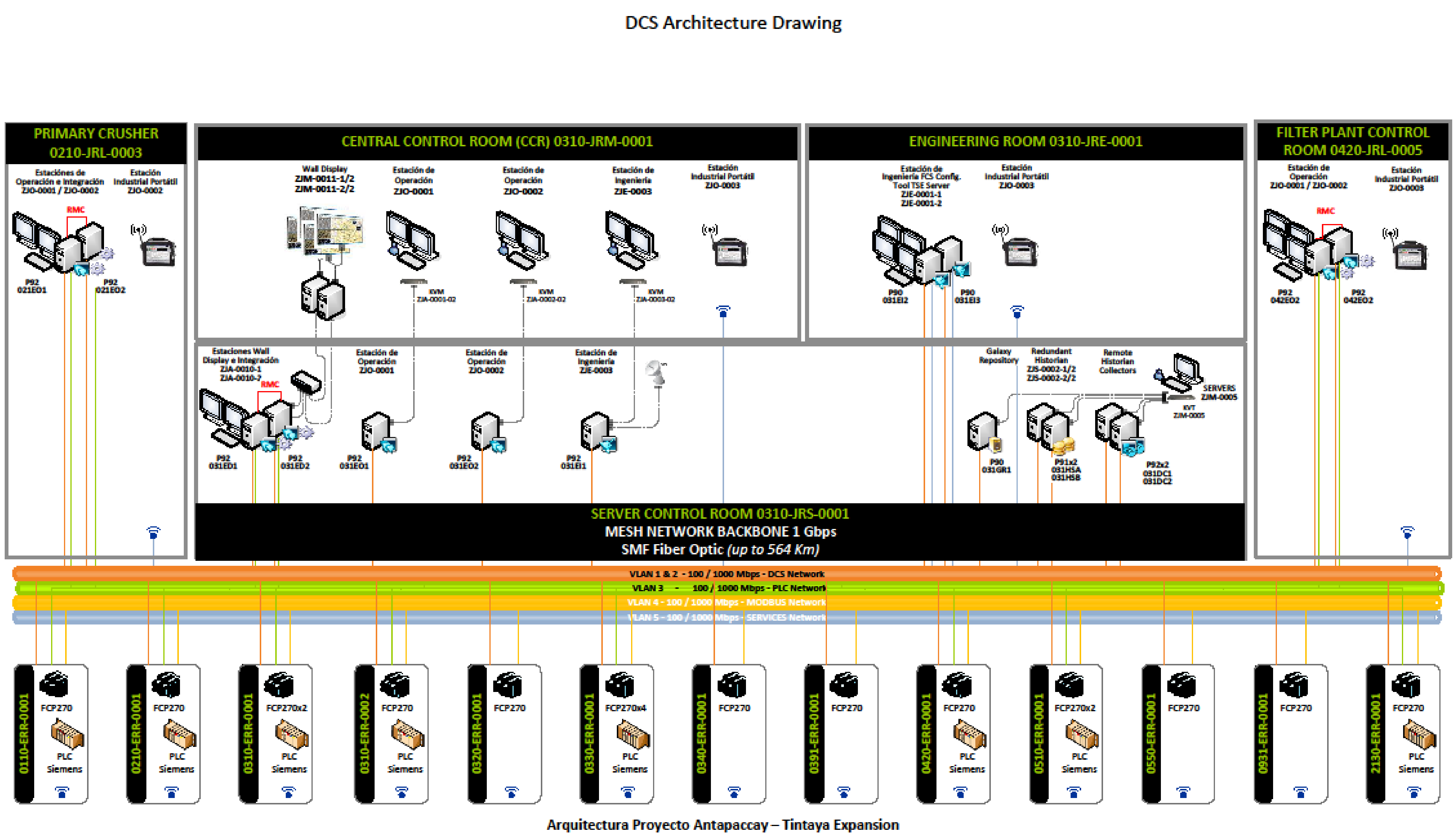
- La red viene prediseñada y configurada desde fabrica lo que permite una aplicación rápida y segura.

- El diseño considera una velocidad de 1 Gbps entre switches BackBone, entre switches puede estar a una distancia de 80 Km conectada con Fibra Óptica.

- También considera una velocidad de 1 Gbps entre switches EDGE y BackBone, entre los switches pueden estar a una distancia de 10 Km conectada con Fibra Óptica tipo monomodo.

- El diseño considera una velocidad de 100 Mbps entre procesadores de control FCP270 e interruptores EDGE, distancia máxima 2 Km, la fibra utilizada es del tipo multimodo.

La arquitectura de control del proyecto se representa en la Fig.4.5.



xstrata copper BECHTEL invensys operations management

Fig.4.5.-Arquitectura Sistema de Control Distribuido - DCS
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

Title		Save Date : 9/1/2012	Scale : NTS
Project Name	Nº Documento Bechtel: 25580-220-V1A-JD01-00017	Nº Documento Invensys: CL0226-ARC-00-001	Rev 6 / Sheet No. 4 of 5

File Name : 25580-220-v1a-jd01-00017...

4.4.2 Topología de la Red

La topología implementada en el proyecto es la de Árbol Invertido modificado dado que la red del proyecto es muy grande y por la utilización de los switches principales con conexiones redundantes entre ellos, esto depende del diseño del fabricante (Invensys).

El tipo de topología es adecuada para redes de control seguras con limitaciones físicas específicas, permitiendo la inclusión de switches standars (EDGE).

El diseño se aplica a Enterasys Switches y a soluciones de terceros. La principal ventaja es la utilización de OIM (administración de dispositivos), que permite compartir las redes de sistemas de terceros. Así mismo la aplicación de la red de comunicaciones depende de la OIM y mediante el uso de una herramienta estándar para la configuración de la topología MESH.

Enterasys considera los siguientes aspectos:

- Velocidad de 1 Gbps entre switches troncales, con distancia máxima de 80 Km, conexión Fibra Óptica.
- Considera velocidades de 100 Mbps entre procesadores de control, PLCs de terceros e interruptores EDGE, distancia entre ellos max. 100 mts con línea de cobre y 2 Km con FO multimodo.

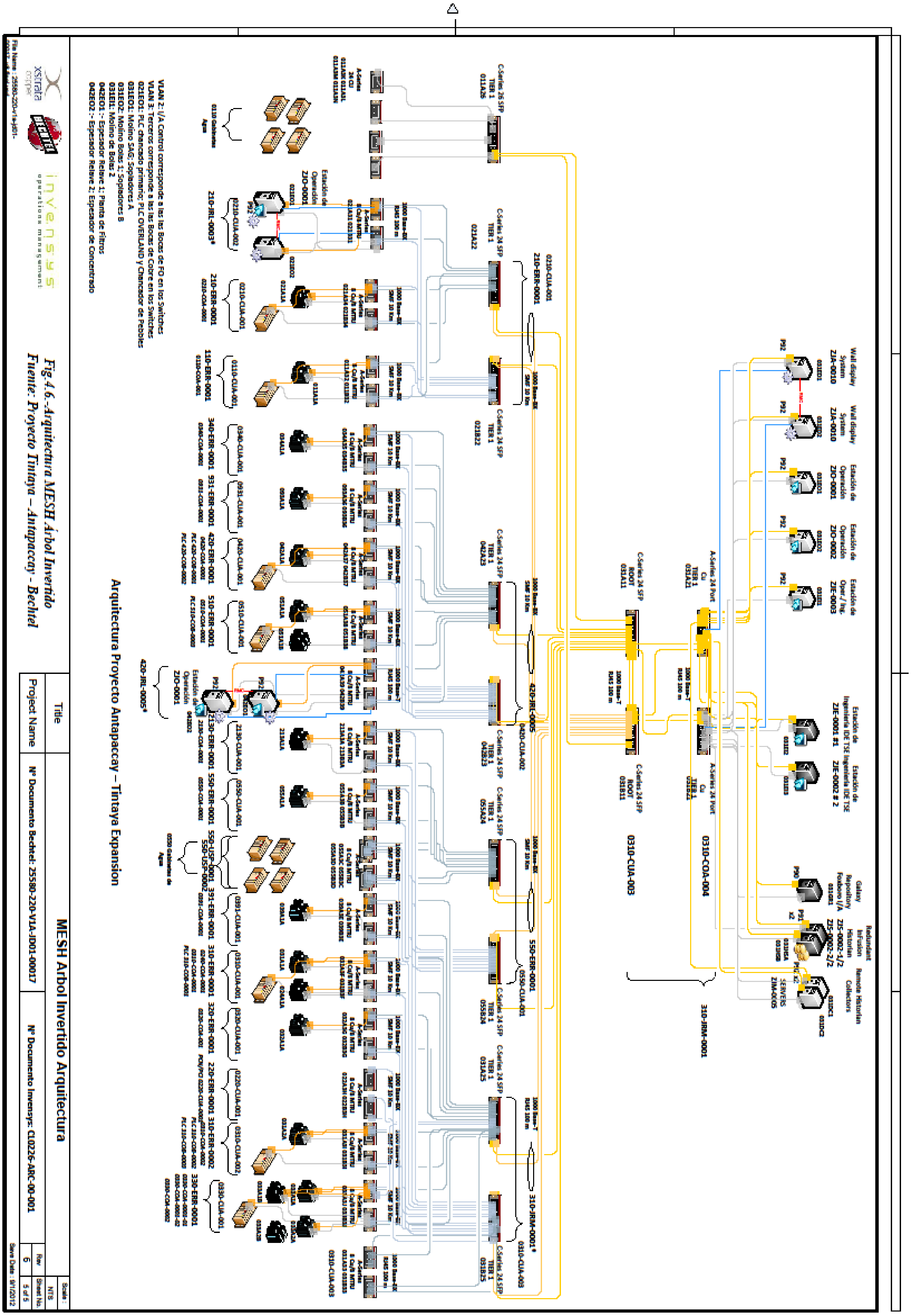


Fig 4.6.-Arquitectura MESH Árbol Invertido
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

4.5 Lógica de Control

La lógica de control del proyecto está desarrollada en la herramienta de diseño de Invensys Archestra, que permite una programación mediante bloques de funciones.

La lógica de control contemplan los siguientes controladores:

- Control de Alimentación de Carga Fresca – Faja 5, 0240-WIC-01140
  - Arranque Apron Feeder 0240-FEA-0005-M1.
  - Arranque Apron Feeder 0240-FEA-0006-M1.
  - Arranque Apron Feeder 0240-FEA-0007-M1.
  - Arranque Apron Feeder 0240-FEA-0008-M1.

- Control Alimentación de Bolas Molino SAG – Controlador Vendor.
  - Arranque Tolva de Alimentación 0240-FET-0005-M1.
  - Arranque Tolva de Alimentación 0240-FET-0006-M1.

- Control de Flujo de Agua Fresca – 0310-FIC-01202.
- Control de Flujo de Cal – 0310-FIC-01201A Y 0310-FIC-01201B.
- Control de Alimentación de Carga Fresca Molino SAG – 0240-WIC-01140.
- Control de Descarga de Mineral Molino SAG 0310-SCR-0001-COB.

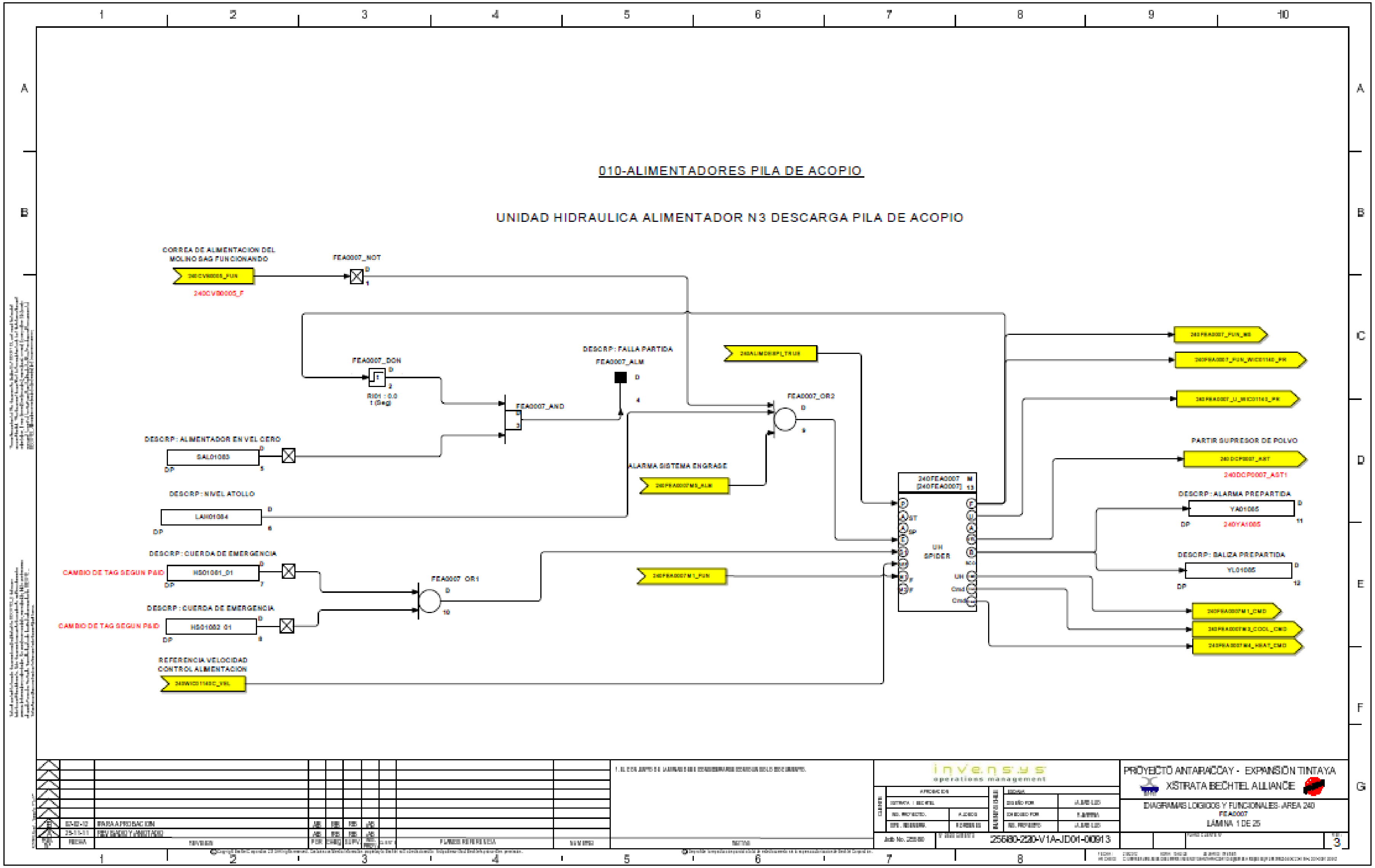


Fig.4.6.-Logica de Control – Apron Feeder 0240-FEA-0007

Fuente: Proyecto Tintaya – Antapaccay - Bechtel

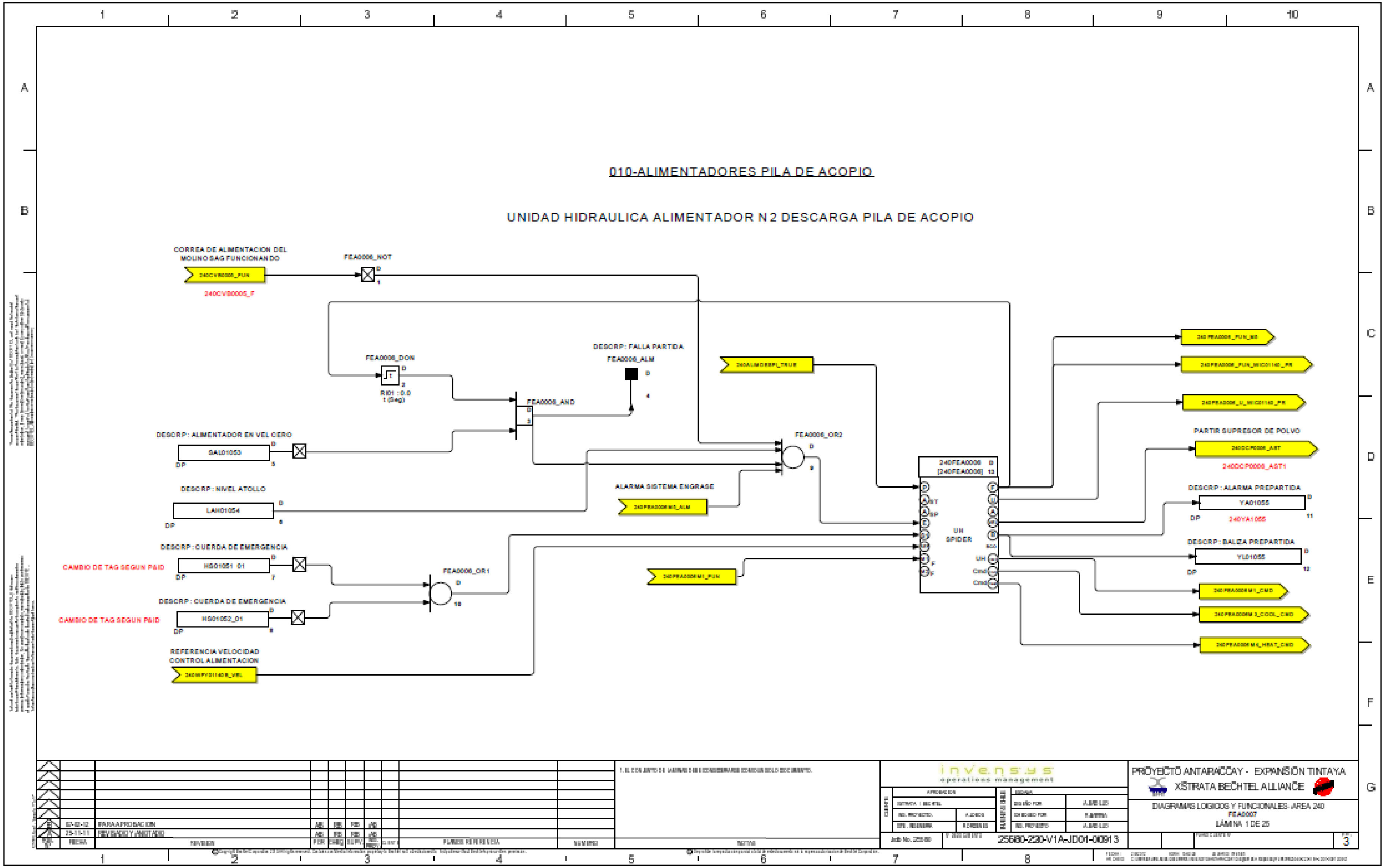


Fig.4.7.-Logica de Control – Apron Feeder 0240-FEA-0006
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

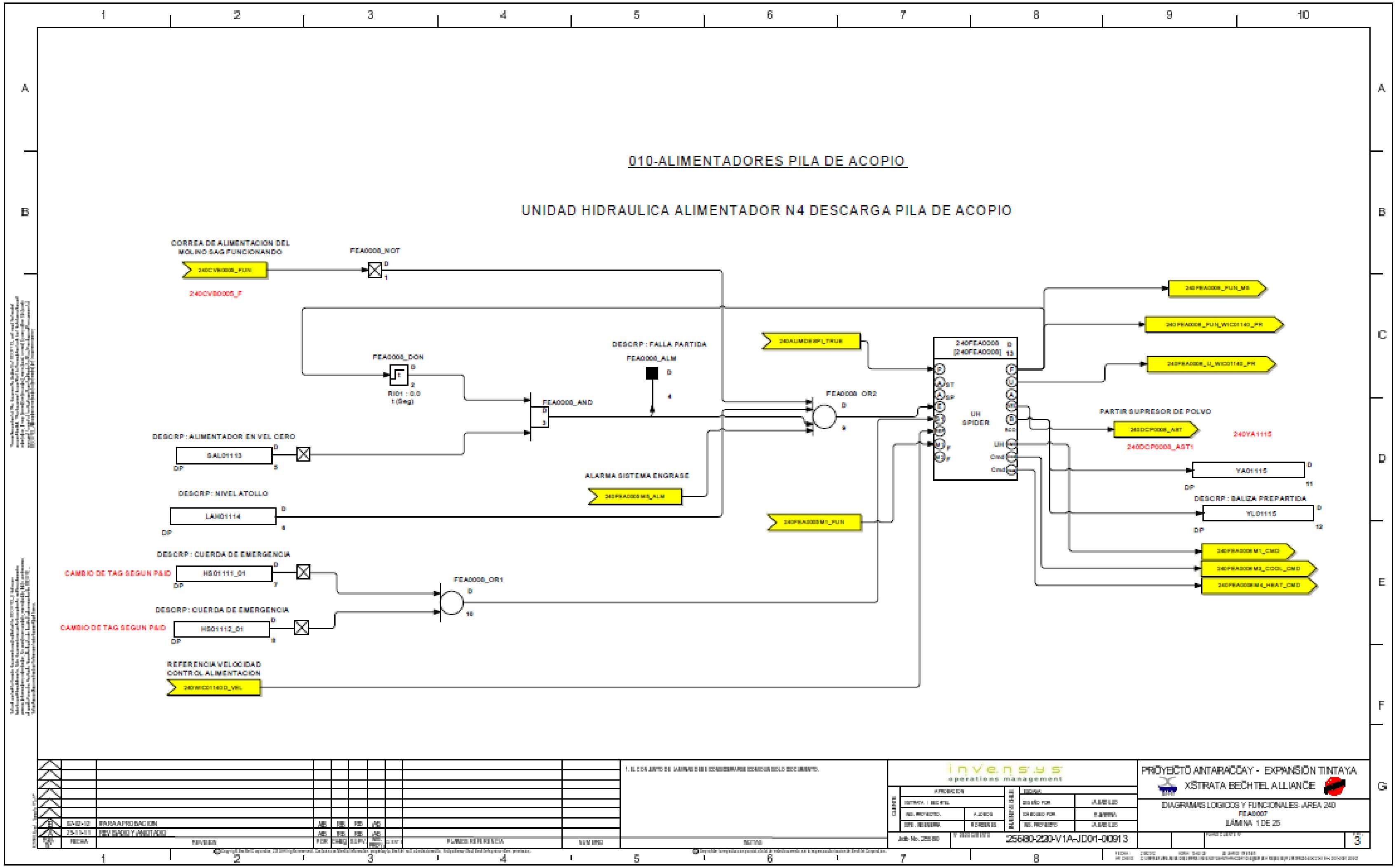


Fig.4.8.-Logica de Control – Apron Feeder 0240-FEA-0008
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

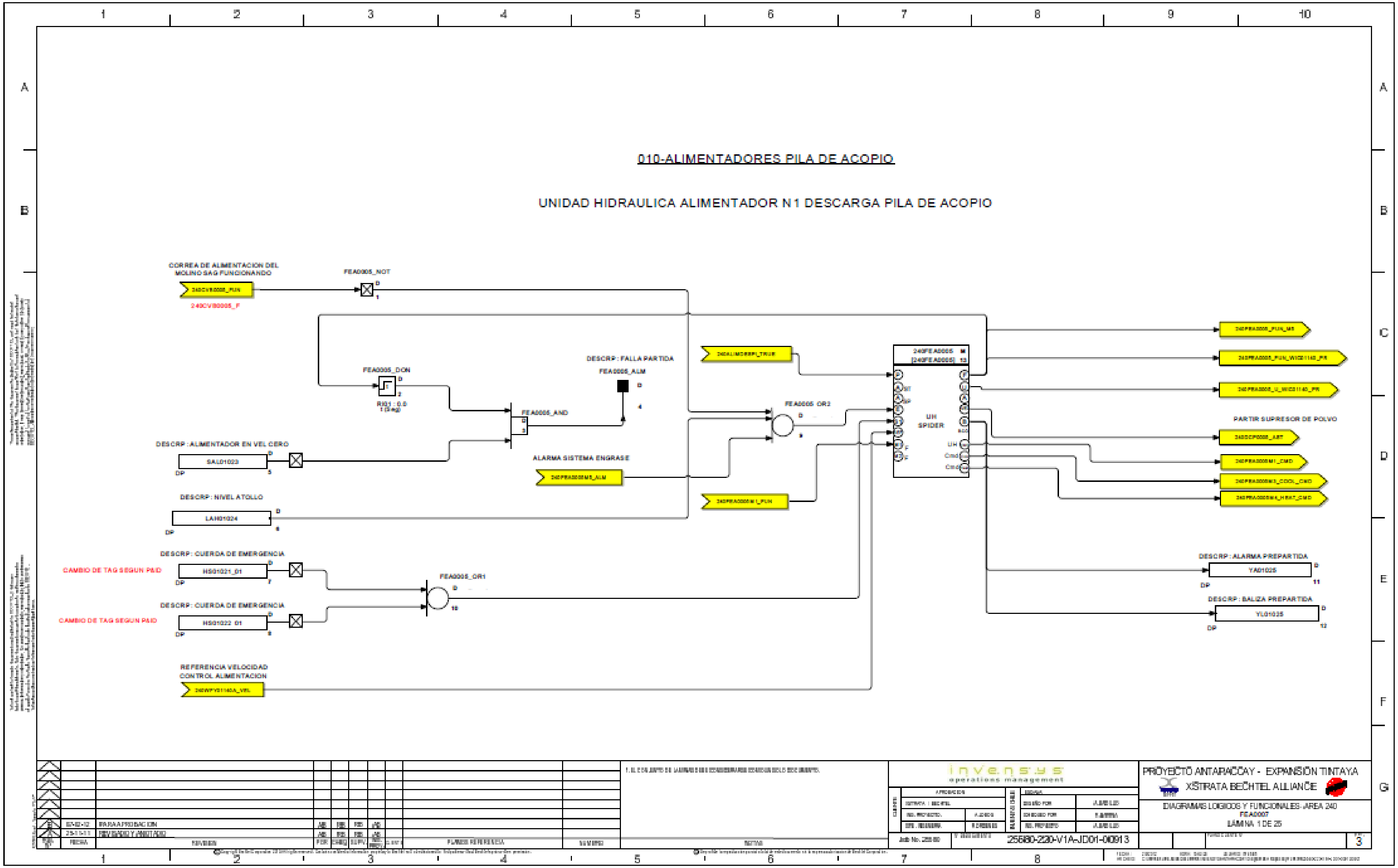


Fig.4.9.-Logica de Control – Apron Feeder 0240-FEA-0005
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

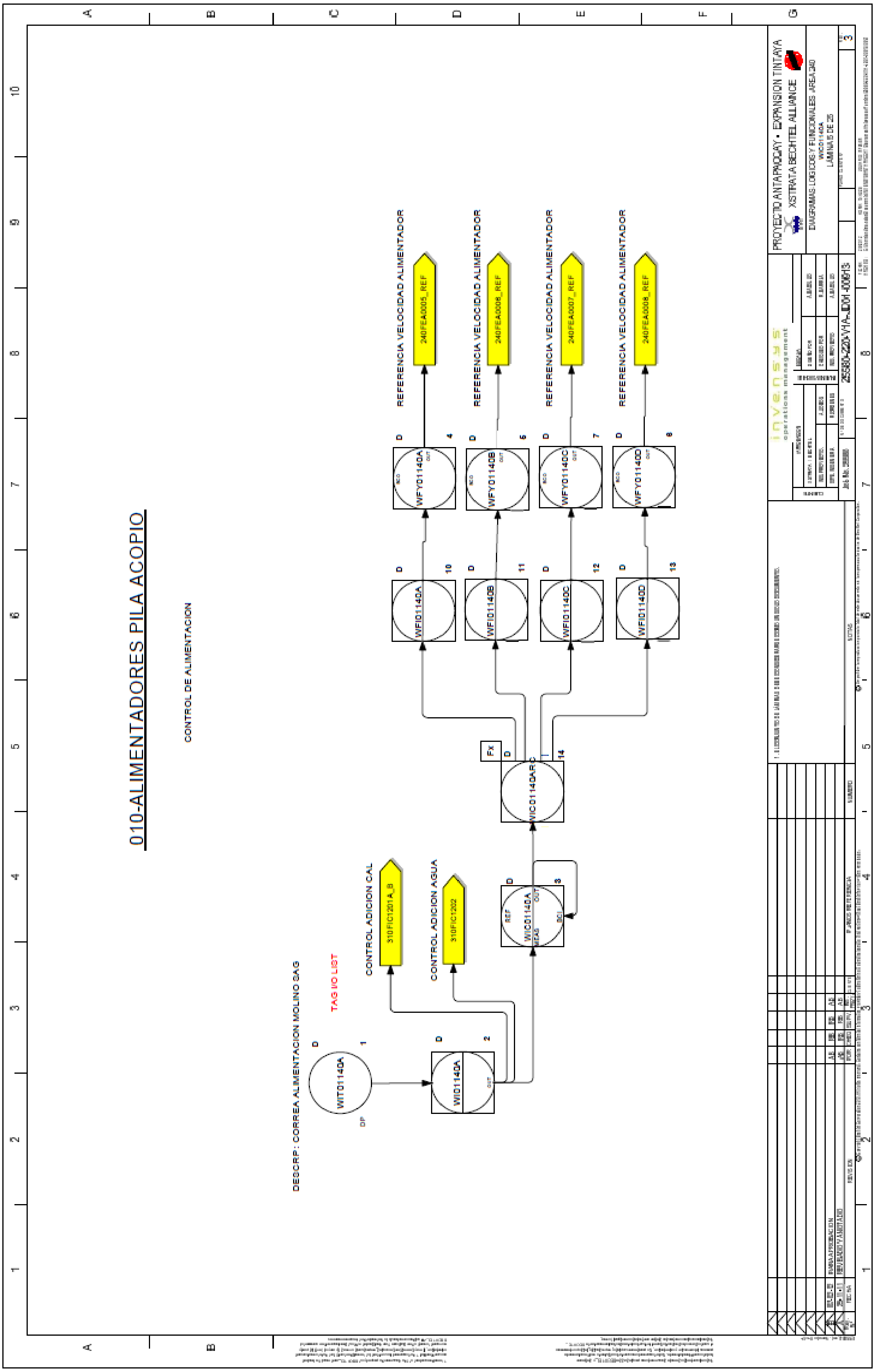


Fig.4.10.-Logica de Control – Velocidad de Referencia Apron Feeder
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

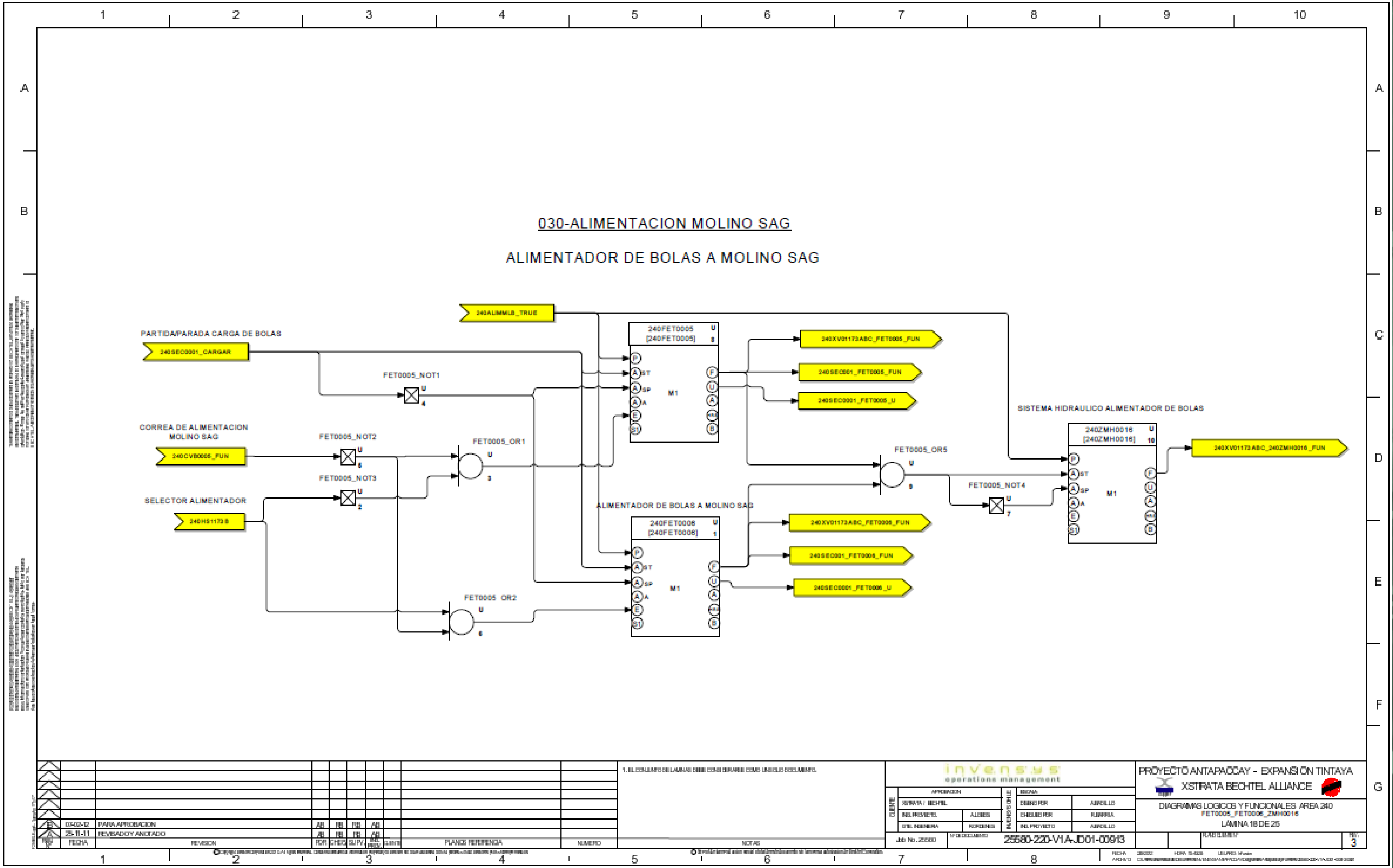


Fig.4.11.-Logica de Control – Alimentador de Bolas Molino SAG
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

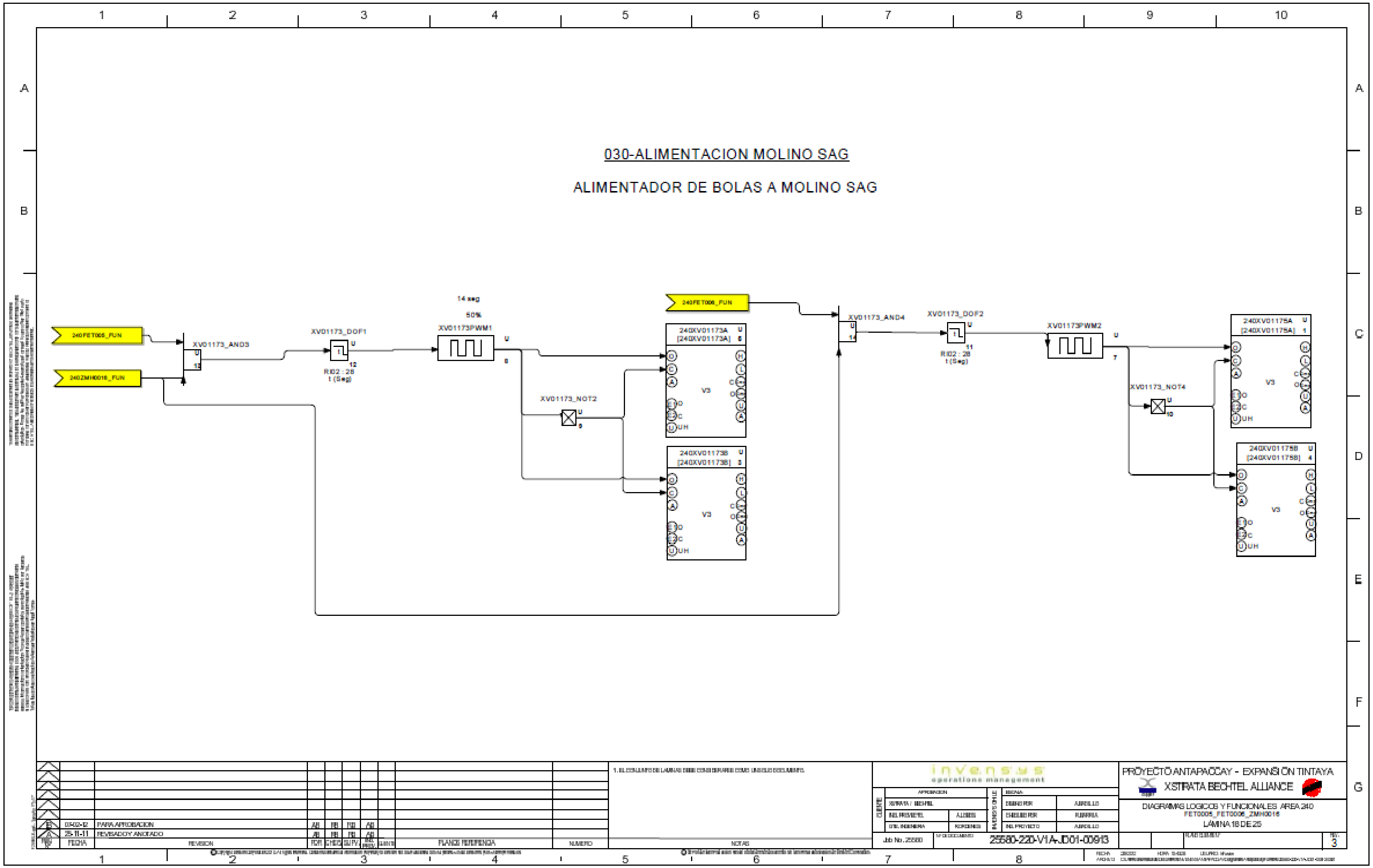


Fig.4.12.-Logica de Control – Alimentador de Bolas Molino SAG
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

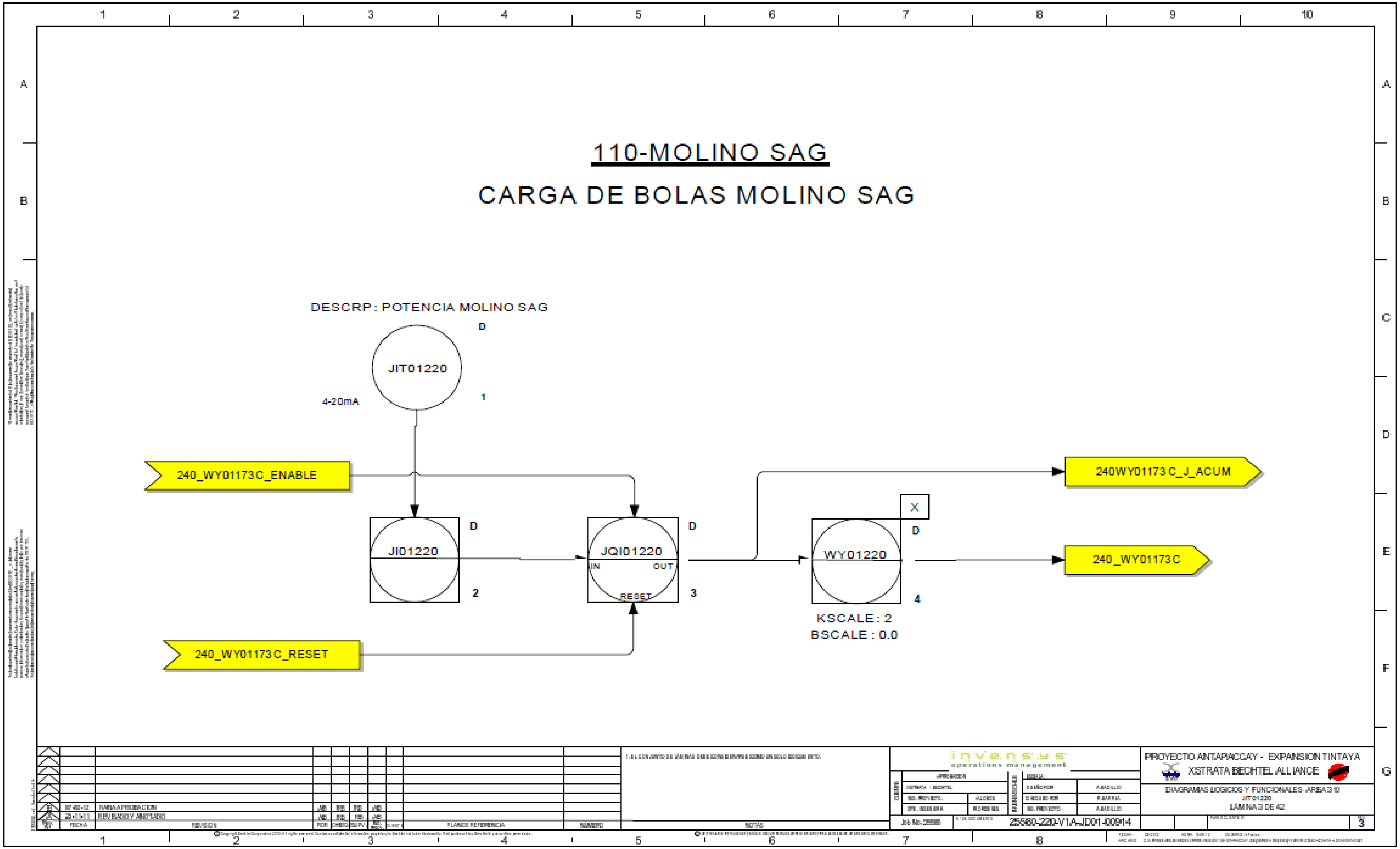


Fig.4.13.-Logica de Control – Alimentador de Bolas Molino SAG - Potencia
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

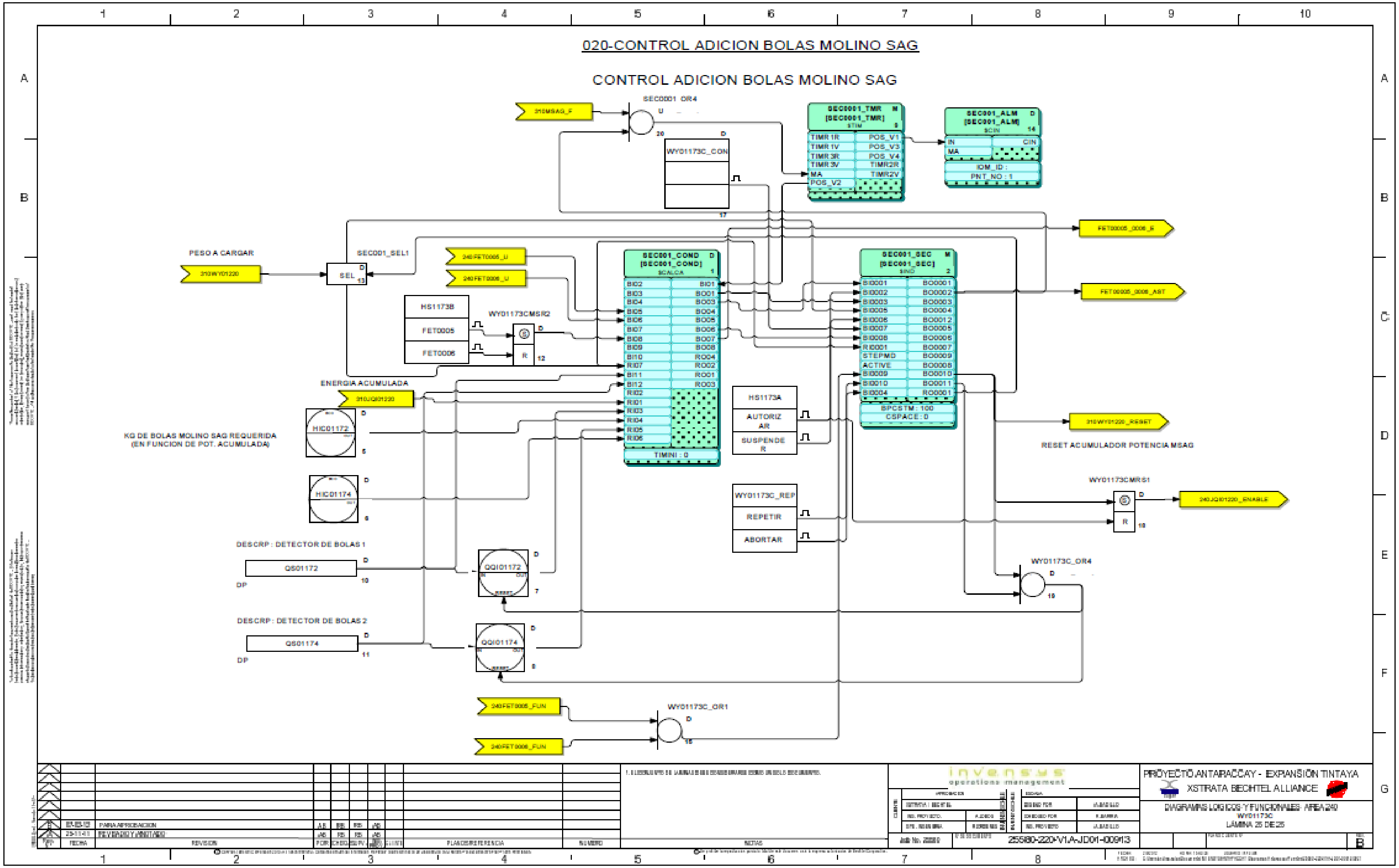


Fig.4.14.-Logica de Control – Control Adición de Bolas a Molino SAG
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

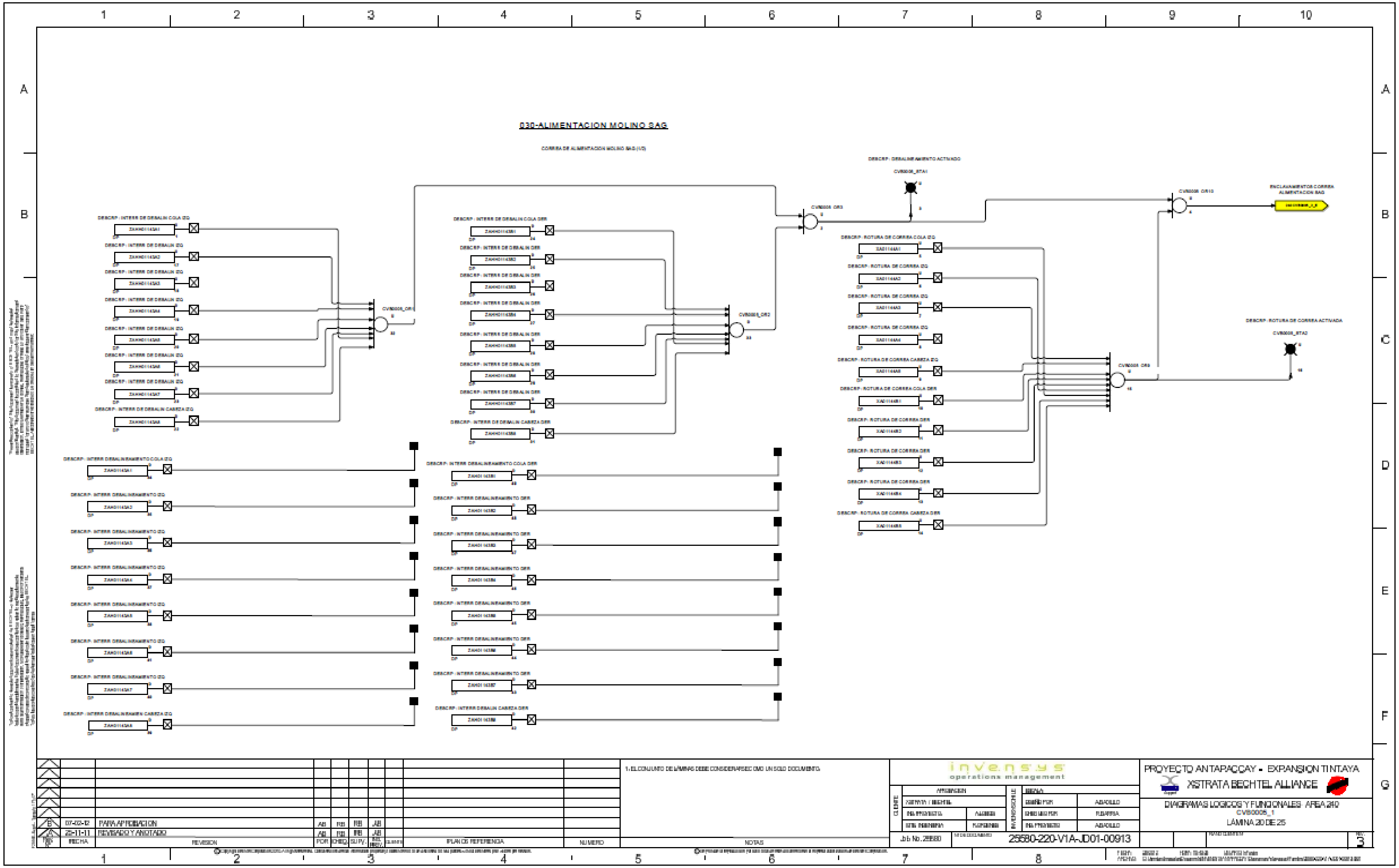


Fig.4.15.-Logica de Control – Correa de Alimentación 0240-CVB-0005 1/2
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

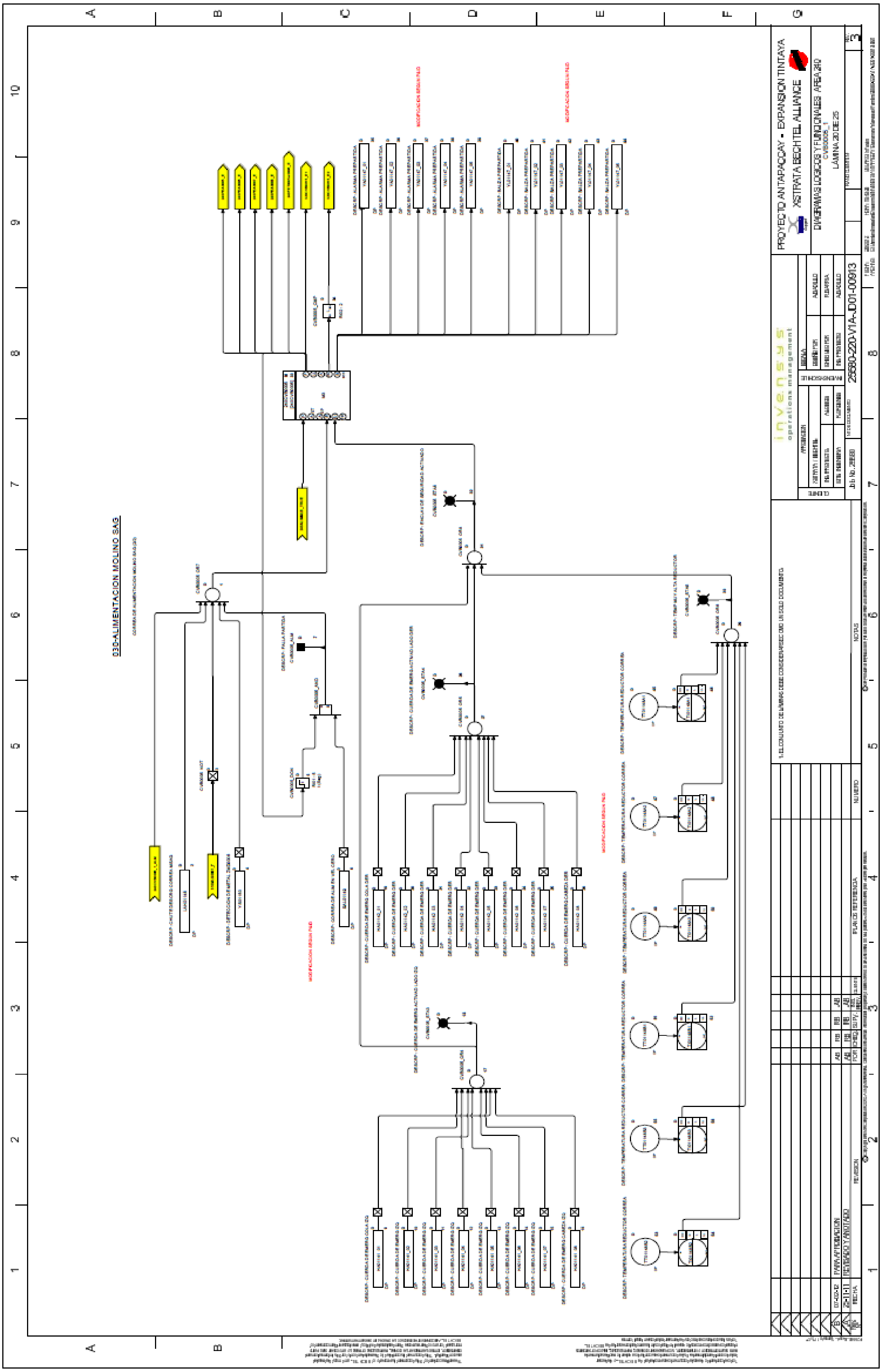


Fig.4.16.-Logica de Control – Correa de Alimentación 0240-CVB-0005 2/2
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

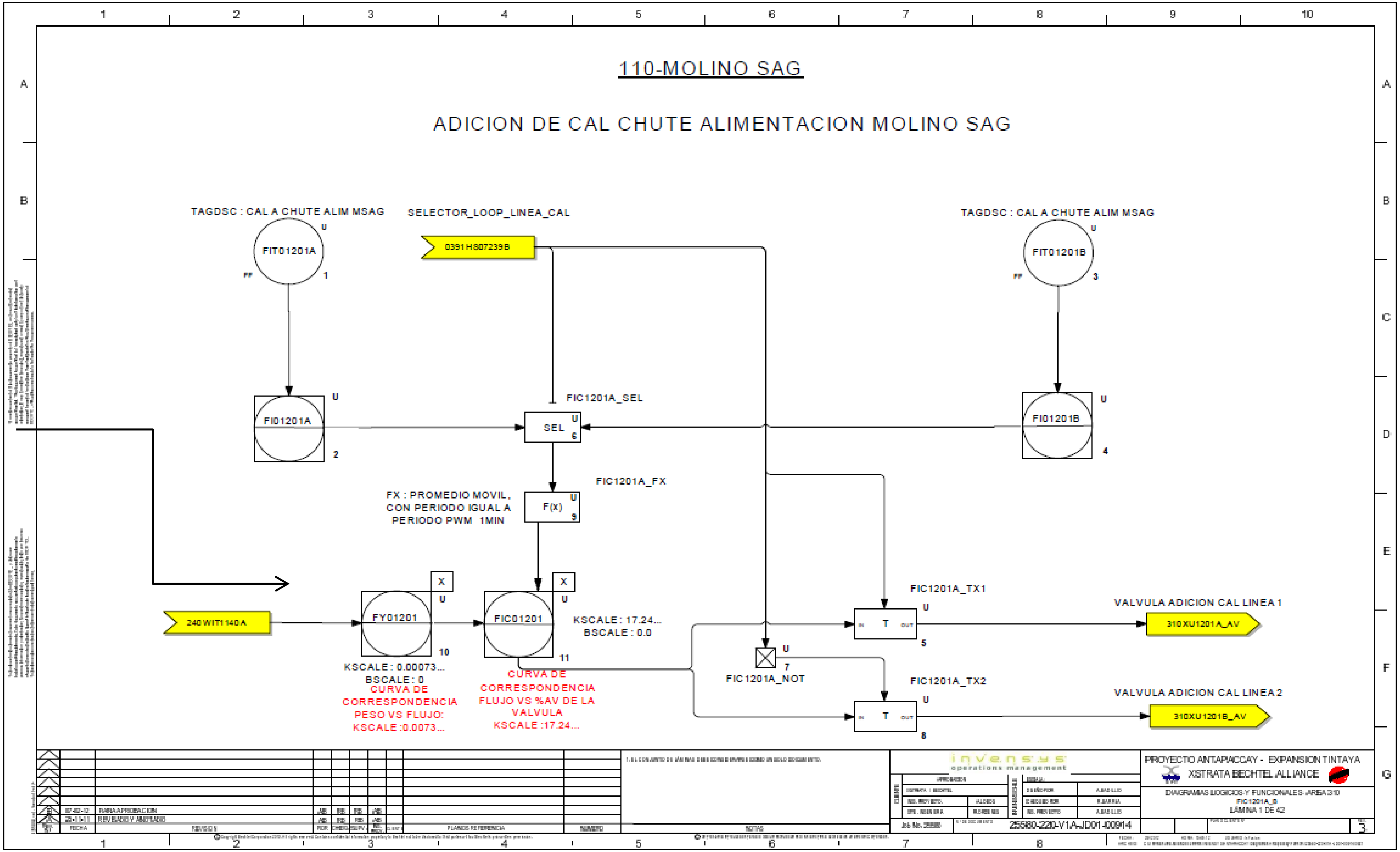


Fig.4.17.-Logica de Control – Adición de Cal al Chute de Alimentación Molino SAG
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

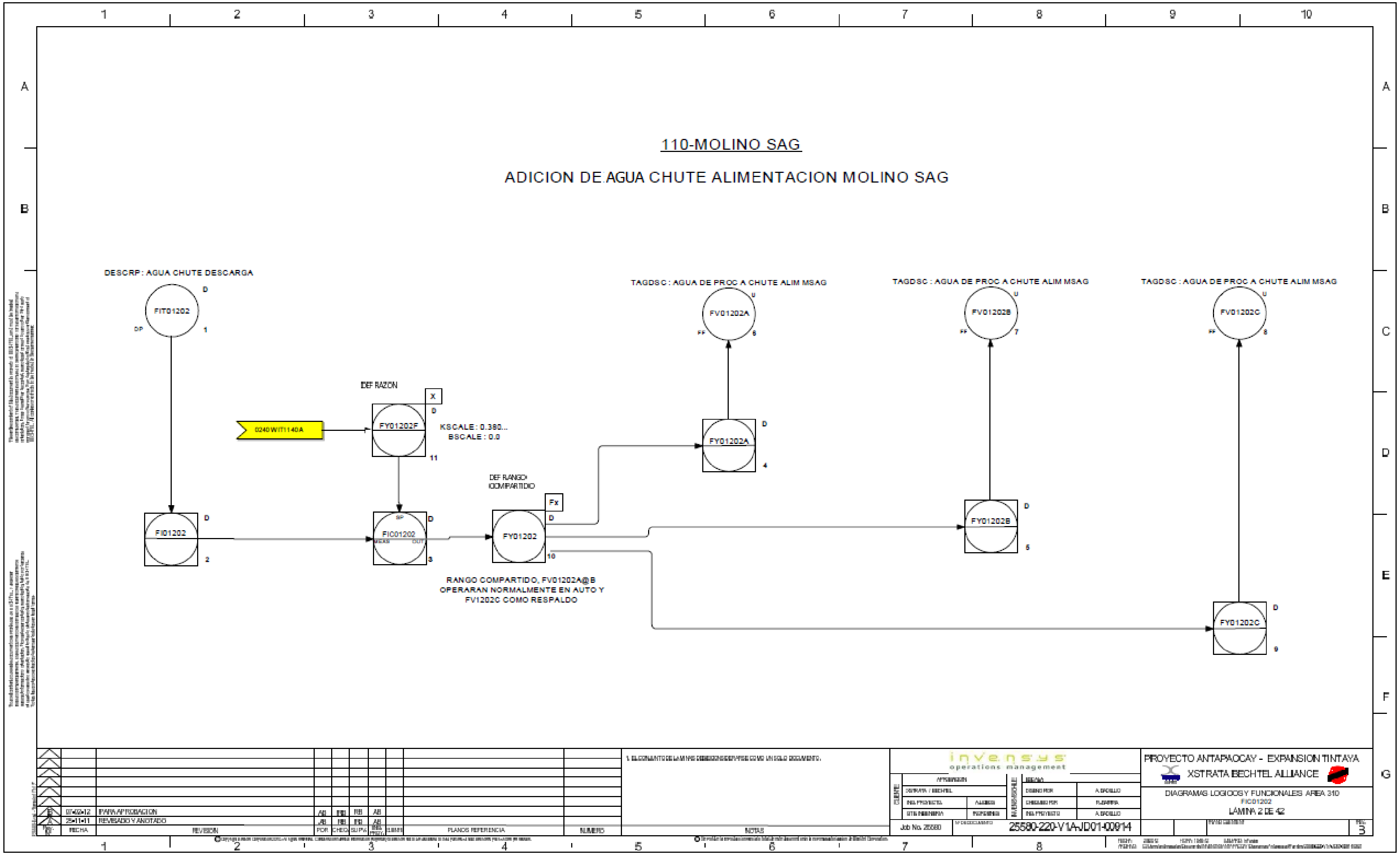


Fig.4.18.-Logica de Control – Adición de Agua al Chute de Alimentación Molino SAG
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

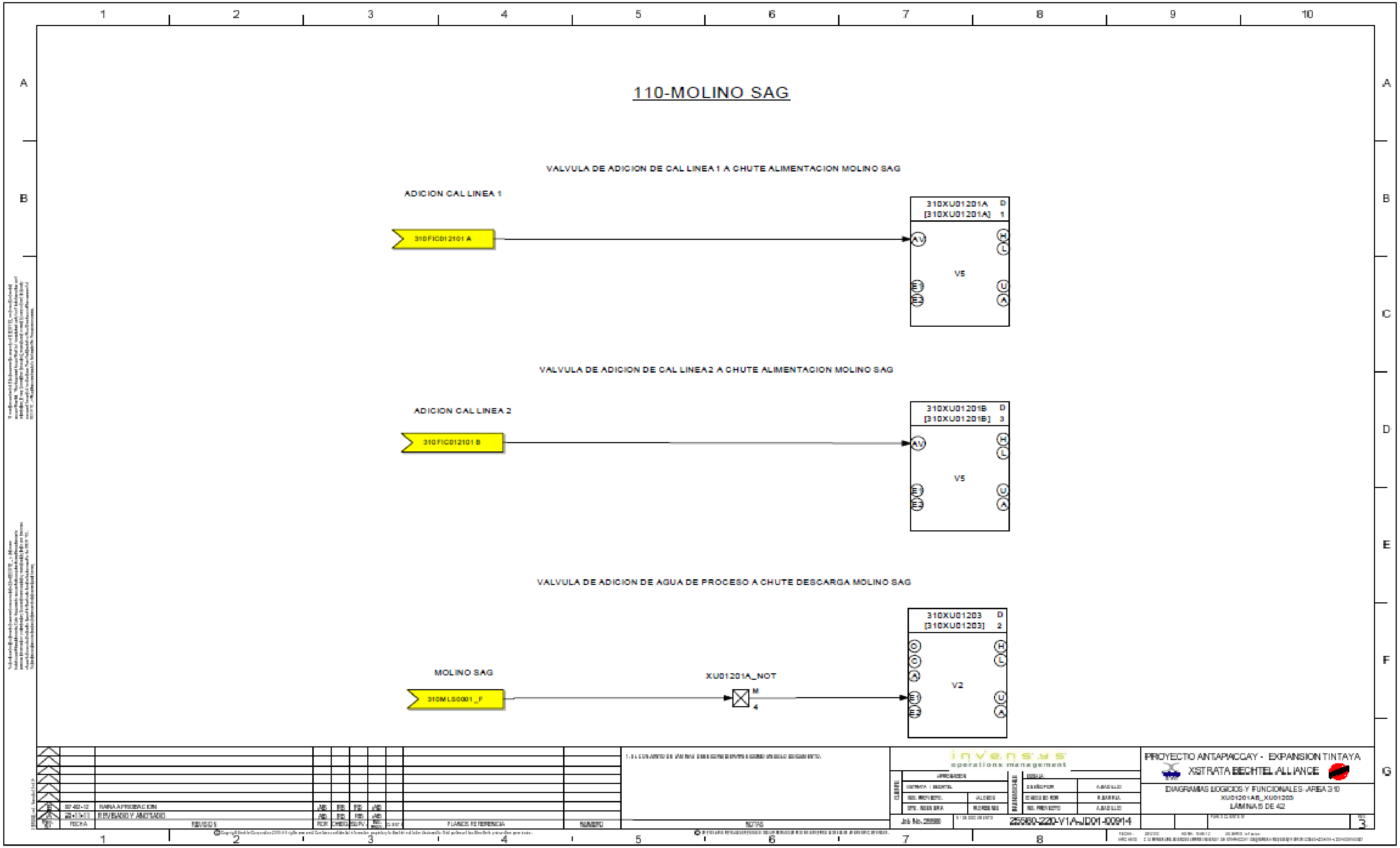


Fig.4.19.-Logica de Control – Accionamiento de Válvula de Control Agua - Cal
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

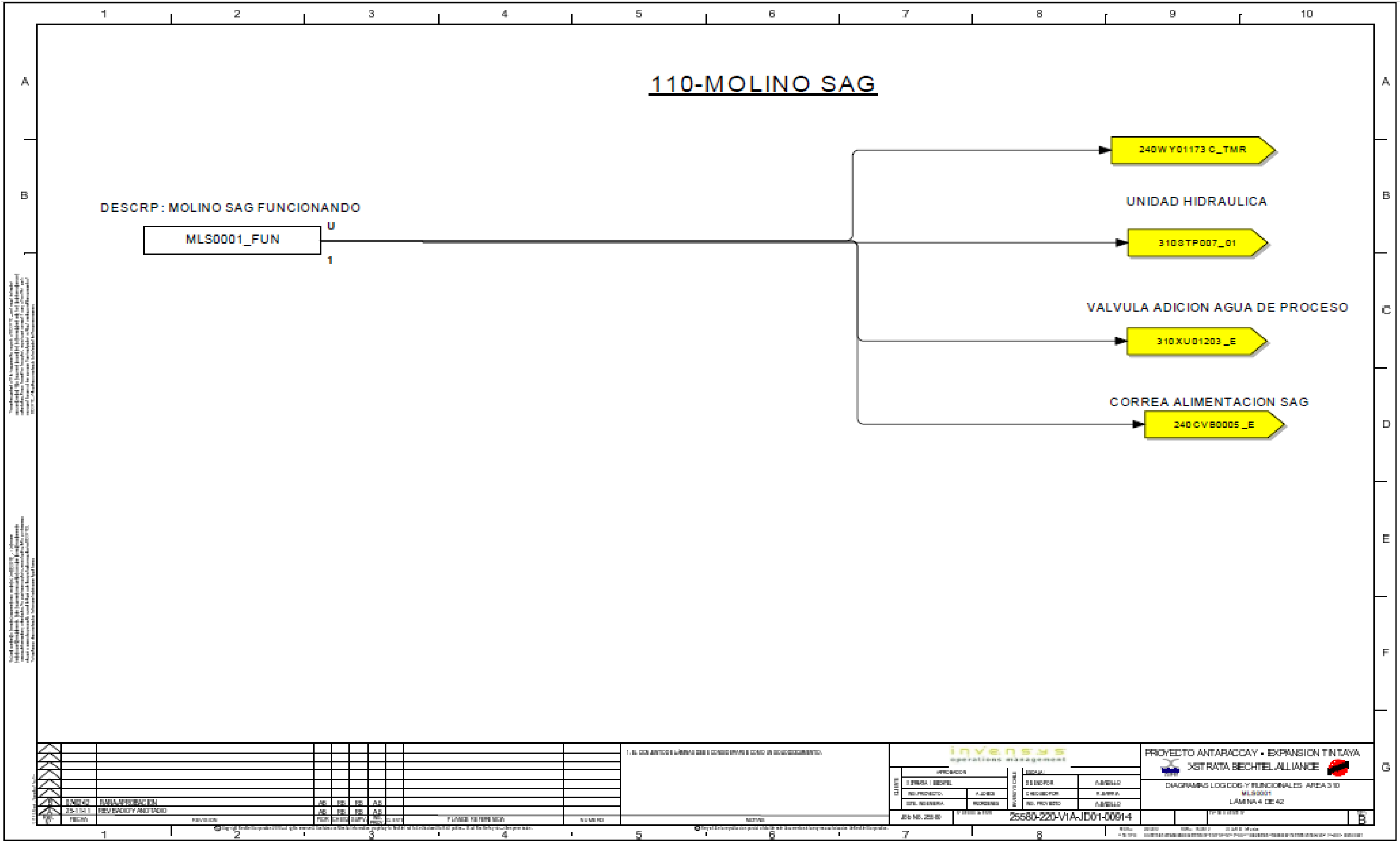


Fig.4.20.-Logica de Control – Condiciones de Funcionamiento Molino SAG 0310-MLS-0001
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

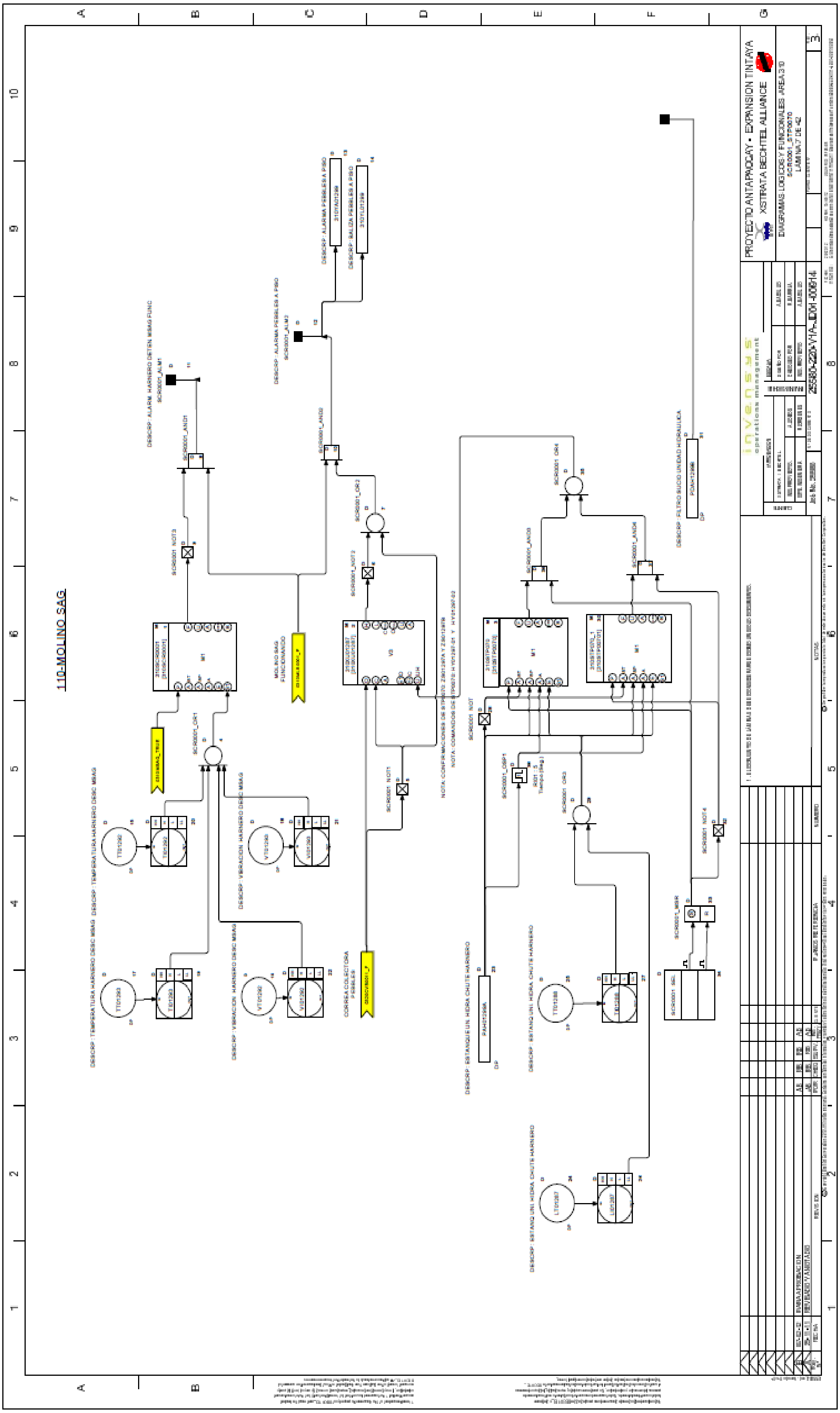


Fig.4.21.-Logica de Control – Control Harnero Vibratorio 0310-SCR-0001
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

4.6 Interfaz Hombre Maquina

En esta sección solo se detallara los interfaces implementados en el Proyecto Antapaccay Expansión Tintaya.

Estaciones de trabajo:

- Estaciones de Ingeniería, utilizan los modelos P92 configurados con el software Wonderware, proporciona una plataforma de trabajo para que el usuario interactúe con sistemas de Invensys Foxboro o Terceros. Sistema operativo Windows XP.
- Estaciones de Trabajo, utilizan modelos P90, configurados con Microsoft Windows Server 2003 como sistema operativo.
- Historiador Server, utilizan modelos P91, también utiliza Microsoft Windows Server 2003, proporciona una plataforma de trabajo para Invensys Foxboro o Terceros aplicaciones configuradas por el usuario.

Para el diseño de los HMI se utilizaron los P&ID del Proyecto, de manera que el control del proceso será fácil de entender y manejar para el operador.

El operador tendrá la opción de cambiar los parámetros de automático/manual y remoto/local, podrá modificar parámetros de control según el proceso lo exija, arranque de motores, apertura de válvulas, monitoreo de señales de proceso a través de los TREND configurados, manejo de históricos para detectar posibles fallas y verificar alarmas y eventos.

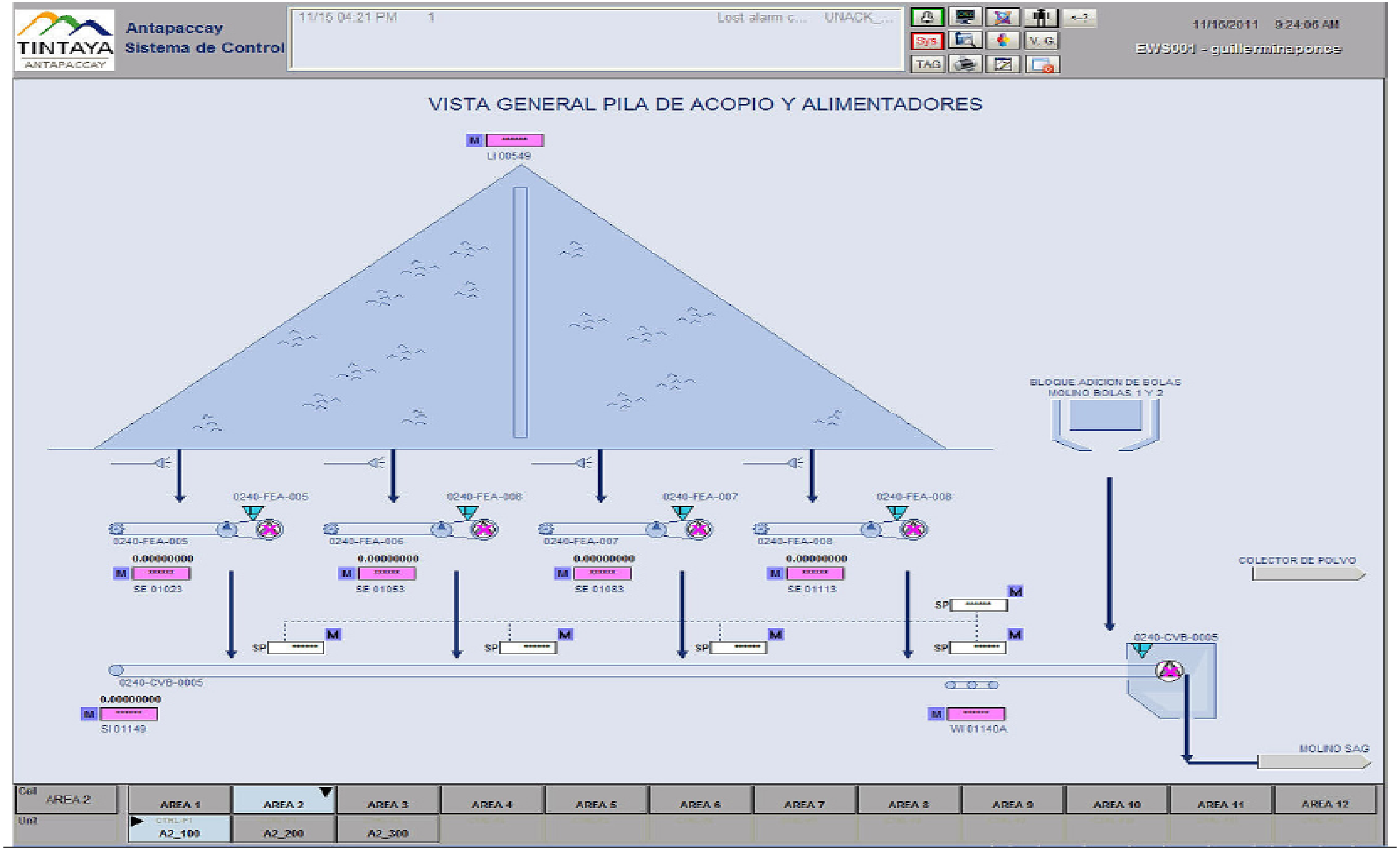


Fig.4.22.-HMI – Alimentadores de Acopio – Vista General

Fuente: Proyecto Tintaya – Antapaccay - Bechtel

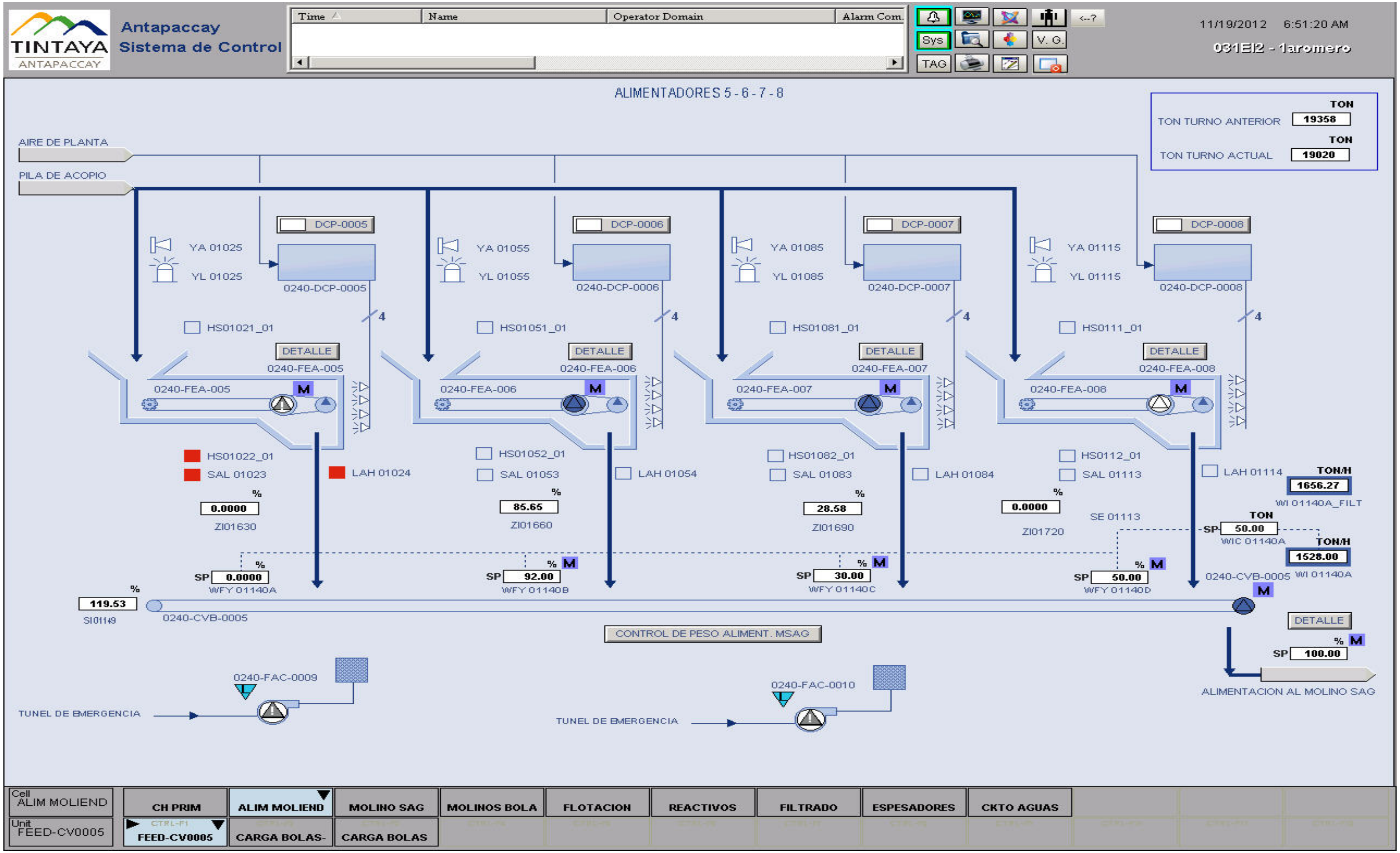


Fig.4.23.-HMI – Apron Feeder 5, 6, 7 y 8 –Alimentadores 0240-CVB-0005

Fuente: Proyecto Tintaya – Antapaccay - Bechtel

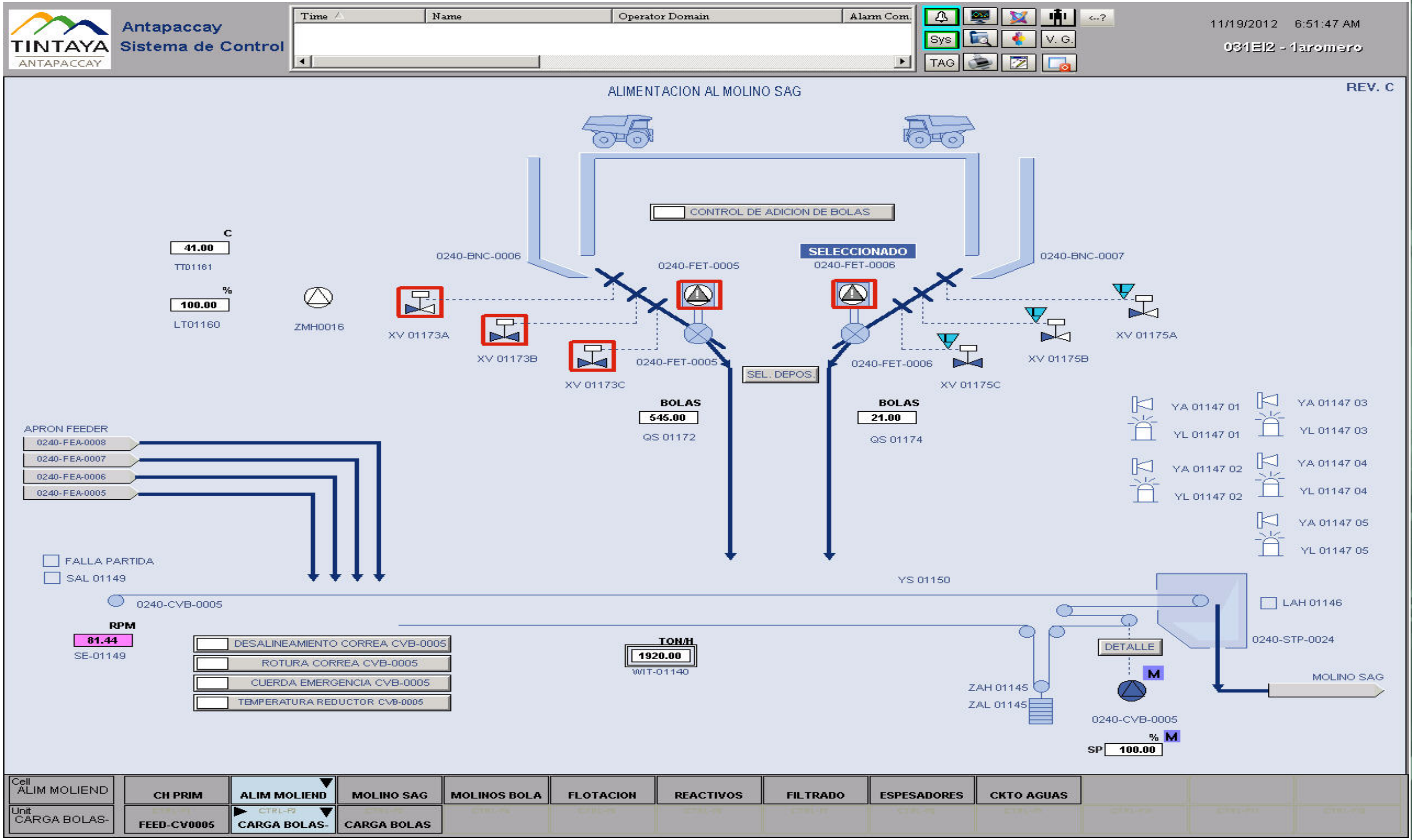


Fig.4.24.-HMI – Alimentador de Bolas – Faja 5 0240-CVB-0005
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

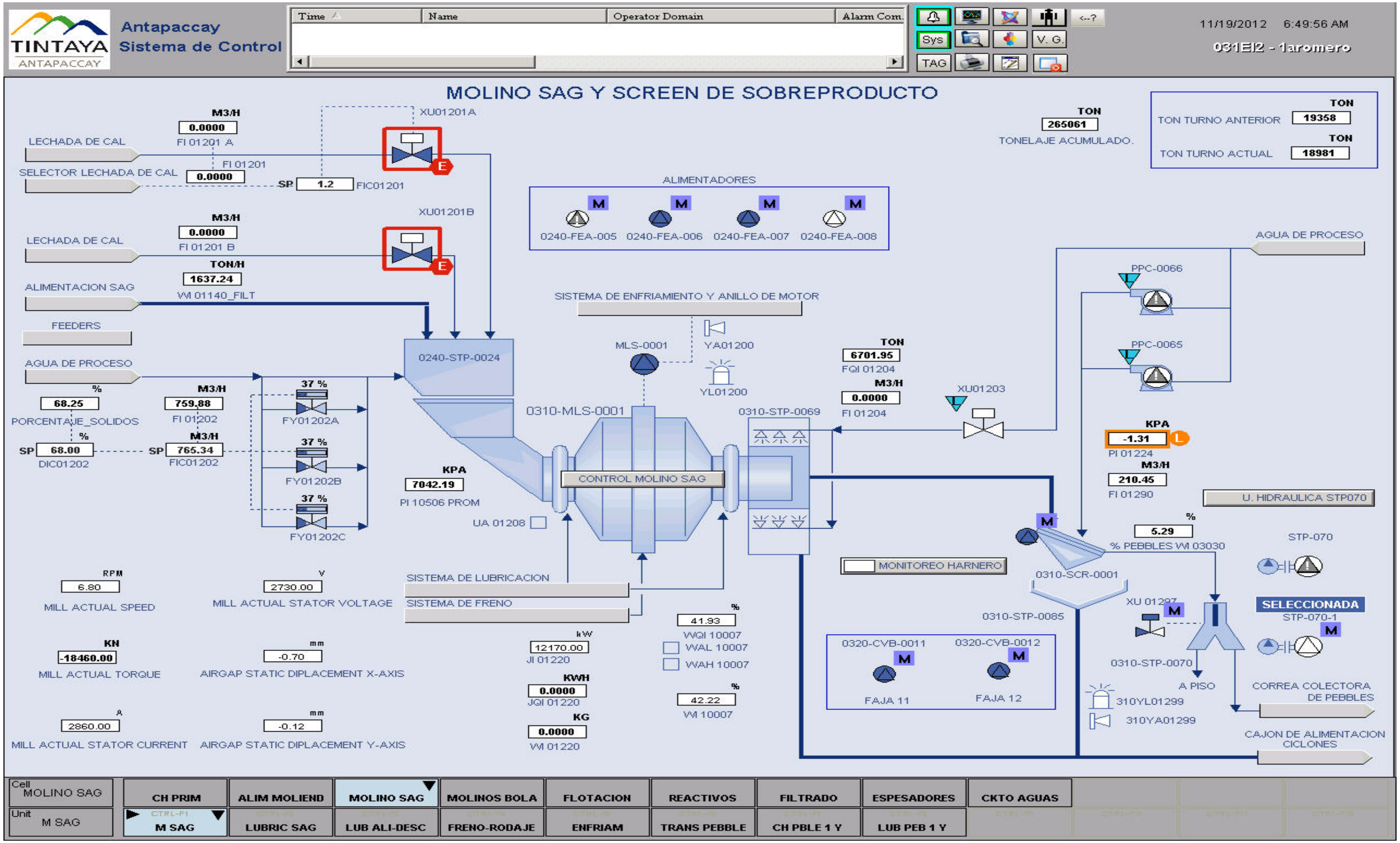


Fig.4.25.-HMI – Molino SAG – Adición de Agua – Adición de Cal

Fuente: Proyecto Tintaya – Antapaccay - Bechtel

4.7 Respuesta de Procesos

Una vez concluida la lógica de control, se procede analizar la respuesta de cada proceso que fueron obtenidos con el método de curva de reacción, aplicando un cambio al proceso mediante el actuador, esperamos la reacción del proceso para estabilizarse.

Cabe resaltar que el control de "Adición de Cal" no ha sido implementado aun y las tolvas de alimentación de bolas se encuentran operando en modo manual.

4.7.1 Lazo de Control – 0240-FEA-0005

Se cambió el porcentaje de velocidad de 55% a 60% para ver la reacción del proceso. Graficando los valores de la tabla obtenemos la curva de reacción mostrada en la Fig.26 y podemos inferir los parámetros de tiempo de retardo (θ), constante de tiempo (ζ) y ganancia (Kp) mostrados en la Tabla 4.14.

Curva de Reacción		
Kp	**θ**	**ζ**
4.976	68	52

Tabla.4.14.- Parámetros Curva de Reacción 0240-FEA-0005

Fuente: Elaboración Propia

Tiempo	MV	PV
08:04:47	55	323.53
08:04:48	55	323.53
08:04:49	55	323.53
08:04:50	55	323.53
08:04:51	55	323.53
08:04:52	55	323.53
08:04:53	55	323.53
08:04:54	55	323.53

$$\mathbf{G}_f = \frac{4.976e^{-68s}}{52s+1}$$

Tabla.4.15.- Respuesta Lazo de Control 0240-FEA-0005

Fuente: Elaboración Propia (Parte 1 de 8)

08:04:55	55	323.53
08:04:56	55	323.53
08:04:57	55	323.53
08:04:58	55	323.53
08:04:59	55	323.53
08:05:00	55	323.53
08:05:01	55	323.53
08:05:02	55	323.53
08:05:03	55	323.53
08:05:04	55	323.53
08:05:05	55	323.53
08:05:06	55	323.53
08:05:07	55	323.53
08:05:08	55	323.53
08:05:09	55	323.53
08:05:10	55	323.53
08:05:11	55	323.53
08:05:12	55	323.53
08:05:13	55	323.53
08:05:14	55	323.53
08:05:15	55	323.53
08:05:16	55	323.53
08:05:17	55	323.53
08:05:18	55	323.53
08:05:19	55	323.53
08:05:20	55	323.53
08:05:21	55	323.53
08:05:22	55	323.53
08:05:23	55	323.53
08:05:24	55	323.53
08:05:25	55	323.53
08:05:26	55	323.53
08:05:27	55	323.53
08:05:28	55	323.53
08:05:29	55	323.53
08:05:30	55	323.53
08:05:31	55	323.53
08:05:32	55	323.53
08:05:33	55	323.53

Tabla.4.15.- Respuesta Lazo de Control 0240-FEA-0005

Fuente: Elaboración Propia (Parte 2 de 8)

08:05:34	55	323.53
08:05:35	55	323.53
08:05:36	55	323.53
08:05:37	55	323.53
08:05:38	55	323.53
08:05:39	55	323.53
08:05:40	55	323.53
08:05:41	55	323.53
08:05:42	55	323.53
08:05:43	55	323.53
08:05:44	55	323.53
08:05:45	55	323.53
08:05:46	55	323.53
08:05:47	60	323.53
08:05:48	60	323.53
08:05:49	60	323.53
08:05:50	60	323.53
08:05:51	60	323.53
08:05:52	60	323.53
08:05:53	60	323.53
08:05:54	60	323.53
08:05:55	60	323.98
08:05:56	60	324.43
08:05:57	60	324.88
08:05:58	60	325.33
08:05:59	60	325.78
08:06:00	60	326.23
08:06:01	60	326.68
08:06:02	60	327.13
08:06:03	60	327.58
08:06:04	60	328.03
08:06:05	60	328.48
08:06:06	60	328.93
08:06:07	60	329.38
08:06:08	60	329.83
08:06:09	60	330.28
08:06:10	60	330.73
08:06:11	60	331.18
08:06:12	60	331.63

Tabla.4.15.- Respuesta Lazo de Control 0240-FEA-0005

Fuente: Elaboración Propia (Parte 3 de 8)

08:06:13	60	332.08
08:06:14	60	332.53
08:06:15	60	332.98
08:06:16	60	333.43
08:06:17	60	333.88
08:06:18	60	334.33
08:06:19	60	334.78
08:06:20	60	335.23
08:06:21	60	335.68
08:06:22	60	336.13
08:06:23	60	336.58
08:06:24	60	337.03
08:06:25	60	337.48
08:06:26	60	337.93
08:06:27	60	338.38
08:06:28	60	338.83
08:06:29	60	339.28
08:06:30	60	339.73
08:06:31	60	340.18
08:06:32	60	340.63
08:06:33	60	341.08
08:06:34	60	341.53
08:06:35	60	341.98
08:06:36	60	342.43
08:06:37	60	342.88
08:06:38	60	343.33
08:06:39	60	343.78
08:06:40	60	344.23
08:06:41	60	344.68
08:06:42	60	345.13
08:06:43	60	345.58
08:06:44	60	346.03
08:06:45	60	346.48
08:06:46	60	346.93
08:06:47	60	347.38
08:06:48	60	347.785
08:06:49	60	348.19
08:06:50	60	348.595
08:06:51	60	349
08:06:52	60	349.405

Tabla.4.15.- Respuesta Lazo de Control 0240-FEA-0005

Fuente: Elaboración Propia (Parte 4 de 8)

08:06:53	60	349.81
08:06:54	60	350.215
08:06:55	60	350.62
08:06:56	60	350.59
08:06:57	60	350.56
08:06:58	60	350.53
08:06:59	60	350.5
08:07:00	60	350.47
08:07:01	60	350.44
08:07:02	60	350.41
08:07:03	60	350.38
08:07:04	60	350.35
08:07:05	60	350.32
08:07:06	60	350.29
08:07:07	60	350.26
08:07:08	60	350.23
08:07:09	60	350.18
08:07:10	60	350.15
08:07:11	60	350.12
08:07:12	60	350.09
08:07:13	60	350.06
08:07:14	60	350.03
08:07:15	60	350
08:07:16	60	349.97
08:07:17	60	349.94
08:07:18	60	349.91
08:07:19	60	349.88
08:07:20	60	349.85
08:07:21	60	349.82
08:07:22	60	349.79
08:07:23	60	349.76
08:07:24	60	349.73
08:07:25	60	349.7
08:07:26	60	349.67
08:07:27	60	349.64
08:07:28	60	349.61
08:07:29	60	349.58
08:07:30	60	349.55

Tabla.4.15.- Respuesta Lazo de Control 0240-FEA-0005

Fuente: Elaboración Propia (Parte 5 de 8)

08:07:31	60	349.52
08:07:32	60	349.49
08:07:33	60	349.46
08:07:34	60	349.43
08:07:35	60	349.4
08:07:36	60	349.37
08:07:37	60	349.34
08:07:38	60	349.31
08:07:39	60	349.28
08:07:40	60	349.25
08:07:41	60	349.22
08:07:42	60	349.19
08:07:43	60	349.16
08:07:44	60	349.13
08:07:45	60	349.1
08:07:46	60	349.07
08:07:47	60	349.04
08:07:48	60	349.01
08:07:49	60	348.98
08:07:50	60	348.95
08:07:51	60	348.92
08:07:52	60	348.89
08:07:53	60	348.86
08:07:54	60	348.83
08:07:55	60	348.8
08:07:56	60	348.77
08:07:57	60	348.74
08:07:58	60	348.71
08:07:59	60	348.68
08:08:00	60	348.65
08:08:01	60	348.62
08:08:02	60	348.59
08:08:03	60	348.56
08:08:04	60	348.53
08:08:05	60	348.5
08:08:06	60	348.47
08:08:07	60	348.44
08:08:08	60	348.41
08:08:09	60	348.41
08:08:10	60	348.41

Tabla.4.15.- Respuesta Lazo de Control 0240-FEA-0005

Fuente: Elaboración Propia (Parte 6 de 8)

08:08:11	60	348.41
08:08:12	60	348.41
08:08:13	60	348.41
08:08:14	60	348.41
08:08:15	60	348.41
08:08:16	60	348.41
08:08:17	60	348.41
08:08:18	60	348.41
08:08:19	60	348.41
08:08:20	60	348.41
08:08:21	60	348.41
08:08:22	60	348.41
08:08:23	60	348.41
08:08:24	60	348.41
08:08:25	60	348.41
08:08:26	60	348.41
08:08:27	60	348.41
08:08:28	60	348.41
08:08:29	60	348.41
08:08:30	60	348.41
08:08:31	60	348.41
08:08:32	60	348.41
08:08:33	60	348.41
08:08:34	60	348.41
08:08:35	60	348.41
08:08:36	60	348.41
08:08:37	60	348.41
08:08:38	60	348.41
08:08:39	60	348.41
08:08:40	60	348.41
08:08:41	60	348.41
08:08:42	60	348.41
08:08:43	60	348.41
08:08:44	60	348.41
08:08:45	60	348.41
08:08:46	60	348.41
08:08:47	60	348.41
08:08:48	60	348.41
08:08:49	60	348.41
08:08:50	60	348.41

Tabla.4.15.- Respuesta Lazo de Control 0240-FEA-0005

Fuente: Elaboración Propia (Parte 7 de 8)

08:08:51	60	348.41
08:08:52	60	348.41
08:08:53	60	348.41
08:08:54	60	348.41
08:08:55	60	348.41
08:08:56	60	348.41
08:08:57	60	348.41
08:08:58	60	348.41
08:08:59	60	348.41
08:09:00	60	348.41
08:09:01	60	348.41
08:09:02	60	348.41
08:09:03	60	348.41
08:09:04	60	348.41
08:09:05	60	348.41
08:09:06	60	348.41
08:09:07	60	348.41
08:09:08	60	348.41
08:09:09	60	348.41
08:09:10	60	348.41
08:09:11	60	348.41
08:09:12	60	348.41
08:09:13	60	348.41
08:09:14	60	348.41
08:09:15	60	348.41
08:09:16	60	348.41
08:09:17	60	348.41
08:09:18	60	348.41
08:09:19	60	348.41
08:09:20	60	348.41
08:09:21	60	348.41
08:09:22	60	348.41
08:09:23	60	348.41
08:09:24	60	348.41
08:09:25	60	348.41
08:09:26	60	348.41
08:09:27	60	348.41
08:09:28	60	348.41
08:09:29	60	348.41
08:09:30	60	348.41

08:09:31	60	348.41
08:09:32	60	348.41
08:09:33	60	348.41
08:09:34	60	348.41
08:09:35	60	348.41
08:09:36	60	348.41
08:09:37	60	348.41
08:09:38	60	348.41
08:09:39	60	348.41
08:09:40	60	348.41
08:09:41	60	348.41
08:09:42	60	348.41
08:09:43	60	348.41
08:09:44	60	348.41
08:09:45	60	348.41

Tabla 4.15.- Respuesta Lazo de Control 0240- FEA-0005
Fuente: Elaboración Propia (8 de 8)

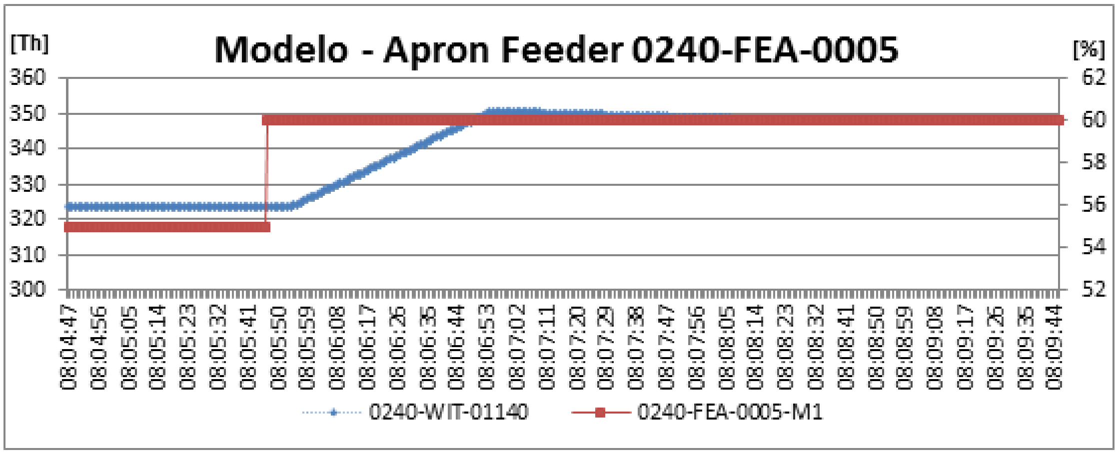


Fig.4.26.-Respuesta - 0240-FEA-0005

Fuente: Elaboración Propia

Una vez identificados los parámetros del proceso obtenidos de la curva de reacción (ver Fig.4.26), se obtienen los parámetros del controlador. Para lo cual utilizaremos el método de sintonización de Zieger y Nichols (ver tabla 4.16).

Se selecciona un control PID por el comportamiento del Peso como variable de proceso, se caracteriza por tener la velocidad de respuesta lenta y tiempo muertos considerables.

Parámetros PID -ZN			
	Kp	**Ti**	**Td**
PID	1.2ζ/(Kp)θ	2θ	0.5θ
PID(s)	0.1844146	136	34
PID(min)	0.00307358	2.26666667	0.56666667

Tabla.4.16.- Parámetros PID-ZN para 0240-FEA-0005

Fuente: Elaboración Propia

4.7.2 Lazo de Control – 0240-FEA-0006

Se cambió el porcentaje de velocidad de 65% a 70% para ver la reacción del proceso. Graficando los valores de la tabla obtenemos la curva de reacción mostrada en la Fig.27 y podemos inferir los parámetros de tiempo de retardo (θ), constante de tiempo (ζ) y ganancia (Kp) mostrados en la Tabla 4.17.

Curva de Reacción		
Kp	**θ**	**ζ**
7.148	69	72

Tabla.4.17.- Parámetros Curva de Reacción 0240-FEA-0006

Fuente: Elaboración Propia

Tiempo	MV	PV
10:11:35	65	355.13
10:11:36	65	355.13
10:11:37	65	355.13
10:11:38	65	355.13
10:11:39	65	355.13
10:11:40	65	355.13
10:11:41	65	355.13
10:11:42	65	355.13
10:11:43	65	355.13
10:11:44	65	355.13
10:11:45	65	355.13
10:11:46	65	355.13
10:11:47	65	355.13
10:11:48	65	355.13
10:11:49	65	355.13
10:11:50	65	355.13
10:11:51	65	355.13
10:11:52	65	355.13
10:11:53	65	355.13
10:11:54	65	355.13

$$\boldsymbol{G_f} = \frac{7.148e^{-69s}}{72s + 1}$$

Tabla.4.18.- Parámetros Curva de Reacción 0240-FEA-0006

Fuente: Elaboración Propia

10:11:55	65	355.13
10:11:56	65	355.13
10:11:57	65	355.13
10:11:58	65	355.13
10:11:59	65	355.13
10:12:00	65	355.13
10:12:01	65	355.13
10:12:02	65	355.13
10:12:03	65	355.13
10:12:04	65	355.13
10:12:05	65	355.13
10:12:06	65	355.13
10:12:07	65	355.13
10:12:08	65	355.13
10:12:09	65	355.13
10:12:10	65	355.13
10:12:11	65	355.13
10:12:12	65	355.13
10:12:13	65	355.13
10:12:14	65	355.13
10:12:15	65	355.13
10:12:16	65	355.13
10:12:17	65	355.13
10:12:18	65	355.13
10:12:19	65	355.13
10:12:20	65	355.13
10:12:21	65	355.13
10:12:22	65	355.13
10:12:23	65	355.13
10:12:24	65	355.13
10:12:25	65	355.13
10:12:26	65	355.13
10:12:27	65	355.13
10:12:28	65	355.13
10:12:29	65	355.13
10:12:30	65	355.13
10:12:31	65	355.13
10:12:32	65	355.13
10:12:33	65	355.13
10:12:34	65	355.13

Tabla.4.18.- Respuesta Lazo de Control 0240-FEA-0006

Fuente: Elaboración Propia (Parte 2 de 8)

10:12:35	65	355.13
10:12:36	65	355.13
10:12:37	65	355.13
10:12:38	65	355.13
10:12:39	70	355.13
10:12:40	70	355.13
10:12:41	70	355.13
10:12:42	70	355.13
10:12:43	70	355.13
10:12:44	70	355.58
10:12:45	70	356.03
10:12:46	70	356.48
10:12:47	70	356.93
10:12:48	70	357.38
10:12:49	70	357.83
10:12:50	70	358.28
10:12:51	70	358.73
10:12:52	70	359.18
10:12:53	70	359.63
10:12:54	70	360.08
10:12:55	70	360.53
10:12:56	70	360.98
10:12:57	70	361.43
10:12:58	70	361.88
10:12:59	70	362.33
10:13:00	70	362.78
10:13:01	70	363.23
10:13:02	70	363.68
10:13:03	70	364.13
10:13:04	70	364.58
10:13:05	70	365.03
10:13:06	70	365.48
10:13:07	70	365.93
10:13:08	70	366.38
10:13:09	70	366.83
10:13:10	70	367.28
10:13:11	70	367.73
10:13:12	70	368.18

Tabla.4.18.- Respuesta Lazo de Control 0240-FEA-0006

Fuente: Elaboración Propia (Parte 3 de 8)

10:13:13	70	368.63
10:13:14	70	369.08
10:13:15	70	369.53
10:13:16	70	369.98
10:13:17	70	370.43
10:13:18	70	370.88
10:13:19	70	371.33
10:13:20	70	371.78
10:13:21	70	372.23
10:13:22	70	372.68
10:13:23	70	373.13
10:13:24	70	373.58
10:13:25	70	374.03
10:13:26	70	374.48
10:13:27	70	374.93
10:13:28	70	375.38
10:13:29	70	375.83
10:13:30	70	376.28
10:13:31	70	376.73
10:13:32	70	377.18
10:13:33	70	377.63
10:13:34	70	378.08
10:13:35	70	378.53
10:13:36	70	378.98
10:13:37	70	379.43
10:13:38	70	379.88
10:13:39	70	380.33
10:13:40	70	380.78
10:13:41	70	381.23
10:13:42	70	381.68
10:13:43	70	382.13
10:13:44	70	382.58
10:13:45	70	383.03
10:13:46	70	383.48
10:13:47	70	383.93
10:13:48	70	384.38
10:13:49	70	384.83
10:13:50	70	385.28
10:13:51	70	385.73
10:13:52	70	386.18
10:13:53	70	386.63

Tabla.4.18.- Respuesta Lazo de Control 0240-FEA-0006

Fuente: Elaboración Propia (Parte 4 de 8)

10:13:54	70	387.08
10:13:55	70	387.53
10:13:56	70	387.98
10:13:57	70	388.43
10:13:58	70	388.88
10:13:59	70	389.33
10:14:00	70	389.78
10:14:01	70	390.23
10:14:02	70	390.68
10:14:03	70	391.13
10:14:04	70	391.58
10:14:05	70	391.55
10:14:06	70	391.52
10:14:07	70	391.49
10:14:08	70	391.46
10:14:09	70	391.43
10:14:10	70	391.4
10:14:11	70	391.37
10:14:12	70	391.34
10:14:13	70	391.31
10:14:14	70	391.28
10:14:15	70	391.25
10:14:16	70	391.22
10:14:17	70	391.19
10:14:18	70	391.16
10:14:19	70	391.13
10:14:20	70	391.1
10:14:21	70	391.07
10:14:22	70	391.04
10:14:23	70	391.01
10:14:24	70	390.98
10:14:25	70	390.95
10:14:26	70	390.92
10:14:27	70	390.89
10:14:28	70	390.86
10:14:29	70	390.83
10:14:30	70	390.8
10:14:31	70	390.77
10:14:32	70	390.74
10:14:33	70	390.71
10:14:34	70	390.68

Tabla.4.18.- Respuesta Lazo de Control 0240-FEA-0006

Fuente: Elaboración Propia (Parte 5 de 8)

10:14:35	70	390.65
10:14:36	70	390.62
10:14:37	70	390.59
10:14:38	70	390.56
10:14:39	70	390.53
10:14:40	70	390.5
10:14:41	70	390.47
10:14:42	70	390.44
10:14:43	70	390.41
10:14:44	70	390.38
10:14:45	70	390.35
10:14:46	70	390.32
10:14:47	70	390.29
10:14:48	70	390.26
10:14:49	70	390.23
10:14:50	70	390.2
10:14:51	70	390.17
10:14:52	70	390.14
10:14:53	70	390.11
10:14:54	70	390.08
10:14:55	70	390.05
10:14:56	70	390.08
10:14:57	70	390.11
10:14:58	70	390.14
10:14:59	70	390.17
10:15:00	70	390.2
10:15:01	70	390.23
10:15:02	70	390.26
10:15:03	70	390.29
10:15:04	70	390.32
10:15:05	70	390.35
10:15:06	70	390.38
10:15:07	70	390.41
10:15:08	70	390.44
10:15:09	70	390.47
10:15:10	70	390.5
10:15:11	70	390.53
10:15:12	70	390.56
10:15:13	70	390.59
10:15:14	70	390.62

Tabla.4.18.- Respuesta Lazo de Control 0240-FEA-0006

Fuente: Elaboración Propia (Parte 6 de 8)

10:15:15	70	390.65
10:15:16	70	390.68
10:15:17	70	390.71
10:15:18	70	390.74
10:15:19	70	390.77
10:15:20	70	390.8
10:15:21	70	390.87
10:15:22	70	390.87
10:15:23	70	390.87
10:15:24	70	390.87
10:15:25	70	390.87
10:15:26	70	390.87
10:15:27	70	390.87
10:15:28	70	390.87
10:15:29	70	390.87
10:15:30	70	390.87
10:15:31	70	390.87
10:15:32	70	390.87
10:15:33	70	390.87
10:15:34	70	390.87
10:15:35	70	390.87
10:15:36	70	390.87
10:15:37	70	390.87
10:15:38	70	390.87
10:15:39	70	390.87
10:15:40	70	390.87
10:15:41	70	390.87
10:15:42	70	390.87
10:15:43	70	390.87
10:15:47	70	390.87
10:15:48	70	390.87
10:15:49	70	390.87
10:15:50	70	390.87
10:15:51	70	390.87

Tabla.4.18.- Respuesta Lazo de Control 0240-FEA-0006

Fuente: Elaboración Propia (Parte 7 de 8)

10:15:52	70	390.87
10:15:53	70	390.87
10:15:54	70	390.87
10:15:55	70	390.87
10:15:56	70	390.87
10:15:57	70	390.87
10:15:58	70	390.87
10:15:59	70	390.87
10:16:00	70	390.87
10:16:01	70	390.87
10:16:02	70	390.87
10:16:03	70	390.87
10:16:04	70	390.87
10:16:05	70	390.87
10:16:06	70	390.87
10:16:07	70	390.87
10:16:08	70	390.87
10:16:09	70	390.87
10:16:10	70	390.87
10:16:11	70	390.87
10:16:12	70	390.87
10:16:13	70	390.87
10:16:14	70	390.87
10:16:15	70	390.87
10:16:16	70	390.87
10:16:17	70	390.87
10:16:18	70	390.87
10:16:19	70	390.87
10:16:20	70	390.87
10:16:21	70	390.87
10:16:22	70	390.87
10:16:23	70	390.87
10:16:24	70	390.87
10:16:25	70	390.87
10:16:26	70	390.87
10:16:27	70	390.87
10:16:28	70	390.87
10:16:29	70	390.87
10:16:30	70	390.87

Tabla.4.18.- Respuesta Lazo de Control 0240-FEA-0006

Fuente: Elaboración Propia (Parte 8 de 8)

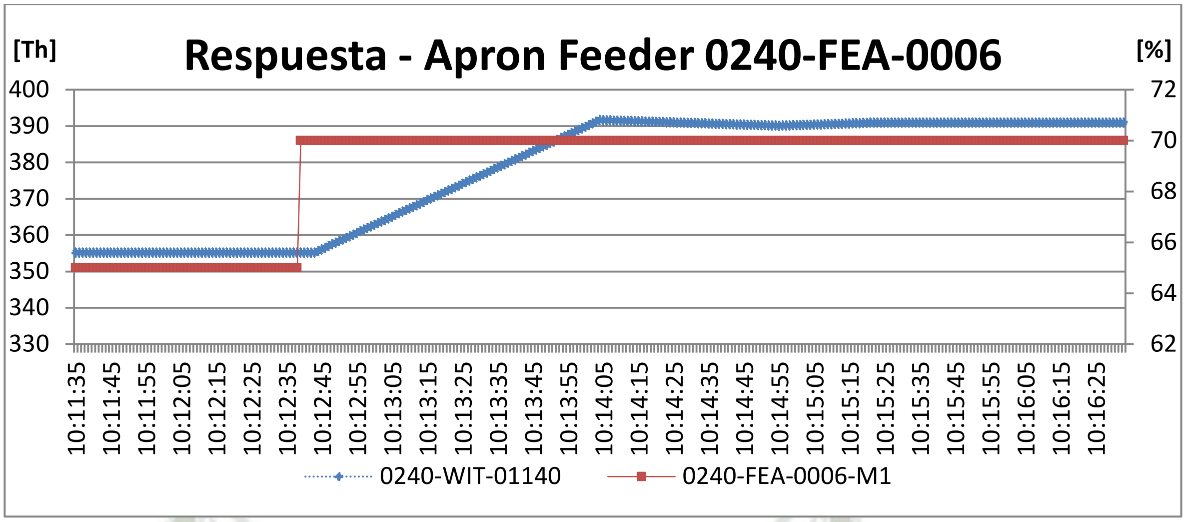


Fig.4.27.- Respuesta - 0240-FEA-0006

Fuente: Elaboración Propia

Una vez identificados los parámetros del proceso obtenidos de la curva de reacción (ver Fig.4.27), se obtienen los parámetros del controlador. Para lo cual utilizaremos el método de sintonización de Zieger y Nichols (ver tabla 4.19).

Se selecciona un control PID por el comportamiento del Peso como variable de proceso, se caracteriza por tener la velocidad de respuesta lenta y tiempo muertos considerables.

Parámetros PID -ZN			
	Kp	**Ti**	**Td**
PID	1.2ζ/(Kp)θ	2θ	0.5θ
PID(s)	0.17517822	138	34.5
PID(min)	0.00291964	2.3	0.575

Tabla.4.19.- Parámetros PID-ZN para 0240-FEA-0006

Fuente: Elaboración Propia

4.7.3 Lazo de Control – 0240-FEA-0007

Se cambió el porcentaje de velocidad de 30% a 35% para ver la reacción del proceso. Graficando los valores de la tabla obtenemos la curva de reacción mostrada en la Fig.28 y podemos inferir los parámetros de tiempo de retardo (θ), constante de tiempo (ζ) y ganancia (Kp) mostrados en la Tabla 4.20.

Curva de Reacción		
Kp	**θ**	**ζ**
6.936	76	77

Tabla.4.20.- Parámetros Curva de Reacción 0240-FEA-0007

Fuente: Elaboración Propia

Tiempo	MV	PV
11:25:34	30	226.36
11:25:35	30	226.36
11:25:36	30	226.36
11:25:37	30	226.36
11:25:38	30	226.36
11:25:39	30	226.36
11:25:40	30	226.36
11:25:41	30	226.36
11:25:42	30	226.36
11:25:43	30	226.36
11:25:44	30	226.36
11:25:45	30	226.36
11:25:46	30	226.36
11:25:47	30	226.36
11:25:48	30	226.36
11:25:49	30	226.36
11:25:50	30	226.36
11:25:51	30	226.36
11:25:52	30	226.36
11:25:53	30	226.36
11:25:54	30	226.36
11:25:55	30	226.36

$$G_f = \frac{6.936e^{-76s}}{77s+1}$$

Tabla.4.21.- Respuesta Lazo de Control 0240-FEA-0007

Fuente: Elaboración Propia (Parte 1 de 8)

11:25:56	30	226.36
11:25:57	30	226.36
11:25:58	30	226.36
11:25:59	30	226.36
11:26:00	30	226.36
11:26:01	30	226.36
11:26:02	30	226.36
11:26:03	30	226.36
11:26:04	30	226.36
11:26:05	30	226.36
11:26:06	30	226.36
11:26:07	30	226.36
11:26:08	30	226.36
11:26:09	30	226.36
11:26:10	30	226.36
11:26:11	30	226.36
11:26:12	30	226.36
11:26:13	30	226.36
11:26:14	30	226.36
11:26:15	30	226.36
11:26:16	30	226.36
11:26:17	30	226.36
11:26:18	30	226.36
11:26:19	30	226.36
11:26:20	30	226.36
11:26:21	30	226.36
11:26:22	30	226.36
11:26:23	30	226.36
11:26:24	30	226.36
11:26:25	30	226.36
11:26:26	30	226.36
11:26:27	30	226.36
11:26:28	30	226.36
11:26:29	30	226.36
11:26:30	30	226.36
11:26:31	30	226.36
11:26:32	30	226.36
11:26:33	30	226.36
11:26:34	30	226.36
11:26:35	30	226.36

Tabla.4.21.- Respuesta Lazo de Control 0240-FEA-0007

Fuente: Elaboración Propia (Parte 2 de 8)

11:26:36	30	226.36
11:26:37	30	226.36
11:26:38	30	226.36
11:26:39	35	226.36
11:26:40	35	226.36
11:26:41	35	226.36
11:26:42	35	226.36
11:26:43	35	226.36
11:26:44	35	226.36
11:26:45	35	226.36
11:26:46	35	226.36
11:26:47	35	226.81
11:26:48	35	227.26
11:26:49	35	227.71
11:26:50	35	228.16
11:26:51	35	228.61
11:26:52	35	229.06
11:26:53	35	229.51
11:26:54	35	229.96
11:26:55	35	230.41
11:26:56	35	230.86
11:26:57	35	231.31
11:26:58	35	231.76
11:26:59	35	232.21
11:27:00	35	232.66
11:27:01	35	233.11
11:27:02	35	233.56
11:27:03	35	234.01
11:27:04	35	234.46
11:27:05	35	234.91
11:27:06	35	235.36
11:27:07	35	235.81
11:27:08	35	236.26
11:27:09	35	236.71
11:27:10	35	237.16
11:27:11	35	237.61
11:27:12	35	238.06
11:27:13	35	238.51

Tabla.4.21.- Respuesta Lazo de Control 0240-FEA-0007

Fuente: Elaboración Propia (Parte 3 de 8)

11:27:14	35	238.96
11:27:15	35	239.41
11:27:16	35	239.86
11:27:17	35	240.31
11:27:18	35	240.76
11:27:19	35	241.21
11:27:20	35	241.66
11:27:21	35	242.11
11:27:22	35	242.56
11:27:23	35	243.01
11:27:24	35	243.46
11:27:25	35	243.91
11:27:26	35	244.36
11:27:27	35	244.81
11:27:28	35	245.26
11:27:29	35	245.71
11:27:30	35	246.16
11:27:31	35	246.61
11:27:32	35	247.06
11:27:33	35	247.51
11:27:34	35	247.96
11:27:35	35	248.41
11:27:36	35	248.86
11:27:37	35	249.31
11:27:38	35	249.76
11:27:39	35	250.21
11:27:40	35	250.66
11:27:41	35	251.11
11:27:42	35	251.56
11:27:43	35	252.01
11:27:44	35	252.46
11:27:45	35	252.91
11:27:46	35	253.36
11:27:47	35	253.81
11:27:48	35	254.26
11:27:49	35	254.71
11:27:50	35	255.16
11:27:51	35	255.61
11:27:52	35	256.06
11:27:53	35	256.51
11:27:54	35	256.96

Tabla.4.21.- Respuesta Lazo de Control 0240-FEA-0007

Fuente: Elaboración Propia (Parte 4 de 8)

11:27:55	35	257.41
11:27:56	35	257.86
11:27:57	35	258.31
11:27:58	35	258.76
11:27:59	35	259.21
11:28:00	35	259.66
11:28:01	35	260.11
11:28:02	35	260.56
11:28:03	35	261.01
11:28:04	35	260.98
11:28:05	35	260.95
11:28:06	35	260.92
11:28:07	35	260.89
11:28:08	35	260.86
11:28:09	35	260.83
11:28:10	35	260.8
11:28:11	35	260.77
11:28:12	35	260.74
11:28:13	35	260.71
11:28:14	35	260.68
11:28:15	35	260.65
11:28:16	35	260.62
11:28:17	35	260.59
11:28:18	35	260.56
11:28:19	35	260.53
11:28:20	35	260.5
11:28:21	35	260.47
11:28:22	35	260.44
11:28:23	35	260.41
11:28:24	35	260.38
11:28:25	35	260.35
11:28:26	35	260.32
11:28:27	35	260.29
11:28:28	35	260.26
11:28:29	35	260.23
11:28:30	35	260.2
11:28:31	35	260.17
11:28:32	35	260.14
11:28:33	35	260.11
11:28:34	35	260.08
11:28:35	35	260.05

Tabla.4.21.- Respuesta Lazo de Control 0240-FEA-0007

Fuente: Elaboración Propia (Parte 5 de 8)

11:28:36	35	260.02
11:28:37	35	259.99
11:28:38	35	259.96
11:28:39	35	259.93
11:28:40	35	259.9
11:28:41	35	259.87
11:28:42	35	259.84
11:28:43	35	259.81
11:28:44	35	259.78
11:28:45	35	259.75
11:28:46	35	259.72
11:28:47	35	259.69
11:28:48	35	259.66
11:28:49	35	259.63
11:28:50	35	259.6
11:28:51	35	259.57
11:28:52	35	259.54
11:28:53	35	259.51
11:28:54	35	259.48
11:28:55	35	259.51
11:28:56	35	259.54
11:28:57	35	259.57
11:28:58	35	259.6
11:28:59	35	259.63
11:29:00	35	259.66
11:29:01	35	259.69
11:29:02	35	259.72
11:29:03	35	259.75
11:29:04	35	259.78
11:29:05	35	259.81
11:29:06	35	259.84
11:29:07	35	259.87
11:29:08	35	259.9
11:29:09	35	259.93
11:29:10	35	259.96
11:29:11	35	259.99
11:29:12	35	260.02
11:29:13	35	260.05
11:29:14	35	260.08
11:29:15	35	260.11
11:29:16	35	260.14

Tabla.4.21.- Respuesta Lazo de Control 0240-FEA-0007

Fuente: Elaboración Propia (Parte 6 de 8)

11:29:17	35	260.17
11:29:18	35	260.2
11:29:19	35	260.23
11:29:20	35	260.26
11:29:21	35	260.29
11:29:22	35	260.32
11:29:23	35	260.35
11:29:24	35	260.38
11:29:25	35	260.41
11:29:26	35	260.44
11:29:27	35	260.47
11:29:28	35	260.5
11:29:29	35	260.53
11:29:30	35	261.04
11:29:31	35	261.04
11:29:32	35	261.04
11:29:33	35	261.04
11:29:34	35	261.04
11:29:35	35	261.04
11:29:36	35	261.04
11:29:37	35	261.04
11:29:38	35	261.04
11:29:39	35	261.04
11:29:40	35	261.04
11:29:41	35	261.04
11:29:42	35	261.04
11:29:43	35	261.04
11:29:44	35	261.04
11:29:45	35	261.04
11:29:46	35	261.04
11:29:47	35	261.04
11:29:48	35	261.04
11:29:49	35	261.04

Tabla.4.21.- Respuesta Lazo de Control 0240-FEA-0007

Fuente: Elaboración Propia (Parte 7 de 8)

11:29:50	35	261.04
11:29:51	35	261.04
11:29:52	35	261.04
11:29:53	35	261.04
11:29:54	35	261.04
11:29:55	35	261.04
11:29:56	35	261.04
11:29:57	35	261.04
11:29:58	35	261.04
11:29:59	35	261.04
11:30:00	35	261.04
11:30:01	35	261.04
11:30:02	35	261.04
11:30:03	35	261.04
11:30:04	35	261.04
11:30:05	35	261.04
11:30:06	35	261.04
11:30:07	35	261.04
11:30:08	35	261.04
11:30:09	35	261.04
11:30:10	35	261.04
11:30:11	35	261.04
11:30:12	35	261.04
11:30:13	35	261.04
11:30:14	35	261.04
11:30:15	35	261.04
11:30:16	35	261.04
11:30:17	35	261.04
11:30:18	35	261.04
11:30:19	35	261.04
11:30:20	35	261.04
11:30:21	35	261.04
11:30:22	35	261.04
11:30:23	35	261.04
11:30:24	35	261.04
11:30:25	35	261.04
11:30:26	35	261.04

Tabla.4.21.- Respuesta Lazo de Control 0240-FEA-0007

Fuente: Elaboración Propia (Parte 8 de 8)

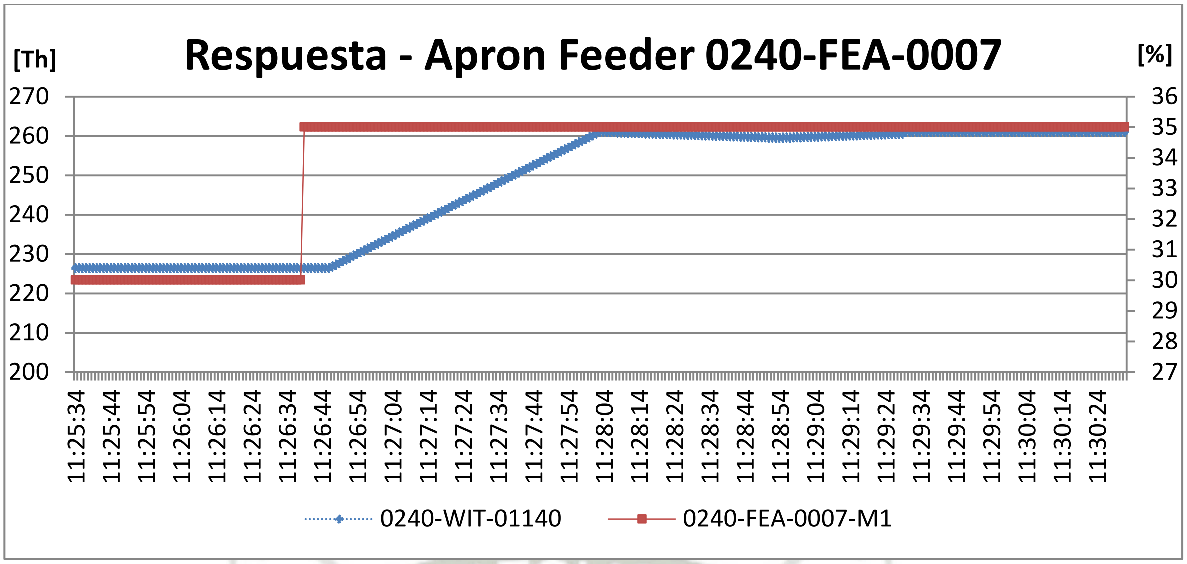


Fig.4.28.- Respuesta - 0240-FEA-0007

Fuente: Elaboración Propia

Una vez identificados los parámetros del proceso obtenidos de la curva de reacción (ver Fig.4.28), se obtienen los parámetros del controlador. Para lo cual utilizaremos el método de sintonización de Zieger y Nichols (ver tabla 4.22).

Se selecciona un control PID por el comportamiento del Peso como variable de proceso, se caracteriza por tener la velocidad de respuesta lenta y tiempo muertos considerables.

Parámetros PID -ZN			
	Kp	**Ti**	**Td**
PID	1.2ζ/(Kp)θ	2θ	0.5θ
PID(s)	0.17528683	152	38.5
PID(min)	0.00292145	2.53333333	0.64166667

Tabla.4.22.- Parámetros PID-ZN para 0240-FEA-0007

Fuente: Elaboración Propia

4.7.4 Lazo de Control – 0240-FEA-0008

Se cambió el porcentaje de velocidad de 45% a 50% para ver la reacción del proceso. Graficando los valores de la tabla obtenemos la curva de reacción mostrada en la Fig.29 y podemos inferir los parámetros de tiempo de retardo (θ), constante de tiempo (ζ) y ganancia (Kp) mostrados en la Tabla 4.20.

Curva de Reacción		
Kp	**θ**	**ζ**
6.92	72	80

Tabla.4.23.- Parámetros Curva de Reacción 0240-FEA-0008

Fuente: Elaboración Propia

$$G_f = \frac{6.92e^{-72s}}{80s+1}$$

Tiempo	MV	PV
11:35:52	45	280.23
11:35:53	45	280.23
11:35:54	45	280.23
11:35:55	45	280.23
11:35:56	45	280.23
11:35:57	45	280.23
11:35:58	45	280.23
11:35:59	45	280.23
11:36:00	45	280.23
11:36:01	45	280.23
11:36:02	45	280.23
11:36:03	45	280.23
11:36:04	45	280.23
11:36:05	45	280.23
11:36:06	45	280.23
11:36:07	45	280.23
11:36:08	45	280.23
11:36:09	45	280.23
11:36:10	45	280.23
11:36:11	45	280.23

Tabla.4.24.- Respuesta Lazo de Control 0240-FEA-0008

Fuente: Elaboración Propia (Parte 1 de 8)

11:36:12	45	280.23
11:36:13	45	280.23
11:36:14	45	280.23
11:36:15	45	280.23
11:36:16	45	280.23
11:36:17	45	280.23
11:36:18	45	280.23
11:36:19	45	280.23
11:36:20	45	280.23
11:36:21	45	280.23
11:36:22	45	280.23
11:36:23	45	280.23
11:36:24	45	280.23
11:36:25	45	280.23
11:36:26	45	280.23
11:36:27	45	280.23
11:36:28	45	280.23
11:36:29	45	280.23
11:36:30	45	280.23
11:36:31	45	280.23
11:36:32	45	280.23
11:36:33	45	280.23
11:36:34	45	280.23
11:36:35	45	280.23
11:36:36	45	280.23
11:36:37	45	280.23
11:36:38	45	280.23
11:36:39	45	280.23
11:36:40	45	280.23
11:36:41	45	280.23
11:36:42	45	280.23
11:36:43	45	280.23
11:36:44	45	280.23
11:36:45	45	280.23
11:36:46	45	280.23
11:36:47	45	280.23
11:36:48	45	280.23
11:36:49	45	280.23
11:36:50	45	280.23
11:36:51	45	280.23

Tabla.4.24.- Respuesta Lazo de Control 0240-FEA-0008

Fuente: Elaboración Propia (Parte 2 de 8)

11:36:52	45	280.23
11:36:53	45	280.23
11:36:54	45	280.23
11:36:55	45	280.23
11:36:56	45	280.23
11:36:57	50	280.23
11:36:58	50	280.23
11:36:59	50	280.23
11:37:00	50	280.23
11:37:01	50	280.23
11:37:02	50	280.68
11:37:03	50	281.13
11:37:04	50	281.58
11:37:05	50	282.03
11:37:06	50	282.48
11:37:07	50	282.93
11:37:08	50	283.38
11:37:09	50	283.83
11:37:10	50	284.28
11:37:11	50	284.73
11:37:12	50	285.18
11:37:13	50	285.63
11:37:14	50	286.08
11:37:15	50	286.53
11:37:16	50	286.98
11:37:17	50	287.43
11:37:18	50	287.88
11:37:19	50	288.33
11:37:20	50	288.78
11:37:21	50	289.23
11:37:22	50	289.68
11:37:23	50	290.13
11:37:24	50	290.58
11:37:25	50	291.03
11:37:26	50	291.48
11:37:27	50	291.93
11:37:28	50	292.38
11:37:29	50	292.83

Tabla.4.24.- Respuesta Lazo de Control 0240-FEA-0008

Fuente: Elaboración Propia (Parte 3 de 8)

11:37:30	50	293.28
11:37:31	50	293.73
11:37:32	50	294.18
11:37:33	50	294.63
11:37:34	50	295.08
11:37:35	50	295.53
11:37:36	50	295.98
11:37:37	50	296.43
11:37:38	50	296.88
11:37:39	50	297.33
11:37:40	50	297.78
11:37:41	50	298.23
11:37:42	50	298.68
11:37:43	50	299.13
11:37:44	50	299.58
11:37:45	50	300.03
11:37:46	50	300.48
11:37:47	50	300.93
11:37:48	50	301.38
11:37:49	50	301.83
11:37:50	50	302.28
11:37:51	50	302.73
11:37:52	50	303.18
11:37:53	50	303.63
11:37:54	50	304.08
11:37:55	50	304.53
11:37:56	50	304.98
11:37:57	50	305.43
11:37:58	50	305.88
11:37:59	50	306.33
11:38:00	50	306.78
11:38:01	50	307.23
11:38:02	50	307.68
11:38:03	50	308.13
11:38:04	50	308.58
11:38:05	50	309.03
11:38:06	50	309.48
11:38:07	50	309.93
11:38:08	50	310.38
11:38:09	50	310.83

Tabla.4.24.- Respuesta Lazo de Control 0240-FEA-0008

Fuente: Elaboración Propia (Parte 4 de 8)

11:38:10	50	311.28
11:38:11	50	311.73
11:38:12	50	312.18
11:38:13	50	312.63
11:38:14	50	313.08
11:38:15	50	313.53
11:38:16	50	313.98
11:38:17	50	314.43
11:38:18	50	314.88
11:38:19	50	315.33
11:38:20	50	315.3
11:38:21	50	315.27
11:38:22	50	315.24
11:38:23	50	315.21
11:38:24	50	315.18
11:38:25	50	315.15
11:38:26	50	315.12
11:38:27	50	315.09
11:38:28	50	315.06
11:38:29	50	315.03
11:38:30	50	315
11:38:31	50	314.97
11:38:32	50	314.94
11:38:33	50	314.91
11:38:34	50	314.88
11:38:35	50	314.85
11:38:36	50	314.82
11:38:37	50	314.79
11:38:38	50	314.76
11:38:39	50	314.73
11:38:40	50	314.7
11:38:41	50	314.67
11:38:42	50	314.64
11:38:43	50	314.61
11:38:44	50	314.58
11:38:45	50	314.55
11:38:46	50	314.52
11:38:47	50	314.49

Tabla.4.24.- Respuesta Lazo de Control 0240-FEA-0008

Fuente: Elaboración Propia (Parte 5 de 8)

11:38:48	50	314.46
11:38:49	50	314.43
11:38:50	50	314.4
11:38:51	50	314.37
11:38:52	50	314.34
11:38:53	50	314.31
11:38:54	50	314.28
11:38:55	50	314.25
11:38:56	50	314.22
11:38:57	50	314.19
11:38:58	50	314.16
11:38:59	50	314.13
11:39:00	50	314.1
11:39:01	50	314.07
11:39:02	50	314.04
11:39:03	50	314.01
11:39:04	50	313.98
11:39:05	50	313.95
11:39:06	50	313.92
11:39:07	50	313.89
11:39:08	50	313.86
11:39:09	50	313.83
11:39:10	50	313.8
11:39:11	50	313.77
11:39:12	50	313.74
11:39:13	50	313.71
11:39:14	50	313.68
11:39:15	50	313.65
11:39:16	50	313.62
11:39:17	50	313.59
11:39:18	50	313.56
11:39:19	50	313.59
11:39:20	50	313.62
11:39:21	50	313.65
11:39:22	50	313.68
11:39:23	50	313.71
11:39:24	50	313.74
11:39:25	50	313.77
11:39:26	50	313.8
11:39:27	50	313.83

Tabla.4.24.- Respuesta Lazo de Control 0240-FEA-0008

Fuente: Elaboración Propia (Parte 6 de 8)

11:39:28	50	313.86
11:39:29	50	313.89
11:39:30	50	313.92
11:39:31	50	313.95
11:39:32	50	313.98
11:39:33	50	314.01
11:39:34	50	314.04
11:39:35	50	314.07
11:39:36	50	314.1
11:39:37	50	314.13
11:39:38	50	314.16
11:39:39	50	314.19
11:39:40	50	314.22
11:39:41	50	314.25
11:39:42	50	314.28
11:39:43	50	314.31
11:39:44	50	314.34
11:39:45	50	314.37
11:39:46	50	314.4
11:39:47	50	314.43
11:39:48	50	314.46
11:39:49	50	314.49
11:39:50	50	314.83
11:39:51	50	314.83
11:39:52	50	314.83
11:39:53	50	314.83
11:39:54	50	314.83
11:39:55	50	314.83
11:39:56	50	314.83
11:39:57	50	314.83
11:39:58	50	314.83
11:39:59	50	314.83
11:40:00	50	314.83
11:40:01	50	314.83
11:40:02	50	314.83
11:40:03	50	314.83
11:40:04	50	314.83
11:40:05	50	314.83

Tabla.4.24.- Respuesta Lazo de Control 0240-FEA-0008

Fuente: Elaboración Propia (Parte 7 de 8)

11:40:06	50	314.83
11:40:07	50	314.83
11:40:08	50	314.83
11:40:09	50	314.83
11:40:10	50	314.83
11:40:11	50	314.83
11:40:12	50	314.83
11:40:13	50	314.83
11:40:14	50	314.83
11:40:15	50	314.83
11:40:16	50	314.83
11:40:17	50	314.83
11:40:18	50	314.83
11:40:19	50	314.83
11:40:20	50	314.83
11:40:21	50	314.83
11:40:22	50	314.83
11:40:23	50	314.83
11:40:24	50	314.83
11:40:25	50	314.83
11:40:26	50	314.83
11:40:27	50	314.83
11:40:28	50	314.83
11:40:29	50	314.83
11:40:30	50	314.83
11:40:31	50	314.83
11:40:32	50	314.83
11:40:33	50	314.83
11:40:34	50	314.83
11:40:35	50	314.83
11:40:36	50	314.83
11:40:37	50	314.83
11:40:38	50	314.83
11:40:39	50	314.83
11:40:40	50	314.83
11:40:41	50	314.83
11:40:42	50	314.83

Tabla.4.24.- Respuesta Lazo de Control 0240-FEA-0008

Fuente: Elaboración Propia (Parte 8 de 8)

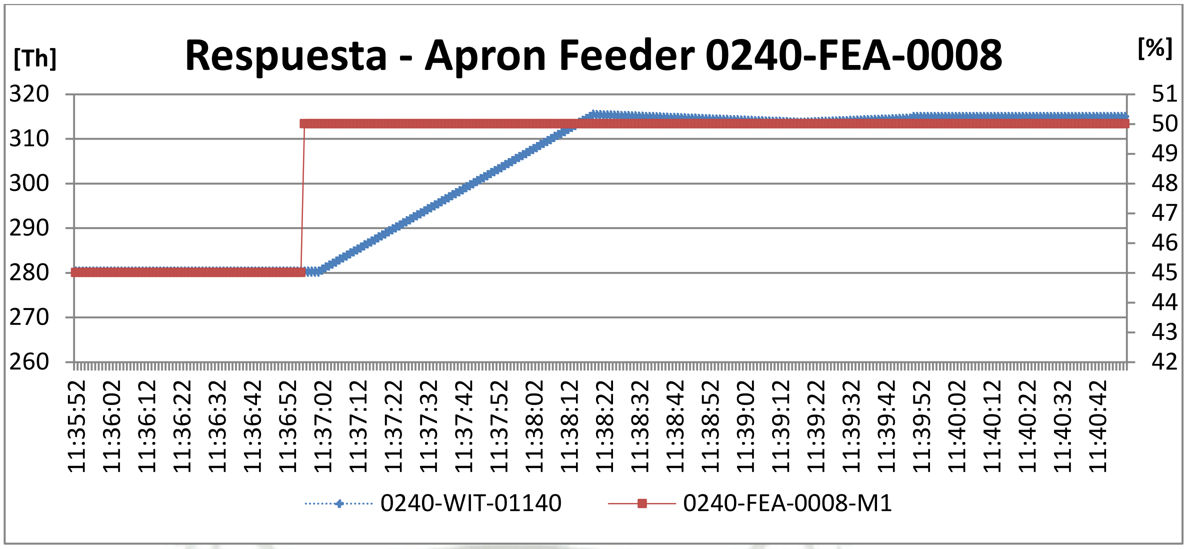


Fig.4.29.- Respuesta - 0240-FEA-0008

Fuente: Elaboración Propia

Una vez identificados los parámetros del proceso obtenidos de la curva de reacción (ver Fig.4.29), se obtienen los parámetros del controlador. Para lo cual utilizaremos el método de sintonización de Zieger y Nichols (ver tabla 4.25).

Se selecciona un control PID por el comportamiento del Peso como variable de proceso, se caracteriza por tener la velocidad de respuesta lenta y tiempo muertos considerables.

Parámetros PID -ZN			
	Kp	**Ti**	**Td**
PID	1.2ζ/(Kp)θ	2θ	0.5θ
PID(s)	0.19267823	144	36
PID(min)	0.0032113	2.4	0.6

Tabla.4.25.- Parámetros PID-ZN para 0240-FEA-0008

Fuente: Elaboración Propia

4.7.5 Lazo de Control – Agua de Proceso

Se cambió el porcentaje de solidos de 35% a 40% para ver la reacción del proceso. Graficando los valores de la tabla obtenemos la curva de reacción mostrada en la Fig.30 y podemos inferir los parámetros de tiempo de retardo (θ), constante de tiempo (ζ) y ganancia (Kp) mostrados en la Tabla 4.26.

Curva de Reacción		
Kp	**θ**	**ζ**
14.15	89	39

Tabla.4.26.- Parámetros Curva de Reacción Agua de Proceso

Fuente: Elaboración Propia

$$G_f = \frac{14.15e^{-89s}}{39s+1}$$

Tiempo	MV	PV
18:50:23	35	762.43
18:50:24	35	762.43
18:50:25	35	762.43
18:50:26	35	762.43
18:50:27	35	762.43
18:50:28	35	762.43
18:50:29	35	762.43
18:50:30	35	762.43
18:50:31	35	762.43
18:50:32	35	762.43
18:50:33	35	762.43
18:50:34	35	762.43
18:50:35	35	762.43
18:50:36	35	762.43
18:50:37	35	762.43
18:50:38	35	762.43
18:50:39	35	762.43
18:50:40	35	762.43
18:50:41	35	762.43
18:50:42	35	762.43
18:50:43	35	762.43

Tabla.4.27.- Respuesta Lazo de Control Agua de Proceso

Fuente: Elaboración Propia (Parte 1 de 8)

18:50:44	35	762.43
18:50:45	35	762.43
18:50:46	35	762.43
18:50:47	35	762.43
18:50:48	35	762.43
18:50:49	35	762.43
18:50:50	35	762.43
18:50:51	35	762.43
18:50:52	35	762.43
18:50:53	35	762.43
18:50:54	35	762.43
18:50:55	35	762.43
18:50:56	35	762.43
18:50:57	35	762.43
18:50:58	35	762.43
18:50:59	35	762.43
18:51:00	35	762.43
18:51:01	35	762.43
18:51:02	35	762.43
18:51:03	35	762.43
18:51:04	35	762.43
18:51:05	35	762.43
18:51:06	35	762.43
18:51:07	35	762.43
18:51:08	35	762.43
18:51:09	35	762.43
18:51:10	35	762.43
18:51:11	35	762.43
18:51:12	35	762.43
18:51:13	35	762.43
18:51:14	35	762.43
18:51:15	35	762.43
18:51:16	35	762.43
18:51:17	35	762.43
18:51:18	35	762.43
18:51:19	35	762.43
18:51:20	35	762.43
18:51:21	35	762.43
18:51:22	35	762.43
18:51:23	35	762.43

Tabla.4.27.- Respuesta Lazo de Control Agua de Proceso

Fuente: Elaboración Propia (Parte 2 de 8)

18:51:24	35	762.43
18:51:25	35	762.43
18:51:26	35	762.43
18:51:27	35	762.43
18:51:28	35	762.43
18:51:29	35	762.43
18:51:30	35	762.43
18:51:31	35	762.43
18:51:32	35	762.43
18:51:33	35	762.43
18:51:34	35	762.43
18:51:35	35	762.43
18:51:36	35	762.43
18:51:37	35	762.43
18:51:38	35	762.43
18:51:39	35	762.43
18:51:40	35	762.43
18:51:41	35	762.43
18:51:42	35	762.43
18:51:43	35	762.43
18:51:44	35	762.43
18:51:45	35	762.43
18:51:46	35	762.43
18:51:47	35	762.43
18:51:48	35	762.43
18:51:49	35	762.43
18:51:50	40	762.43
18:51:51	40	762.43
18:51:52	40	762.43
18:51:53	40	764.23
18:51:54	40	766.03
18:51:55	40	767.83
18:51:56	40	769.63
18:51:57	40	771.43
18:51:58	40	773.23
18:51:59	40	775.03
18:52:00	40	776.83
18:52:01	40	778.63

Tabla.4.27.- Respuesta Lazo de Control Agua de Proceso

Fuente: Elaboración Propia (Parte 3 de 8)

18:52:02	40	780.43
18:52:03	40	782.23
18:52:04	40	784.03
18:52:05	40	785.83
18:52:06	40	787.63
18:52:07	40	789.43
18:52:08	40	791.23
18:52:09	40	793.03
18:52:10	40	794.83
18:52:11	40	796.63
18:52:12	40	798.43
18:52:13	40	800.23
18:52:14	40	802.03
18:52:15	40	803.83
18:52:16	40	805.63
18:52:17	40	807.43
18:52:18	40	809.23
18:52:19	40	811.03
18:52:20	40	812.83
18:52:21	40	814.63
18:52:22	40	816.43
18:52:23	40	818.23
18:52:24	40	820.03
18:52:25	40	821.83
18:52:26	40	823.63
18:52:27	40	825.43
18:52:28	40	827.23
18:52:29	40	829.03
18:52:30	40	830.83
18:52:31	40	832.63
18:52:32	40	833.53
18:52:33	40	834.43
18:52:34	40	835.33
18:52:35	40	836.23
18:52:36	40	837.13
18:52:37	40	838.03
18:52:38	40	838.93
18:52:39	40	839.43
18:52:40	40	839.93
18:52:41	40	840.43
18:52:42	40	840.93

Tabla.4.27.- Respuesta Lazo de Control Agua de Proceso

Fuente: Elaboración Propia (Parte 4 de 8)

18:52:43	40	840.98
18:52:44	40	841.03
18:52:45	40	841.08
18:52:46	40	841.13
18:52:47	40	840.12
18:52:48	40	839.11
18:52:49	40	838.1
18:52:50	40	837.09
18:52:51	40	836.08
18:52:52	40	835.07
18:52:53	40	834.06
18:52:54	40	833.97
18:52:55	40	833.88
18:52:56	40	833.79
18:52:57	40	833.7
18:52:58	40	833.61
18:52:59	40	833.52
18:53:00	40	833.43
18:53:01	40	833.34
18:53:02	40	833.25
18:53:03	40	833.16
18:53:04	40	833.18
18:53:05	40	833.18
18:53:06	40	833.18
18:53:07	40	833.18
18:53:08	40	833.18
18:53:09	40	833.18
18:53:10	40	833.18
18:53:11	40	833.18
18:53:12	40	833.18
18:53:13	40	833.18
18:53:14	40	833.18
18:53:15	40	833.18
18:53:16	40	833.18
18:53:17	40	833.18
18:53:18	40	833.18
18:53:19	40	833.18
18:53:20	40	833.18
18:53:21	40	833.18
18:53:22	40	833.18
18:53:23	40	833.18

Tabla.4.27.- Respuesta Lazo de Control Agua de Proceso

Fuente: Elaboración Propia (Parte 5 de 8)

18:53:24	40	833.18
18:53:25	40	833.18
18:53:26	40	833.18
18:53:27	40	833.18
18:53:28	40	833.18
18:53:29	40	833.18
18:53:30	40	833.18
18:53:31	40	833.18
18:53:32	40	833.18
18:53:33	40	833.18
18:53:34	40	833.18
18:53:35	40	833.18
18:53:36	40	833.18
18:53:37	40	833.18
18:53:38	40	833.18
18:53:39	40	833.18
18:53:40	40	833.18
18:53:41	40	833.18
18:53:42	40	833.18
18:53:43	40	833.18
18:53:44	40	833.18
18:53:45	40	833.18
18:53:46	40	833.18
18:53:47	40	833.18
18:53:48	40	833.18
18:53:49	40	833.18
18:53:50	40	833.18
18:53:51	40	833.18
18:53:52	40	833.18
18:53:53	40	833.18
18:53:54	40	833.18
18:53:55	40	833.18
18:53:56	40	833.18
18:53:57	40	833.18
18:53:58	40	833.18
18:53:59	40	833.18
18:54:00	40	833.18
18:54:01	40	833.18
18:54:02	40	833.18
18:54:03	40	833.18
18:54:04	40	833.18

Tabla.4.27.- Respuesta Lazo de Control Agua de Proceso

Fuente: Elaboración Propia (Parte 6 de 8)

18:54:05	40	833.18
18:54:06	40	833.18
18:54:07	40	833.18
18:54:08	40	833.18
18:54:09	40	833.18
18:54:10	40	833.18
18:54:11	40	833.18
18:54:12	40	833.18
18:54:13	40	833.18
18:54:14	40	833.18
18:54:15	40	833.18
18:54:16	40	833.18
18:54:17	40	833.18
18:54:18	40	833.18
18:54:19	40	833.18
18:54:20	40	833.18
18:54:21	40	833.18
18:54:22	40	833.18
18:54:23	40	833.18
18:54:24	40	833.18
18:54:25	40	833.18
18:54:26	40	833.18
18:54:27	40	833.18
18:54:28	40	833.18
18:54:29	40	833.18
18:54:30	40	833.18
18:54:31	40	833.18
18:54:32	40	833.18
18:54:33	40	833.18
18:54:34	40	833.18
18:54:35	40	833.18
18:54:36	40	833.18
18:54:37	40	833.18

Tabla.4.27.- Respuesta Lazo de Control Agua de Proceso

Fuente: Elaboración Propia (Parte 7 de 8)

18:54:38	40	833.18
18:54:39	40	833.18
18:54:40	40	833.18
18:54:41	40	833.18
18:54:42	40	833.18
18:54:43	40	833.18
18:54:44	40	833.18
18:54:45	40	833.18
18:54:46	40	833.18
18:54:47	40	833.18
18:54:48	40	833.18
18:54:49	40	833.18
18:54:50	40	833.18
18:54:51	40	833.18
18:54:52	40	833.18
18:54:53	40	833.18
18:54:54	40	833.18
18:54:55	40	833.18
18:54:56	40	833.18
18:54:57	40	833.18
18:54:58	40	833.18
18:54:59	40	833.18
18:55:00	40	833.18
18:55:01	40	833.18
18:55:02	40	833.18
18:55:03	40	833.18
18:55:04	40	833.18
18:55:05	40	833.18
18:55:06	40	833.18
18:55:07	40	833.18
18:55:08	40	833.18
18:55:09	40	833.18
18:55:10	40	833.18
18:55:11	40	833.18
18:55:12	40	833.18
18:55:13	40	833.18
18:55:14	40	833.18

Tabla.4.27.- Respuesta Lazo de Control Agua de Proceso

Fuente: Elaboración Propia (Parte 8 de 8)

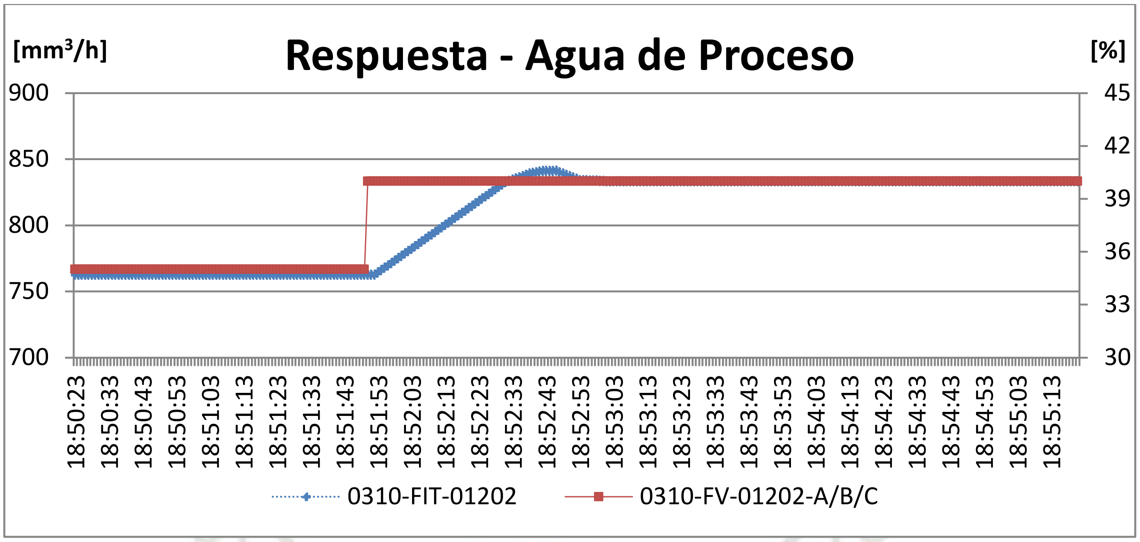


Fig.4.30.- Respuesta - Agua de Proceso

Fuente: Elaboración Propia

Una vez identificados los parámetros del proceso obtenidos de la curva de reacción (ver Fig.4.30), se obtienen los parámetros del controlador. Para lo cual utilizaremos el método de sintonización de Zieger y Nichols (ver tabla 4.28).

Se selecciona un control PI por el comportamiento del flujo de agua como variable de proceso, se caracteriza por tener una capacitancia media, velocidad de respuesta pequeño y tiempo muerto pequeño.

Parámetros PID -ZN		
	Kp	**Ti**
PI	0.9(Kζ)/θ	θ/0.3
PI(s)	5.58050562	29.6666667
PI(min)	5.58	0.49444444

Tabla.4.28.- Parámetros PID-ZN para lazo de control 0310-FIC-01202

Fuente: Elaboración Propia

4.7.6 Lazo de Control – Alimentación Carga Fresca Molino SAG

Se cambió la variable control de 1500 – 1600 Tn/h para ver la reacción del proceso. Graficando los valores de la tabla obtenemos la curva de reacción mostrada en la Fig.31 y podemos inferir los parámetros de tiempo de retardo (θ), constante de tiempo (ζ) y ganancia (Kp) mostrados en la Tabla 4.29.

Curva de Reacción		
Kp	**θ**	**ζ**
19.928	96	92

Tabla.4.29.- Parámetros Curva de Reacción Carga Fresca Molino SAG

Fuente: Elaboración Propia

$$G_f = \frac{19.928e^{-96s}}{92s+1}$$

Tiempo	MV	PV(TN)
14:23:03	20	1106
14:23:04	20	1106
14:23:05	20	1106
14:23:06	20	1106
14:23:07	20	1106
14:23:08	20	1106
14:23:09	20	1106
14:23:10	20	1106
14:23:11	20	1106
14:23:12	20	1106
14:23:13	20	1106
14:23:14	20	1106
14:23:15	20	1106
14:23:16	20	1106
14:23:17	20	1106
14:23:18	20	1106
14:23:19	20	1106
14:23:20	20	1106
14:23:21	20	1106
14:23:22	20	1106
14:23:23	20	1106
14:23:24	20	1106

Tabla.4.30.- Respuesta Lazo de Control Alimentación Carga Fresca Molino Sag

Fuente: Elaboración Propia (Parte 1 de 8)

14:23:25	20	1106
14:23:26	20	1106
14:23:27	20	1106
14:23:28	20	1106
14:23:29	20	1106
14:23:30	20	1106
14:23:31	20	1106
14:23:32	20	1106
14:23:33	20	1106
14:23:34	20	1106
14:23:35	20	1106
14:23:36	20	1106
14:23:37	20	1106
14:23:38	20	1106
14:23:39	20	1106
14:23:40	20	1106
14:23:41	20	1106
14:23:42	20	1106
14:23:43	20	1106
14:23:44	20	1106
14:23:45	20	1106
14:23:46	20	1106
14:23:47	20	1106
14:23:48	20	1106
14:23:49	20	1106
14:23:50	20	1106
14:23:51	20	1106
14:23:52	20	1106
14:23:53	20	1106
14:23:54	20	1106
14:23:55	20	1106
14:23:56	20	1106
14:23:57	20	1106
14:23:58	20	1106
14:23:59	20	1106
14:24:00	20	1106
14:24:01	20	1106
14:24:02	20	1106
14:24:03	20	1106
14:24:04	20	1106

Tabla.4.30.- Respuesta Lazo de Control Alimentación Carga Fresca Molino Sag

Fuente: Elaboración Propia (Parte 2 de 8)

14:24:05	20	1106
14:24:06	20	1106
14:24:07	20	1106
14:24:08	20	1106
14:24:09	20	1106
14:24:10	20	1106
14:24:11	20	1106
14:24:12	20	1106
14:24:13	20	1106
14:24:14	20	1106
14:24:15	20	1106
14:24:16	20	1106
14:24:17	20	1106
14:24:18	20	1106
14:24:19	20	1106
14:24:20	20	1106
14:24:21	20	1106
14:24:22	20	1106
14:24:23	20	1106
14:24:24	20	1106
14:24:25	20	1106
14:24:26	20	1106
14:24:27	20	1106
14:24:28	20	1106
14:24:29	20	1106
14:24:30	20	1106
14:24:31	20	1106
14:24:32	20	1106
14:24:33	25	1106
14:24:34	25	1106
14:24:35	25	1106
14:24:36	25	1106
14:24:37	25	1106
14:24:38	25	1106
14:24:39	25	1106
14:24:40	25	1106
14:24:41	25	1106.8
14:24:42	25	1107.6

Tabla.4.30.- Respuesta Lazo de Control Alimentación Carga Fresca Molino Sag

Fuente: Elaboración Propia (Parte 3 de 8)

14:24:43	25	1108.4
14:24:44	25	1109.2
14:24:45	25	1110
14:24:46	25	1110.8
14:24:47	25	1111.6
14:24:48	25	1112.4
14:24:49	25	1113.2
14:24:50	25	1114
14:24:51	25	1114.8
14:24:52	25	1115.6
14:24:53	25	1116.4
14:24:54	25	1117.2
14:24:55	25	1118
14:24:56	25	1118.8
14:24:57	25	1119.6
14:24:58	25	1120.4
14:24:59	25	1121.2
14:25:00	25	1122
14:25:01	25	1122.8
14:25:02	25	1123.6
14:25:03	25	1124.4
14:25:04	25	1125.2
14:25:05	25	1126
14:25:06	25	1126.8
14:25:07	25	1127.6
14:25:08	25	1128.61
14:25:09	25	1129.62
14:25:10	25	1130.63
14:25:11	25	1131.64
14:25:12	25	1132.65
14:25:13	25	1133.66
14:25:14	25	1134.67
14:25:15	25	1135.68
14:25:16	25	1136.69
14:25:17	25	1137.7
14:25:18	25	1138.71
14:25:19	25	1139.72
14:25:20	25	1140.73
14:25:21	25	1141.74
14:25:22	25	1142.75

Tabla.4.30.- Respuesta Lazo de Control Alimentación Carga Fresca Molino Sag

Fuente: Elaboración Propia (Parte 4 de 8)

14:25:23	25	1143.76
14:25:24	25	1144.77
14:25:25	25	1145.78
14:25:26	25	1146.79
14:25:27	25	1147.8
14:25:28	25	1148.81
14:25:29	25	1149.82
14:25:30	25	1150.83
14:25:31	25	1151.84
14:25:32	25	1152.85
14:25:33	25	1153.86
14:25:34	25	1154.87
14:25:35	25	1155.88
14:25:36	25	1156.89
14:25:37	25	1157.9
14:25:38	25	1158.91
14:25:39	25	1159.92
14:25:40	25	1160.93
14:25:41	25	1161.94
14:25:42	25	1162.95
14:25:43	25	1163.96
14:25:44	25	1164.97
14:25:45	25	1165.98
14:25:46	25	1166.99
14:25:47	25	1168
14:25:48	25	1169.01
14:25:49	25	1170.02
14:25:50	25	1171.03
14:25:51	25	1172.04
14:25:52	25	1173.05
14:25:53	25	1174.06
14:25:54	25	1175.07
14:25:55	25	1176.08
14:25:56	25	1177.09
14:25:57	25	1178.1
14:25:58	25	1179.11
14:25:59	25	1180.12
14:26:00	25	1181.13

Tabla.4.30.- Respuesta Lazo de Control Alimentación Carga Fresca Molino Sag

Fuente: Elaboración Propia (Parte 5 de 8)

14:26:01	25	1182.14
14:26:02	25	1183.64
14:26:03	25	1185.14
14:26:04	25	1186.64
14:26:05	25	1188.14
14:26:06	25	1189.64
14:26:07	25	1191.14
14:26:08	25	1192.64
14:26:09	25	1194.14
14:26:10	25	1195.64
14:26:11	25	1197.14
14:26:12	25	1198.64
14:26:13	25	1200.14
14:26:14	25	1201.64
14:26:15	25	1203.14
14:26:16	25	1204.64
14:26:17	25	1206.14
14:26:18	25	1207.64
14:26:19	25	1209.14
14:26:20	25	1210.94
14:26:21	25	1212.74
14:26:22	25	1214.54
14:26:23	25	1216.34
14:26:24	25	1218.14
14:26:25	25	1219.94
14:26:26	25	1221.74
14:26:27	25	1223.54
14:26:28	25	1221.74
14:26:29	25	1219.94
14:26:30	25	1218.14
14:26:31	25	1216.34
14:26:32	25	1214.54
14:26:33	25	1212.74
14:26:34	25	1210.94
14:26:35	25	1209.14
14:26:36	25	1207.34
14:26:37	25	1205.54
14:26:38	25	1205.64
14:26:39	25	1205.64
14:26:40	25	1205.64

Tabla.4.30.- Respuesta Lazo de Control Alimentación Carga Fresca Molino Sag

Fuente: Elaboración Propia (Parte 6 de 8)

14:26:41	25	1205.64
14:26:42	25	1205.64
14:26:43	25	1205.64
14:26:44	25	1205.64
14:26:45	25	1205.64
14:26:46	25	1205.64
14:26:47	25	1205.64
14:26:48	25	1205.64
14:26:49	25	1205.64
14:26:50	25	1205.64
14:26:51	25	1205.64
14:26:52	25	1205.64
14:26:53	25	1205.64
14:26:54	25	1205.64
14:26:55	25	1205.64
14:26:56	25	1205.64
14:26:57	25	1205.64
14:26:58	25	1205.64
14:26:59	25	1205.64
14:27:00	25	1205.64
14:27:01	25	1205.64
14:27:02	25	1205.64
14:27:03	25	1205.64
14:27:04	25	1205.64
14:27:05	25	1205.64
14:27:06	25	1205.64
14:27:07	25	1205.64
14:27:08	25	1205.64
14:27:09	25	1205.64
14:27:10	25	1205.64
14:27:11	25	1205.64
14:27:12	25	1205.64
14:27:13	25	1205.64
14:27:14	25	1205.64
14:27:15	25	1205.64
14:27:16	25	1205.64
14:27:17	25	1205.64
14:27:18	25	1205.64

Tabla.4.30.- Respuesta Lazo de Control Alimentación Carga Fresca Molino Sag

Fuente: Elaboración Propia (Parte 7 de 8)

14:27:19	25	1205.64
14:27:20	25	1205.64
14:27:21	25	1205.64
14:27:22	25	1205.64
14:27:23	25	1205.64
14:27:24	25	1205.64
14:27:25	25	1205.64
14:27:26	25	1205.64
14:27:27	25	1205.64
14:27:28	25	1205.64
14:27:29	25	1205.64
14:27:30	25	1205.64
14:27:31	25	1205.64
14:27:32	25	1205.64
14:27:33	25	1205.64
14:27:34	25	1205.64
14:27:35	25	1205.64
14:27:36	25	1205.64
14:27:37	25	1205.64
14:27:38	25	1205.64
14:27:39	25	1205.64
14:27:40	25	1205.64
14:27:41	25	1205.64
14:27:42	25	1205.64
14:27:43	25	1205.64
14:27:44	25	1205.64
14:27:45	25	1205.64
14:27:46	25	1205.64
14:27:47	25	1205.64
14:27:48	25	1205.64
14:27:49	25	1205.64
14:27:50	25	1205.64
14:27:51	25	1205.64
14:27:52	25	1205.64
14:27:53	25	1205.64
14:27:54	25	1205.64
14:27:55	25	1205.64

Tabla.4.30.- Respuesta Lazo de Control Alimentación Carga Fresca Molino SAG

Fuente: Elaboración Propia (Parte 8 de 8)

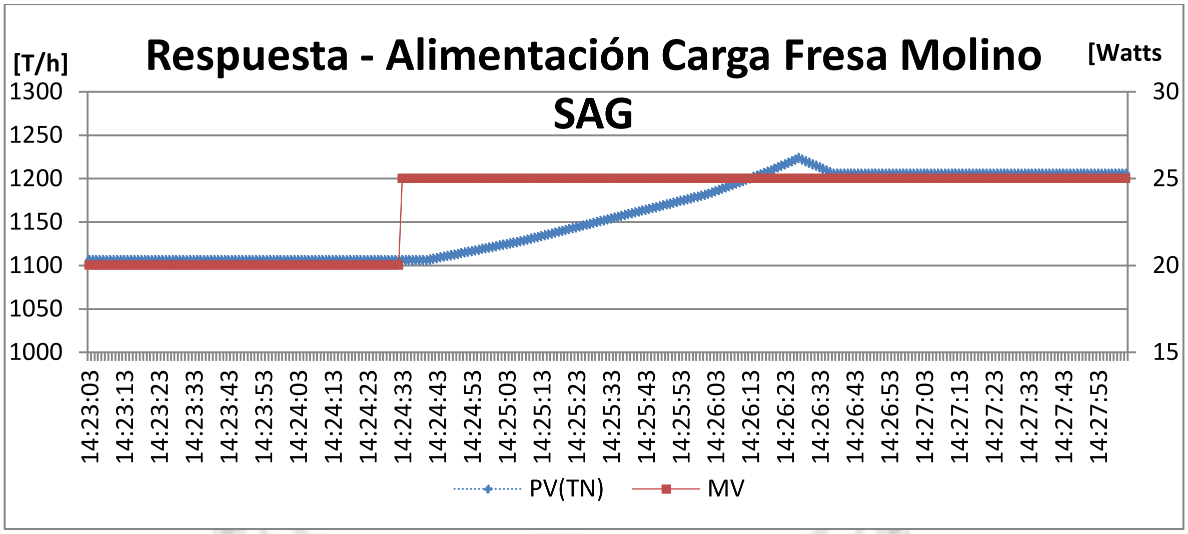


Fig.4.31.- Respuesta - Alimentación Carga Fresca Molino SAG

Fuente: Elaboración Propia

Una vez identificados los parámetros del proceso obtenidos de la curva de reacción (ver Fig.4.31), se obtienen los parámetros del controlador. Para lo cual utilizaremos el método de sintonización de Zieger y Nichols (ver tabla 4.31).

Se selecciona un control PID por el comportamiento del Peso como variable de proceso, se caracteriza por tener la velocidad de respuesta lenta y tiempo muertos considerables.

Parámetros PID -ZN			
	Kp	**Ti**	**Td**
PID	1.2ζ/(Kp)θ	2θ	0.5θ
PID(s)	0.05770775	192	48
PID(min)	0.0009618	3.2	0.8

Tabla.4.31.- Parámetros PID-ZN para lazo de control Alimentación Molino SAG

Fuente: Elaboración Propia

4.7.7 Lazo de Control – Descarga de Mineral Molino SAG

Se cambió el porcentaje de velocidad de 85% a 100%para ver la reacción del proceso. Graficando los valores de la tabla obtenemos la curva de reacción mostrada en la Fig.4.32 y podemos inferir los parámetros de tiempo de retardo (θ), constante de tiempo (ζ) y ganancia (Kp) mostrados en la Tabla 4.32.

Curva de Reacción		
Kp	**θ**	**ζ**
0.164	128	9

Tabla.4.32.- Parámetros Curva de Reacción Descarga de Mineral Molino SAG

Fuente: Elaboración Propia

Tiempo	MV	PV(mm/s)
19:23:03	85	20.924
19:23:04	85	20.924
19:23:05	85	20.924
19:23:06	85	20.924
19:23:07	85	20.924
19:23:08	85	20.924
19:23:09	85	20.924
19:23:10	85	20.924
19:23:11	85	20.924
19:23:12	85	20.924
19:23:13	85	20.924
19:23:14	85	20.924
19:23:15	85	20.924
19:23:16	85	20.924
19:23:17	85	20.924
19:23:18	85	20.924
19:23:19	85	20.924
19:23:20	85	20.924
19:23:21	85	20.924
19:23:22	85	20.924
19:23:23	85	20.924

$$G_f = \frac{0.164e^{-128s}}{9s+1}$$

Tabla.4.33.- Respuesta Lazo de Control Descarga de Mineral Molino Sag

Fuente: Elaboración Propia (Parte 1 de 8)

19:23:24	85	20.924
19:23:25	85	20.924
19:23:26	85	20.924
19:23:27	85	20.924
19:23:28	85	20.924
19:23:29	85	20.924
19:23:30	85	20.924
19:23:31	85	20.924
19:23:32	85	20.924
19:23:33	85	20.924
19:23:34	85	20.924
19:23:35	85	20.924
19:23:36	85	20.924
19:23:37	85	20.924
19:23:38	85	20.924
19:23:39	85	20.924
19:23:40	85	20.924
19:23:41	85	20.924
19:23:42	85	20.924
19:23:43	85	20.924
19:23:44	85	20.924
19:23:45	85	20.924
19:23:46	85	20.924
19:23:47	85	20.924
19:23:48	85	20.924
19:23:49	85	20.924
19:23:50	85	20.924
19:23:51	85	20.924
19:23:52	85	20.924
19:23:53	85	20.924
19:23:54	85	20.924
19:23:55	85	20.924
19:23:56	85	20.924
19:23:57	85	20.924
19:23:58	85	20.924
19:23:59	85	20.924
19:24:00	85	20.924
19:24:01	85	20.924
19:24:02	85	20.924
19:24:03	85	20.924
19:24:04	85	20.924

Tabla.4.33.- Respuesta Lazo de Control Descarga de Mineral Molino Sag

Fuente: Elaboración Propia (Parte 2 de 8)

19:24:05	85	20.924
19:24:06	85	20.924
19:24:07	85	20.924
19:24:08	85	20.924
19:24:09	85	20.924
19:24:10	85	20.924
19:24:11	85	20.924
19:24:12	85	20.924
19:24:13	85	20.924
19:24:14	85	20.924
19:24:15	85	20.924
19:24:16	85	20.924
19:24:17	85	20.924
19:24:18	85	20.924
19:24:19	85	20.924
19:24:20	85	20.924
19:24:21	85	20.924
19:24:22	85	20.924
19:24:23	85	20.924
19:24:24	85	20.924
19:24:25	85	20.924
19:24:26	85	20.924
19:24:27	85	20.924
19:24:28	85	20.924
19:24:29	85	20.924
19:24:30	85	20.924
19:24:31	85	20.924
19:24:32	85	20.924
19:24:33	85	20.924
19:24:34	85	20.924
19:24:35	85	20.924
19:24:36	85	20.924
19:24:37	85	20.924
19:24:38	85	20.924
19:24:39	85	20.924
19:24:40	85	20.924
19:24:41	85	20.924
19:24:42	85	20.924
19:24:43	85	20.924
19:24:44	85	20.924
19:24:45	85	20.924

Tabla.4.33.- Respuesta Lazo de Control Descarga de Mineral Molino Sag

Fuente: Elaboración Propia (Parte 3 de 8)

19:24:46	85	20.924
19:24:47	85	20.924
19:24:48	85	20.924
19:24:49	85	20.924
19:24:50	85	20.924
19:24:51	85	20.924
19:24:52	85	20.924
19:24:53	85	20.924
19:24:54	85	20.924
19:24:55	85	20.924
19:24:56	85	20.924
19:24:57	85	20.924
19:24:58	85	20.924
19:24:59	85	20.924
19:25:00	85	20.924
19:25:01	85	20.924
19:25:02	85	20.924
19:25:03	85	20.924
19:25:04	85	20.924
19:25:05	85	20.924
19:25:06	85	20.924
19:25:07	85	20.924
19:25:08	85	20.924
19:25:09	100	20.924
19:25:10	100	20.924
19:25:11	100	20.924
19:25:12	100	20.924
19:25:13	100	21.424
19:25:14	100	21.924
19:25:15	100	22.424
19:25:16	100	22.924
19:25:17	100	23.024
19:25:18	100	23.124
19:25:19	100	23.224
19:25:20	100	23.304
19:25:21	100	23.384
19:25:22	100	23.398
19:25:23	100	23.398
19:25:24	100	23.398
19:25:25	100	23.398
19:25:26	100	23.398

Tabla.4.33.- Respuesta Lazo de Control Descarga de Mineral Molino Sag

Fuente: Elaboración Propia (Parte 4 de 8)

19:25:27	100	23.398
19:25:28	100	23.398
19:25:29	100	23.398
19:25:30	100	23.398
19:25:31	100	23.398
19:25:32	100	23.398
19:25:33	100	23.398
19:25:34	100	23.398
19:25:35	100	23.398
19:25:36	100	23.398
19:25:37	100	23.398
19:25:38	100	23.398
19:25:39	100	23.398
19:25:40	100	23.398
19:25:41	100	23.398
19:25:42	100	23.398
19:25:43	100	23.398
19:25:44	100	23.398
19:25:45	100	23.398
19:25:46	100	23.398
19:25:47	100	23.398
19:25:48	100	23.398
19:25:49	100	23.398
19:25:50	100	23.398
19:25:51	100	23.398
19:25:52	100	23.398
19:25:53	100	23.398
19:25:54	100	23.398
19:25:55	100	23.398
19:25:56	100	23.398
19:25:57	100	23.398
19:25:58	100	23.398
19:25:59	100	23.398
19:26:00	100	23.398
19:26:01	100	23.398
19:26:02	100	23.398
19:26:03	100	23.398
19:26:04	100	23.398
19:26:05	100	23.398
19:26:06	100	23.398
19:26:07	100	23.398

Tabla.4.33.- Respuesta Lazo de Control Descarga de Mineral Molino Sag

Fuente: Elaboración Propia (Parte 5 de 8)

19:26:08	100	23.398
19:26:09	100	23.398
19:26:10	100	23.398
19:26:11	100	23.398
19:26:12	100	23.398
19:26:13	100	23.398
19:26:14	100	23.398
19:26:15	100	23.398
19:26:16	100	23.398
19:26:17	100	23.398
19:26:18	100	23.398
19:26:19	100	23.398
19:26:20	100	23.398
19:26:21	100	23.398
19:26:22	100	23.398
19:26:23	100	23.398
19:26:24	100	23.398
19:26:25	100	23.398
19:26:26	100	23.398
19:26:27	100	23.398
19:26:28	100	23.398
19:26:29	100	23.398
19:26:30	100	23.398
19:26:31	100	23.398
19:26:32	100	23.398
19:26:33	100	23.398
19:26:34	100	23.398
19:26:35	100	23.398
19:26:36	100	23.398
19:26:37	100	23.398
19:26:38	100	23.398
19:26:39	100	23.398
19:26:40	100	23.398
19:26:41	100	23.398
19:26:42	100	23.398
19:26:43	100	23.398
19:26:44	100	23.398
19:26:45	100	23.398
19:26:46	100	23.398
19:26:47	100	23.398

Tabla.4.33.- Respuesta Lazo de Control Descarga de Mineral Molino Sag

Fuente: Elaboración Propia (Parte 6 de 8)

19:26:48	100	23.398
19:26:49	100	23.398
19:26:50	100	23.398
19:26:51	100	23.398
19:26:52	100	23.398
19:26:53	100	23.398
19:26:54	100	23.398
19:26:55	100	23.398
19:26:56	100	23.398
19:26:57	100	23.398
19:26:58	100	23.398
19:26:59	100	23.398
19:27:00	100	23.398
19:27:01	100	23.398
19:27:02	100	23.398
19:27:03	100	23.398
19:27:04	100	23.398
19:27:05	100	23.398
19:27:06	100	23.398
19:27:07	100	23.398
19:27:08	100	23.398
19:27:09	100	23.398
19:27:10	100	23.398
19:27:11	100	23.398
19:27:12	100	23.398
19:27:13	100	23.398
19:27:14	100	23.398
19:27:15	100	23.398
19:27:16	100	23.398
19:27:17	100	23.398

Tabla.4.33.- Respuesta Lazo de Control Descarga de Mineral Molino Sag

Fuente: Elaboración Propia (Parte 7 de 8)

19:27:18	100	23.398
19:27:19	100	23.398
19:27:20	100	23.398
19:27:21	100	23.398
19:27:22	100	23.398
19:27:23	100	23.398
19:27:24	100	23.398
19:27:25	100	23.398
19:27:26	100	23.398
19:27:27	100	23.398
19:27:28	100	23.398
19:27:29	100	23.398
19:27:30	100	23.398
19:27:31	100	23.398
19:27:32	100	23.398
19:27:33	100	23.398
19:27:34	100	23.398
19:27:35	100	23.398
19:27:36	100	23.398
19:27:37	100	23.398
19:27:38	100	23.398
19:27:39	100	23.398
19:27:40	100	23.398
19:27:41	100	23.398
19:27:42	100	23.398
19:27:43	100	23.398
19:27:44	100	23.398
19:27:45	100	23.398
19:27:46	100	23.398
19:27:47	100	23.398
19:27:48	100	23.398
19:27:49	100	23.398
19:27:50	100	23.398
19:27:51	100	23.398
19:27:52	100	23.398
19:27:53	100	23.398
19:27:54	100	23.398

Tabla.4.33.- Respuesta Lazo de Control Descarga de Mineral Molino SAG

Fuente: Elaboración Propia (Parte 8 de 8)

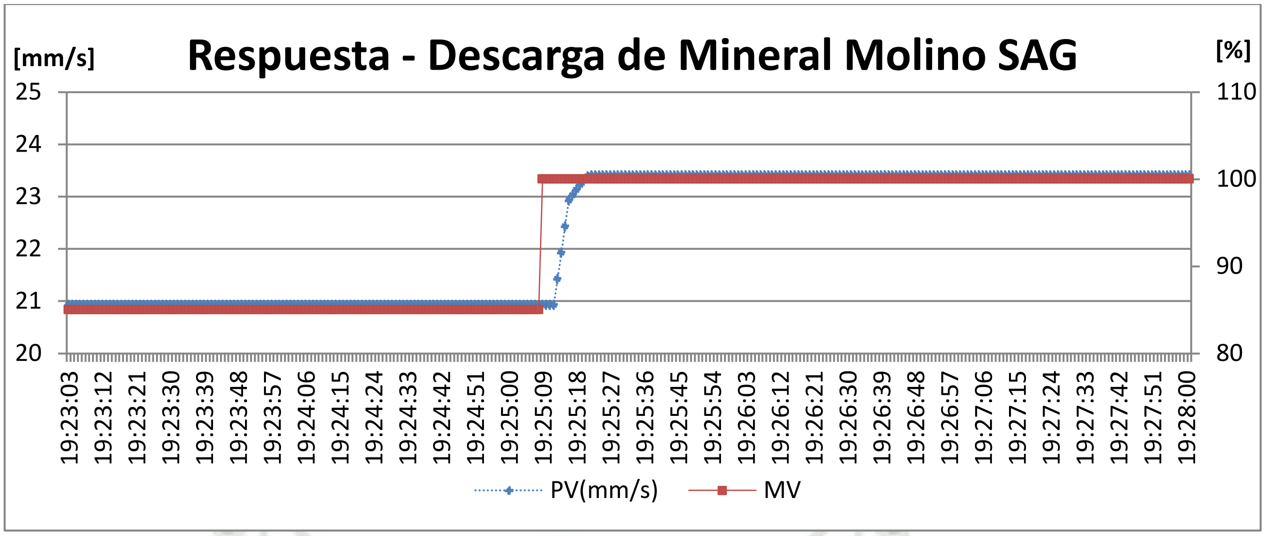


Fig.4.32.- Respuesta Modelo Descarga de Mineral Molino SAG

Fuente: Elaboración Propia

Una vez identificados los parámetros del proceso obtenidos de la curva de reacción (ver Fig.4.32), se obtienen los parámetros del controlador. Para lo cual utilizaremos el método de sintonización de Zieger y Nichols (ver tabla 4.34).

Se selecciona un control PI por el comportamiento del flujo de agua como variable de proceso, se caracteriza por tener una capacitancia baja, velocidad de respuesta pequeño y tiempo muerto pequeño.

Parámetros PID -ZN		
	Kp	**Ti**
PI	0.9(Kζ)/θ	θ/0.3
PI(s)	0.01043719	42.6666667
PI(min)	0.01	0.71111111

Tabla.4.34.- Parámetros PID-ZN para lazo de control Descarga Molino SAG

Fuente: Elaboración Propia

CAPITULO V

PRUEBAS

Este capítulo reflejara las pruebas de Pre – Comisionamiento que se realizó en cada de lazo de control mencionado en el capítulo 4, con excepción del control de carguío de bolas y control de lechada de cal que se probaron en modo manual y en modo remoto desde el DCS, esto se dio que el cliente tomo posición de las áreas antes de la sintonización.

Las pruebas se realizaron bajo la supervisión Ing. Nelson Bedoya (FLSmidth), Ing. Claudio Miranda Badilla (Líder DCS – Pre operaciones Bechtel), Sr. Rene Roque Salas (Ingeniero Supervisor DCS - Área Molienda Bechtel) y Personal de Invensys Perú.

Cada control estuvo acompañado por una secuencia de pruebas que se realizaron tanto modo manual / Automático y Local / Remoto.

En esta etapa, primero se realizó las pruebas de la filosofía de control en modo manual, una vez obtenido los resultados esperados, se implementó la estrategia de control que consiste en la lógica de control, la cual fue cargada al DCS (Capitulo 4 – Sección 4.5), segundo se implementó las estaciones de control y de ingeniería, para monitoreo de las señales y tendencias de los procesos.

Para lo cual se trabajó con los siguientes lazos de control:

- Control de Alimentadores de Acopio Faja 5 - Apron Feeders.
- Control de Alimentación de Carga Fresca Molino SAG.
- Control Carguío de Bolas (Modo Manual)
- Control de Adición de Agua Fresca.
- Control de Descarga Molino SAG.

5.1 Desarrollo de las Pruebas

Para estas pruebas se siguió la siguiente secuencia de trabajo:

- Arranque de Motores.
- Apertura y Cierre de Válvulas de Control.
- Pruebas de Agua de Proceso Alimentación Molino SAG
- Carguío de Bolas (Modo Manual)
- Pruebas de Carga del Molino SAG del 10% al 35%.

5.1.1 Arranque de Motores

En las pruebas de comisionado de los motores se realizaron los arranques en modo manual, modo remoto, interloks de control y configuración de equipos desde el DCS. Los parámetros de trabajo de los motores se pueden verificar en la Tabla 4.13.
Estas pruebas consisten en accionar los motores en vacío (sin carga), durante un mínimo de cuatro horas y posteriormente ocho horas. Durante las dos pruebas se verifico la temperatura registrada por las RTDs situada en la cabeza de cada motor no excediendo los 150°C.

Apron Feeders:

Estas pruebas consistieron en generar fallas con el fin de probar las protecciones de los motores y de las unidades hidráulicas de manera de verificar los parámetros configurados en el DCS, a continuación se detalla los parámetros de configuración típicos para la unidad hidráulica (ver tabla 5.1) y los motores (ver tabla 5.2).
Las condiciones principales que se monitoreo fueron los pull cords de cada Apron Feeders y los Level Switch de los chute alimentadores.

La referencia de los parámetros de configuración es para los cuatro Apron Feeders.

LG1.BI01	Pet modo AUTO (HMI)	LG2.BI01	Encl de Proceso	LG3.BI01	Petición Partir desde HMI	LG4.BI01	Encl Proceso (LG2.BO02)
LG1.BI02	Pet modo AUTO (Logic)	LG2.BI02	Encl Seguridad	LG3.BI02	Petición Parada desde HMI	LG4.BI02	Falla de Comunicación a Lógica (LG2.BO03)
LG1.BI03	Pet modo Man (HMI)	LG2.BI03	UH en Falla (Sum Alarm) Desde Campo	LG3.BI03	Petición Partida AUTO	LG4.BI03	Falla de Partida (LG2.BO04)
LG1.BI04	Pet mod MAN (Logic)	LG2.BI04	Resumen de Alarma UH Drive 1 Desde Campo	LG3.BI04	Petición Detención AUTO	LG4.BI04	Encl Seguridad (LG2.BO07)
LG1.BI05	Resumen Falla (LG2.BO01)	**LG2.BI05**		LG3.BI05	FBK REM(1)/LOC(0) Desde Campo	LG4.BI05	UH en Falla (LG2.BO05)
LG1.BI06	Forzar modo AUTO	LG2.BI06	Falla Comunicación Desde Campo (No hace lógica solo conectado)	LG3.BI06	Flag AUT(1)/MAN(0)(LG1.BO01)	LG4.BI06	Parada de EMERGENCIA (LG2.BO06)
LG1.BI07	Forzar modo MAN	LG2.BI07	Parada de EMERGENCIA Desde Campo	LG3.BI07	Permisivo de Partida	LG4.BI07	
LG1.BI08	Pet modo REM (HMI)	LG2.BI08	**UH Drive 1 Funcionando Desde Campo**	LG3.BI08	Resumen de Falla para detener el motor(LG2.BO01)	LG4.BI08	
LG1.BI09	Pet modo REM (Logic)	LG2.BI09		LG3.BI09	Partida LOC (LOC PB-Campo)	LG4.BI09	
LG1.BI10	Forzar modo REM	LG2.BI10	Flag de PARTIDA (LG3.BO01)	LG3.BI10	Petición Partir LOC HMI	LG4.BI10	
LG1.BI11	Pet modo LOC (HMI)	LG2.BI11	Flag REM(1)/LOC(0) (Campo)	LG3.BI11	Enclavamiento de Proceso(LG2.BI01)	LG4.BI11	
LG1.BI12	Pet modo LOC (Logic)	LG2.BI12	Resumen de Alarma NO RECONOCIDA	LG3.BI12		LG4.BI12	
LG1.BI13	Forzar modo LOC	LG2.BI13	Estado Requerido por Lógica (LG3.BO08)	LG3.BI13	UH Listo para Partir	LG4.BI13	
LG1.BI14		LG2.BI14		LG3.BI14		LG4.BI14	
LG1.BI15		LG2.BI15		LG3.BI15		LG4.BI15	Estado requerido por lógica (LG3.BO08)
LG1.BI16		LG2.BI16	FBK REM(1)/LOC(0) Desde Campo (LG3.BI05)	LG3.BI16	Petición Parar LOC HMI	LG4.BI16	
LG1.BO01	Flag AUTO/MAN	LG2.BO01	Resumen de Falla para detener el motor	LG3.BO01	Comando PARTIR(1)/PARAR(0) Campo (LG2.BI10)	LG4.BO01	Encl Proceso
LG1.BO02	Requerimiento REM/LOC	LG2.BO02	Encl Proceso Activo ("bypasseada" en modo LOC)	LG3.BO02		LG4.BO02	Falla de Comunicación a Lógica
LG1.BO03		LG2.BO03	Falla de Comunicación a Lógica	LG3.BO03	Listo/Partir Originado en Lógica	LG4.BO03	Falla de Partida
LG1.BO04		LG2.BO04	Bit Falla de Partida	LG3.BO04	Botón Partir desde HMI hacia otras lógicas	LG4.BO04	Encl Seguridad
LG1.BO05		LG2.BO05	Bit de UH en Falla (Sum Alarm) a Lógica	LG3.BO05		LG4.BO05	UH en Falla
LG1.BO06		LG2.BO06	Bit de Parada de Emergencia a Lógica	LG3.BO06		LG4.BO06	Parada de EMERGENCIA
LG1.BO07		LG2.BO07	Encl de Seguridad	LG3.BO07	Comando a la BALIZA	LG4.BO07	
LG1.BO08		LG2.BO08	Reset de Alarma, hacia campo	LG3.BO08	Estado requerido por lógica	LG4.BO08	
		LG2.RO01	Resumen para permisivo	LG2.RI01	Resumen de sin Permiso(0= Permiso Ok)(LG2.RO01)		

Tabla.5.1.- Parámetros de Configuración Unidad Hidráulica UH

Fuente: Invensys

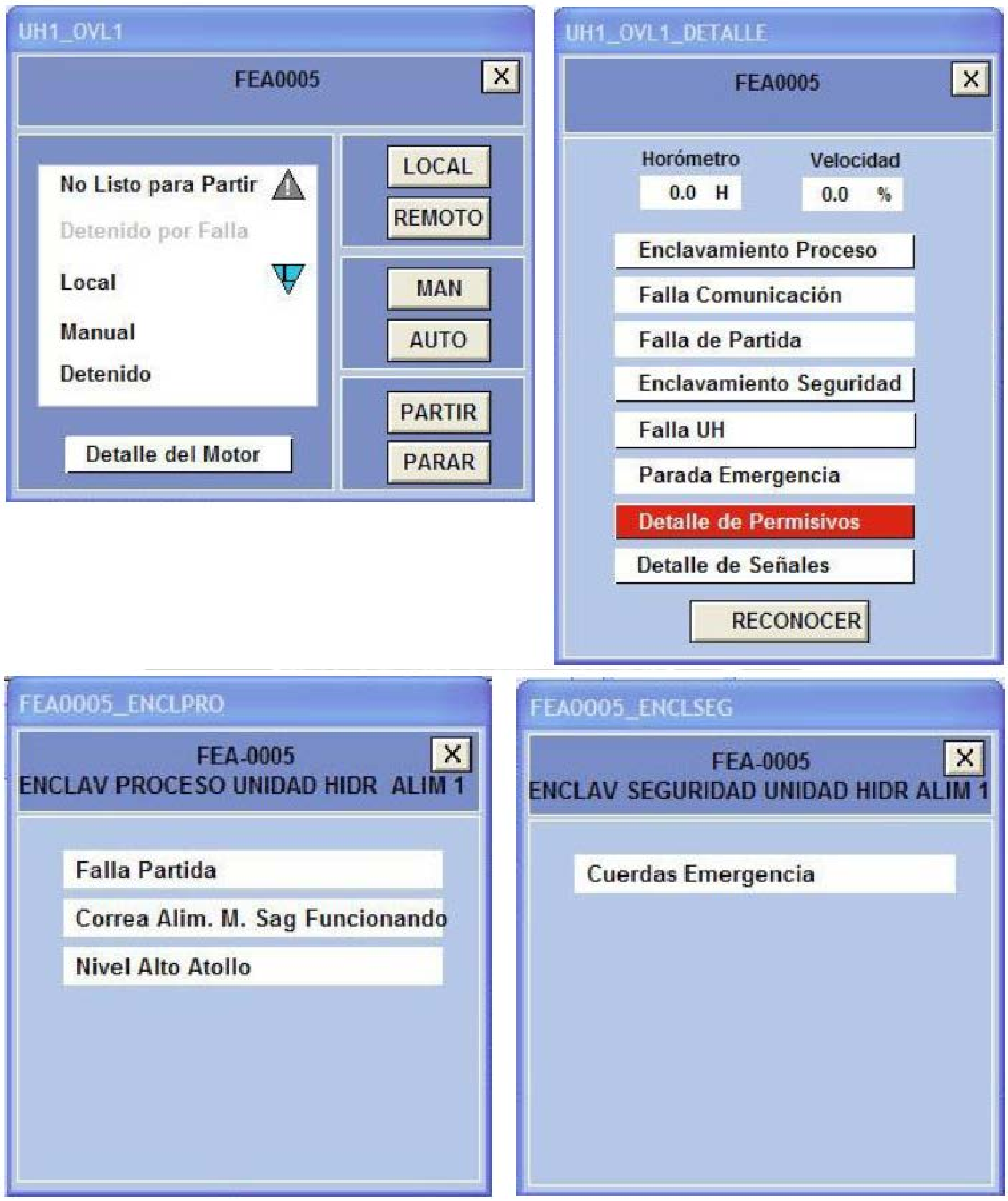
LG1.BI01	Pet modo AUTO (HMI)	LG2.BI01	Encl de Proceso	LG3.BI01	Petición Partir desde HMI	LG4.BI01	Encl Proceso (LG2.BO02)
LG1.BI02	Pet modo AUTO (Logic)	LG2.BI02	Encl Seguridad	LG3.BI02	Petición Parada desde HMI	LG4.BI02	Falla de Comunicación a Lógica (LG2.BO03)
LG1.BI03	Pet modo Man (HMI)	LG2.BI03		LG3.BI03	Petición Partida AUTO	LG4.BI03	Falla de Partida (LG2.BO04)
LG1.BI04	Pet mod MAN (Logic)	LG2.BI04	Falla Tensión Control	LG3.BI04	Petición Detención AUTO	LG4.BI04	Encl Seguridad (LG2.BO07)
LG1.BI05	Resumen Falla (LG2.BO01)	LG2.BI05	Falla Eléctrica	LG3.BI05	Flag REM/LOC (LG1.BO02)	LG4.BI05	
LG1.BI06	Forzar modo AUTO	LG2.BI06	Falla Comunicación	LG3.BI06	Flag AUT/MAN(LG1.BO01)	LG4.BI06	Falla Tensión Control (LG2.BO08)
LG1.BI07	Forzar modo MAN	LG2.BI07	Parada de EMERGENCIA	LG3.BI07	Permisivo de Partida	LG4.BI07	Falla Eléctrica (LG2.BO05)
LG1.BI08	Pet modo REM (HMI)	LG2.BI08	FBK DETENIDO (No hace lógica solo conectado)	LG3.BI08	Resumen Falla para detener el motor (LG2.BO01)	LG4.BI08	Parada de EMERGENCIA (LG2.BO06)
LG1.BI09	Pet modo REM (Logic)	LG2.BI09	FBK Funcionando	LG3.BI09	Partida LOC (LOC PB-Campo)	LG4.BI09	
LG1.BI10	Forzar modo REM	LG2.BI10	Flag de PARTIDA (LG3.BO01)	LG3.BI10	Petición Partir LOC HMI	LG4.BI10	
LG1.BI11	Pet modo LOC (HMI)	LG2.BI11	Flag REM/LOC (LG1.BO02)	LG3.BI11	Enclavamiento de Proceso(LG2.BI01)	LG4.BI11	
LG1.BI12	Pet modo LOC (Logic)	LG2.BI12	Alarma NO RECONOCIDA	LG3.BI12		LG4.BI12	
LG1.BI13	Forzar modo LOC	LG2.BI13	Estado Requerido por Lógica (LG3.BO08)	LG3.BI13		LG4.BI13	
LG1.BI14		LG2.BI14		LG3.BI14		LG4.BI14	
LG1.BI15		LG2.BI15		LG3.BI15		LG4.BI15	Estado requerido por lógica (LG3.BO08)
LG1.BI16		LG2.BI16		LG3.BI16	Petición Parar LOC HMI	LG4.BI16	Reset Primera Salida
LG1.BO01	Flag AUTO/MAN	LG2.BO01	Resumen de Falla para detener el motor	LG3.BO01	Comando PARTIR/PARAR Campo (LG2.BI10)	LG4.BO01	Encl Proceso
LG1.BO02	Flag REM/LOC	LG2.BO02	Encl Proceso Activo ("bypasseada" modo LOC)	LG3.BO02		LG4.BO02	Falla de Comunicación a Lógica
LG1.BO03		LG2.BO03	Falla de Comunicación a Lógica	LG3.BO03	Listo/Partir	LG4.BO03	Falla Partida
LG1.BO04		LG2.BO04	Bit Falla de Partida	LG3.BO04	Botón Partir desde HMI hacia otras lógicas	LG4.BO04	Encl Seguridad
LG1.BO05		LG2.BO05	Bit de Falla Eléctrica a Lógica	LG3.BO05		LG4.BO05	
LG1.BO06		LG2.BO06	Bit de Parada de Emergencia a Lógica	LG3.BO06		LG4.BO06	Falla tensión
LG1.BO07		LG2.BO07	Encl de Seguridad	LG3.BO07	Comando a la BALIZA	LG4.BO07	Falla Eléctrica
LG1.BO08		LG2.BO08	Falla de tensión	LG3.BO08	Estado requerido por lógica	LG4.BO08	Parada de EMERGENCIA

Tabla.5.2.- Parámetros de Configuración Motor Apron Feeder

Fuente: Invensys

Interloks de control:

Teniendo configurados los parámetros de configuración de las Unidades Hidráulicas y Motores se procedió a forzar las señales de control, de manera que si falla un equipo este será detectada desde el DCS a través de las siguientes pantallas.



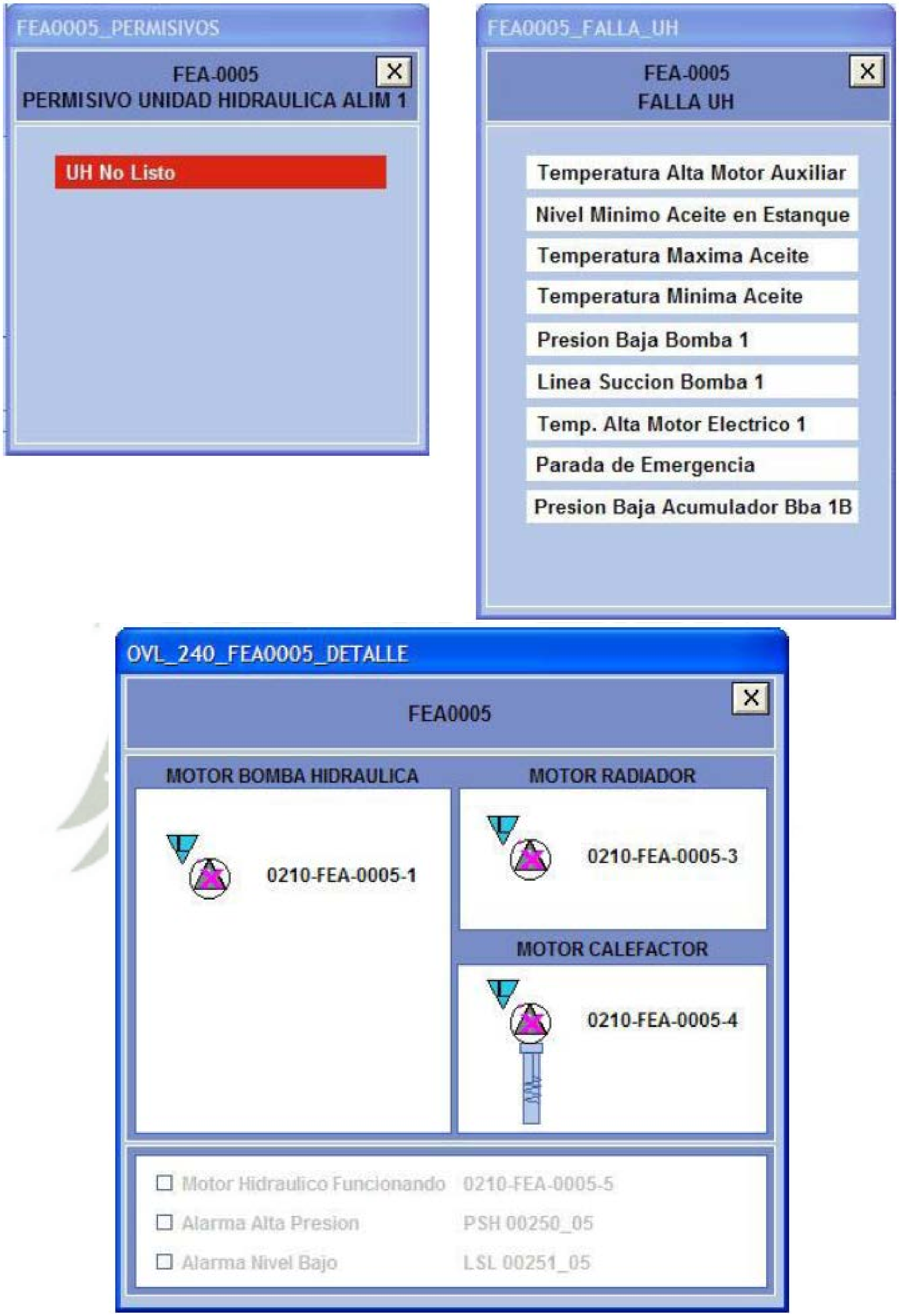


Fig.5.1.- Pantallas de Control Apron Feeders

Fuente: Invensys

El procedimiento realizado en pruebas de pre comisionado y comisionado.

- Verificación de Gabinetes de Control**.**
- Verificación de Protocolos de Comunicación Profibus.
- Verificación de Instrumentación UH.
- Desactivar paradas de Emergencia, arranques desde Sala de Control.
- Verificación de Interloks, deben encontrarse operativos (sin marca roja).
- Primer Arranque, se realiza desde campo a través de del supervisor de Área.
- Verificar status del motor desde Sala de Control.
- Forzar Fallas en Campo, para ser detectadas desde Sala de Control.
- Parada de Motor, se realiza desde campo a través de del supervisor de Área.
- Segundo Arranque, se realizad a través del DCS.
- Confirmación de arranque del Motor en campo y en DCS.
- Verificación de lectura de parámetros desde el DCS.
- Parada de Motor, se realiza desde Sala de Control a través del DCS.
- Confirmación de parada de motor en campo y en DCS.

Faja de Alimentación Molino SAG - 0240-CVB-0005

Estas pruebas consistieron en generar fallas con el fin de probar las protecciones de los motores y de las unidades hidráulicas de manera de verificar los parámetros configurados en el DCS, a continuación se detalla los parámetros de configuración típicos para la unidad hidráulica (ver tabla 5.1) y los motores (ver tabla 5.3).

Las condiciones principales que se monitoreo fueron los pull cords, sensores de rotura de faja y des alineamiento de faja.

LG1.BI01	Pet modo AUTO (HMI)	LG2.BI01	Encl de Proceso	LG3.BI01	Petición Partir desde HMI	LG4.BI01	Encl Proceso (LG2.BO02)
LG1.BI02	Pet modo AUTO (Logic)	LG2.BI02	Encl Seguridad	LG3.BI02	Petición Parada desde HMI	LG4.BI02	Falla de Comunicación a Lógica (LG2.BO03)
LG1.BI03	Pet modo Man (HMI)	LG2.BI03	VDF en Falla	LG3.BI03	Petición Partida AUTO	LG4.BI03	Falla de Partida (LG2.BO04)
LG1.BI04	Pet mod MAN (Logic)	LG2.BI04	Falla Tensión Control (No hace lógica solo está conectado)	LG3.BI04	Petición Detención AUTO	LG4.BI04	Encl Seguridad (LG2.BO07)
LG1.BI05	Resumen Falla (LG2.BO01)	LG2.BI05	–	LG3.BI05	Flag REM/LOC (LG1.BO02)	LG4.BI05	
LG1.BI06	Forzar modo AUTO	LG2.BI06	Falla Comunicación (No hace lógica solo conectado)	LG3.BI06	Flag AUT/MAN(LG1.BO01)	LG4.BI06	Falla Tensión Control (LG2.BO08)
LG1.BI07	Forzar modo MAN	LG2.BI07	Parada de EMERGENCIA	LG3.BI07	Permisivo de Partida	LG4.BI07	Falla Eléctrica (LG2.BO05)
LG1.BI08	Pet modo REM (HMI)	LG2.BI08	Listo para Operar (LG2.BI08 & LG2.BI09 = FBK FUN)	LG3.BI08	Resumen de Falla para detener el motor (LG2.BO01)	LG4.BI08	Parada de EMERGENCIA (LG2.BO06)
LG1.BI09	Pet modo REM (Logic)	LG2.BI09	Operación Habilitada (LG2.BI08 & LG2.BI09 = FBK FUN)	LG3.BI09	Partida LOC (LOC PB-Campo)	LG4.BI09	
LG1.BI10	Forzar modo REM	LG2.BI10	Flag de PARTIDA (LG3.BO01)	LG3.BI10	Petición Partir LOC HMI	LG4.BI10	
LG1.BI11	Pet modo LOC (HMI)	LG2.BI11	Flag REM/LOC (LG1.BO02)	LG3.BI11	Enclavamiento de Proceso(LG2.BI01)	LG4.BI11	
LG1.BI12	Pet modo LOC (Logic)	LG2.BI12	Resumen de Alarma NO RECONOCIDA	LG3.BI12		LG4.BI12	
LG1.BI13	Forzar modo LOC	LG2.BI13	Estado Requerido por Lógica (LG3.BO08)	LG3.BI13	VDF Listo	LG4.BI13	
LG1.BI14		LG2.BI14		LG3.BI14		LG4.BI14	
LG1.BI15		LG2.BI15		LG3.BI15		LG4.BI15	Estado requerido por lógica (LG3.BO08)
LG1.BI16		LG2.BI16		LG3.BI16	Petición Parar LOC HMI	LG4.BI16	
LG1.BO01	Flag AUTO/MAN	LG2.BO01	Resumen de Falla para detener el motor	LG3.BO01	Comando PARTIR/PARAR Campo (LG2.BI10)	LG4.BO01	Encl Proceso
LG1.BO02	Flag REM/LOC	LG2.BO02	Encl Proceso Activo ("bypasseada" en modo LOC)	LG3.BO02		LG4.BO02	Falla de Comunicación a Lógica
LG1.BO03		LG2.BO03	Falla de Comunicación a Lógica	LG3.BO03	Listo/Partir	LG4.BO03	Falla Partida
LG1.BO04		LG2.BO04	Bit Falla de Partida	LG3.BO04	Botón Partir desde HMI hacia otras lógicas	LG4.BO04	Encl Seguridad
LG1.BO05		LG2.BO05	Bit de Falla Eléctrica a Lógica	LG3.BO05		LG4.BO05	VDF en Falla
LG1.BO06		LG2.BO06	Bit de Parada de Emergencia a Lógica	LG3.BO06		LG4.BO06	Falla tensión
LG1.BO07		LG2.BO07	Encl de Seguridad	LG3.BO07	Comando a la BALIZA	LG4.BO07	Falla Eléctrica
LG1.BO08		LG2.BO08	Falla de tensión	LG3.BO08	Estado requerido por lógica	LG4.BO08	Parada de EMERGENCIA
		LG2.RO01	Resumen de sin Permiso (0 = Permiso Ok)	LG2.RI01	Resumen de sin Permiso (0 = Permiso Ok)(LG2.RO01)		
		LG2.RO02	FBK Funcionando (LG2.BI08 & LG2.BI09 = FBK FUN)				
		LG2.RO03	Sin FBK Funcionando (LG2.BI08 & LG2.BI09 = FBK FUN)				

Tabla.5.3.- Parámetros Motor Faja de Alimentación 0240-CVB-0005

Fuente: Invensys

Los parámetros configurados de la Unidad Hidráulica de la Faja Transportadora es igual mostrada en la tabla 5.1.

Interloks de Control:

Las pruebas para la faja de alimentación fueron realizadas entre 10% a 35% según su capacidad. La Fig.5.2 muestra las pantallas de control, donde se verifico el detalle funcional del motor y su verificación de fallas.

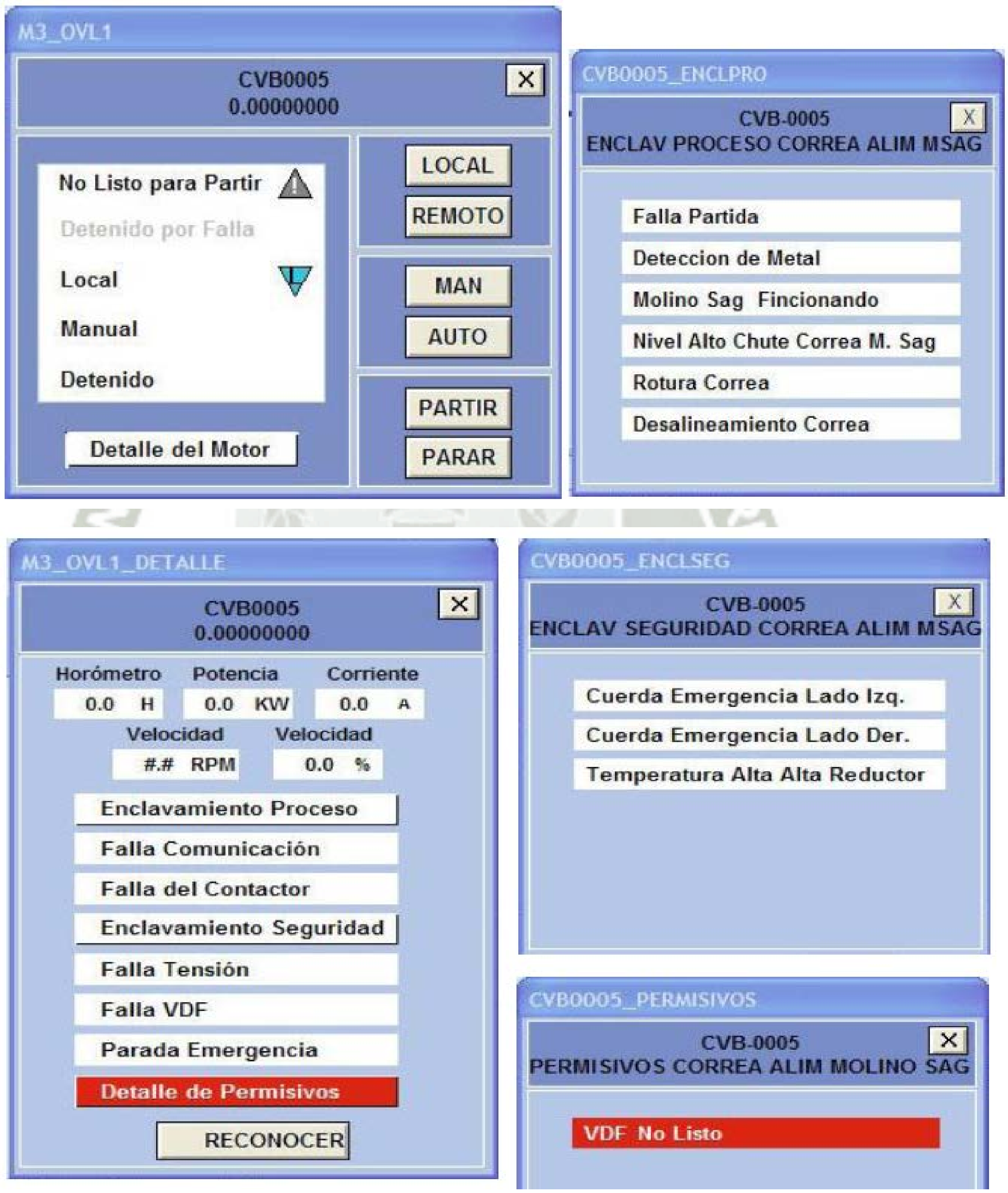


Fig.5.2.- Pantallas de Control Faja de Alimentación 0240-CVB-0005

Fuente: Invensys

El procedimiento realizado en pruebas de pre comisionado y comisionado.

- Verificación de Gabinetes de Control.
- Verificación de Protocolos de Comunicación Profibus.
- Verificación de Instrumentación UH.
- Verificación de Pull Cords, Rotura y Des alineadores de Faja
- Desactivar paradas de Emergencia, arranques desde Sala de Control.
- Verificación de Interloks, deben encontrarse operativos (sin marca roja).
- Primer Arranque, se realiza desde campo a través de del supervisor de Área.
- Verificar status del motor desde Sala de Control.
- Forzar Fallas en Campo, para ser detectadas desde Sala de Control.
- Parada de Motor, se realiza desde campo a través de del supervisor de Área.
- Segundo Arranque, se realizad a través del DCS.
- Confirmación de arranque del Motor en campo y en DCS.
- Verificación de lectura de parámetros desde el DCS.
- Parada de Motor, se realiza desde Sala de Control a través del DCS.
- Confirmación de parada de motor en campo y en DCS.

Carguío de Bolas – Molino SAG

Como se mencionó antes, el control para Carguío de Bolas no se llegó a concluir por petición del cliente Xstrata Cooper. Todas las pruebas se realizaron en modo Local /Remoto. Los parámetros de configuración en el DCS son los mismos mostrados en la tabla 5.2.

Interloks de Control:

Los interloks de los dos carguíos de bolas son iguales, solo se detallara del 0240-FET-0005.

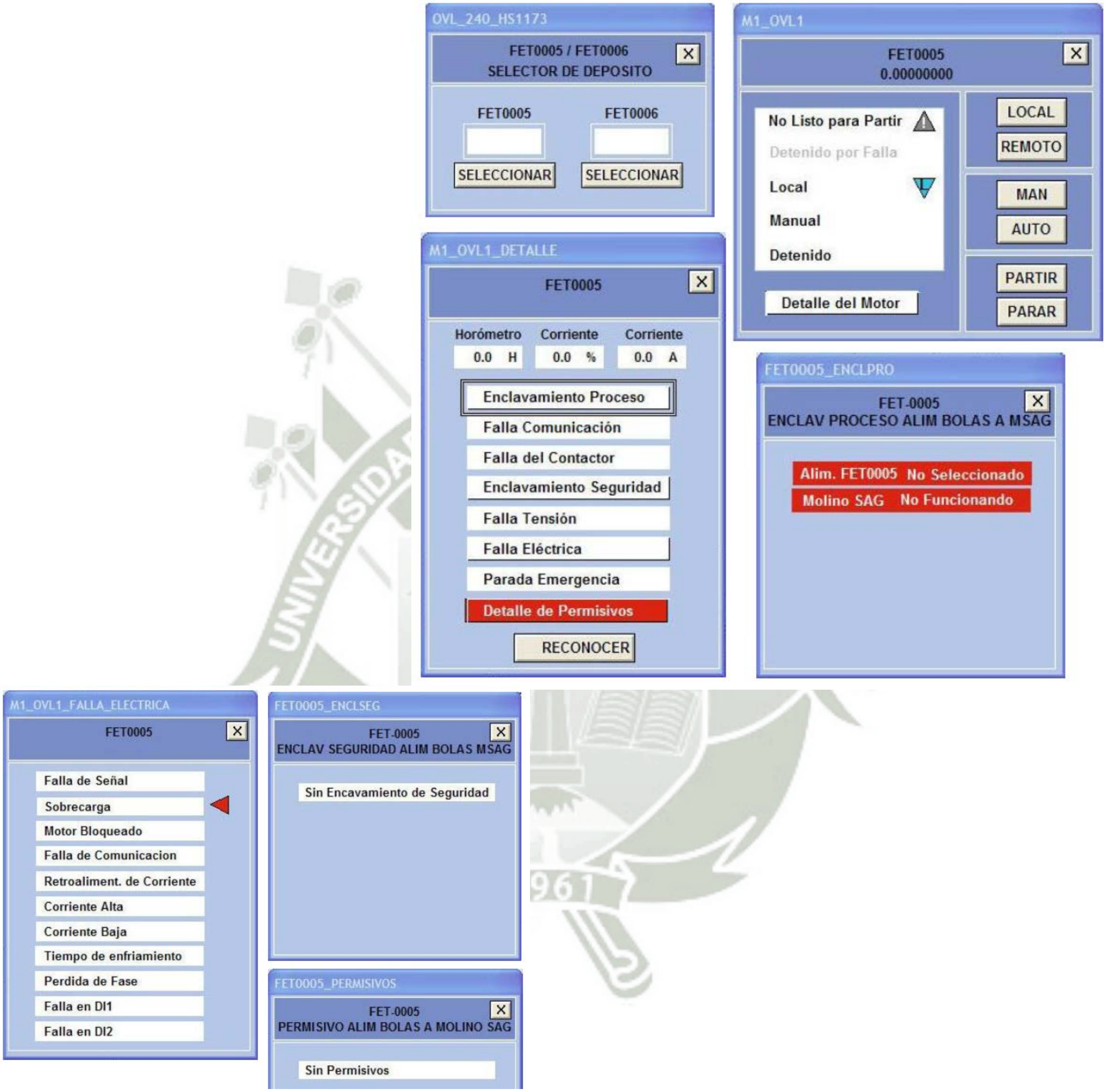


Fig.5.3.- Pantallas de Control Carguío de Bolas

Fuente: Invensys

Molino SAG

Estas pruebas consistieron en generar fallas con el fin de probar las protecciones de los motores y de las unidades hidráulicas de manera de verificar los parámetros configurados en el DCS, a continuación se detalla los parámetros de configuración típicos de arranque del Molino SAG son igual a los mostrados en la Tabla 5.2.

Interloks de Control:

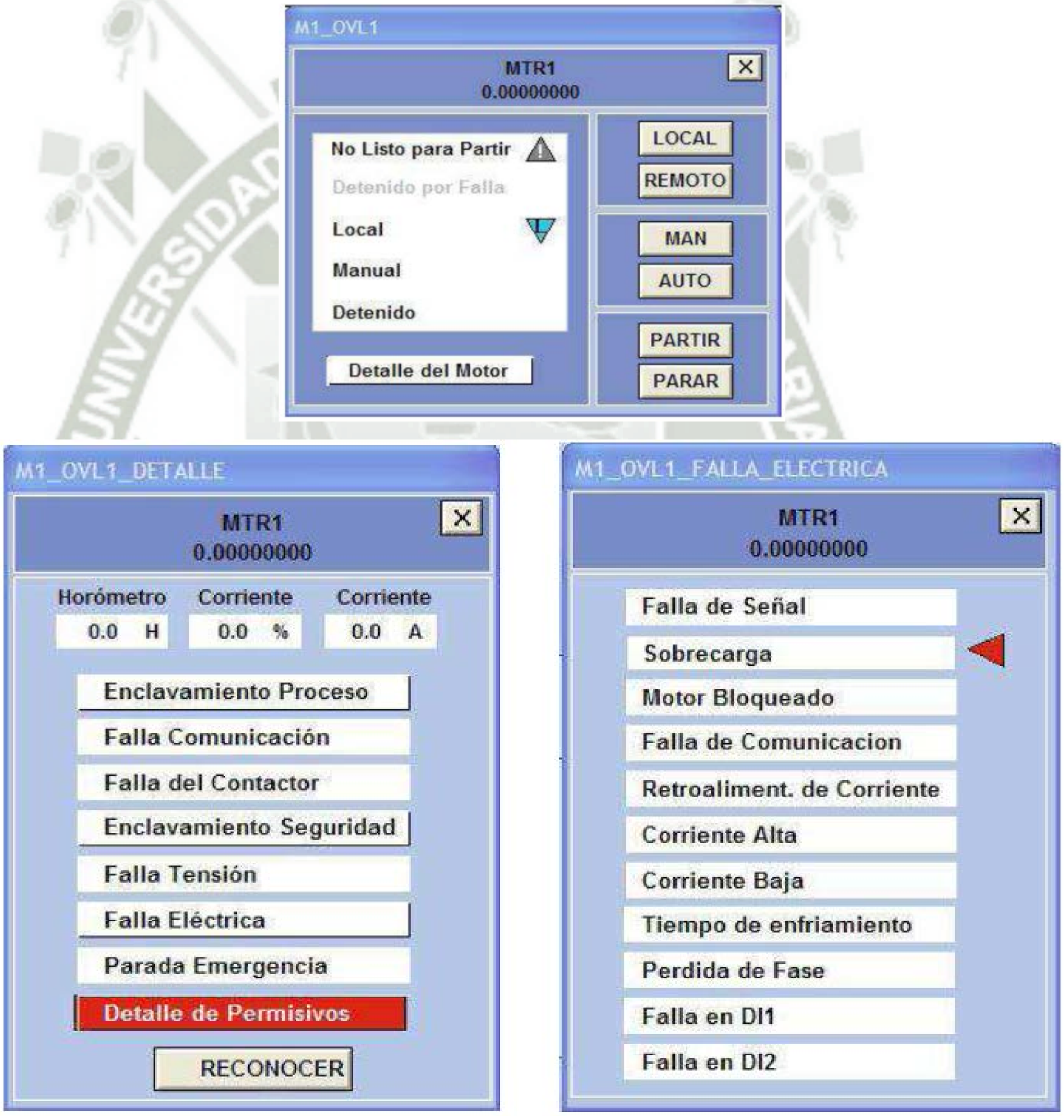


Fig.5.4.- Pantallas de Control Molino SAG

Fuente: Invensys

El procedimiento realizado en pruebas de pre comisionado y comisionado:

- Verificación de Construcción e Instalación del Molino, revisión de P&IDs.
- Calibración de Instrumentos.
- Alineamiento de Ejes del Molino.
- Verificación de Presiones de UH.
- Verificación de Sistema de Frenos.
- Realizar un Mapeo de Proceso del Procedimiento de Energización de Equipos.
- Plan de Energización
- Etiqueta de Energización
- Señalización para desocupar el Área de Pruebas
- Retirar Bloqueo.
- Desactivar paradas de Emergencia, arranques desde Sala de Control.
- Verificación de Interloks, deben encontrarse operativos (sin marca roja).
- Primer Arranque, se realiza desde campo a través de del supervisor de Área.
- Verificar status del motor desde Sala de Control.
- Forzar Fallas en Campo, para ser detectadas desde Sala de Control.
- Parada de Motor, se realiza desde campo a través de del supervisor de Área.
- Segundo Arranque, se realizad a través del DCS.
- Confirmación de arranque del Motor en campo y en DCS.
- Verificación de lectura de parámetros desde el DCS.
- Parada de Motor, se realiza desde Sala de Control a través del DCS.
- Confirmación de parada de motor en campo y en DCS.
- Monitoreo de Vibración ejercida por el Molino SAG.

5.1.2 Apertura y Cierre de Válvulas de Control

Otra de las pruebas realizadas por pre operaciones, es la respuesta de las válvulas de control, donde se verifico el Tag del equipo, respuesta de apertura o cierre frente una acción rampa, calibración del posicionador según la señal de entrada de corriente. Los parámetros de trabajo de las válvulas se pueden verificar en la Tabla 4.12.

Válvulas de Agua de Proceso Alimentación Molino SAG

De igual forma que los motores se configuro los parámetros de las válvulas en el DCS para verificar fallas durante las pruebas (ver tabla 5.4).

LG1.BI01	Pet modo AUTO (HMI)	LG2.BI01	Comando de ABRIR/CERRAR(LG3.BO01)	LG3.BI01	Pet ABRIR (HMI)	LG4.BI01	Falla al ABRIR
LG1.BI02	Pet modo AUTO (Logic)	LG2.BI02	Comando CERRAR/ABRIR (LG3.BO02)	LG3.BI02	Pet CERRAR (HMI)	LG4.BI02	Falla al CERRAR
LG1.BI03	Pet modo MAN (HMI)	LG2.BI03	FBk de ABIERTO	LG3.BI03	Pet ABRIR (logic)	LG4.BI03	Falla de Comunicación
LG1.BI04	Pet modo MAN (Logic)	LG2.BI04	Fbk de CERRADO	LG3.BI04	Pet CERRAR (Logic)	LG4.BI04	Resumen de Falla
LG1.BI05	Resumen de Falla (LG2.BO04)	LG2.BI05		LG3.BI05	Flag REM/LOC (LG1.BO02)	LG4.BI05	
LG1.BI06	Forzar a AUTO	LG2.BI06	Falla de FBM (BLKSTA.B24)	LG3.BI06	Flag AUT/MAN (LG1.BO01)	LG4.BI06	
LG1.BI07	Forzar a MAN	LG2.BI07		LG3.BI07	Enclavamiento de Apertura	LG4.BI07	
LG1.BI08	Pet modo REM (HMI)	LG2.BI08		LG3.BI08	Enclavamiento de Cierre	LG4.BI08	
LG1.BI09	Pet modo REM (Logic)	LG2.BI09		LG3.BI09	Pet LOC ABRIR	LG4.BI09	
LG1.BI10	Forzar a REM	LG2.BI10		LG3.BI10	Pet LOC CERRAR	LG4.BI10	
LG1.BI11	Pet modo LOC (HMI)	LG2.BI11		LG3.BI11	Falla de Comunicación (LG2.BO03)	LG4.BI11	
LG1.BI12	Pet modo LOC (Logic)	LG2.BI12	Alarma no Reconocida	LG3.BI12	Resumen de Falla (LG2.BO04)	LG4.BI12	
LG1.BI13	Forzar a LOC	LG2.BI13		LG3.BI13	Fbk ABIERTO	LG4.BI13	
LG1.BI14		LG2.BI14		LG3.BI14	Fbk CERRADO	LG4.BI14	
LG1.BI15		LG2.BI15		LG3.BI15	Selección de modo de Falla	LG4.BI15	Reset de Falla
LG1.BI16		LG2.BI16		LG3.BI16		LG4.BI16	
LG1.BO01	Flag AUTO/MAN	LG2.BO01	Falla de Apertura	LG3.BO01	Comando ABRIR/CERRAR	LG4.BO01	Falla al ABRIR
LG1.BO02	Flag REM/LOC	LG2.BO02	Falla de Cierre	LG3.BO02	Comando CERRAR/ABRIR	LG4.BO02	Falla al CERRAR
LG1.BO03		LG2.BO03	Falla de COMUNICACIÓN	LG3.BO03	Indicador de ultimo comando enviado	LG4.BO03	Falla de Comunicación
LG1.BO04		LG2.BO04	Resumen de Falla	LG3.BO04	Reset de Falla	LG4.BO04	
LG1.BO05		LG2.BO05	Válvula en Recorrido	LG3.BO05		LG4.BO05	
LG1.BO06		LG2.BO06		LG3.BO06		LG4.BO06	
LG1.BO07		LG2.BO07		LG3.BO07		LG4.BO07	
LG1.BO08		LG2.BO08		LG3.BO08		LG4.BO08	

Tabla.5.4.- Parámetros de Válvulas Agua de Proceso Alimentación Molino SAG

Fuente: Invensys

Interloks de Control:

Las pantallas que se muestran en la Fig.5.5 se aplican en todas las válvulas mencionadas en tabla 4.12. El detalle de falla de cada válvula se basa en falla de comunicación, falla al abrir y falla al cerrar.

Fig.5.4.- Pantallas de Control Molino SAG

Fuente: Invensys

5.1.3 Pruebas de Agua de Proceso Alimentación Molino SAG

En la Fig.5.5 muestra la prueba realizada en el Lazo de Control de Agua de Proceso, donde la señal de acción de control es enviada a las válvulas 0310-FV-01202A/B/C encargada de alimentar de agua al Molino SAG, regulando el porcentaje de solidos a través del controlador 0310-DIC-01202 y del controlador 0310-FIC-01202.

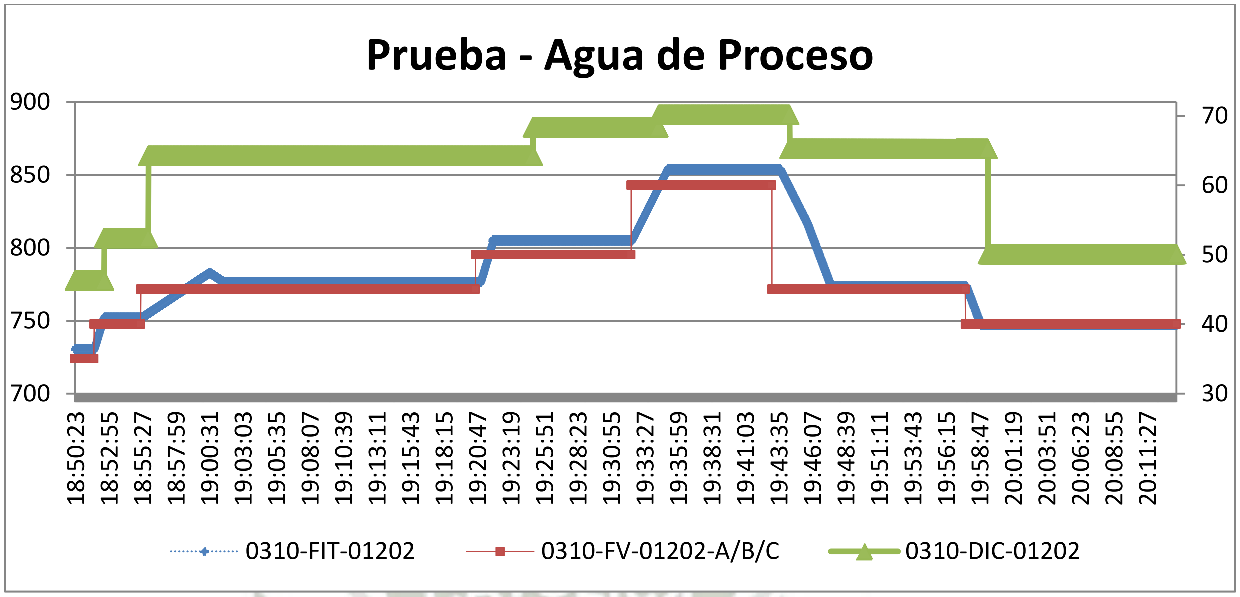


Fig.5.5.- Prueba Agua de Proceso Alimentación Molino SAG

Fuente: Reporte de Pruebas Pre Comisionado

Como se observar en la gráfica cuando el porcentaje de solidos excede el 70% el lazo de control se activa regulando el flujo de ingreso de agua al Molino SAG obteniendo un respuesta adecuada. La posición de las válvulas de operaciones vario entre el 35% al 60% de apertura.

5.1.4 Prueba de Carguío de Bolas

La prueba en modo automático no se pudo concluir, pero su funcionamiento en modo manual permite realizar las pruebas de carga del Molino SAG en modo automático.

5.1.5 Pruebas de Carga del Molino SAG del

Las pruebas fueron verificadas por el Vendor de FLSmidth Ing. Nelson Bedoya, quien emitió los siguientes resultados en su reporte (el reporte completo no puede ser adjuntado por temas de confiabilidad entre FLSmidth y Bechtel, solo se detallara los datos obtenidos durante las pruebas).

Los resultados de las prueba muestra el detalle con mínima carga al 10% y máxima carga al 35% de bolas, según especificaciones del Vendor.
Las primeras pruebas se realizaran frente la potencia del molino SAG frente al ingreso de bolas.

FLSmidth MINERALS

WET SAG/BALL MILL CIRCUIT

PROCESS DATA INPUT/SUMMARY

INPUT DATA:

CUSTOMER:	XSTRATA c/o BECHTEL
PROJECT:	STANDARD CONCENTRATOR
PROPOSAL NO:	08-91010-726
SITE LOCATION:	PERU
ELEVATION:	4000 meters ASL

CIRCUIT TYPE:	SAG/CYC/BALL	
MATERIAL:	Copper	
ORE SPECIFIC GRAVITY:	2.80	
CAPACITY:	4,400.00	DMTPH
BOND WORK INDEX:	16.50	KWH/MT
FEED MOISTURE:	5.0%	
AVAILABILITY:	92.8%	
DAILY TONNAGE (DMTPD):	98,000.00	

SAG MILL F_{100} (microns):	300,000 µ
SAG MILL F_{80} (microns):	60,000 µ
PEBBLE CRUSHER P_{80} (microns):	6,300 µ
SAG MILL P_{80} (microns):	2,100 µ
SAG MILL P_{80} (pebble crushing adjustment):	2,730 µ
BALL MILL F_{80} (microns):	2,100 µ
BALL MILL P_{80} (microns):	200 µ
PEBBLE RECIRCULATION:	20.0%
BALL MILL SPLIT:	65.0%
BALL MILL CIRCULATING LOAD:	350.0%
SOLIDS (%): SAG MILL:	70.0%
BALL MILL:	70.0%
CYCLONE FEED:	55.0%
CYCLONE OVERFLOW:	30.0%

PROCESS DATA:

PROCESS POWER	BASE	ADJUSTMENTS	ADJUSTMENTS	TOTAL POWER		MILL QTY / SIZE / POWER
SAG MILL (@ pinion)	17967.58 KW	1.15 (diam)	1.00	20,663 KW	27,709 HP	(1) 40'-0" x 25'-0" SAG Mill / 32,184 HP (24,000 kW)
BALL MILL (@ pinion)	37268.00 KW	1.000 (fine)	0.95 (SAG prod)	35,405 KW	47,478 HP	(2) 26'-0" x 40'-6" Ball Mill / 21,992 HP (16,400 kW)

Fig.5.5.- Prueba Molino SAG – Ingreso de Datos de Proceso

Fuente: Reporte de Pruebas FLSmidth

Respuesta al 10% de Carga de Bolas

Se ajustó el controlador al 10% (mínimo) de Carga de Bolas, equivale a 448,817 Kg de carga ingresante al molino SAG. En la Fig.5.6 se observa la variación de la potencia con respecto al porcentaje carga.

FLSmidth MINERALS

WET SAG/BALL MILL CIRCUIT

SAG MILL POWER

CUSTOMER:	BECHTEL c/o XSTRATA	MILL VOLUME	
PROJECT:	STANDARD CONCENTRATOR (ANTAPACCAY)	SHELL:	26,415.94 ft³ / 748.04 m³
PROPOSAL NO:	08-91010-726	HEADS: (15.0°)	4,122.98 ft³ / 116.75 m³
MILL SIZE:	40'-0" × 25'-0" SAG Mill	TOTAL:	30,538.92 ft³ / 864.80 m³
MILL DIAMETER:	40.00 ft / 39.10 ft (eff) / 11.92 m (eff)	WET/DRY GRINDING:	WET
MILL LENGTH:	25.00 ft / 22.00 ft (eff) / 6.71 m (eff)	MILL DISCHARGE:	GRATE
TRUNNION I.D.:	10.0 ft / 3.05 m	MEDIA MATERIAL:	Forged
D:L RATIO:	1.777	BALL CHARGE:	10.0%
MOTOR POWER (@1.0 S.F.):	32,184 HP / 24,000 kW	METAL LINER CONDITION:	New
PROCESS POWER:	27,709 HP / 20,663 kW	LINER PROFILE:	Heavy
DRIVE TYPE:	Gearless		GOOD MILL FLOW

MILL LOADING	60.00 % TCS		67.00 % TCS		74.00 % TCS		80.00 % TCS		85.00 % TCS		TOTAL CHARGE	
	7.35 RPM		8.21 RPM		9.07 RPM		9.80 RPM		10.42 RPM			
%	BHP	BkW	BHP	BkW	BHP	BkW	BHP	BkW	BHP	BkW	lb	kg
10%	16,471	12,283	18,393	13,716	20,314	15,149	21,962	16,377	23,334	17,401	989,461	448,817
11%	16,714	12,464	18,664	13,918	20,614	15,372	22,285	16,618	23,678	17,657	1,015,419	460,591
12%	17,143	12,784	19,143	14,275	21,143	15,767	22,857	17,045	24,286	18,110	1,041,377	472,366
13%	17,602	13,126	19,655	14,657	21,709	16,188	23,469	17,501	24,936	18,595	1,067,335	484,140
14%	18,325	13,665	20,463	15,259	22,601	16,854	24,433	18,220	25,960	19,359	1,093,293	495,915
15%	18,828	14,040	21,025	15,678	23,221	17,316	25,104	18,720	26,673	19,891	1,119,251	507,689
16%	19,795	14,761	22,104	16,484	24,414	18,206	26,393	19,682	28,043	20,912	1,145,210	519,464
17%	20,401	15,213	22,781	16,988	25,161	18,763	27,201	20,284	28,901	21,552	1,171,168	531,238
18%	20,538	15,315	22,934	17,102	25,330	18,889	27,384	20,421	29,096	21,697	1,197,126	543,013
19%	20,635	15,388	23,042	17,183	25,450	18,978	27,513	20,517	29,233	21,799	1,223,084	554,787
20% *	20,723	15,454	23,141	17,257	25,559	19,059	27,631	20,605	29,358	21,893	1,249,042	566,562
21%	20,921	15,601	23,361	17,421	25,802	19,241	27,894	20,801	29,637	22,101	1,275,000	578,336
22%	21,073	15,715	23,532	17,548	25,991	19,381	28,098	20,953	29,854	22,263	1,300,958	590,111
23%	21,184	15,797	23,656	17,640	26,127	19,483	28,246	21,063	30,011	22,380	1,326,916	601,885
24%	21,227	15,830	23,704	17,676	26,180	19,523	28,303	21,106	30,072	22,425	1,352,874	613,660
25%	21,287	15,874	23,770	17,726	26,254	19,578	28,382	21,165	30,156	22,488	1,378,832	625,434
26%	21,347	15,919	23,838	17,776	26,329	19,634	28,463	21,225	30,242	22,552	1,404,790	637,209
27%	21,421	15,974	23,921	17,838	26,420	19,702	28,562	21,299	30,347	22,630	1,430,748	648,983
28%	21,455	15,999	23,958	17,866	26,461	19,732	28,606	21,332	30,394	22,665	1,456,707	660,758
29%	21,478	16,016	23,983	17,885	26,489	19,753	28,637	21,355	30,427	22,690	1,482,665	672,532
30%	21,504	16,036	24,013	17,907	26,522	19,778	28,672	21,381	30,464	22,718	1,508,623	684,307
31%	21,532	16,056	24,044	17,930	26,556	19,803	28,709	21,409	30,503	22,747	1,534,581	696,081
32%	21,562	16,079	24,077	17,955	26,593	19,831	28,749	21,439	30,546	22,779	1,560,539	707,856
33%	21,554	16,073	24,069	17,948	26,583	19,824	28,739	21,431	30,535	22,770	1,586,497	719,630
34%	21,509	16,040	24,018	17,911	26,528	19,782	28,679	21,386	30,471	22,723	1,612,455	731,405
35%	21,474	16,014	23,979	17,882	26,485	19,750	28,632	21,351	30,422	22,686	1,638,413	743,179

* Nominal Expected Operating Condition

NOTES: 1. Values good up to maximum 15% ball charge
2. Operation above 78% TCS may cause erratic performance

Fig.5.6.- Prueba de Potencia Molino SAG – Carga de Bolas al 10%

Fuente: Reporte de Pruebas FLSmidth

Los resultados de la prueba a mínima carga del Lazo de Control Vendor – Molino SAG se muestran en la Fig.5.7. En las gráficas muestran como el controlador Vendor responde ante la disminución de carga dentro del molino, reduciendo la potencia con el fin de generar la misma fuerza centrífuga dentro del molino y mantener el efecto cascada dentro del mismo.

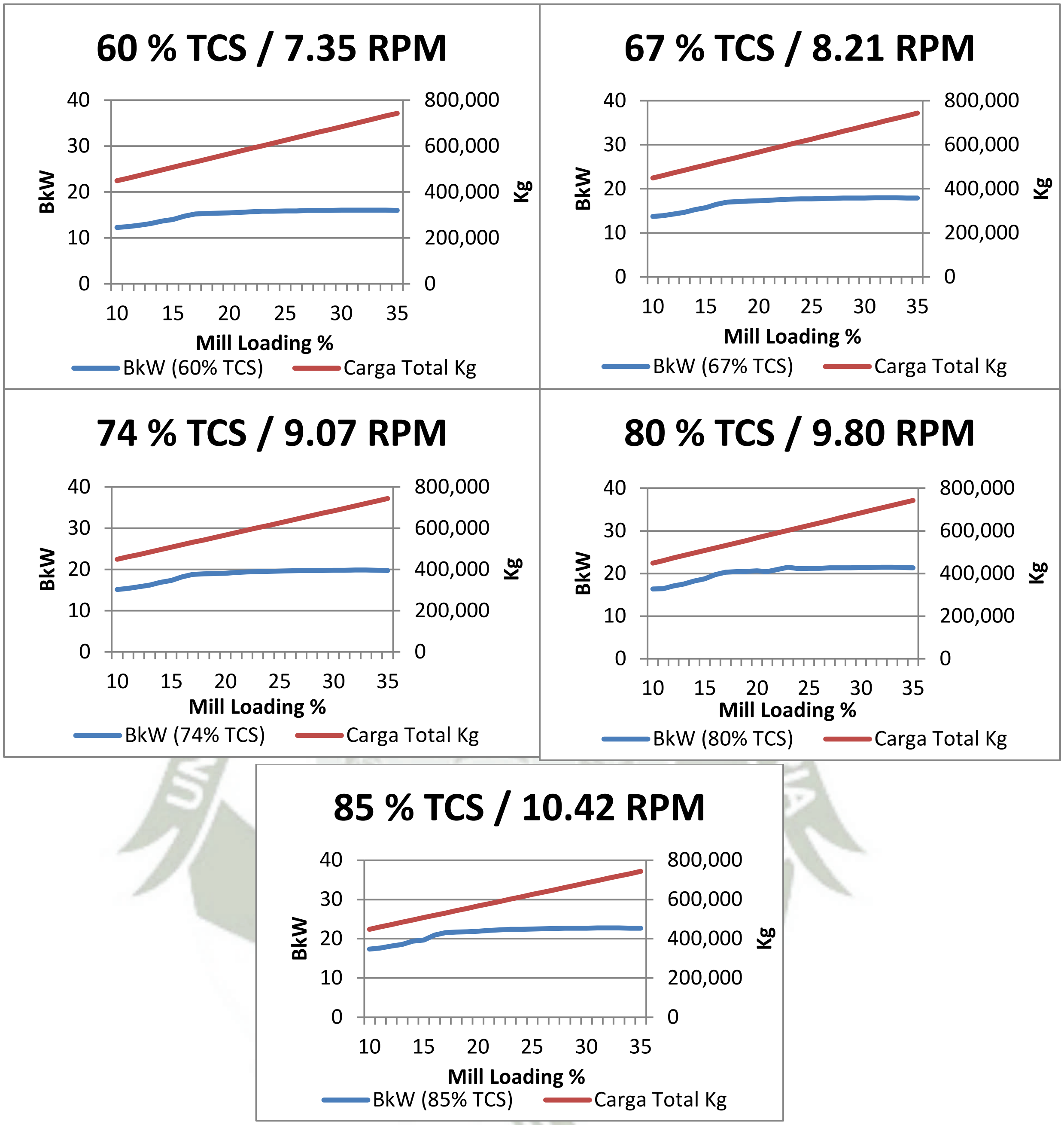


Fig.5.7.- Prueba de Potencia vs. Carga Molino SAG (mínima)

Fuente: Reporte de Pruebas Pre Comisionado

Respuesta al 16% de Carga de Bolas

Se ajustó el controlador al 16% (máximo) de Carga de Bolas, equivale a 718,107 Kg de carga ingresante al molino SAG. En la Fig.5.8 se observa la variación de la potencia con respecto al porcentaje carga.

FLSMIDTH MINERALS

WET SAG/BALL MILL CIRCUIT

SAG MILL POWER

CUSTOMER:	BECHTEL c/o XSTRATA		
PROJECT:	STANDARD CONCENTRATOR (ANTAPACCAY)		
PROPOSAL NO:	08-91010-726		
MILL SIZE:	40'-0" × 25'-0" SAG Mill		
MILL DIAMETER:	40.00 ft	39.10 ft (eff)	11.92 m (eff)
MILL LENGTH:	25.00 ft	22.00 ft (eff)	6.71 m (eff)
TRUNNION I.D.:	10.0 ft		3.05 m
D:L RATIO:	1.777		
MOTOR POWER (@1.0 S.F.):	32,184 HP		24,000 kW
PROCESS POWER:	27,709 HP		20,663 kW
DRIVE TYPE:	Gearless		

MILL VOLUME			
SHELL:		26,415.94 ft³	748.04 m³
HEADS:	(15.0°)	4,122.98 ft³	116.75 m³
TOTAL:		30,538.92 ft³	864.80 m³
WET/DRY GRINDING:	WET		
MILL DISCHARGE:	GRATE		
MEDIA MATERIAL:	Forged		
BALL CHARGE:	16.0%		
METAL LINER CONDITION:	New		
LINER PROFILE:	Heavy		

GOOD MILL FLOW

MILL LOADING	60.00 % TCS 7.35 RPM		67.00 % TCS 8.21 RPM		74.00 % TCS 9.07 RPM		80.00 % TCS 9.80 RPM		85.00 % TCS 10.42 RPM		TOTAL CHARGE	
%	BHP	BkW	BHP	BkW	BHP	BkW	BHP	BkW	BHP	BkW	lb	kg
10%	0	0	0	0	0	0	0	0	0	0	1,427,389	647,459
11%	0	0	0	0	0	0	0	0	0	0	1,453,347	659,234
12%	0	0	0	0	0	0	0	0	0	0	1,479,305	671,009
13%	0	0	0	0	0	0	0	0	0	0	1,505,263	682,783
14%	0	0	0	0	0	0	0	0	0	0	1,531,222	694,558
15%	0	0	0	0	0	0	0	0	0	0	1,557,180	706,332
16%	23,249	17,337	25,961	19,360	28,674	21,382	30,998	23,116	32,936	24,561	1,583,138	718,107
17%	23,618	17,612	26,373	19,667	29,128	21,721	31,490	23,483	33,458	24,950	1,609,096	729,881
18%	24,076	17,954	26,885	20,049	29,694	22,143	32,102	23,939	34,108	25,435	1,635,054	741,656
19%	24,546	18,304	27,409	20,439	30,273	22,575	32,727	24,405	34,773	25,931	1,661,012	753,430
20%	25,060	18,687	27,983	20,867	30,907	23,048	33,413	24,916	35,501	26,474	1,686,970	765,205
21%	27,630	20,604	30,854	23,008	34,077	25,412	36,840	27,472	39,143	29,189	1,712,928	776,979
22%	27,686	20,646	30,916	23,054	34,146	25,463	36,914	27,527	39,221	29,248	1,738,886	788,754
23%	27,690	20,649	30,921	23,058	34,151	25,467	36,920	27,532	39,228	29,253	1,764,844	800,528
24%	27,611	20,590	30,833	22,992	34,054	25,394	36,815	27,453	39,116	29,169	1,790,802	812,303
25%	27,558	20,550	30,773	22,948	33,988	25,346	36,744	27,401	39,041	29,113	1,816,760	824,077
26%	27,511	20,515	30,721	22,909	33,930	25,302	36,682	27,354	38,974	29,064	1,842,719	835,852
27%	27,485	20,496	30,692	22,887	33,899	25,279	36,647	27,328	38,938	29,036	1,868,677	847,626
28%	27,412	20,441	30,610	22,826	33,808	25,211	36,549	27,255	38,833	28,959	1,894,635	859,401
29%	27,329	20,379	30,517	22,757	33,706	25,135	36,438	27,173	38,716	28,871	1,920,593	871,175
30%	27,254	20,324	30,434	22,695	33,614	25,066	36,339	27,098	38,610	28,792	1,946,551	882,950
31%	27,185	20,272	30,356	22,637	33,528	25,002	36,246	27,029	38,511	28,718	1,972,509	894,724
32%	27,122	20,225	30,286	22,585	33,450	24,944	36,162	26,967	38,423	28,652	1,998,467	906,499
33%	27,015	20,145	30,166	22,495	33,318	24,846	36,020	26,860	38,271	28,539	2,024,425	918,273
34%	26,865	20,033	29,999	22,370	33,133	24,708	35,819	26,711	38,058	28,380	2,050,383	930,048
35%	26,730	19,933	29,849	22,259	32,968	24,584	35,641	26,578	37,868	28,239	2,076,341	941,822

* Nominal Expected Operating Condition

NOTES: 1. Values good up to maximum 15% ball charge
2. Operation above 78% TCS may cause erratic performance

Fig.5.8.- Prueba de Potencia Molino SAG – Carga de Bolas al 16%
Fuente: Reporte de Pruebas FLSmidth

Los resultados de la prueba a mínima carga del Lazo de Control Vendor – Molino SAG se muestran en la Fig.5.9. En las gráficas muestran como el controlador Vendor responde ante el aumento de carga dentro del molino, aumentando la potencia con el fin de generar la misma fuerza centrífuga dentro del molino y mantener el efecto cascada dentro del mismo.

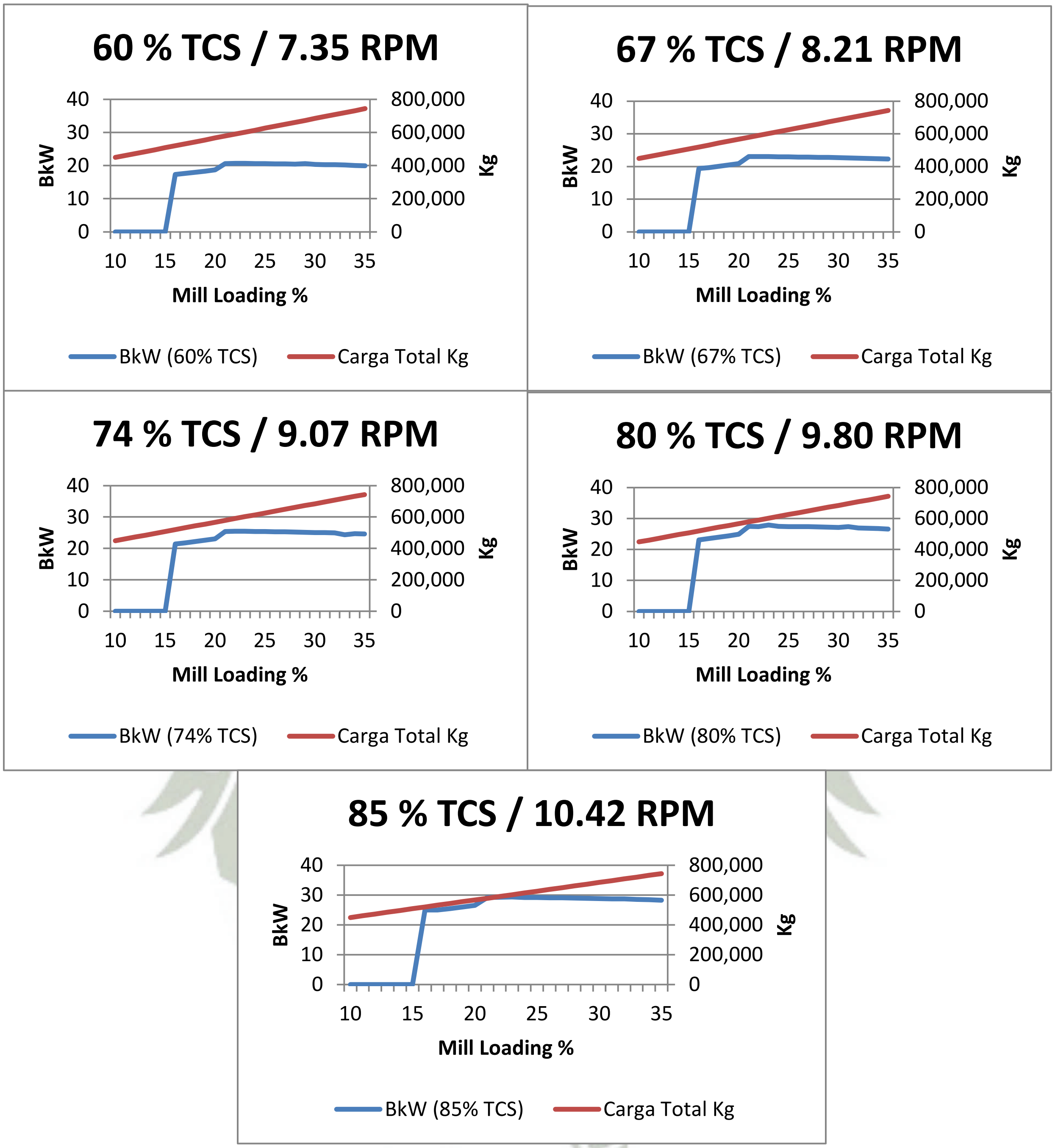


Fig.5.9.- Prueba de Potencia vs. Carga Molino SAG (máxima)

Fuente: Reporte de Pruebas Pre Comisionado

Prueba Volumen de Carga Molino SAG

La prueba de volumen de carga del Molino SAG, se realizó al 25% de su carga total, con carga de bolas al 12% y operando a una potencia de 20,663 KW.

Los parámetros PID obtenidos luego de la sintonización se observan la Tabla 4.31. Estos parámetros fueron obtenidos por medio del método de ajuste sistemático (Prueba y error).

FLSmidth MINERALS

WET SAG/BALL MILL CIRCUIT

SAG MILL VOLUME LOADING

CUSTOMER:	XSTRATA c/o BECHTEL		
PROJECT:	STANDARD CONCENTRATOR		
PROPOSAL NO:	08-91010-726		
MILL SIZE:	(1) 40'-0" x 25'-0" SAG Mill		
EFFECTIVE DIAMETER:	39.1 ft	11.92 m	
EFFECTIVE LENGTH:	22.0 ft	6.71 m	
TRUNNION I.D.:	10.0 ft	3.05 m	
TOTAL VOLUME:	30,539 ft³	864.80 m³	
BALL CHARGE:		12.00%	
TOTAL CHARGE:		25.00%	

NEW FEED (per mill):		6,266 WMTPH
PEBBLE RECIRCULATION		20.0%
TOTAL FEED (per mill):		7,166 WMTPH
SOLIDS:		70.0%
ORE SPECIFIC GRAVITY:		2.80
SLURRY BULK DENSITY	81 lb/ft³	1.29 T/m³
BALL BULK DENSITY	290 lb/ft³	4.65 T/m³
FLOW EFFECTS:		POSITIVE
GRATE OPEN AREA:	92.93 ft²	8.63 m²

MILL VOLUME			DISTANCE CENTERLINE-TO-CHARGE		BALL CHARGE			SLURRY					TOTAL WEIGHT	
					FILL	BALL WEIGHT		FILL	SLURRY WEIGHT		VOID WEIGHT			
%	ft³	m³	in	mm	%	lb	kg	%	lb	kg	lb	kg	lb	kg
0%	0.00	0.00			0%	0	0	35%	862,792	391,360	0	0	862,792	391,360
1%	305.39	8.65	233.19	5,923.1	1%	88,563	40,172	34%	838,141	380,178	9,860	4,473	936,565	424,823
2%	610.78	17.30	210.01	5,334.4	2%	177,126	80,344	33%	813,490	368,997	19,721	8,945	1,010,337	458,286
3%	916.17	25.94	202.32	5,138.9	3%	265,689	120,516	32%	788,839	357,815	29,581	13,418	1,084,109	491,749
4%	1,221.56	34.59	195.33	4,961.3	4%	354,251	160,687	31%	764,188	346,633	39,442	17,891	1,157,881	525,211
5%	1,526.95	43.24	188.85	4,796.9	5%	442,814	200,859	30%	739,536	335,452	49,302	22,363	1,231,653	558,674
6%	1,832.34	51.89	182.99	4,647.9	6%	531,377	241,031	29%	714,885	324,270	59,163	26,836	1,305,425	592,137
7%	2,137.72	60.54	177.36	4,504.9	7%	619,940	281,203	28%	690,234	313,088	69,023	31,309	1,379,197	625,600
8%	2,443.11	69.18	171.73	4,361.9	8%	708,503	321,375	27%	665,583	301,906	78,884	35,781	1,452,970	659,063
9%	2,748.50	77.83	166.57	4,230.8	9%	797,066	361,547	26%	640,932	290,725	88,744	40,254	1,526,742	692,526
10%	3,053.89	86.48	161.40	4,099.7	10%	885,629	401,719	25%	616,280	279,543	98,605	44,727	1,600,514	725,988
11%	3,359.28	95.13	156.24	3,968.6	11%	974,192	441,890	24%	591,629	268,361	108,465	49,200	1,674,286	759,451
12%	3,664.67	103.78	151.55	3,849.4	12%	1,062,754	482,062	23%	566,978	257,179	118,326	53,672	1,748,058	792,914
13%	3,970.06	112.42	146.39	3,718.3	13%	1,151,317	522,234	22%	542,327	245,998	128,186	58,145	1,821,830	826,377
14%	4,275.45	121.07	141.70	3,599.1	14%	1,239,880	562,406	21%	517,675	234,816	138,047	62,618	1,895,602	859,840
15%	4,580.84	129.72	137.01	3,480.0	15%	1,328,443	602,578	20%	493,024	223,634	147,907	67,090	1,969,375	893,302
16%	4,886.23	138.37	132.78	3,372.7	15%	1,328,443	602,578	21%	517,675	234,816	147,907	67,090	1,994,026	904,484
17%	5,191.62	147.02	128.56	3,265.4	15%	1,328,443	602,578	22%	542,327	245,998	147,907	67,090	2,018,677	915,666
18%	5,497.01	155.66	123.87	3,146.3	15%	1,328,443	602,578	23%	566,978	257,179	147,907	67,090	2,043,328	926,848
19%	5,802.40	164.31	119.65	3,039.0	15%	1,328,443	602,578	24%	591,629	268,361	147,907	67,090	2,067,979	938,029
20%	6,107.78	172.96	115.42	2,931.7	15%	1,328,443	602,578	25%	616,280	279,543	147,907	67,090	2,092,631	949,211
21%	6,413.17	181.61	110.73	2,812.6	15%	1,328,443	602,578	26%	640,932	290,725	147,907	67,090	2,117,282	960,393
22%	6,718.56	190.26	106.98	2,717.2	15%	1,328,443	602,578	27%	665,583	301,906	147,907	67,090	2,141,933	971,574
23%	7,023.95	198.90	102.75	2,610.0	15%	1,328,443	602,578	28%	690,234	313,088	147,907	67,090	2,166,584	982,756
24%	7,329.34	207.55	100.88	2,562.3	15%	1,328,443	602,578	29%	714,885	324,270	147,907	67,090	2,191,236	993,938
25%	7,634.73	216.20	94.78	2,407.4	15%	1,328,443	602,578	30%	739,536	335,452	147,907	67,090	2,215,887	1,005,120

Fig.5.10.- Prueba de Volumen de Carga Molino SAG

Fuente: Reporte de Pruebas FLSmidth

Los resultados de la prueba del lazo del controlador Vendor se muestran en la gráfica Fig.5.11.

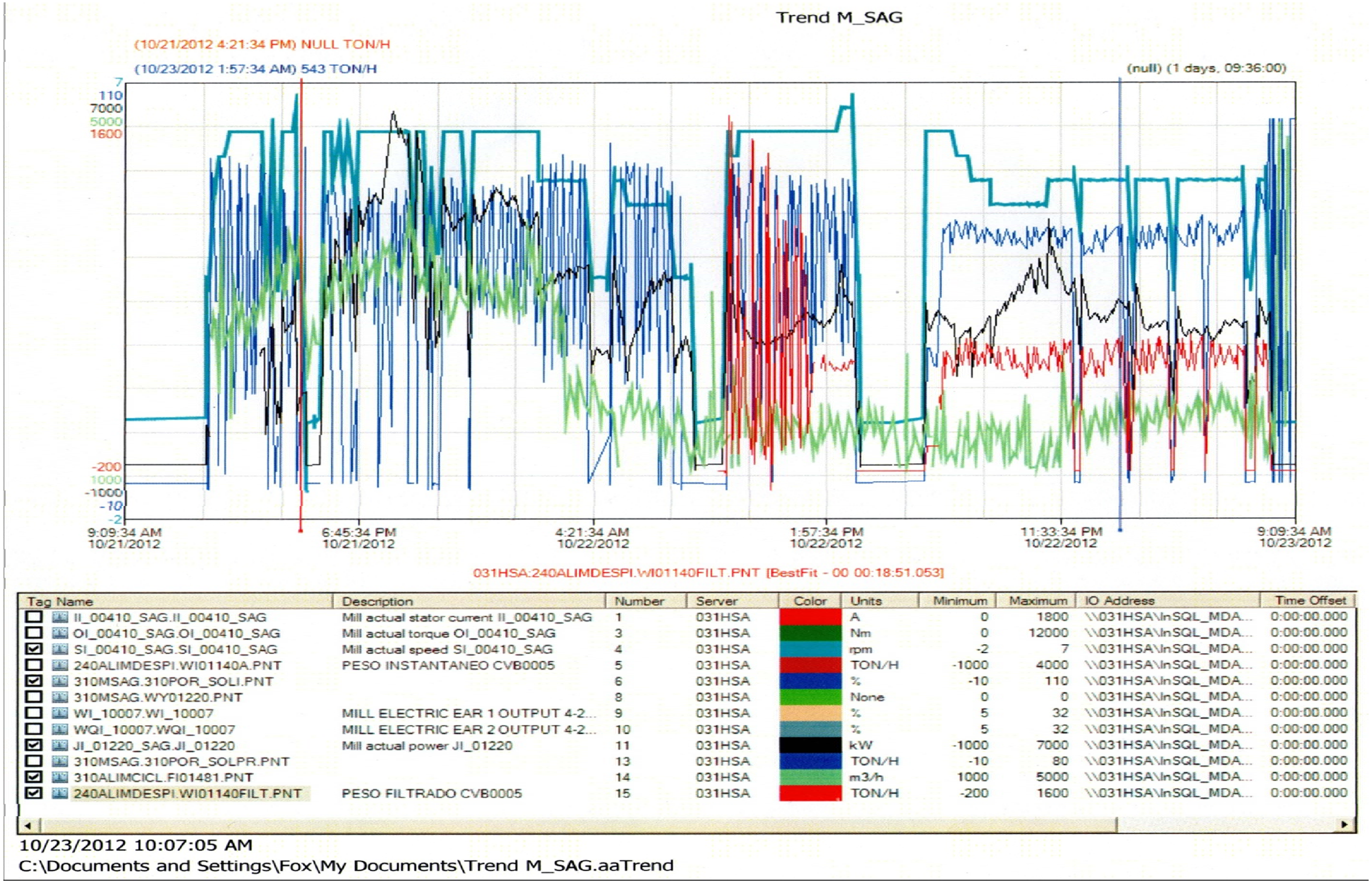


Fig.5.11.- Tendencias de Volumen Molino SAG

Fuente: Reporte de Pruebas Pre Comisionado

CONCLUSIONES

Primera: Se realizó una filosofía de control, de acuerdo con los requerimientos del Cliente Xstrata Cooper y diseñar las estrategias de control para el proceso de molienda SAG.

Segunda: Se implementó el Arquitectura de control de Invensys permite la inclusión de varios subsistemas como Allen Bradley, Siemens, ABB, utilizando controladores Foxboro permite el manejo de protocolos de comunicación como Foundation Fieldbus, Profibus, DeviceNet, HART, Ethernet y 4 – 20mA.

Tercera: Se realizó el controlar el flujo de carga de los Alimentadores de Acopio (Apron Feeders) hacia la Faja de Alimentación del Molino SAG implementando un control PID obteniendo una respuesta adecuada según los parámetros de diseño del proyecto.

Cuarta: Se realizó el controlar el flujo de Agua de Proceso ingresante al Molino SAG implementando un control continuo PI, obteniendo una respuesta adecuada según los parámetros de diseño del proyecto.

Quinta: La ingeniería diseñada para los Alimentadores de Acopio contemplo un cuarto Apron Feeder para utilizar de soporte cuando se realicen mantenimientos en los supresores de polvo.

Sexta: Se realizó el controlar la alimentación de Carga Fresca del Molino SAG implementando un control Continuo PID, obteniendo una respuesta adecuada según los parámetros de diseño del proyecto.

Sétima: Se controló la velocidad del molino según la carga de mineral al molino SAG, se realizó el estudio del movimiento de carga que apunta a examinar los mecanismos de consumo de energía del molino y el aprovechamiento de la energía en el proceso de molienda según las especificaciones del proyecto.

Octava: Las propiedades de la carga consideradas en el proyecto considero que la presencia de tamaños mayores de carga es importante para mantener un volumen de carga interna adecuado al interior del molino, lo que permite operar con velocidades mayores sin arriesgar la integridad de los revestimientos.

Novena: Se estimó el nivel de llenado de carga de mineral del Molino SAG, se realizó una relación entre mediciones puntuales del nivel de llenado volumétrico con el molino detenido y presión de inyección de lubricante en los descansos del molino al momento de detenerlo. Así, al variar la presión en los descansos, se considera que ha ocurrido variaciones en el peso de la carga interna y ello debe reflejar variaciones en el nivel de llenado volumétrico del molino.

Decima: La ingeniería contempla a futuro una faja alimentadora de carga, que estará ubicada en los chute de alimentación de los molinos bolas, con el fin de no disminuir la producción cuando el molino SAG se encuentre en mantenimiento.

RECOMENDACIONES

Primera: Los instrumentos de campo deberían ser calibrados tanto en el laboratorio de pruebas como en el proceso, dado que en las pruebas pre operacionales se encontraron equipos configurados con otras unidades de ingeniería que no correspondía a los especificados en los datasheet aprobados por los supervisores de campo.

Segunda: Durante la pruebas pre operacionales se detectó que el molino giraba con bolas de acero y agua, ocasionado daños a los revestimientos del molino SAG, esto se dio, dado que los operadores registraron una carga normal dentro del molino. Por lo que se sugiere la instalación de impactometros alrededor del molino con el fin de detectar y diferenciar los cambios de carga y su movimiento dentro del molino a través del sonido emitido por carga y por las bolas de acero.

Tercera: Se recomienda limitar el acceso a la pantallas de algunas áreas debido que durante las pruebas pre operacionales se detectaron sabotajes internos con el fin de ganar tiempo en trabajos de constructivos.

Cuarta: Crear tres tipos de acceso a los operadores: acceso de monitoreo de señales, acceso de modificación de parámetros y acceso de modificación de lógica de control. Crear usuarios y contraseñas personales detallando nombre y apellidos.

BIBLIOGRAFIA

- FLSmidth. Installation, Operation and Maintenance Manual, 2011, 3034 pp.
- FLSmidth. Automatización Soluciones, 2011, 11 pp.
- Estándares de Aplicación del Proyecto (PAS) Configuración Base de Datos, Invensys, 2011.
- Capacitación Operaciones Xstrata – Proyecto Antapaccay, 2012.
- Instrumentación Básica de Procesos Industriales, 2007, 722 pp.
- Creus, Antonio. Instrumentación Industrial, 1998, 199 pp.
- More, Hawke. Introduction to Fieldbus, 2006, 8 pp.
- Bautista, Juan. Líneas de Transmisión de Potencia, 2001, 252 pp.
- Metso, Guía de Instalación, Operación y Mantenimiento, 2010, 2530 pp.
- Ogata, Katsuhiko. Ingeniería de Control Moderna, 1993, 1020pp.
- Instrument Society of America. Instrumentation Symbols and Identification, American National Standard, 1984, 64 pp
- Kuo, Benjamín. Sistemas de Control Automático, 1996, 1340pp.
- Mantenimiento de Tableros y Equipos Eléctrico de Mando, 2005, 23 pp.
- Robb, Luis. Diccionario para Ingenieros, 1997, 340 pp.
- SAMSON. Technical Information, Foundation Fieldbus, 2008, 44 pp.
- Siemens. Logical Control – SAG Mill, 2011, 4030 pp.
- www.flsmidth.com
- www.emerson.com
- www.siemens.com
- www.metso.com

Constancia de Participación

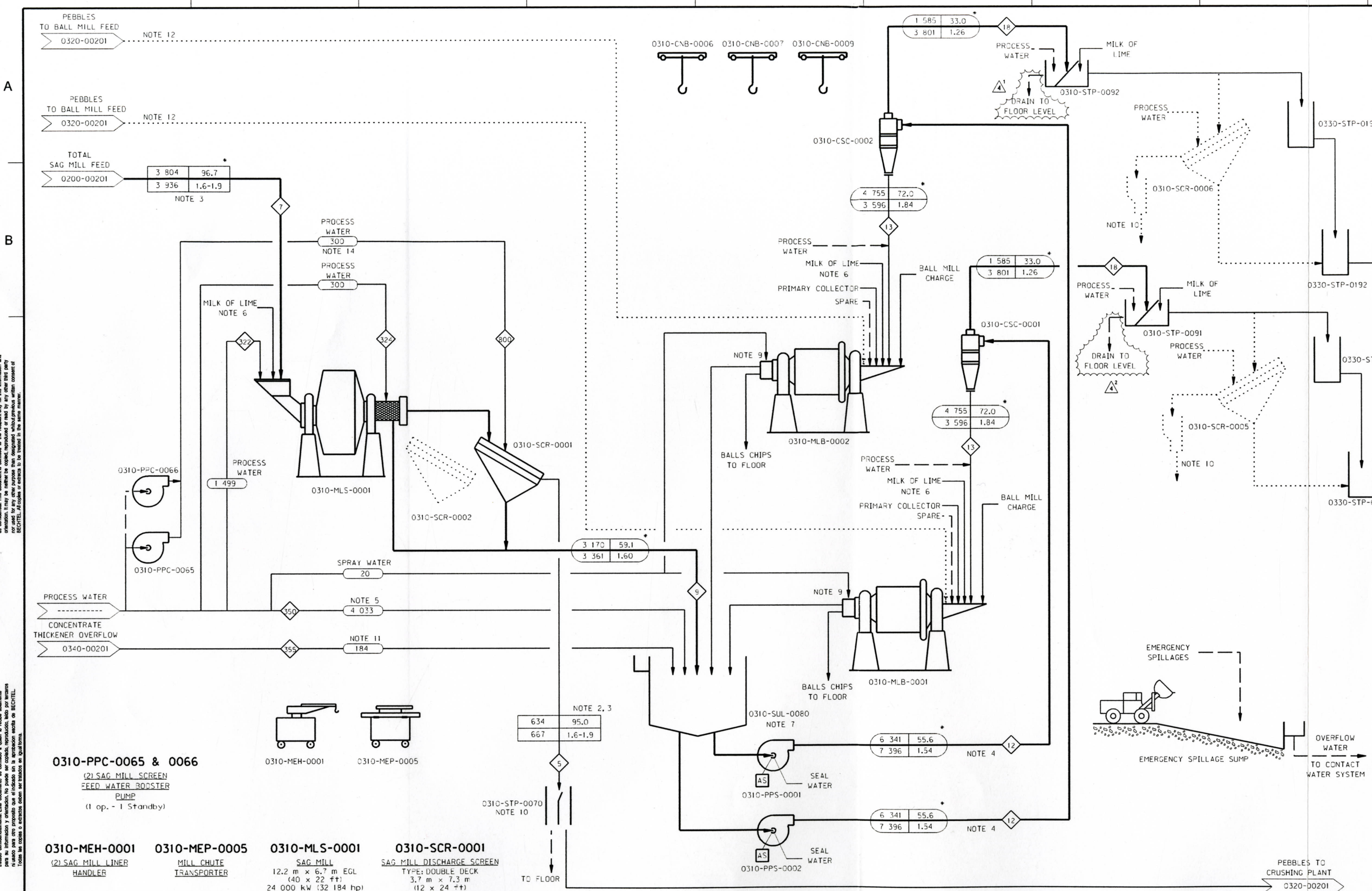
El Ing. Claudio Miranda Badilla identificado con RUN 13549812-2 quien desempeña el cargo de Líder de Área de Sistema de Control y Automatización en el Proyecto Antapaccay Expansión Tintaya.

Certifica

Que el Sr. Rene Roque Salas identificado con DNI 43872729, es su labor de Ingeniero DCS ha participado en la puesta en la ejecución y puesta en marcha del Proyecto Antapaccay, encargándose de la revisión y modificación de la lógica de control, supervisión en configuración de señales de control, revisión de conexionados de fibra óptica, supervisión del sistema SCADA, modificación de parámetros en instrumentación de campo, supervisión en pruebas en vacio, agua y carga.

Cuzco – Espinar 19 de Noviembre del 2012

Claudio Miranda Babilla
13549812-2
Ing. DCS Pre - Operaciones



NOTES:

1. BALANCE FLOWS ARE FOR A NEW FEED RATE OF 70 000 TONS PER 24 h/d WITH AN AVAILABILITY FACTOR OF 92 %.
2. MASS BALANCE REFLECT 20% PEBBLES RECIRCULATING LOAD. EQUIPMENT TO BE DESIGNED FOR 30% CIRCULATING LOAD.
3. MASS BALANCE BASED ON PEBBLE CRUSHER PRODUCT BEING RETURNED TO SAG MILL FEED.
4. FLOW AND DENSITY MEASUREMENT REQUIRED (FE & DE).
5. DESIGN FLOWS FOR LINES MARKED * ARE 1.15 X BALANCE FLOW.
6. LIME SUPPLY ASSUMED TO BE IN SLURRY FORM.
7. CYCLONE FEED SUMP DESIGN ACCORDING TO STUDY NO. 25422-220-3TS-M69-00002, REV 0.
8. FLOWSHEET BASED ON XSTRATA ANTAPACCAY COPPER FLOWSHEETS BY PROMET 101, DRAWING NO. 310-F-001, REV E3.
9. MAGNETIC TROMMEL.
10. TRAMP MATERIAL O/S TO BE DIRECTED TO BUND AREA AT FLOOR LEVEL.
11. DESIGN FLOW IS 2.0 x BALANCE FLOW.
12. PEBBLE RETURN SYSTEM TO BALL MILLS WILL BE FUTURE, PROVISIONS ON LAYOUT FOR FUTURE INSTALLATION.
13. MANIFOLD HAS FOURTEEN OUTPUTS FOR 10 CYCLONES OPERATING AND TWO STANDBY.
14. DESIGN FLOW IS 820 m3/h, ACCORDING TO VENDOR INFORMATION.

0310-PPC-0065 & 0066
(2) SAG MILL SCREEN FEED WATER BOOSTER PUMP
(1 op. - 1 Standby)

0310-MEH-0001
(2) SAG MILL LINER HANDLER

0310-MEP-0005
MILL CHUTE TRANSPORTER

0310-MLS-0001
SAG MILL
12.2 m x 6.7 m EGL
(40 x 22 ft)
24 000 kW (32 184 hp)

0310-SCR-0001
SAG MILL DISCHARGE SCREEN
TYPE: DOUBLE DECK
3.7 m x 7.3 m
(12 x 24 ft)

0310-SCR-0002
SAG MILL DISCHARGE SCREEN
TYPE: DOUBLE DECK
3.7 m x 7.3 m
(12 x 24 ft)
(FUTURE)

0310-STP-0070
PEBBLES OVERSIZE CHUTE

0310-SUL-0080
GRINDING CYCLONE FEED SUMP

0310-PPS-0001 & 0002
(2) GRINDING CYCLONE FEED PUMP

0310-CSC-0001 & 0002
(2) BALL MILL CYCLONE CLUSTER
838 mm DIA. (33 Inches)
12 cyclones per cluster
(10 op. - 2 Standby)
NOTE 13

0310-MLB-0001 & 0002
(2) BALL MILL
7.9 m x 12.2 m EGL
(26 x 40 ft)
16 400 kW (22 000 hp)

0310-SCR-0005 & 0006
(2) SCALPING SCREEN
(FUTURE)

0310-CNB-0006
SAG MILL BRIDGE CRANE

0310-CNB-0007
BALL MILL BRIDGE CRANE

0310-CNB-0009
GRINDING CYCLONE BRIDGE CRANE

0310-STP-0091 & 0092
CYCLONE OVERFLOW TRANSFER BOX

0330-STP-0189 THRU 0192
(4) ENERGY DISPERSER BOX

Rev. N°	FECHA	REVISION	POR	CHEQ.	SUPV.	ING. PROY.	CLIENTE
4	02-JUN-11	REVISED AS NOTED	JAS	PRM	PRM	AVP	
3	01-FEB-11	REVISED AS NOTED	JAS	PRM	PRM	AVP	
2	21-OCT-10	REVISED AS NOTED	GPA	PRM	PRM	AVP	
1	20-MAY-10	REVISED AS NOTED	GPA	MT	PRM	AV	
0	05-APR-10	ISSUED FOR CONSTRUCTION	GPA	MT	PRM	AV	
B	15-JAN-10	ISSUED FOR APPROVAL	PRM	MLC	MLC	CZ	
A	01-DEC-09	ISSUED FOR COORDINATION	PRM	MLC	MLC	CZ	

PLANOS REFERENCIA | NUMERO | NOTAS

Bechtel Chile Ltda.

CLIENTE	APROBACION	FECHA
XSTRATA		
ING. PROYECTO.		
GTE. INGENIERIA		

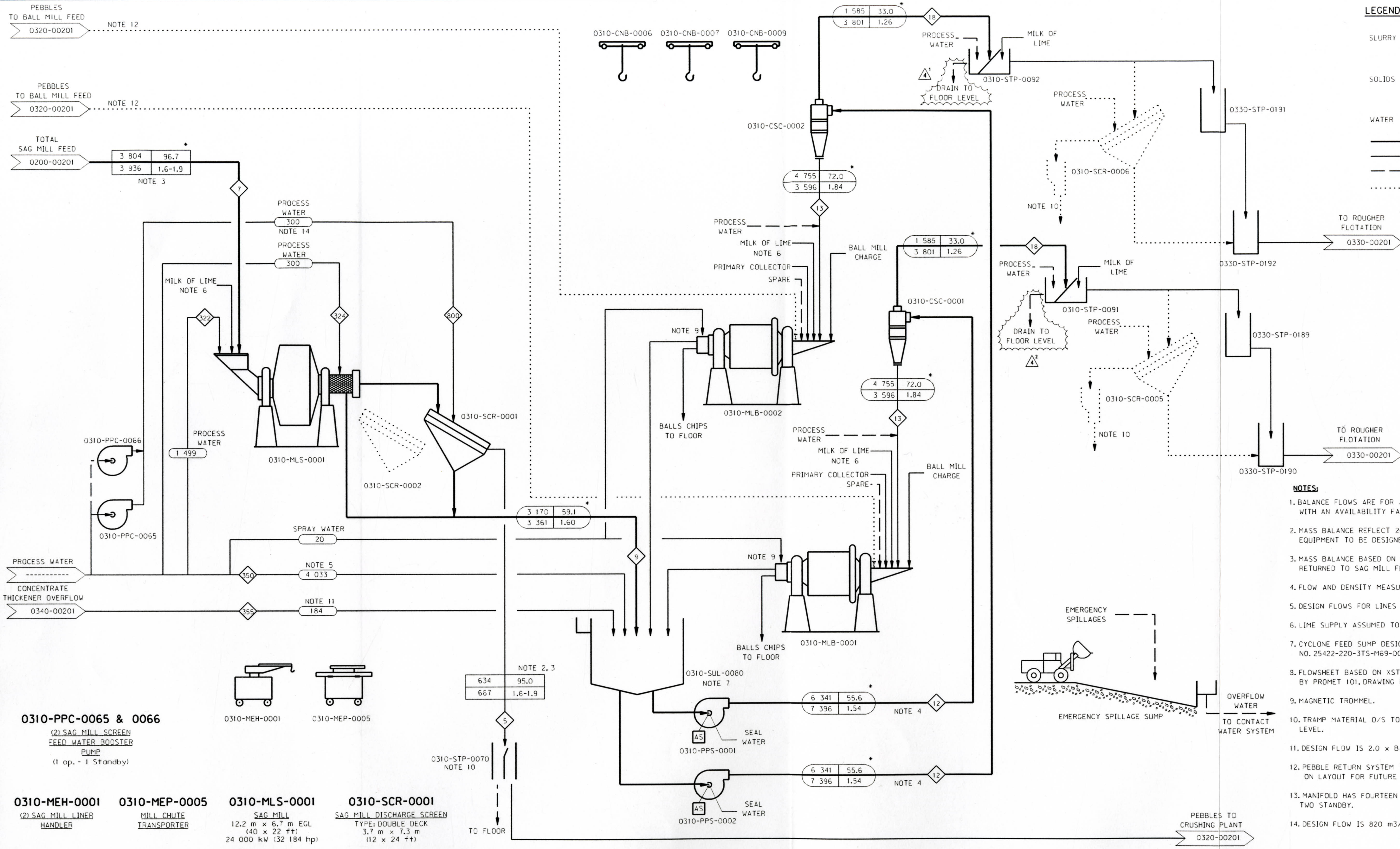
BECHTEL CHILE		FECHA
ESCALA: S/E		
DISEÑO POR	G. PARDO / C. LOPEZ	05-APR-10
CHEQUEO POR	P. MARDONES	05-APR-10
ING. PROYECTO	ALEJANDRO VERDUGO	05-APR-10
GTE. INGENIERIA	CLAUDIO ZAMORANO	05-APR-10

SIGNED

Job No. 25560 | PLANO BECHTEL N° 25580-220-M5-0310-00201

PROYECTO ANTAPACCAY - EXPANSION TINTAYA
XSTRATA BECHTEL ALLIANCE
XSTRATA COPPER FLOWSHEET
GRINDING
PROCESS FLOW DIAGRAM

PLANO CLIENTE N° | REV. 4



LEGEND:

SLURRY	SOLIDS / PULP	t/h / m3/h	%SOLIDS / SP. GR	BALANCE
SOLIDS	SOLIDS, DRY / SOLIDS, WET	t/h / t/h	%SOLIDS / t/m3	BALANCE
WATER		m3/h		BALANCE

PRIMARY FLOW
SECONDARY FLOW
ALTERNATE FLOW
FUTURE
STREAM NUMBER

NOTES:

1. BALANCE FLOWS ARE FOR A NEW FEED RATE OF 70 000 TONS PER 24 h/d WITH AN AVAILABILITY FACTOR OF 92 %.
2. MASS BALANCE REFLECT 20% PEBBLES RECIRCULATING LOAD. EQUIPMENT TO BE DESIGNED FOR 30% CIRCULATING LOAD.
3. MASS BALANCE BASED ON PEBBLE CRUSHER PRODUCT BEING RETURNED TO SAG MILL FEED.
4. FLOW AND DENSITY MEASUREMENT REQUIRED (FE & DE).
5. DESIGN FLOWS FOR LINES MARKED * ARE 1.15 X BALANCE FLOW.
6. LIME SUPPLY ASSUMED TO BE IN SLURRY FORM.
7. CYCLONE FEED SUMP DESIGN ACCORDING TO STUDY NO. 25422-220-3TS-M69-00002, REV 0.
8. FLOWSHEET BASED ON XSTRATA ANTAPACCAY COPPER FLOWSHEETS BY PROMET 101, DRAWING NO. 310-F-001, REV E3.
9. MAGNETIC TROMMEL.
10. TRAMP MATERIAL O/S TO BE DIRECTED TO BUND AREA AT FLOOR LEVEL.
11. DESIGN FLOW IS 2.0 x BALANCE FLOW.
12. PEBBLE RETURN SYSTEM TO BALL MILLS WILL BE FUTURE, PROVISIONS ON LAYOUT FOR FUTURE INSTALLATION.
13. MANIFOLD HAS FOURTEEN OUTPUTS FOR 10 CYCLONES OPERATING AND TWO STANDBY.
14. DESIGN FLOW IS 820 m3/h, ACCORDING TO VENDOR INFORMATION.

0310-PPC-0065 & 0066
(2) SAG MILL SCREEN FEED WATER BOOSTER PUMP
(1 op. - 1 Standby)

0310-MEH-0001
(2) SAG MILL LINER HANDLER

0310-MEP-0005
MILL CHUTE TRANSPORTER

0310-MLS-0001
SAG MILL
12.2 m x 6.7 m EGL
(40 x 22 ft)
24 000 kW (32 184 hp)

0310-SCR-0001
SAG MILL DISCHARGE SCREEN
TYPE: DOUBLE DECK
3.7 m x 7.3 m
(12 x 24 ft)

0310-SCR-0002
SAG MILL DISCHARGE SCREEN
TYPE: DOUBLE DECK
3.7 m x 7.3 m
(12 x 24 ft)
(FUTURE)

0310-STP-0070
PEBBLES OVERSIZE CHUTE

0310-SUL-0080
GRINDING CYCLONE FEED SUMP

0310-PPS-0001 & 0002
(2) GRINDING CYCLONE FEED PUMP

0310-CSC-0001 & 0002
(2) BALL MILL CYCLONE CLUSTER
838 mm DIA. (33 Inches)
12 cyclones per cluster
(10 op. - 2 Standby)
NOTE 13

0310-MLB-0001 & 0002
(2) BALL MILL
7.9 m x 12.2 m EGL
(26 x 40 ft)
16 400 kW (22 000 hp)

0310-SCR-0005 & 0006
(2) SCALPING SCREEN
(FUTURE)

0310-CNB-0006
SAG MILL BRIDGE CRANE

0310-CNB-0007
BALL MILL BRIDGE CRANE

0310-CNB-0009
GRINDING CYCLONE BRIDGE CRANE

0310-STP-0091 & 0092
CYCLONE OVERFLOW TRANSFER BOX

0330-STP-0189 THRU 0192
(4) ENERGY DISPERSER BOX

Rev. N°	FECHA	REVISION	POR	CHEQ.	SUPV.	ING. PROY.	CLIENTE
4	02-JUN-11	REVISED AS NOTED	JAS	PRM	PRM	AVP	
3	01-FEB-11	REVISED AS NOTED	JAS	PRM	PRM	AVP	
2	21-OCT-10	REVISED AS NOTED	GPA	PRM	PRM	AVP	
1	20-MAY-10	REVISED AS NOTED	GPA	MT	PRM	AV	
0	05-APR-10	ISSUED FOR CONSTRUCTION	GPA	MT	PRM	AV	
B	15-JAN-10	ISSUED FOR APPROVAL	PRM	MLC	MLC	CZ	
A	01-DEC-09	ISSUED FOR COORDINATION	PRM	MLC	MLC	CZ	

PLANOS REFERENCIA | NUMERO | NOTAS

Bechtel Chile Ltda.

CLIENTE — APROBACION: XSTRATA | ING. PROYECTO. | GTE. INGENIERIA | FECHA

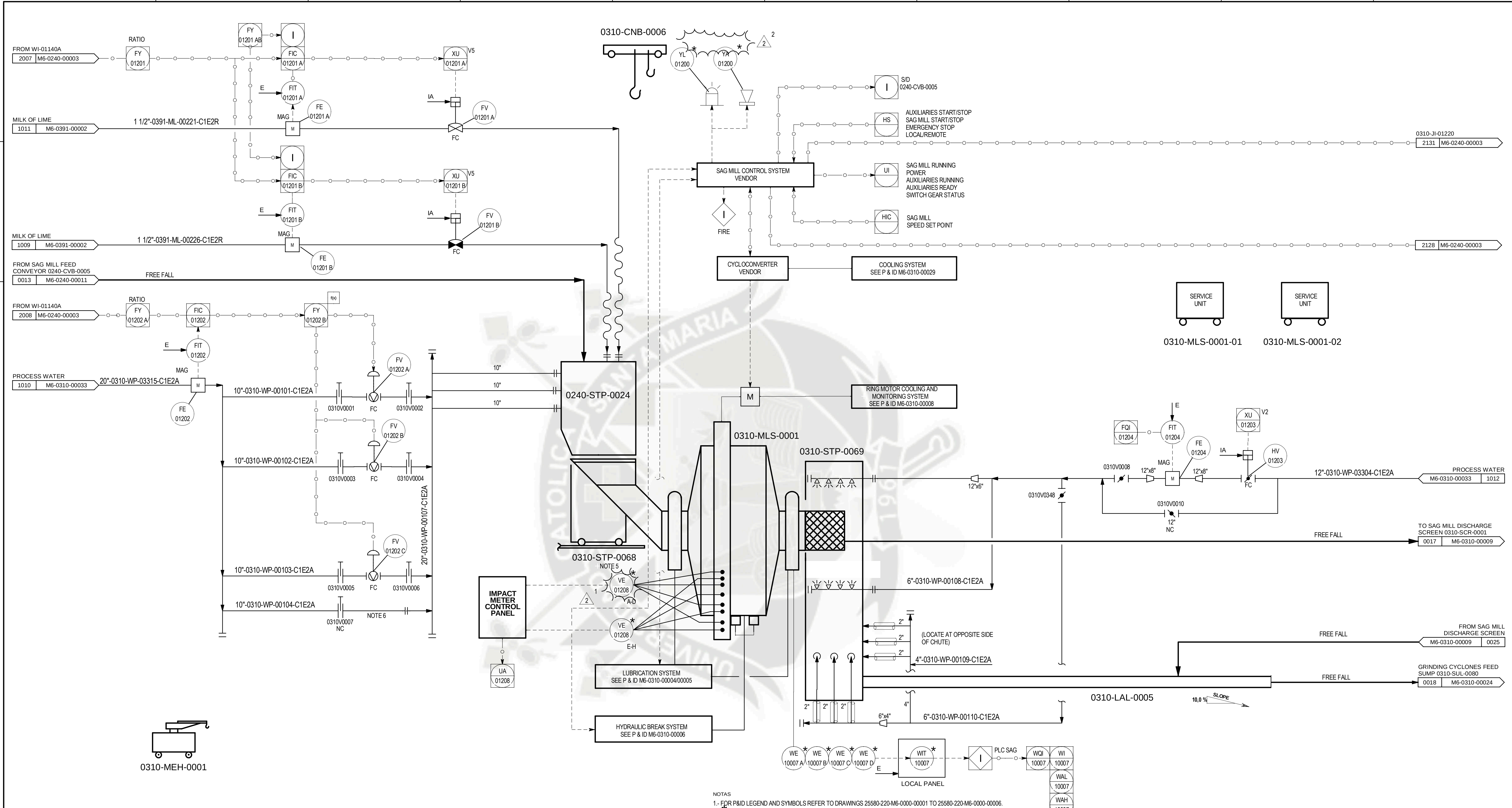
BECHTEL CHILE — ESCALA: S/E

			FECHA
DISEÑO POR	G. PARGA	C. LOPEZ	05-APR-10
CHEQUEO POR	M. ...	P. MARDONES	05-APR-10
ING. PROYECTO	SIGNED	ALEJANDRO VERDUGO	05-APR-10
GTE. INGENIERIA		CLAUDIO ZAMORANO	05-APR-10

Job No. 25580 | PLANO BECHTEL N° 25580-220-M5-0310-00201

PROYECTO ANTAPACCAY - EXPANSION TINTAYA
XSTRATA BECHTEL ALLIANCE
XSTRATA COPPER FLOWSHEET
GRINDING
PROCESS FLOW DIAGRAM

PLANO CLIENTE N° | REV. 4



NOTAS

1.- FOR P&ID LEGEND AND SYMBOLS REFER TO DRAWINGS 25580-220-M6-0000-00001 TO 25580-220-M6-0000-00006.
2.- * INDICATES SUPPLIED WITH VENDOR PACKAGE.
3.- DETAILED INFORMATION ABOUT PCS / PLC SIGNALS ON "INSTRUCCIONES DE OPERACION GEARLESS N° 25580-V1A-EV00-00666 & FUNCTIONAL SPECIFICATION FOR ELECTRICAL CONTROL OF GEARLESS SAG MILL DOC. N° 25580-220-V1A-MFMS-00144.
4.- FUNCTION AY-01201AB COMMAND CONTROL VALVE "A" OR "B" ACCORDING TO THE MILK OF LIME LOOP IN OPERATION.
5.- MOVABLE FEED CHUTE SUPPLIED WITH SAG MILL.
6.- PROVIDE SPACE TO ALLOW FUTURE CONVERSION OF MANUAL VALVE TO REMOTE ACTUATED VALVE WITH IT'S CUT-OFF VALVES.

0310-MEH-0001
SAG MILL LINER HANDLER
for handling 6,000 kg liners
2 x 37 kW

0240-STP-0024
SAG MILL FEED CONVEYOR DISCHARGE CHUTE
carbon steel with abrasion resistant steel liner

0310-STP-0068
SAG MILL FEED CHUTE
carbon steel with abrasion resistant steel liner

0310-CNB-0006
SAG MILL BRIDGE CRANE
115/20 t
110 kW ; 90 kW ; 4x9 kW; 3x5 kW ; 2x2.2 kW

0310-MLS-0001
SAG MILL
40 ft x 22 ft EGL
24 000 kW

0310-STP-0069
SAG MILL TROMMEL DISCHARGE CHUTE
carbon steel with abrasion resistant steel liner

0310-LAL-0005
SAG MILL AND SCREEN UNDERSIZE DISCHARGE LAUNDER
carbon steel with ceramic liner

0310-MLS-0001-01 & 02
BRAKE SERVICE UNIT

Rev. N°	FECHA	REVISION	POR	CHEQ.	SUPV.	ING. PROY.	CLIENTE
2	28 Mar 12	REVISED AS NOTED	PGE	CGB	JCM	AVP	
1	16 Mar 11	REVISED AS NOTED	ABC	GFS	FGR	AVP	
0	25 Ago 10	ISSUED FOR CONSTRUCTION	PGE	MCT	FLC	AVP	
C	31 May 10	REVISED AND REISSUED FOR APPROVAL	PGE	MCT	FLG	AVP	
B	14 Oct 09	ISSUED FOR APPROVAL IN PROJECT 25429	AG	MT	FC	RH	
A	28 Ago 09	ISSUED FOR COORDINATION	AG	MT	FC	RH	

PLANOS REFERENCIA	NUMERO
XSTRATA COPPER FLOWSHEET- PRIMARY GRINDING	M5-0310-00001

Fig.4.3.-P&ID Molino SAG
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

Bechtel Chile Ltda.

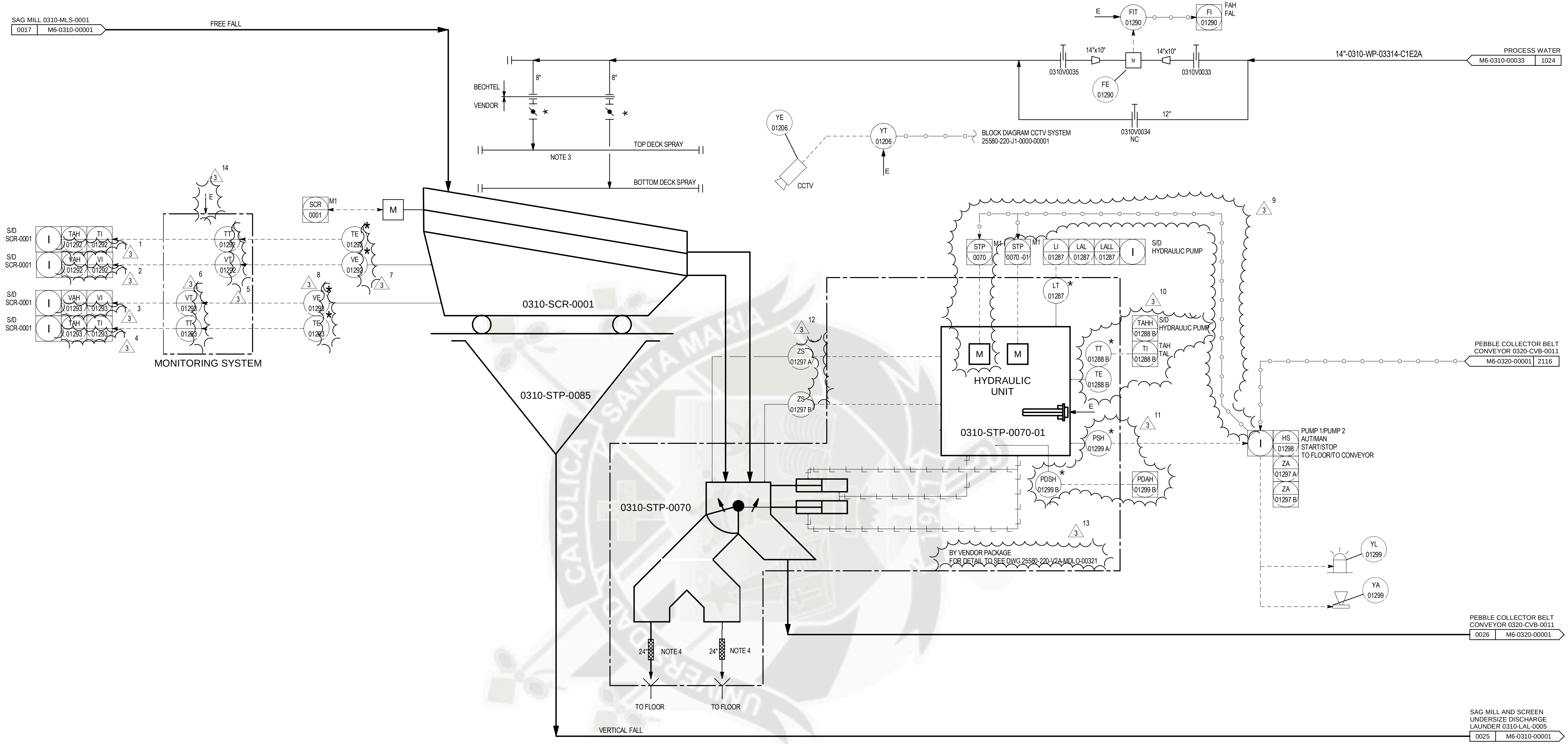
APROBACION — CLIENTE: XSTRATA; ING. PROYECTO.; GTE. INGENIERIA; FECHA
BECHTEL CHILE — ESCALA; DISEÑO POR: M. TANO; DIBUJADO POR: A. GONZALEZ, 9-OCT-09; CHEQUEO POR: M. TANO; A. GONZALEZ, 9-OCT-09; ING. PROYECTO: A. DIGGO, 25-AUG-10; GTE. INGENIERIA: C. ZAMORANO, 25-AUG-10
SIGNED

Job No. 25580 — PLANO BECHTEL N° 25580-220-M6-0310-00001

PROYECTO ANTAPACCAY - EXPANSION TINTAYA
XSTRATA BECHTEL ALLIANCE

GRINDING
SAG MILL
P & ID

PLANO CLIENTE N° — REV. 2



NOTAS

1.- FOR P&ID LEGEND AND SYMBOLS REFER TO DRAWINGS 25580-220-M6-0000-00001 TO 25580-220-M6-0000-00006.

2.- * INDICATES SUPPLIED WITH VENDOR PACKAGE.

3.- SEE VENDOR DRAWING 2654-405318/2A (VP 25580-220-V1A-MFSS-00004) FOR DETAILS OF SPRAY BARS.

4.- HOSES INCLUDED IN THE SUPPLY OF CHUTE.

0310-SCR-0001
SAG MILL DISCHARGE SCREEN
3.7m x 7.3m Cap. 1 619 t/h
double deck vibration screen type
75 kW

0310-STP-0070
SCREEN OVERSIZE DISCHARGE CHUTE
Carbon steel, rubber lined.

0310-STP-0070-01
GATE HYDRAULIC UNIT FOR SCREEN OVERSIZE DISCHARGE CHUTE
1.5 kW

0310-STP-0085
SAG MILL SCREEN UNDERSIZE DISCHARGE CHUTE
Carbon steel, rubber lined

Rev. N°	FECHA	REVISION	POR	CHEQ.	SUPV.	ING. PROY.	CLIENTE
3	28 Mar 12	REVISED AS NOTED	PGE	CGB	JCM	GST	
2	20 Jun 11	REVISED AS NOTED	CLL	CGB	FGR	GST	
1	28 Mar 11	REVISED AS NOTED	ABC	GFS	FGR	GST	
0	08 Oct 10	ISSUED FOR CONSTRUCTION	ABC	MCT	FGR	AVP	
C	03 Sep 10	REVISED AND REISSUED FOR APPROVAL	VSM	MCT	FGR	AVP	
B	21 Oct 09	ISSUED FOR APPROVAL IN PROJECT N° 25429-220-M6-0310-10009	AG	MT	FC	SDLT	
A	28 Aug 09	ISSUED FOR COORDINATION	AG	MT	FC	SDLT	

PLANOS REFERENCIA	NUMERO
XSTRATA COPPER FLOWSHEET- PRIMARY GRINDING	M5-0310-00001

Fig.4.4.-P&ID Harnero Vibratorio
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

Bechtel Chile Ltda.

APROBACION — CLIENTE: XSTRATA; ING. PROYECTO.; GTE. INGENIERIA; FECHA

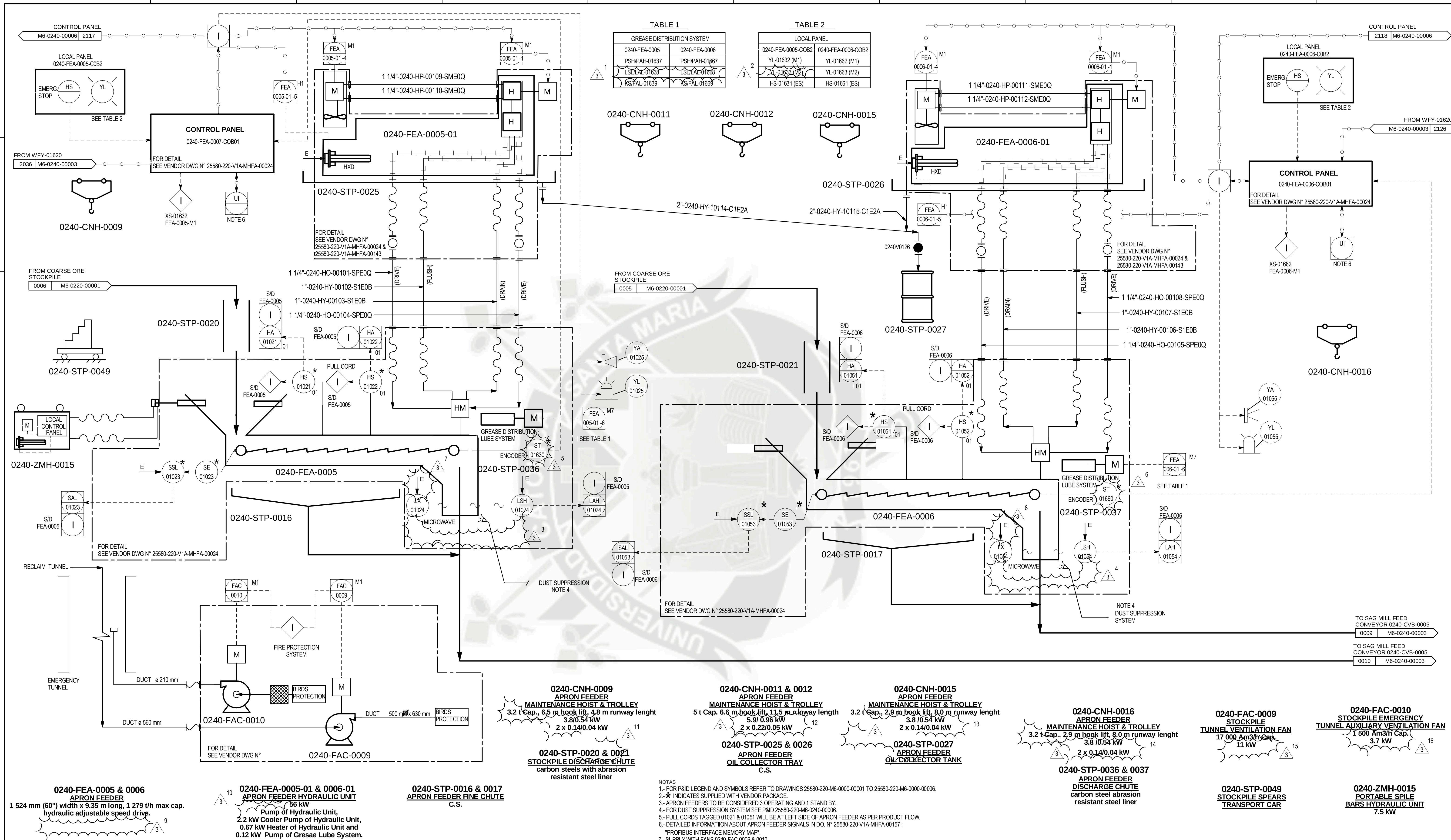
BECHTEL CHILE — ESCALA: ; DISEÑO POR: M.TANO; DIBUJADO POR: P.ATICA; 15-OCT-09; CHEQUEO POR: M.TANO; G.GONZALEZ; 15-OCT-09; ING. PROYECTO: R.RUBIO; 08-OCT-10; GTE. INGENIERIA: C.ZAMORANO; 08-OCT-10

SIGNED

Job No. 25580 — PLANO BECHTEL N° 25580-220-M6-0310-00009

PROYECTO ANTAPACCAY - EXPANSION TINTAYA
XSTRATA BECHTEL ALLIANCE
GRINDING
SAG MILL OVERSIZE PRODUCT SCREEN
P & ID

PLANO CLIENTE N° — REV. 3 14



Rev. N°	FECHA	REVISION	POR	CHEQ.	SUPV.	ING. PROY.	CLIENTE
3	11 Abr 12	REVISED AS NOTED	PGE	CGB	JCM	GST	
2	21 Sep 11	REVISED AS NOTED	PGE	CGB	JCM	GST	
1	21 Apr 11	REVISED AS NOTED	CLL	GFS	FGR	GST	
0	03 Aug 10	ISSUED FOR CONSTRUCTION	AAB	MCT	FLG	AVP	
C	28 May 10	REVISED & REISSUED FOR APPROVAL	AAB	MCT	FLG	AVP	
B	24 Aug 09	ISSUED FOR APPROVAL IN PROJECT 25429	PG	MT	FC	SDLT	
A	04 Aug 09	ISSUED FOR COORDINATION	AG	MT	FC	SDLT	

PLANOS REFERENCIA	NUMERO
H.D. COARSE ORE RECLAIM STOCK PILE 60" WIPE APRON FEEDER	V1A-MHFA-00143
PIPING & INSTRMENT DIAGRAM STOCK PILE 60" WIDE APRON FEEDER	V1A-MHFA-00024

Fig.4.1.-P&ID Apron Feeder

Fuente: Proyecto Tintaya – Antapaccay - Bechtel

Bechtel Chile Ltda.

PROYECTO ANTAPACCAY - EXPANSION TINTAYA

XSTRATA BECHTEL ALLIANCE

COARSE ORE RECLAIM
APRON FEEDER
P & ID (SHEET 1 OF 2)

Job No. 25580

25580-220-M6-0240-00001

REV. 3

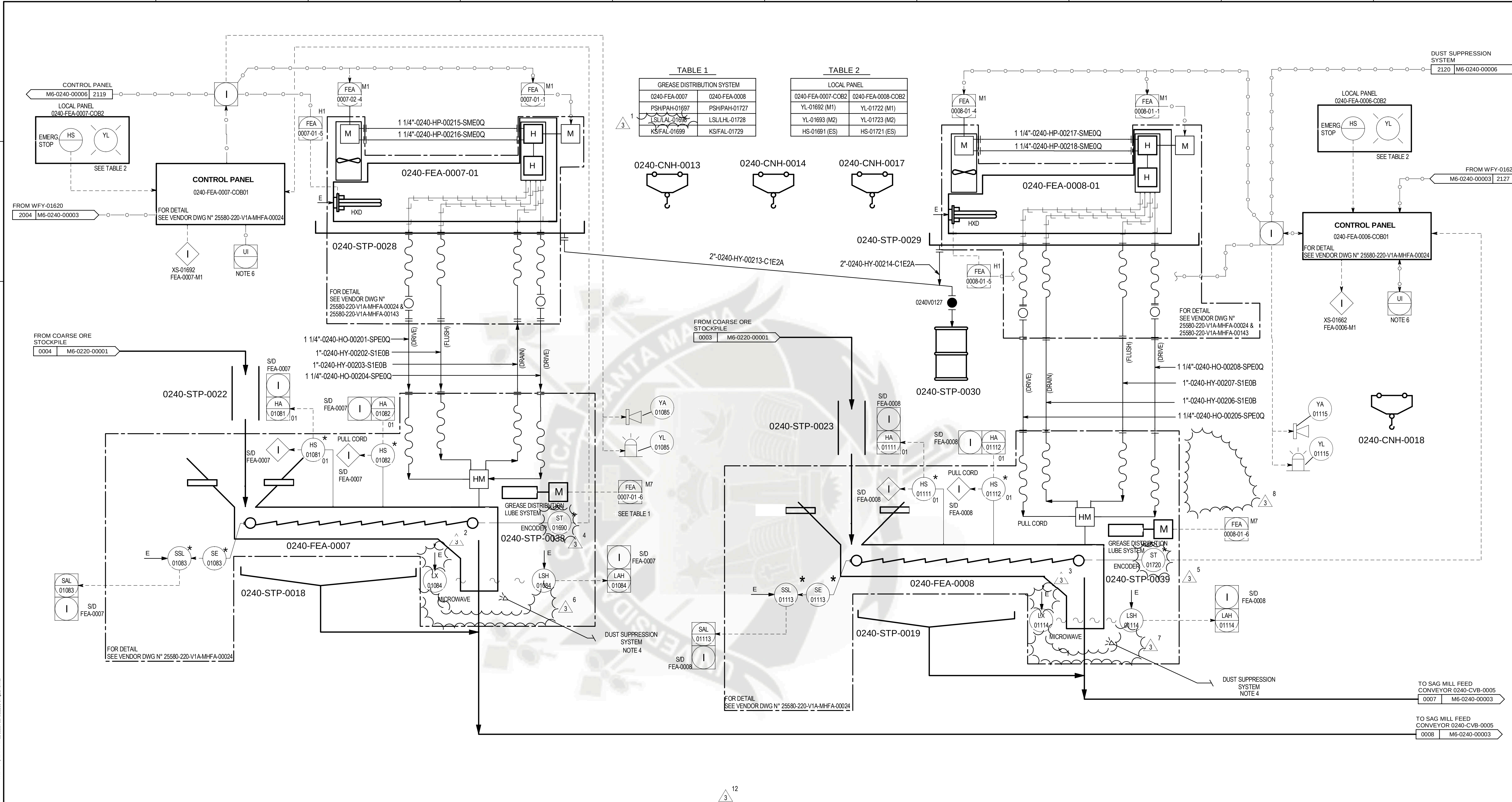


TABLE 1

GREASE DISTRIBUTION SYSTEM	
0240-FEA-0007	0240-FEA-0008
PSH/PAH-01697	PSH/PAH-01727
LSL/LAL-01698	LSL/LHL-01728
KS/FAL-01699	KS/FAL-01729

TABLE 2

LOCAL PANEL	
0240-FEA-0007-COB2	0240-FEA-0008-COB2
YL-01692 (M1)	YL-01722 (M1)
YL-01693 (M2)	YL-01723 (M2)
HS-01691 (ES)	HS-01721 (ES)

0240-CNH-0013 & 0014
APRON FEEDER
MAINTENANCE HOIST & TROLLEY
5 ton. Cap. 6.6 m hook lift, 11.5 m runway length
5.9 kW; 2 x 0.22 kW

0240-CNH-0017
APRON FEEDER
MAINTENANCE HOIST & TROLLEY
3.2 t Cap., 2.9 m hook lift, 8 m runway lenght
3.8 /0.54 kW
2 x 0.14 /0.04 kW

0240-CNH-0018
APRON FEEDER
MAINTENANCE HOIST & TROLLEY
3.2 t Cap., 7.2 m hook lift, 14 m runway lenght
3.8 /0.54 kW
2 x 0.14 /0.04 kW

0240-FEA-0007 & 0008
APRON FEEDER HYDRAULIC UNIT
56 kW
Pump of Hydraulic Unit,
2.2 kW Cooler Pump of Hydraulic Unit,
0.67 kW Heater of Hydraulic Unit and
0.12 kW Pump of Gresae Lube System.

0240-FEA-0007 & 0008
APRON FEEDER
1 524 mm (60") width x 9.35 m long, 1 279 t/h max cap.
Capacity, hydraulic adjustable speed drive,

0240-STP-0018 & 0019
APRON FEEDER
FINE CHUTE
C.S.

0240-STP-0022 & 0023
STOCKPILE DISCHARGE CHUTE
carbon steel with abrasion
resistant steel lined

0240-STP-0028 & 0029
APRON FEEDER
OIL COLLECTOR TRAY
C.S.

0240-STP-0030
APRON FEEDER
OIL COLLECTOR TANK

0240-STP-0038 & 0039
APRON FEEDER
DISCHARGE CHUTE
carbon steel abrasion
resistant steel liner

Rev. N°	FECHA	REVISION	POR	CHEQ.	SUPV.	ING. PROY.	CLIENTE	PLANOS REFERENCIA	NUMERO
3	11 Abr 12	REVISED AS NOTED	PGE	CGB	JCM	GST			
2	21 Sep 11	REVISED AS NOTED	PGE	CGB	JCM	GST			
1	21 Abr 11	REVISED AS NOTED	ABC	GFS	FGR	GST			
0	03 Ago 10	ISSUED FOR CONSTRUCTION	PGE	MCT	FLG	AVP			
C	28 May 10	REVISED & REISSUED FOR APPROVAL	AAB	MCT	FLG	AVP			
B	24 Ago 09	ISSUED FOR APPROVAL IN PROJECT 25429	PG	MT	FC	SDLT		H.D. COARSE ORE RECLAIM STOCK PILE 60" WIPE APRON FEEDER	V1A-MHFA-00143
A	04 Ago 09	ISSUED FOR COORDINATION	AG	MT	FC	SDLT		PIPING & INSTRMENT DIAGRAM STOCK PILE 60" WIDE APRON FEEDER	V1A-MHFA-00024

1.- FOR P&ID LEGEND AND SYMBOLS REFER TO DRAWINGS 25580-220-M6-0000-00001 TO 25580-220-M6-0000-00006.
2.- * INDICATES SUPPLIED WITH VENDOR PACKAGE.
3.- APRON FEEDERS TO BE CONSIDERED 3 OPERATING AND 1 STAND BY.
4.- DUST SUPPRESSION SYSTEM SEE P&ID 25580-220-M6-0240-00006.
5.- PULL CORDS TAGGED 01081 & 01111 WILL BE AT LEFT SIDE OF APRON FEEDER AS PER PRODUCT FLOW.
6.- DETAILED INFORMATIION ABOUT APRON FEEDER SIGNALS IN DO. N° 25580-220-V1A-MHFA-00157 :
"PROFIBUS INTERFACE MEMORY MAP".

NOTAS

Bechtel Chile Ltda.

CLIENTE — APROBACION: XSTRATA | FECHA; ING. PROYECTO.; GTE. INGENIERIA

BECHTEL CHILE — ESCALA: | FECHA
DISEÑO POR M. TANO — DIBUJADO POR A. BASAEZ — 03-AUG-09
CHEQUEO POR M. TANO — SUPV. DIS. F. GONZALEZ — 03-AUG-09
ING. PROYECTO A. VERDUGO — 03-AUG-10
GTE. INGENIERIA C.ZAMORANO — 03-AUG-10

SIGNED

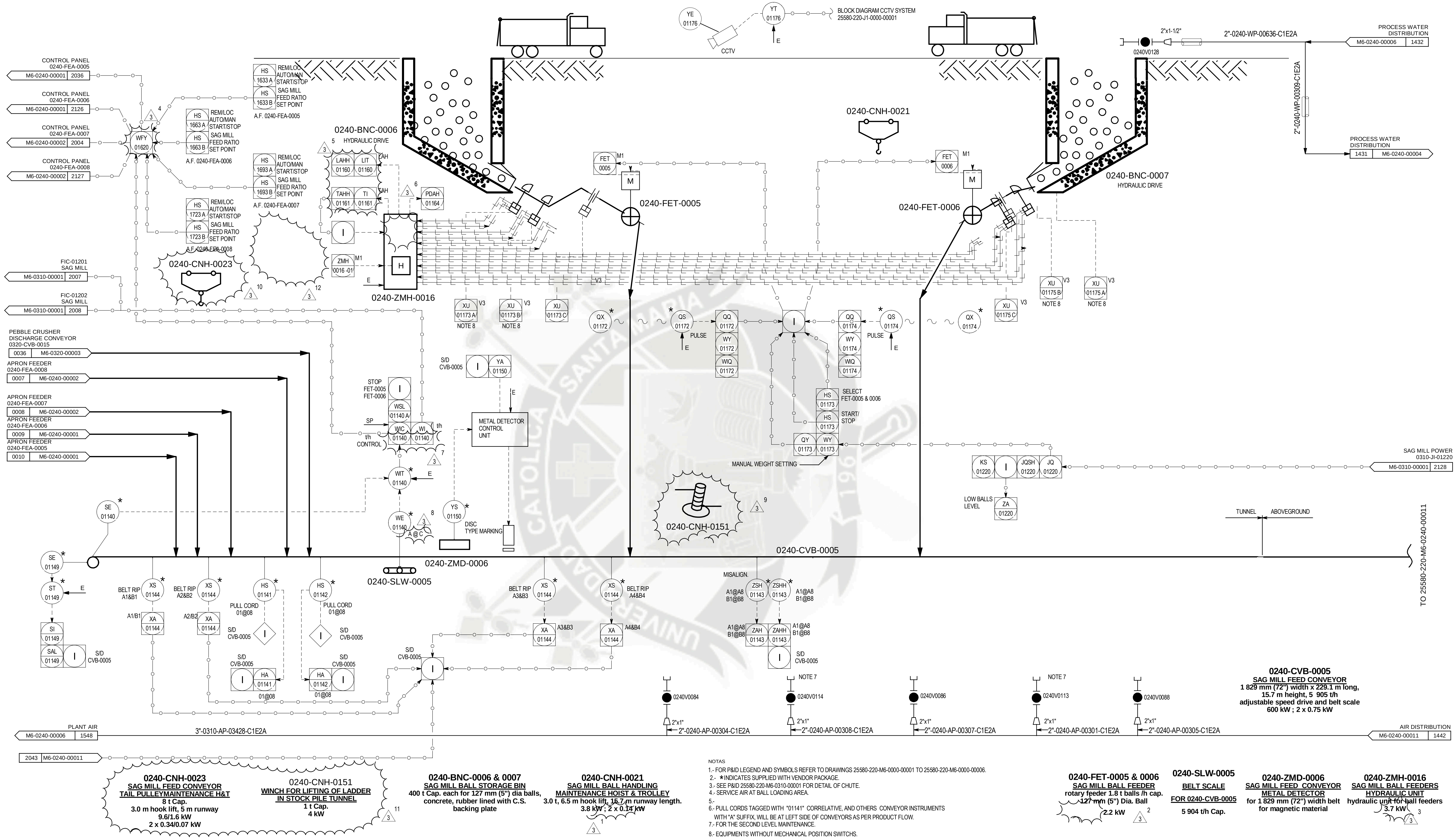
Job No. 25580
PLANO BECHTEL N° 25580-220-M6-0240-00002

PROYECTO ANTAPACCAY - EXPANSION TINTAYA
xstrata copper
XSTRATA BECHTEL ALLIANCE

COARSE ORE RECLAIM
APRON FEEDER
P & ID
(SHEET 2 OF 2)

PLANO CLIENTE N°
REV. 3 13

FECHA: 11-04-2012 HORA: 17:55:12 USUARIO: PGATICA
ARCHIVO:



Rev. N°	FECHA	REVISION	POR	CHEQ.	SUPV.	ING. PROY.
3	11 Abr 12	REVISED AS NOTED	PGE	CGB	JCM	GST
2	09 Jan 12	REVISED AS NOTED	PGE	CGB	JCM	GST
1	21 Apr 11	REVISED AS NOTED	ABC	GFS	FGR	GST
0	03 Aug 10	ISSUED FOR CONSTRUCTION	AAB	MCT	FLG	AVP
C	31 May 10	REVISED & REISSUED FOR APPROVAL	AAB	MCT	FLG	AVP
B	21 Oct 09	EMITIDO PARA APROBACION PROYECTO N° 25429	AG	MT	FC	SDLT
A	14-AGO-09	EMITIDO PARA COORDINACION	AG	MT	FC	SDLT

CLIENTE — PLANOS REFERENCIA — NUMERO

Fig.4.2.-P&ID Carguío de Bolas – Molino SAG
Fuente: Proyecto Tintaya – Antapaccay - Bechtel

Bechtel Chile Ltda.

APROBACION — XSTRATA — FECHA — ING. PROYECTO. — GTE. INGENIERIA

ESCALA: — DISEÑO POR: M. TANO — DIBUJADO POR: A. GONZALEZ 15-OCT-09 — CHEQUEO POR: M. TANO — A. GONZALEZ 15-OCT-09 — ING. PROYECTO: A. VERDUGO 03-AUG-10 — GTE. INGENIERIA: C. ZAMORANO 03-AUG-10

SIGNED

Job No. 25580 — PLANO BECHTEL N° 25580-220-M6-0240-00003

PROYECTO ANTAPACCAY - EXPANSION TINTAYA
XSTRATA BECHTEL ALLIANCE

COARSE ORE RECLAIM
SAG MILL - FEED CONVEYOR
P & ID

SHEET 1 OF 2 — PLANO CLIENTE N° — REV. 3 — 13

GENERAL	1	Job No. / Customer	25580	Minera Xstrata Tintaya S.A.
	2	Project Name	Antapaccay - Expansion Tintaya	
	3	Tag number	0310-FIT -01201A	
	4	Service	CAL A CHUTE ALIMENTACION MOLINO SAG	
	5	Line number / P&ID	1 1/2"-0391-ML-00221-C1E2R	25580-220-M6-0310-00001
	6	Hazardous area class / Ignition temp ident number	GENERAL PURPOSE	N/A
	7	Ambient temperature Min / Max	-5ºC	18ºC
	8	Environ. Condit. / Seismic Norm / Sea Level Elevat.	WET & DUSTY / NTE E.030 ZONE 2	4100 m
PIPE LINE	9	Line size / Line Schd. / Liner Mat. / Thickness	1 1/2 in / 80	NA
	10	Pipe mat. class / Pipe material / Pipe insulation	C1E2R / CS ASTM A53-B/API 5L-B GE	

PROCESS CONDITIONS			Units	Minimum	Normal	Maximum
	11	Fluid name / Fluid state	MILK OF LIME		Liquid	
	12	Corrosive / Erosive / Toxic / Build-up tendency	No	Yes	Yes	Yes
	13	PROCESS DESIGN CONDITIONS	Units	Minimum	Normal	Maximum
	14	Design pressure	kPa-g	730		1034
	15	Design temperature	ºC	-10		35
	16	Limits on pressure drop across flowmeter	kPa	--------		0
	17	Fluid Conductivity	µS/cm			
	18	% Solids	%			
	19	Critical pressure / Density/Sp gr @ base		kPa-g		kg/m³
	20	Base pressure / Base temperature		kPa		ºC
	21	MATERIAL FLOW CONDITIONS	Units	@ Minimum flow	@ Norm flow	@ Maximum flow
	22	Flow rate	m³/h	2.2	2.9	5.8
	23	Inlet pressure	kPa-g	608	608	608
	24	Inlet temperature	ºC			
	25	Density / Specific gravity	kg/m³			1160
	26	Velocity	m/s			
	27	Viscosity	cP			
	28	Vapor pressure	kPa			
	29	Molecular wt / Specific Heat Ratio / Min / Nor / Max				

METERING ELEMENT				TRANS / MONITOR			
	30	Meter type	FLANGED		49	Enclosure Type	NEMA 4X
	31	End conn nom size	1 1/2 in / Rating cl 150		50	Enclosure Material	ALUMINUM EPOXY COATE
	32	End conn term category	flanged / Type RF		51	Cert/Approval type	GENERAL PURPOSE
	33	Flange Ansi Std.	B 16.5		52	Power Supply	115 VAC / 60 Hz
	34	Bolting material	NA		53	Diagnostic Capability	YES
	35	Exterior coating matl	POLYURETHANE		54	Diagnostic Fail Action	ALARM
	36	End termination matl	NA		55	Output Signal Type	FOUNDATION FIELDBUS
	37	Gasket material	NA		56	Digital Communication	FOUNDATION FIELDBUS
	38	Face to Face Dims	7.87 in		57	Process Alarm	FOUNDATION FIELDBUS
	39	Body Size	1 1/2 in		58	Indicator/Type	DIGITAL / LCD
	40	Body Material	304 SST		59	Analog Sig Isolation	NA
	41	Liner Material	Linatex Natural Rubber		60	Mounting Type/Loc	WALL / FIELD
	42	Mounting Type/Loc	Flanged		61	Signal Cable Length	15 m
	43	Electrode Type	FLUSH		62	Operating Temp	-25 a 65ºC
	44	Electrode Material	Nickel Alloy C-276		63	Empty Pipe Detection	INCLUDED
	45	Power Supply	FROM TRANSMITTER		64	Paint Specification	POLYURETHANE
	46	Enclosure Type	NEMA 4X		65	Accuracy	+/- 0,25% OF RATE
	47	Ground Type/Material	STRAP / SS	PURCHASE	66	M R No.	25580-220-MRA-JQ01-00001
	48	Electrical Connection	2 x 1/2" FNPT		67	Item No	2.001

Notes: Seller to complete or correct all instrument properties or calculated values of proposed items.

68	Tag No	Calibration	Range Min	Range Max	Units	----	Calib. Min	Calib. Max	Units
69	0310-FIT -01201A	Transmitter	0	6.5	m³/h	----			
70						----			
71						----			

72	Tag No	Instrument type	Manufacturer	Model number
73	0310-FIT -01201A	Flowmeter	ROSEMOUNT	8732ESR1G4NAM5DTB6Q4
74	0310-FE -01201A	Flow sensor	ROSEMOUNT	8705LHA015C1W0NAQ4DT
75				FIT:08712-0060-0001/08712-0061-0001

No	By	Chk	Appr	Date	Description
0	MCE	CSN	ROV	3/25/2011	Issued for Purchase
C	MCE	CSN	ROV	10/13/2010	Issued for Bid
B	MCE	CSN	ROV	9/15/2010	Issued for Approval
A	EGL	CSN	ROV	8/17/2010	Issued for Coordination

INSTRUMENT DATA SHEET

Magnetic Flowmeter M&M

xstrata copper

Client No.:

DS No.: 25580-220-JQD-JQ01-02001

Sheet 1 of 2 Form Rev 0

Code: 22189 Rev: 0

GENERAL	1	Job No.	Customer				25580	Minera Xstrata Tintaya S.A.		
	2	Project Name					Antapaccay - Expansion Tintaya			
	3	Tag number					0310-FIT -01201B			
	4	Service					CAL A CHUTE ALIMENTACION MOLINO SAG			
	5	Line number	P&ID				1 1/2"-0391-ML-00226-C1E2R	25580-220-M6-0310-00001		
	6	Hazardous area class	Ignition temp ident number				GENERAL PURPOSE	N/A		
	7	Ambient temperature	Min	Max			-5ºC	18ºC		
	8	Environ. Condit.	Seismic Norm	Sea Level Elevat.			WET & DUSTY	NTE E.030 ZONE 2	4100 m	
PIPE LINE	9	Line size	Line Schd.	Liner Mat. / Thickness			1 1/2 in	80	NA	
	10	Pipe mat. class	Pipe material	Pipe insulation			C1E2R	CS ASTM A53-B/API 5L-B GE		
PROCESS CONDITIONS	11	Fluid name	Fluid state				MILK OF LIME	Liquid		
	12	Corrosive	Erosive	Toxic	Build-up tendency		No	Yes	Yes	Yes
	13	PROCESS DESIGN CONDITIONS					Units	Minimum	Normal	Maximum
	14	Design pressure					kPa-g	730		1034
	15	Design temperature					ºC	-10		35
	16	Limits on pressure drop across flowmeter					kPa	--------		0
	17	Fluid Conductivity					µS/cm			
	18	% Solids					%			
	19	Critical pressure	Density/Sp gr @ base				kPa-g	kg/m³		
	20	Base pressure	Base temperature				kPa	ºC		
	21	MATERIAL FLOW CONDITIONS					Units	@ Minimum flow	@ Norm flow	@ Maximum flow
	22	Flow rate					m³/h	2.2	2.9	5.8
	23	Inlet pressure					kPa-g	608	608	608
	24	Inlet temperature					ºC			
	25	Density / Specific gravity					kg/m³			1160
	26	Velocity					m/s			
	27	Viscosity					cP			
	28	Vapor pressure					kPa			
	29	Molecular wt	Specific Heat Ratio	Min	Nor	Max				

METERING ELEMENT	30	Meter type	FLANGED			TRANS / MONITOR	49	Enclosure Type	NEMA 4X	
	31	End conn nom size	1 1/2 in	Rating	cl 150		50	Enclosure Material	ALUMINUM EPOXY COATE	
	32	End conn term category	flanged	Type	RF		51	Cert/Approval type	GENERAL PURPOSE	
	33	Flange Ansi Std.	B 16.5				52	Power Supply	115 VAC / 60 Hz	
	34	Bolting material	NA				53	Diagnostic Capability	YES	
	35	Exterior coating matl	POLYURETHANE				54	Diagnostic Fail Action	ALARM	
	36	End termination matl	NA				55	Output Signal Type	FOUNDATION FIELDBUS	
	37	Gasket material	NA				56	Digital Communication	FOUNDATION FIELDBUS	
	38	Face to Face Dims	7.87	in			57	Process Alarm	FOUNDATION FIELDBUS	
	39	Body Size	1 1/2 in				58	Indicator/Type	DIGITAL	LCD
	40	Body Material	304 SST				59	Analog Sig Isolation	NA	
	41	Liner Material	Linatex Natural Rubber				60	Mounting Type/Loc	WALL	FIELD
	42	Mounting Type/Loc	Flanged				61	Signal Cable Length	15 m	
	43	Electrode Type	FLUSH				62	Operating Temp	-25 a 65ºC	
	44	Electrode Material	Nickel Alloy C-276				63	Empty Pipe Detection	INCLUDED	
	45	Power Supply	FROM TRANSMITTER				64	Paint Specification	POLYURETHANE	
	46	Enclosure Type	NEMA 4X				65	Accuracy	+/- 0,25% OF RATE	
	47	Ground Type/Material	STRAP	SS		PURCHASE	66	M R No.	25580-220-MRA-JQ01-00001	
	48	Electrical Connection	2 x 1/2" FNPT				67	Item No	2.002	

Notes: Seller to complete or correct all instrument properties or calculated values of proposed items.

68	Tag No	Calibration	Range Min	Range Max	Units	----	Calib. Min	Calib. Max	Units
69	0310-FIT -01201B	Transmitter	0	6.5	m³/h	----			
70						----			
71						----			

72	Tag No	Instrument type	Manufacturer	Model number
73	0310-FIT -01201B	Flowmeter	ROSEMOUNT	8732ESR1G4NAM5DTB6Q4
74	0310-FE -01201B	Flow sensor	ROSEMOUNT	8705LHA015C1W0NAQ4DT
75				FIT:08712-0060-0001/08712-0061-0001

No	By	Chk	Appr	Date	Description
0	MCE	CSN	ROV	3/25/2011	Issued for Purchase
C	MCE	CSN	ROV	10/13/2010	Issued for Bid
B	MCE	CSN	ROV	9/15/2010	Issued for Approval
A	MCE	CSN	ROV	8/17/2010	Issued for Coordination

INSTRUMENT DATA SHEET

Magnetic Flowmeter M&M

xstrata copper

BECHTEL

Client No.:	Sheet 1 of 2	Form Rev 0
DS No.: 25580-220-JQD-JQ01-02002	Code: 22189	Rev: 0

GENERAL	1	Job No. / Customer	25580	Minera Xstrata Tintaya S.A.	
	2	Project Name	Antapaccay - Expansion Tintaya		
	3	Tag number	0310-FIT -01202		
	4	Service	AGUA DE PROCESO A CHUTE ALIMENTACION MOLINO SAG		
	5	Line number / P&ID	20"-0310-WP-03315-C1E2A	25580-220-M6-0310-00001	
	6	Hazardous area class / Ignition temp ident number	GENERAL PURPOSE	N/A	
	7	Ambient temperature / Min / Max	-5°C	18 °C	
	8	Environ. Condit. / Seismic Norm / Sea Level Elevat.	WET & DUSTY	NTE E.030 ZONE 2	4100 m
PIPE LINE	9	Line size / Line Schd. / Liner Mat. / Thickness	20 in	STD	
	10	Pipe mat. class / Pipe material / Pipe insulation	C1E2A	CS ASTM A53-B/API 5L-B	

PROCESS CONDITIONS	11	Fluid name / Fluid state	PROCESS WATER		Liquid	
	12	Corrosive / Erosive / Toxic / Build-up tendency	No	No	No	No
	13	PROCESS DESIGN CONDITIONS	Units	Minimum	Normal	Maximum
	14	Design pressure	kPa-g	730		1034
	15	Design temperature	°C	-10		35
	16	Limits on pressure drop across flowmeter	kPa	--------		
	17	Fluid Conductivity	µS/cm			
	18	% Solids	%			
	19	Critical pressure / Density/Sp gr @ base	kPa-g		1000 kg/m³	
	20	Base pressure / Base temperature	101.3 kPa		15 °C	
	21	MATERIAL FLOW CONDITIONS	Units	@ Minimum flow	@ Norm flow	@ Maximum flow
	22	Flow rate	m³/h	1200	1499	1800
	23	Inlet pressure	kPa-g			
	24	Inlet temperature	°C		10	22
	25	Density / Specific gravity	kg/m³		1000	
	26	Velocity	m/s	1.78	2.22	2.66
	27	Viscosity	cP			
	28	Vapor pressure	kPa			
	29	Molecular wt / Specific Heat Ratio / Min / Nor / Max				

METERING ELEMENT	30	Meter type	FLANGED	TRANS / MONITOR	49	Enclosure Type	NEMA 4
	31	End conn nom size	20 in / Rating cl 150		50	Enclosure Material	ALUMINUM EPOXY COATE
	32	End conn term category	FLANGED / Type RF		51	Cert/Approval type	GENERAL PURPOSE
	33	Flange Ansi Std.	ANSI B16.5		52	Power Supply	115 VAC / 60 Hz
	34	Bolting material	NA		53	Diagnostic Capability	YES
	35	Exterior coating matl	VTS		54	Diagnostic Fail Action	ALARM
	36	End termination matl	NA		55	Output Signal Type	FOUNDATION FIELDBUS
	37	Gasket material	NA		56	Digital Communication	FOUNDATION FIELDBUS
	38	Face to Face Dims	VTS in		57	Process Alarm	FOUNDATION FIELDBUS
	39	Body Size	20 in		58	Indicator/Type	DIGITAL / LCD
	40	Body Material	316 SST		59	Analog Sig Isolation	NA
	41	Liner Material	PTFE		60	Mounting Type/Loc	BRACKET / FIELD
	42	Mounting Type/Loc	FLANGED		61	Signal Cable Length	15 m
	43	Electrode Type	FLUSH		62	Operating Temp	VTS
	44	Electrode Material	316 SST		63	Empty Pipe Detection	REQUIRED
	45	Power Supply	FROM TRANSMITTER		64	Paint Specification	VTS
	46	Enclosure Type	Nema 4		65	Accuracy	+/- 0,25% OF RATE
	47	Ground Type/Material	STRAP / SS	PURCHASE	66	M R No.	25580-220-MRA-JQ01-00001
	48	Electrical Connection	2x 1/2" FNPT		67	Item No	2.067

Notes: Seller to complete or correct all instrument properties or calculated values of proposed items.

68	Tag No	Calibration	Range Min	Range Max	Units	----	Calib. Min	Calib. Max	Units
69	0310-FIT -01202	Transmitter	0	1800	m³/h	----			
70						----			
71						----			

72	Tag No	Instrument type	Manufacturer	Model number
73	0310-FIT -01202	Flowmeter	ROSEMOUNT	8732ESR1G4NAM5DTB6Q4
74	0310-FE -01202	Flow Tube	ROSEMOUNT	8705TSA200C1W0NAQ4DT
75				

No	By	Chk	Appr	Date	Description
0	MCE	CAE	ROV	7/29/2011	Issued for Purchase
A	DAC	CSN	ROV	4/15/2011	Issued for Approval and Bid

INSTRUMENT DATA SHEET

Magnetic Flowmeter M&M

xstrata copper

BECHTEL

Client No.:

DS No.: 25580-220-JQD-JQ01-02075

Sheet 1 of 2 Form Rev 0

Code: 22189 Rev: 0

xstrata copper | metso

ANTAPACCAY PROJECT

BASIC ENGINEERING 60" WIDE APRON FEEDER TAG N° 0240-FEA-0005 INSTRUMENTS' LIST	XSTRATA NUMBER: 25580-220-V1A-MHFA-00027	SHEET 1 / 1
	METSO NUMBER: 2141020342002	REV. 4

REV.	DATE	BY	VER.	APR.	AUT	TE	DESCRIPTION
1	8/20/2010	JVC	DHF	RCG	RCG	B	FIRST ISSUE
2	11/10/2010	DHF	JVC	RCG	RCG	B	REVISED AS COMMENTS 25580-220-G26-GPS-00444 AND OTHER CHANGES ARE MARKED ON RED COLOR
3	12/8/2010	DHF	JVC	RCG	RCG	B	REVISED AS COMMENTS 25580-220-G26-GPS-01439 AND OTHER CHANGES ARE MARKED ON RED COLOR
4	1/26/2011	DHF	JVC	RCG	RCG	J	CERTIFIED AS 25580-220-G26-GPS-02071

CERTIFIED DOCUMENT

R.C.G. 26/01/11

THIS EQUIPMENT WILL BE CONSTRUCTED ACCORDING TO THIS CERTIFIED DOCUMENT.

TE - TYPE OF EMISSION (by METSO)

A	PRELIMINARY	F	AS PURCHASED
B	FOR APPROVED	G	AS BUILT
C	FOR KNOWLEGDE	H	ELIMINATED
D	TO QUOTE	J	CERTIFIED
E	FOR CONSTRUCTION		

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed

2 Revise & Resubmit. Work may proceed subject to incorporation of changes

3 Revise & Resubmit. Work may NOT proceed

4 Review not required. Work may proceed

5 Cancelled / Superseded

Document Status: 4

Reviewer Name: ______ Date: 10/27/2011 00:00:00

Discipline: EM - Mechanical Doc Type Code: V1A

Job # 25580-220 VP # 25580-220-V1A-MHFA-00027

Subm 005 Equip # 0240-FEA-005;

Program # NA;

Job # ______ VP # ______

SEQ # ______ Equip # ______

ANTAPACCAY PROJECT

INSTRUMENT LIST

BASIC ENGINEERING
60" WIDE APRON FEEDER
TAG N° 0240-FEA-0005
INSTRUMENTS' LIST

XSTRATA NUMBER: 25580-220-V1A-MHFA-00027 — SHEET 1 / 2
METSO NUMBER: 2141020342002 — REV.: 4

TAG IDENTIFICATION	LOCATION	DESCRIPTION (FUNCTION)	MANUFACTURER	MODEL	TYPE	OBSERVATION
HS-01021-01	60" APRON FEEDER 0240-FEA-0005	PULL CORD EMERGENCY STOP	CONVEYOR COMPONENTS	RS-2E	PULLCORD SWITCH	DPDT
HS-01022-01	60" APRON FEEDER 0240-FEA-0005	PULL CORD EMERGENCY STOP	CONVEYOR COMPONENTS	RS-2E	PULLCORD SWITCH	DPDT
LX-01024 / LSH-01024	60" APRON FEEDER 0240-FEA-0005	PLUGGED DISCHARGE CHUTE	HYCONTROL	HYCMWSSTSR110X	MICROWAVE LEVEL SWITCH	SUPPLIED BY BECHTEL
SE/SSL-01023	60" APRON FEEDER 0240-FEA-0005	ZERO SPEED DETECTOR	MILLTRONICS	MSP-12/MF A4P	LIGHT PULSES MEASURE	
YA-01025 / YL-01025	60" APRON FEEDER 0240-FEA-0005	PRE-START WARNING	EDWARDS SIGNALING	B-KM-8130-N5 / 49R-N5-40WH	HORN & BEACON	SUPPLIED BY BECHTEL
PSH-01637	GREASE LUBE SYSTEM	HIGH PRESSURE SENSOR	ASTA	TP AT DA 40 IA	DIAPHRAGM	
LSL-01638	GREASE LUBE SYSTEM	LOW LEVEL SWITCH	KAP	LB305H	LIMIT SWITCH	
KS-01639	GREASE LUBE SYSTEM	CICLE COUNTER	KAP	LB305K	LIMIT SWITCH	
PI-00XXX	GREASE LUBE SYSTEM	PRESSURE GAUGE	WOERNER	HDB.A		THERE'S NO TAG FOR THIS COMPONENTS AS CUSTOMER SPECS.
PSV-00XXX	GREASE LUBE SYSTEM	PRESSURE RELIEF VALVE	WOERNER / WIKA	111.16	MANOMETER	
TE-01646	HYDRAULIC DRIVE LUBE SYSTEM	OIL TEMPERATURE SENSOR	INOR	66RNS1011251213	ANALOG TEMPERATURE SENSOR Pt100	BY HÄGGLUNDS
LIT-01647	HYDRAULIC DRIVE LUBE SYSTEM	LOW LEVEL SENSOR	Bühler	63 kN L=370	LEVEL SENSOR	BY HÄGGLUNDS
PDSH-01642	HYDRAULIC DRIVE LUBE SYSTEM	OIL FILTER PRESSURE SWITCH (DRAIN LINE)	Hägglunds Drives	VD 2.2 LE.1/-30C-SO378-03507800	FILTER INDICATOR	BY HÄGGLUNDS
PDSH-01640	HYDRAULIC DRIVE LUBE SYSTEM	OIL FILTER PRESSURE SWITCH (RETURN LINE)	Hägglunds Drives	VD 2.2 LE.1/-30C-SO378-03507800	FILTER INDICATOR	BY HÄGGLUNDS
ZS-01643	HYDRAULIC DRIVE LUBE SYSTEM	SUCTION VALVE LIMIT SWITCH (MAIN HYD PUMP)	STEUTE	ES 95 R 1Ö/1S	SUCTION LINE INDICATOR	BY HÄGGLUNDS

INSTRUMENT LIST

ANTAPACCAY PROJECT

BASIC ENGINEERING
60" WIDE APRON FEEDER
TAG N° 0240-FEA-0005
INSTRUMENTS' LIST

XSTRATA NUMBER: 25580-220-V1A-MHFA-00027 — SHEET 2 / 2

METSO NUMBER: 2141020342002 — REV.: 4

TAG IDENTIFICATION	LOCATION	DESCRIPTION (FUNCTION)	MANUFACTURER	MODEL	TYPE	OBSERVATION
PSL-01648	HYDRAULIC DRIVE LUBE SYSTEM	LOW CHARGE PRESSURE SENSOR	HYDAC	EDS 410-060-4-062	PRESSURE SWITCH	BY HÄGGLUNDS
PSL-01649	HYDRAULIC DRIVE LUBE SYSTEM	LOW CHARGE PRESSURE SENSOR (ACCUMULATOR)	HYDROPA	DS-802/M 0,5-15 bar	PRESSURE SWITCH	BY HÄGGLUNDS
PIT-01645	HYDRAULIC DRIVE LUBE SYSTEM	PRESSURE TRANSMITTER	HYDAC	HDA4745-A-400-000	PRESSURE TRANSMITTER	BY HÄGGLUNDS
ZT-01630	HYDRAULIC DRIVE LUBE SYSTEM	SPEED DRIVE SENSOR (ENCODER)	Hägglunds DRIVES	SPDB-3600	SPEED ENCODER	BY HÄGGLUNDS
FY-01651	HYDRAULIC DRIVE LUBE SYSTEM	PROPORTIONAL VALVE (FLOW A-PORT)	Hägglunds DRIVES	577 6216-056	SOLENOID	BY HÄGGLUNDS
FY-01652	HYDRAULIC DRIVE LUBE SYSTEM	PROPORTIONAL VALVE (FLOW B-PORT)	Hägglunds DRIVES	577 6216-056	SOLENOID	BY HÄGGLUNDS
ZS-01653	HYDRAULIC DRIVE LUBE SYSTEM	SHUT-OFF VALVE SWITCH (A-PORT) MOUNTED IN PIPE SYSTEM	REMOTE CONTROL	RCE 4L MEK	LIMIT SWITCH	BY HÄGGLUNDS
ZS-01654	HYDRAULIC DRIVE LUBE SYSTEM	SHUT-OFF VALVE SWITCH (B-PORT) MOUNTED IN PIPE SYSTEM	REMOTE CONTROL	RCE 4L MEK	LIMIT SWITCH	BY HÄGGLUNDS
TE-01655	HYDRAULIC DRIVE LUBE SYSTEM	THERMISTOR HIGH TEMPERATURE MOTOR #1	ABB	3GZF360	PTC	BY HÄGGLUNDS
TE-01656	HYDRAULIC DRIVE LUBE SYSTEM	THERMISTOR HIGH TEMPERATURE COOLING MOTOR	ABB	3GZF360	PTC	BY HÄGGLUNDS

xstrata copper | metso

ANTAPACCAY PROJECT

BASIC ENGINEERING 60" WIDE APRON FEEDER TAG N° 0240-FEA-0006 INSTRUMENTS' LIST	XSTRATA NUMBER: 25580-220-V1A-MHFA-00177	SHEET
	METSO NUMBER: 2141020343002	REV. 2

REV.	DATE	BY	VER.	APR.	AUT	TE	DESCRIPTION
1	4/12/2010	JVC	DHF	RCG	RCG	B	FIRST ISSUE
2	8/1/2011	JVC	DHF	RCG	RCG	E	GRD 25580-220-G26-GPS-06225

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4
Reviewer Name:
Date: 9/5/2011 00:00:00
Discipline: EM - Mechanical
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-MHFA-00177
Subm 002
Equip # 0240-FEA-0006;
Program # GRD-102034-083-11;
Job #
VP #
SEQ #
Equip #

CERTIFIED DOCUMENT

R.C.G. 01/08/11

THIS EQUIPMENT WILL BE CONSTRUCTED ACCORDING TO THIS CERTIFIED DOCUMENT.

TE - TYPE OF EMISSION (by METSO)			
A	PRELIMINARY	F	AS PURCHASED
B	FOR APPROVED	G	AS BUILT
C	FOR KNOWLEGDE	H	ELIMINATED
D	TO QUOTE	J	CERTIFIED
E	FOR CONSTRUCTION		

INSTRUMENT LIST

ANTAPACCAY PROJECT

BASIC ENGINEERING
60" WIDE APRON FEEDER
TAG N° 0240-FEA-0006
INSTRUMENTS' LIST

XSTRATA NUMBER: 25580-220-V1A-MHFA-00177

SHEET

METSO NUMBER: 2141020343002

REV.: 2

TAG IDENTIFICATION	LOCATION	DESCRIPTION (FUNCTION)	MANUFACTURER	MODEL	TYPE	OBSERVATION
HS-01051-01	60" APRON FEEDER 0240-FEA-0006	PULL CORD EMERGENCY STOP	CONVEYOR COMPONENTS	RS-2E	PULLCORD SWITCH	DPDT
HS-01052-01	60" APRON FEEDER 0240-FEA-0006	PULL CORD EMERGENCY STOP	CONVEYOR COMPONENTS	RS-2E	PULLCORD SWITCH	DPDT
LX-01054 / LSH-01054	60" APRON FEEDER 0240-FEA-0006	PLUGGED DISCHARGE CHUTE	HYCONTROL	HYCMWSSTSR110X	MICROWAVE LEVEL SWITCH	SUPPLIED BY BECHTEL
SE/SSL-01053	60" APRON FEEDER 0240-FEA-0006	ZERO SPEED DETECTOR	MILLTRONICS	MSP-12/MF A4P	LIGHT PULSES MEASURE	
YA-01055 / YL-01055	60" APRON FEEDER 0240-FEA-0006	PRE-START WARNING	EDWARDS SIGNALING	B-KM-8130-N5 / 49R-N5-40WH	HORN & BEACON	SUPPLIED BY BECHTEL
PSH-01667	GREASE LUBE SYSTEM	HIGH PRESSURE SENSOR	ASTA	TP AT DA 40 IA	DIAPHRAGM	
LSL-01668	GREASE LUBE SYSTEM	LOW LEVEL SWITCH	KAP	LB305H	LIMIT SWITCH	
KS-01669	GREASE LUBE SYSTEM	CICLE COUNTER	KAP	LB305K	LIMIT SWITCH	
PI	GREASE LUBE SYSTEM	PRESSURE GAUGE	WOERNER	HDB.A		THERE'S NO TAG FOR THIS COMPONENTS AS CUSTOMER SPECS.
PSV	GREASE LUBE SYSTEM	PRESSURE RELIEF VALVE	WOERNER / WIKA	111.16	MANOMETER	
TE-01676	HYDRAULIC DRIVE LUBE SYSTEM	OIL TEMPERATURE SENSOR	INOR	66RNS1011251213	ANALOG TEMPERATURE SENSOR Pt100	BY HÄGGLUNDS
LIT-01677	HYDRAULIC DRIVE LUBE SYSTEM	LOW LEVEL SENSOR	Bühler	63 kN L=370	LEVEL SENSOR	BY HÄGGLUNDS

PDSH-01672	HYDRAULIC DRIVE LUBE SYSTEM	OIL FILTER PRESSURE SWITCH (DRAIN LINE)	Hägglunds Drives	VD 2.2 LE.1/-30C-SO378-03 507800	FILTER INDICATOR	BY HÄGGLUNDS
PDSH-01670	HYDRAULIC DRIVE LUBE SYSTEM	OIL FILTER PRESSURE SWITCH (RETURN LINE)	Hägglunds Drives	VD 2.2 LE.1/-30C-SO378-03 507800	FILTER INDICATOR	BY HÄGGLUNDS
ZS-01673	HYDRAULIC DRIVE LUBE SYSTEM	SUCTION VALVE LIMIT SWITCH (MAIN HYD PUMP)	STEUTE	ES 95 R 1Ö/1S	SUCTION LINE INDICATOR	BY HÄGGLUNDS
PSL-01678	HYDRAULIC DRIVE LUBE SYSTEM	LOW CHARGE PRESSURE SENSOR	HYDAC	EDS 410-060-4-062	PRESSURE SWITCH	BY HÄGGLUNDS
PSL-01679	HYDRAULIC DRIVE LUBE SYSTEM	LOW CHARGE PRESSURE SENSOR (ACCUMULATOR)	HYDROPA	DS-802/M 0,5-15 bar	PRESSURE SWITCH	BY HÄGGLUNDS
PIT-01675	HYDRAULIC DRIVE LUBE SYSTEM	PRESSURE TRANSMITTER	HYDAC	HDA4745-A-400-000	PRESSURE TRANSMITTER	BY HÄGGLUNDS
ZT-01660	HYDRAULIC DRIVE LUBE SYSTEM	SPEED DRIVE SENSOR (ENCODER)	Hägglunds DRIVES	SPDB-3600	SPEED ENCODER	BY HÄGGLUNDS
FY-01681	HYDRAULIC DRIVE LUBE SYSTEM	PROPORTIONAL VALVE (FLOW A-PORT)	Hägglunds DRIVES	577 6216-056	SOLENOID	BY HÄGGLUNDS
FY-01682	HYDRAULIC DRIVE LUBE SYSTEM	PROPORTIONAL VALVE (FLOW B-PORT)	Hägglunds DRIVES	577 6216-056	SOLENOID	BY HÄGGLUNDS
ZS-01683	HYDRAULIC DRIVE LUBE SYSTEM	SHUT-OFF VALVE SWITCH (A-PORT) MOUNTED IN PIPE SYSTEM	REMOTE CONTROL	RCE 4L MEK	LIMIT SWITCH	BY HÄGGLUNDS
ZS-01684	HYDRAULIC DRIVE LUBE SYSTEM	SHUT-OFF VALVE SWITCH (B-PORT) MOUNTED IN PIPE SYSTEM	REMOTE CONTROL	RCE 4L MEK	LIMIT SWITCH	BY HÄGGLUNDS
TE-01685	HYDRAULIC DRIVE LUBE SYSTEM	THERMISTOR HIGH TEMPERATURE MOTOR #1	ABB	3GZF360	PTC	BY HÄGGLUNDS
TE-01686	HYDRAULIC DRIVE LUBE SYSTEM	THERMISTOR HIGH TEMPERATURE COOLING MOTOR	ABB	3GZF360	PTC	BY HÄGGLUNDS

xstrata copper	metso	**ANTAPACCAY PROJECT**	
BASIC ENGINEERING 60" WIDE APRON FEEDER TAG N° 0240-FEA-0006 ELECTRICAL LOADS' LIST		XSTRATA NUMBER: 25580-220-V1A-MHFA-00178	SHEET
		METSO NUMBER: 2141020343004	REV. 2

REV.	DATE	BY	VER.	APR.	AUT	TE	DESCRIPTION
1	6/30/2011	JVC	DHF	RCG	RCG	B	FIRST ISSUE
2	8/1/2011	JVC	DHF	RCG	RCG	E	GRD 25580-220-G26-GPS-06225

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4

Reviewer Name: ______ Date: 9/5/2011 00:00:00

Discipline: EM - Mechanical Doc Type Code: V1A

Job # 25580-220 VP # 25580-220-V1A-MHFA-00178

Subm 002 Equip # 0240-FEA-0006;

Program # GRD-102034-083-11;

Job # ______ VP # ______

SEQ # ______ Equip # ______

CERTIFIED DOCUMENT

R.C.G. 01/08/11

THIS EQUIPMENT WILL BE CONSTRUCTED ACCORDING TO THIS CERTIFIED DOCUMENT.

TE - TYPE OF EMISSION (by METSO)			
A	PRELIMINARY	F	AS PURCHASED
B	FOR APPROVED	G	AS BUILT
C	FOR KNOWLEGDE	H	ELIMINATED
D	TO QUOTE	J	CERTIFIED
E	FOR CONSTRUCTION		

xstrata copper | metso

LOADS' LIST

ANTAPACCAY PROJECT

BASIC ENGINEERING
60" WIDE APRON FEEDER
TAG N° 0240-FEA-0006
ELECTRICAL LOADS' LIST

XSTRATA NUMBER: 25580-220-V1A-MHFA-00178

SHEET

METSO NUMBER: 2141020343004

REV. 2

LEGEND:
IN-NOMINAL CURRENT
IP-START CURRENT
TB-LOCKED ROTOR WITHSTAND TIME (s)
SCM-SQUIRREL CAGE MOTOR
MS-SYNCHRONOUS MOTOR
MC-DIRECT CURRENT MOTOR
MA-WOUND ROTOR
ME-SPECIAL MOTOR

IDENTIFICATION TAG	APPLICATION	TYPE	HP	NOMINAL POWER (kW)	POLES NUMBER	NOMINAL VOLTAGE (V) 60hz	PHASE	IN (A)	IP/IN	COS Ø	TB (s)	MOTOR FRAME	PROTECTION CLASS	MANUFACTURER	OBS
0240-FEA-0006-M1	PUMP OF HYDRAULIC MOTOR	SCM	75.00	56.00	4	460	3	89	9.48	0.83		M3BN 405 SMC 4/405	IP55	ABB	
0240-FEA-0006-M2	COOLER PUMP OF HYDRAULIC UNIT	SCM	3.00	2.20	6	460	3						IP55	HÄGGLUNDS DRIVES	TYPE: HDCA 275-4-X-5-0-0
0240-FEA-0006-HXD	HEATER OF THE HYDRAULIC UNIT		0.90	0.67		460	-		-	-	-	-	-	BACKER	TYPE OE331/K7
0240-FEA-0006-M3	PUMP OF GREASE LUBE SYSTEM	SCM	0.16	0.07		230	1	1.6	1.80	0.75	8	71	IPW55	WEG	
	HEATER OF HYDRAULIC DRIVE MOTOR			0.06	-	230	1								
	HEATER OF THE COOLER FAN MOTOR			0.027	-	230	1								

xstrata copper | metso | **ANTAPACCAY PROJECT**

BASIC ENGINEERING 60" WIDE APRON FEEDER TAG N° 0240-FEA-0007 CONTROL CABLES' LIST	XSTRATA NUMBER: 25580-220-V1A-MHFA-00189	SHEET
	METSO NUMBER: 2141020344007	REV. 2

REV.	DATE	BY	VER.	APR.	AUT	TE	DESCRIPTION
1	4/14/2011	DHF	JVC	RCG	RCG	B	FIRST ISSUE
2	8/5/2011	DHF	JVC	RCG	RCG	E	GRD 25580-220-G26-GPS-06225

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4
Reviewer Name:
Date: 9/7/2011 00:00:00
Discipline: EM - Mechanical
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-MHFA-00189
Subm 002
Equip # 0240-FEA-0007;
Program # GRD-102034-083-11;
Job #
VP #
SEQ #
Equip #

CERTIFIED DOCUMENT

R.C.G. 05/08/11

THIS EQUIPMENT WILL BE CONSTRUCTED ACCORDING TO THIS CERTIFIED DOCUMENT.

TE - TYPE OF EMISSION (by METSO)			
A	PRELIMINARY	F	AS PURCHASED
B	FOR APPROVED	G	AS BUILT
C	FOR KNOWLEGDE	H	ELIMINATED
D	TO QUOTE	J	CERTIFIED
E	FOR CONSTRUCTION		

ANTAPACCAY PROJECT

BASIC ENGINEERING
60" WIDE APRON FEEDER
TAG N° 0240-FEA-0007
CONTROL CABLES' LIST

XSTRATA NUMBER: 25580-220-V1A-MHFA-00189
SHEET
METSO NUMBER: 2141020344007
ISSUE 2

Item	Identification	Cable – Conductor – Nominal Voltage (v)	Cable – Conductor – Nº Cable Circuit	Cable – Conductor – Nº Cond.	Cable – Conductor – Nominal Section (mm^2)	Cable – Conductor – Insulation – Type	Cable – Conductor – Insulation – Voltage (kV)	Signal Type (Data, Power, Control)	Feature	Length (m)	From – Equipament	To – Equipament	Route	Coil Number	Note
							CONTROL								
1	HS0108101C001	120	5	1	1.5	PVC	0,6kV	Control			HS-01081-01	PCS	SEE DRAWING 2111020344014		CUSTOMER SCOPE
2	HS0108201C001	120	5	1	1.5	PVC	0,6kV	Control			HS-01082-01	PCS	SEE DRAWING 2111020344014		CUSTOMER SCOPE
3	LX01084C001	120	5	1	1.5	PVC	0,6kV	Control			LX-01084	PCS	SEE DRAWING 2111020344014		CUSTOMER SCOPE
4	LSH01084C001	120	7	1	1.5	PVC	0,6kV	Control			LSH-01084	PCS	SEE DRAWING 2111020344014		CUSTOMER SCOPE
5	SSL01083I001	24	2	1	0.25	PVC	300V	Data	Armored		SE-01083	AMPLIFIER MFA 4P	SEE DRAWING 2111020344014		METSO SCOPE
6	SSL01083C001	120	7	1	1.5	PVC	0,6kV	Control			AMPLIFIER MFA 4P	PCS	SEE DRAWING 2111020344014		CUSTOMER SCOPE
7	YA01085C001	120	3	1	1.5	PVC	0,6kV	Control			YA-01085	PCS	SEE DRAWING 2111020344014		CUSTOMER SCOPE
8	YL01085C001	120	3	1	1.5	PVC	0,6kV	Control			YL-01085	PCS	SEE DRAWING 2111020344014		CUSTOMER SCOPE
9															
10	PSH01697C001	120	7	1	1.5	PVC	0,6kV	Control			PSH-01697	0240-FEA-0007-JBD2	SEE DRAWING 2111020344014		METSO SCOPE (¹)
11	LSL01698C001	120	7	1	1.5	PVC	0,6kV	Control			LSL-01698	0240-FEA-0007-JBD2	SEE DRAWING 2111020344014		METSO SCOPE (¹)
12	KS01699C001	120	5	1	1.5	PVC	0,6kV	Control			KS-01699	0240-FEA-0007-JBD2	SEE DRAWING 2111020344014		CUSTOMER SCOPE
13															
14	HS01691ESC001	120	3	1	1.5	PVC	0,6kV	Control			0240-FEA-0007-COB2	0240-FEA-0007-JBD1			CUSTOMER SCOPE
15															
16															
17															
18															
19															
20															
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															
31															
32															
33															
34															
35															
36															
37															

NOTES(¹) PRE WIRED ON VENDOR FACILITIES

ANTAPACCAY PROJECT

BASIC ENGINEERING
60" WIDE APRON FEEDER
TAG N° 0240-FEA-0007
CONTROL CABLES' LIST

XSTRATA NUMBER: 25580-220-V1A-MHFA-00189
SHEET
METSO NUMBER: 2141020344007
ISSUE 2

Cable											From	To	Route	Coil Number	Note
Item	Identification	Conductor						Signal Type (Data, Power, Control)	Feature	Length (m)	Equipament	Equipament			
		Nominal Voltage (v)	Nº Cable Circuit	Nº Cond.	Nominal Section (mm^2)	Insulation Type	Insulation Voltage (kV)								
		DATA													
1	ZT01690A001		8		0.25	PVC		Data			ZT-01690	0240-FEA-0007-COB1	SEE DRAWING 2111020344014		METSO SCOPE
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															
31															
32															
33															
34															
35															
36															
37															

xstrata copper	metso	ANTAPACCAY PROJECT	
BASIC ENGINEERING 60" WIDE APRON FEEDER TAG N° 0240-FEA-0007 CONTROL CABLES' LIST		XSTRATA NUMBER: 25580-220-V1A-MHFA-00189	SHEET
		METSO NUMBER: 2141020344007	ISSUE 2

Cable											From	To	Route	Coil Number	Note
		Conductor						Signal Type (Data, Power, Control)	Feature	Length (m)	Equipament	Equipament			
Item	Identification	Nominal Voltage (v)	Nº Cable Circuit	Nº Cond.	Nominal Section (mm^2)	Insulation Type	Insulation Voltage (kV)								
							POWER								
1	0240FEA0007M1F01	460	4	1		PVC	1kV	Power			0240-FEA-0007-M1	MCC	SEE DRAWING 2111020344014		CUSTOMER SCOPE
2	0240FEA0007M2F01	460	4	1		PVC	1kV	Power			0240-FEA-0007-M2	MCC	SEE DRAWING 2111020344014		CUSTOMER SCOPE
3	0240FEA0007HXDF01	460	3	1		PVC	1kV	Power			0240-FEA-0007-HXD	MCC	SEE DRAWING 2111020344014		CUSTOMER SCOPE
4															
5	0240FEA0007M3F01	230	2	1		PVC	1kV	Power			0240-FEA-0007-M3	MCC	SEE DRAWING 2111020344014		CUSTOMER SCOPE
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															
31															
32															
33															
34															
35															
36															
37															

CLIENT: XSTRATA TINTAYA S.A.

PROJECT TITLE: ANTAPACCAY PROJECT

PROJECT LOCATION: CUSCO, PERÚ

P.O.N°: 25580-220-POA-MHFA-00001

UNIT: LOW VOLTAGE AC INDUCTION MOTORS

EQUIPMENT TITLE: STOCKPILE CRUSHER RECLAIM APRON FEEDER

EQUIPMENT N°: 0240-FEA-0006-M1

REFER TO SPECIFICATION N°: 25580-220-3PS-MUMI-00001

For General Requirements

APPLICABLE CODES NEMA MG 1-2006 Revision 1

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4
Reviewer Name: Date: 9/5/2011 00:00:00
Discipline: EM - Mechanical Doc Type Code: V1A
Job # 25580-220 VP # 25580-220-V1A-MHFA-00179
Subm 002 Equip # N/A;
Program # GRD-102034-083-11;
Job # VP #
SEQ # Equip #

COMMENTS:

TAG ID's As per MR.

CERTIFIED DOCUMENT

R.C.G. **05/08/11**

THIS EQUIPMENT WILL BE CONSTRUCTED ACCORDING TO THIS CERTIFIED DOCUMENT.

Nº Metso: 2141020343005

REV	DATE	REASON FOR REVISION	BY	CHECK	EGS	PE	CLIENT
2	5-Aug-11	GRD 25580-220-G26-GPS-06225	DHF	JVC	RCG		
1	30-Jun-11	FIRST ISSUE	DHF	JVC	RCG		

xstrata copper metso

DATA SHEET FOR LOW VOLTAGE INDUCTION MOTORS

JOB No.	
DATA SHEET No.	REV. No.
-	1

LINE No.	DESCRIPTION	UNITS	SPECIFIED	SELLER PROPOSAL
1.00	**GENERAL**			
1.01	Manufacturer	-	By Seller	ABB LV Motors
1.02	Address / Location of assembly plant	-	By Seller	Vaasa Finland
1.03	Phone / fax	-	By Seller	+358102211
1.04	email address	-	By Seller	NA
1.05	Proposal No. / Date	-	By Seller	NA
1.06	Location of Assembly Plant	-	By Seller	Vaasa Finland
1.07	Catalog / Serial / Model / No.	-	By Seller	3GBN802230-BDG
2.00	**SITE CONDITIONS (Environment)**			
2.01	Altitude	m.a.s.l.	4200	4200
2.02	Ambient temperature max	°C	22	22
2.03	Ambient temperature min	°C	-10	-10
2.04	Ambient temperature Average	°C	8.3	8.3
2.05	Hazardous Location Motors	-	Not Required	Not Rquiered
2.06	Explosion Proof Class	-	N/A	N/A
2.07	Explosion Proof Group	-	N/A	N/A
2.08	Explosion Proof Division	-	N/A	N/A
3.00	**POWER SYSTEM**			
3.01	Rated Voltage	V	480	460
3.02	Phases	ph	3 ph	3
3.03	Frequency	Hz	60	60
3.04	Short circuit Capacity	kA	65 kA	NA
3.05	Grounding Type	-	Solid	Solid
4.00	**MOTOR STANDARD**		NEMA MG-1 2006	NEMA
5.00	**LOAD MECHANICAL CHARACTERISTICS**			
5.01	Driven equipment	-	As per MR	Hydraulic Motor
5.02	Shaft coupling method	-	As per MR	Torsionally felxible coupling
5.03	Mounting Position	-	As per MR	Vertical
5.04	Speed Type	-	As per MR	
5.05	Speed Range	-	As per MR	
5.06	Duty Type	-	As per MR	
5.07	Locations	Indoor/outdoor	Outdoor	Outdoor
6.00	**MOTOR DATA**			
6.01	Type of Induction Motor	-	SCIM	SCIM
6.02	Power Output	HP/kW	each specific application	75 / 56
6.03	Rated Voltage	V	460	460
6.04	Phases	ph	3	3
6.05	Frequency	Hz	60	60
6.06	Service Factor @ operating altitude	-	1.15	1.15
6.07	Poles	-	By Seller	4
6.08	RPM	RPM	By Seller	1785
6.09	Minimum terminal voltage during starting	per unit	0.85	0.86
6.10	Nema Design	-	B	B
6.11	Insulation Class	-	F	F
6.12	Temperature rise	-	Class B (80°C) at full load	F
6.13	Special insulations considerations	-	Not required	NA
6.14	Enclosure	-	TEFC	TEFC self ventilated
6.15	Frame	-	By Seller	M3BN 405 SMC 4 / 405
6.16	Weight	lb / kg	By Seller	1090 / 495
6.17	Starting Method DOL: Direct On Line SS: Soft Starter AFD: Adjustable Frequency Driver	-	each specific application	DOL

LINE No.	DESCRIPTION	UNITS	SPECIFIED	SELLER PROPOSAL
6.16	Motor Efficiency Type	-	NEMA Premium	High Efficiency (IE2)
6.17	Efficiency at 100% of full load	%	By Seller	94.5
6.18	Efficiency at 75 % of full load	%	By Seller	94
6.19	Efficiency at 50 % of full load	%	By Seller	91.7
6.20	Power Factor at 100% of full load	%	By Seller	0.83
6.21	Power Factor at 75 % of full load	%	By Seller	0.77
6.22	Power Factor at 50 % of full load	%	By Seller	0.68
6.23	Full Load Current	A	By Seller	89
6.24	Locked rotor current @ Full Voltage	A	By Seller	844
6.25	Locked rotor current @ 90% Voltage	A	By Seller	
6.26	Sound Power Level (No Load) @ 1 meter	dBA	90 dBA (Max) - By Motor Manufacturer	70 dBA (at load)
6.27	Allowable Stall Time @ Full Voltage (s)	sec	By Seller	NA
6.28	Allowable Stall Time @ 90 % Voltage (s.)	sec	By Seller	NA
6.29	Starting Torque @ Minimum Starting Voltage	%	120% of driven load	239%
6.30	Winding Connection		Wye	Delta
6.31	Number of starts per hours (cold/hot)	No.	By Seller	375
6.32	Thermal life of insulation at rated load at 40° ambient.	yrs	By Seller	25
7.00	**BEARINGS**			
7.01	Type	-	Anti-friction	Ball Bearings
7.02	Lubrication Method	-	Re-greasable	Re-greasable
7.03	Manufacturer & Number	-	By Seller	6315/C3 - 6316/C3
7.04	Bearing Life. L-10 life, 100,000 hrs for direct coupled; 60,000 hours for conveyor idlers and blower; 80,000 hours for gear drives, reducers and pillow block for conveyor pulleys and 3,000 hours for trolleys and hoists	hrs	By Seller	According ISSO 281
7.05	Bearing Protection	-	Labyrinth type Taconite seal	Labyrinth seal
8.00	**ADDITIONAL REQUIREMENTS FOR AFD SERVICE**			NA
8.01	Inverter Type	-		
8.02	Rated operation modes - VT / CT / CP	-		
8.03	Rated power output at Base Speed	hp		
8.04	Base Speed	rpm		
8.05	Constant Power speed range	rpm		
8.06	Constant Torque speed range	rpm		
8.07	Continuous Constant Torque speed range	rpm		
8.08	Variable Torque speed range	rpm		
8.09	Variable Torque speed exponent	-		
8.10	Starting (breakaway) torque	per unit		
8.11	Run up torque	per unit		
8.12	Inching speed	rpm		
8.13	Inching torque	per unit		
8.14	Inching duration	min		

LINE No.	DESCRIPTION	UNITS	SPECIFIED	SELLER PROPOSAL
9.00	**ACCESSORIES**			
9.01	Space Heaters		Required for TEFC 75 kW / 100 hp motors and above	
9.02	Space Heaters Volts	V	220 V	220
9.03	Space Heaters Watts	W	By Seller	60W
9.04	Separate Space Heater Connection	-	Required	Yes
9.05	Space heater terminal box location	-	By Seller	Inside main terminal box
9.06	RTD´s	-	Required for 298 kW / 400 hp motors and above	NA
9.07	Winding Temperature RTD´s (6 - 2 per phase)	-		NA
9.08	Bearing Temperature RTD´s (2 - 1 per bearing)			NA
9.09	Separate RTD box	-	Required	NA
9.10	RTD´s terminal box location	-	By Seller	NA
9.11	Moisture System for Submersible Motors	-	humidity sensor required	NA
9.12	Cable Entry Length for Submersible Motors	-	By Seller	NA
9.13	Ground lugs inside main terminal box	-	Required	Yes
9.14	Ground lugs on frame (2/0 AWG cable)	-	Required	Yes
9.15	Main terminal box location	-	By Seller	Top
9.16	Space heater terminal box location	-	By Seller	Inside the main terminal box
9.17	Motor Manufacturer nameplate with all motor parameters	-	Required	Yes
9.18	Nameplates shall be stainless steel		Required	Yes
9.19	Nameplates shall include operation altitude of 4200 masl indication		Required	Yes
9.20	Lifting lugs or eyesbolts for frames 182 and larger		Required	Yes
10.00	**TESTING**		According to requirements of NEMA MG1 p. 12.55.2	
10.01	ROUTINE TESTS			
10.02	Measurement of Winding Resistance	-	Required	Yes
10.03	No load current and speed at rated voltage and frequency	-	Required	Yes
10.04	Current input at rated frequency with rotor at standstill for squirrel-cage motors	-	Required	Yes
10.05	High-potential test	-	Required	Yes
10.06		-		
10.07	SPECIAL TESTING	-		
10.08	Determination of efficiency at 100%, 75% and 50% of full load	%	Not Required	
10.09	Determination of power factor at 100%, 75% and 50% of full load	%	Not Required	
10.10	Temperature rise test	°C	Not Required	
10.11	Measure locked rotor current	A	Not Required	
10.12	Measure breakdown and starting torques	-	Not Required	
10.13	Sound test per IEEE 85	dBA	Not Required	
10.14	Speed torque test	-	Not Required	
10.15	Bearing Temperature	°C	Not Required	

xstrata copper | metso | **ANTAPACCAY PROJECT**

BASIC ENGINEERING 60" WIDE APRON FEEDER TAG N° 0240-FEA-0007 INSTRUMENTS' LIST	XSTRATA NUMBER: 25580-220-V1A-MHFA-00184	SHEET
	METSO NUMBER: 2141020344002	REV. 2

REV.	DATE	BY	VER.	APR.	AUT	TE	DESCRIPTION
1	4/12/2011	JVC	DHF	RCG	RCG	B	FIRST ISSUE
2	8/5/2011	JVC	DHF	RCG	RCG	E	GRD 25580-220-G26-GPS-06225

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 1
Reviewer Name:
Date: 9/5/2011 00:00:00
Discipline: EM - Mechanical
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-MHFA-00184
Subm 002
Equip # 0240-FEA-0007;
Program # GRD-102034-083-11;
Job #
VP #
SEQ #
Equip #

CERTIFIED DOCUMENT

R.C.G. 05/08/11

THIS EQUIPMENT WILL BE CONSTRUCTED ACCORDING TO THIS CERTIFIED DOCUMENT.

TE - TYPE OF EMISSION (by METSO)			
A	PRELIMINARY	F	AS PURCHASED
B	FOR APPROVED	G	AS BUILT
C	FOR KNOWLEGDE	H	ELIMINATED
D	TO QUOTE	J	CERTIFIED
E	FOR CONSTRUCTION		

xstrata copper	metso	INSTRUMENT LIST	ANTAPACCAY PROJECT	
BASIC ENGINEERING 60" WIDE APRON FEEDER TAG N° 0240-FEA-0007 INSTRUMENTS' LIST			XSTRATA NUMBER: 25580-220-V1A-MHFA-00184	SHEET
			METSO NUMBER: 2141020344002	REV.: 2

TAG IDENTIFICATION	LOCATION	DESCRIPTION (FUNCTION)	MANUFACTURER	MODEL	TYPE	OBSERVATION
HS-01081-01	60" APRON FEEDER 0240-FEA-0007	PULL CORD EMERGENCY STOP	CONVEYOR COMPONENTS	RS-2E	PULLCORD SWITCH	DPDT
HS-01082-01	60" APRON FEEDER 0240-FEA-0007	PULL CORD EMERGENCY STOP	CONVEYOR COMPONENTS	RS-2E	PULLCORD SWITCH	DPDT
LX-01084 / LSH-01084	60" APRON FEEDER 0240-FEA-0007	PLUGGED DISCHARGE CHUTE	HYCONTROL	HYCMWSSTSR110X	MICROWAVE LEVEL SWITCH	SUPPLIED BY BECHTEL
SE/SSL-01083	60" APRON FEEDER 0240-FEA-0007	ZERO SPEED DETECTOR	MILLTRONICS	MSP-12/MF A4P	LIGHT PULSES MEASURE	
YA-01085 / YL-01085	60" APRON FEEDER 0240-FEA-0007	PRE-START WARNING	EDWARDS SIGNALING	B-KM-8130-N5 / 49R-N5-40WH	HORN & BEACON	SUPPLIED BY BECHTEL
PSH-01697	GREASE LUBE SYSTEM	HIGH PRESSURE SENSOR	ASTA	TP AT DA 40 IA	DIAPHRAGM	
LSL-01698	GREASE LUBE SYSTEM	LOW LEVEL SWITCH	KAP	LB305H	LIMIT SWITCH	
KS-01699	GREASE LUBE SYSTEM	CICLE COUNTER	KAP	LB305K	LIMIT SWITCH	
PI	GREASE LUBE SYSTEM	PRESSURE GAUGE	WOERNER	HDB.A		THERE'S NO TAG FOR THIS COMPONENTS AS CUSTOMER SPECS.
PSV	GREASE LUBE SYSTEM	PRESSURE RELIEF VALVE	WOERNER / WIKA	111.16	MANOMETER	
TE-01706	HYDRAULIC DRIVE LUBE SYSTEM	OIL TEMPERATURE SENSOR	INOR	66RNS1011251213	ANALOG TEMPERATURE SENSOR Pt100	BY HÄGGLUNDS
LIT-01707	HYDRAULIC DRIVE LUBE SYSTEM	LOW LEVEL SENSOR	Bühler	63 kN L=370	LEVEL SENSOR	BY HÄGGLUNDS

PDSH-01702	HYDRAULIC DRIVE LUBE SYSTEM	OIL FILTER PRESSURE SWITCH (DRAIN LINE)	Hägglunds Drives	VD 2.2 LE.1/-30C-SO378-03 507800	FILTER INDICATOR	BY HÄGGLUNDS
PDSH-01700	HYDRAULIC DRIVE LUBE SYSTEM	OIL FILTER PRESSURE SWITCH (RETURN LINE)	Hägglunds Drives	VD 2.2 LE.1/-30C-SO378-03 507800	FILTER INDICATOR	BY HÄGGLUNDS
ZS-01703	HYDRAULIC DRIVE LUBE SYSTEM	SUCTION VALVE LIMIT SWITCH (MAIN HYD PUMP)	STEUTE	ES 95 R 1Ö/1S	SUCTION LINE INDICATOR	BY HÄGGLUNDS
PSL-01708	HYDRAULIC DRIVE LUBE SYSTEM	LOW CHARGE PRESSURE SENSOR	HYDAC	EDS 410-060-4-062	PRESSURE SWITCH	BY HÄGGLUNDS
PSL-01709	HYDRAULIC DRIVE LUBE SYSTEM	LOW CHARGE PRESSURE SENSOR (ACCUMULATOR)	HYDROPA	DS-802/M 0,5-15 bar	PRESSURE SWITCH	BY HÄGGLUNDS
PIT-01705	HYDRAULIC DRIVE LUBE SYSTEM	PRESSURE TRANSMITTER	HYDAC	HDA4745-A-400-000	PRESSURE TRANSMITTER	BY HÄGGLUNDS
ZT-01690	HYDRAULIC DRIVE LUBE SYSTEM	SPEED DRIVE SENSOR (ENCODER)	Hägglunds DRIVES	SPDB-3600	SPEED ENCODER	BY HÄGGLUNDS
FY-01711	HYDRAULIC DRIVE LUBE SYSTEM	PROPORTIONAL VALVE (FLOW A-PORT)	Hägglunds DRIVES	577 6216-056	SOLENOID	BY HÄGGLUNDS
FY-01712	HYDRAULIC DRIVE LUBE SYSTEM	PROPORTIONAL VALVE (FLOW B-PORT)	Hägglunds DRIVES	577 6216-056	SOLENOID	BY HÄGGLUNDS
ZS-01713	HYDRAULIC DRIVE LUBE SYSTEM	SHUT-OFF VALVE SWITCH (A-PORT) MOUNTED IN PIPE SYSTEM	REMOTE CONTROL	RCE 4L MEK	LIMIT SWITCH	BY HÄGGLUNDS
ZS-01714	HYDRAULIC DRIVE LUBE SYSTEM	SHUT-OFF VALVE SWITCH (B-PORT) MOUNTED IN PIPE SYSTEM	REMOTE CONTROL	RCE 4L MEK	LIMIT SWITCH	BY HÄGGLUNDS
TE-01715	HYDRAULIC DRIVE LUBE SYSTEM	THERMISTOR HIGH TEMPERATURE MOTOR #1	ABB	3GZF360	PTC	BY HÄGGLUNDS
TE-01716	HYDRAULIC DRIVE LUBE SYSTEM	THERMISTOR HIGH TEMPERATURE COOLING MOTOR	ABB	3GZF360	PTC	BY HÄGGLUNDS

xstrata copper	metso	**ANTAPACCAY PROJECT**	
BASIC ENGINEERING 60" WIDE APRON FEEDER TAG N° 0240-FEA-0007 ELECTRICAL LOADS' LIST		XSTRATA NUMBER: 25580-220-V1A-MHFA-00186	SHEET
		METSO NUMBER: 2141020344004	REV. 2

REV.	DATE	BY	VER.	APR.	AUT	TE	DESCRIPTION
1	6/30/2011	JVC	DHF	RCG	RCG	B	FIRST ISSUE
2	8/3/2011	JVC	DHF	RCG	RCG	E	GRD 25580-220-G26-GPS-06225

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4
Reviewer Name:
Date: 9/5/2011 00:00:00
Discipline: EM - Mechanical
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-MHFA-00186
Subm 002
Equip # 0240-FEA-0007;
Program # GRD-102034-083-11;
Job #
VP #
SEQ #
Equip #

CERTIFIED DOCUMENT

R.C.G. 03/08/11

THIS EQUIPMENT WILL BE CONSTRUCTED ACCORDING TO THIS CERTIFIED DOCUMENT.

TE - TYPE OF EMISSION (by METSO)			
A	PRELIMINARY	F	AS PURCHASED
B	FOR APPROVED	G	AS BUILT
C	FOR KNOWLEGDE	H	ELIMINATED
D	TO QUOTE	J	CERTIFIED
E	FOR CONSTRUCTION		

xstrata copper	metso	LOADS' LIST	ANTAPACCAY PROJECT	
BASIC ENGINEERING 60" WIDE APRON FEEDER TAG N° 0240-FEA-0007 ELECTRICAL LOADS' LIST			XSTRATA NUMBER: 25580-220-V1A-MHFA-00186	SHEET
			METSO NUMBER: 2141020344004	REV. 2

LEGEND:	IN-NOMINAL CURRENT IP-START CURRENT TB-LOCKED ROTOR WITHSTAND TIME (s)	SCM-SQUIRREL CAGE MOTOR MS-SYNCHRONOUS MOTOR MC-DIRECT CURRENT MOTOR	MA-WOUND ROTOR ME-SPECIAL MOTOR

IDENTIFICATION TAG	APPLICATION	TYPE	HP	NOMINAL POWER (kW)	POLES NUMBER	NOMINAL VOLTAGE (V) 60hz	PHASE	IN (A)	IP/IN	COS Ø	TB (s)	MOTOR FRAME	PROTECTION CLASS	MANUFACTURER	OBS
0240-FEA-0007-M1	PUMP OF HYDRAULIC MOTOR	SCM	75.00	56.00	4	460	3	89	9.48	0.83		M3BN 405 SMC 4/405	IP55	ABB	
															CANCELED
0240-FEA-0007-M2	COOLER PUMP OF HYDRAULIC UNIT	SCM	3.00	2.20	6	460	3						IP55	HÄGGLUNDS DRIVES	TYPE: HDCA 275-4-X-5-0-0
0240-FEA-0007-HXD	HEATER OF THE HYDRAULIC UNIT		0.90	0.67		460	-		-	-	-	-	-	BACKER	TYPE OE331/K7
0240-FEA-0007-M3	PUMP OF GREASE LUBE SYSTEM	SCM	0.16	0.07		230	1	1.6	1.80	0.75	8	71	IPW55	WEG	
	HEATER OF HYDRAULIC DRIVE MOTOR			0.06	-	230	1								
	HEATER OF THE COOLER FAN MOTOR			0.027	-	230	1								

CLIENT:	XSTRATA TINTAYA S.A.	**EQUIPMENT NO.:**	**0240-FEA-0006-M1**
PROJECT:	ANTAPACCAY PROJECT	**P.O. NO.:**	**25580-220-POA-MHFA-00001**
LOCATION:	CUSCO, PERÚ	**UNIT:**	LOW VOLTAGE AC INDUCTION MOTORS

LINE No.	DESCRIPTION	UNITS	SPECIFIED	SELLER PROPOSAL
1.00	**GENERAL**			
1.01	Manufacturer	-	By Seller	ABB LV Motors
1.02	Address / Location of assembly plant	-	By Seller	Vaasa Finland
1.03	Phone / fax	-	By Seller	+358102211
1.04	email address	-	By Seller	NA
1.05	Proposal No. / Date	-	By Seller	NA
1.06	Location of Assembly Plant	-	By Seller	Vaasa Finland
1.07	Catalog / Serial / Model / No.	-	By Seller	3GBN802230-BDG
2.00	**SITE CONDITIONS (Environment)**			
2.01	Altitude	m.a.s.l.	4200	4200
2.02	Ambient temperature max	°C	22	22
2.03	Ambient temperature min	°C	-10	-10
2.04	Ambient temperature Average	°C	8.3	8.3
2.05	Hazardous Location Motors	-	Not Required	Not Rquiered
2.06	Explosion Proof Class	-	N/A	N/A
2.07	Explosion Proof Group	-	N/A	N/A
2.08	Explosion Proof Division	-	N/A	N/A
3.00	**POWER SYSTEM**			
3.01	Rated Voltage	V	480	460
3.02	Phases	ph	3 ph	3
3.03	Frequency	Hz	60	60
3.04	Short circuit Capacity	kA	65 kA	NA
3.05	Grounding Type	-	Solid	Solid
4.00	**MOTOR STANDARD**		NEMA MG-1 2006	NEMA
5.00	**LOAD MECHANICAL CHARACTERISTICS**			
5.01	Driven equipment	-	As per MR	Hydraulic Motor
5.02	Shaft coupling method	-	As per MR	Torsionally felxible coupling
5.03	Mounting Position	-	As per MR	Vertical
5.04	Speed Type	-	As per MR	
5.05	Speed Range	-	As per MR	
5.06	Duty Type	-	As per MR	
5.07	Locations	Indoor/outdoor	Outdoor	Outdoor
6.00	**MOTOR DATA**			
6.01	Type of Induction Motor	-	SCIM	SCIM
6.02	Power Output	HP/kW	each specific application	75 / 56
6.03	Rated Voltage	V	460	460
6.04	Phases	ph	3	3
6.05	Frequency	Hz	60	60
6.06	Service Factor @ operating altitude	-	1.15	1.15
6.07	Poles	-	By Seller	4
6.08	RPM	RPM	By Seller	1785
6.09	Minimum terminal voltage during starting	per unit	0.85	0.86
6.10	Nema Design	-	B	B
6.11	Insulation Class	-	F	F
6.12	Temperature rise	-	Class B (80°C) at full load	F
6.13	Special insulations considerations	-	Not required	NA
6.14	Enclosure	-	TEFC	TEFC self ventilated
6.15	Frame	-	By Seller	M3BN 405 SMC 4 / 405
6.16	Weight	lb / kg	By Seller	1090 / 495
6.17	Starting Method DOL: Direct On Line SS: Soft Starter AFD: Adjustable Frequency Driver	-	each specific application	DOL

xstrata copper / metso	**DATA SHEET FOR LOW VOLTAGE INDUCTION MOTORS** **Sheet 2 of 4**	JOB No.	
		DATA SHEET No.	REV. No.
		-	2

CLIENT:	XSTRATA TINTAYA S.A.	EQUIPMENT NO.:	**0240-FEA-0007-M1**
PROJECT:	ANTAPACCAY PROJECT	P.O. NO.:	**25580-220-POA-MHFA-00001**
LOCATION:	CUSCO, PERÚ	UNIT:	LOW VOLTAGE AC INDUCTION MOTORS

LINE No.	DESCRIPTION	UNITS	SPECIFIED	SELLER PROPOSAL
1.00	**GENERAL**			
1.01	Manufacturer	-	By Seller	ABB LV Motors
1.02	Address / Location of assembly plant	-	By Seller	Vaasa Finland
1.03	Phone / fax	-	By Seller	+358102211
1.04	email address	-	By Seller	NA
1.05	Proposal No. / Date	-	By Seller	NA
1.06	Location of Assembly Plant	-	By Seller	Vaasa Finland
1.07	Catalog / Serial / Model / No.	-	By Seller	3GBN802230-BDG
2.00	**SITE CONDITIONS (Environment)**			
2.01	Altitude	m.a.s.l.	4200	4200
2.02	Ambient temperature max	°C	22	22
2.03	Ambient temperature min	°C	-10	-10
2.04	Ambient temperature Average	°C	8.3	8.3
2.05	Hazardous Location Motors	-	Not Required	Not Rquiered
2.06	Explosion Proof Class	-	N/A	N/A
2.07	Explosion Proof Group	-	N/A	N/A
2.08	Explosion Proof Division	-	N/A	N/A
3.00	**POWER SYSTEM**			
3.01	Rated Voltage	V	480	460
3.02	Phases	ph	3 ph	3
3.03	Frequency	Hz	60	60
3.04	Short circuit Capacity	kA	65 kA	NA
3.05	Grounding Type	-	Solid	Solid
4.00	**MOTOR STANDARD**		NEMA MG-1 2006	NEMA
5.00	**LOAD MECHANICAL CHARACTERISTICS**			
5.01	Driven equipment	-	As per MR	Hydraulic Motor
5.02	Shaft coupling method	-	As per MR	Torsionally felxible coupling
5.03	Mounting Position	-	As per MR	Vertical
5.04	Speed Type	-	As per MR	
5.05	Speed Range	-	As per MR	
5.06	Duty Type	-	As per MR	
5.07	Locations	Indoor/outdoor	Outdoor	Outdoor
6.00	**MOTOR DATA**			
6.01	Type of Induction Motor	-	SCIM	SCIM
6.02	Power Output	HP/kW	each specific application	75 / 56
6.03	Rated Voltage	V	460	460
6.04	Phases	ph	3	3
6.05	Frequency	Hz	60	60
6.06	Service Factor @ operating altitude	-	1.15	1.15
6.07	Poles	-	By Seller	4
6.08	RPM	RPM	By Seller	1785
6.09	Minimum terminal voltage during starting	per unit	0.85	0.86
6.10	Nema Design	-	B	B
6.11	Insulation Class	-	F	F
6.12	Temperature rise	-	Class B (80°C) at full load	F
6.13	Special insulations considerations	-	Not required	NA
6.14	Enclosure	-	TEFC	TEFC self ventilated
6.15	Frame	-	By Seller	M3BN 405 SMC 4 / 405
6.16	Weight	lb / kg	By Seller	1090 / 495
6.17	Starting Method DOL: Direct On Line SS: Soft Starter AFD: Adjustable Frequency Driver	-	each specific application	DOL

xstrata copper / metso	**DATA SHEET FOR LOW VOLTAGE INDUCTION MOTORS** **Sheet 2 of 4**	JOB No.	
		DATA SHEET No.	REV. No.
		25580-220-V1A-MHFA-00187	2

LINE No.	DESCRIPTION	UNITS	SPECIFIED	SELLER PROPOSAL
6.16	Motor Efficiency Type	-	NEMA Premium	High Efficiency (IE2)
6.17	Efficiency at 100% of full load	%	By Seller	94.5
6.18	Efficiency at 75 % of full load	%	By Seller	94
6.19	Efficiency at 50 % of full load	%	By Seller	91.7
6.20	Power Factor at 100% of full load	%	By Seller	0.83
6.21	Power Factor at 75 % of full load	%	By Seller	0.77
6.22	Power Factor at 50 % of full load	%	By Seller	0.68
6.23	Full Load Current	A	By Seller	89
6.24	Locked rotor current @ Full Voltage	A	By Seller	844
6.25	Locked rotor current @ 90% Voltage	A	By Seller	
6.26	Sound Power Level (No Load) @ 1 meter	dBA	90 dBA (Max) - By Motor Manufacturer	70 dBA (at load)
6.27	Allowable Stall Time @ Full Voltage (s)	sec	By Seller	NA
6.28	Allowable Stall Time @ 90 % Voltage (s.)	sec	By Seller	NA
6.29	Starting Torque @ Minimum Starting Voltage	%	120% of driven load	239%
6.30	Winding Connection		Wye	Delta
6.31	Number of starts per hours (cold/hot)	No.	By Seller	375
6.32	Thermal life of insulation at rated load at 40° ambient.	yrs	By Seller	25
7.00	**BEARINGS**			
7.01	Type	-	Anti-friction	Ball Bearings
7.02	Lubrication Method	-	Re-greasable	Re-greasable
7.03	Manufacturer & Number	-	By Seller	6315/C3 - 6316/C3
7.04	Bearing Life. L-10 life, 100,000 hrs for direct coupled; 60,000 hours for conveyor idlers and blower; 80,000 hours for gear drives, reducers and pillow block for conveyor pulleys and 3,000 hours for trolleys and hoists	hrs	By Seller	According ISSO 281
7.05	Bearing Protection	-	Labyrinth type Taconite seal	Labyrinth seal
8.00	**ADDITIONAL REQUIREMENTS FOR AFD SERVICE**			NA
8.01	Inverter Type	-		
8.02	Rated operation modes - VT / CT / CP	-		
8.03	Rated power output at Base Speed	hp		
8.04	Base Speed	rpm		
8.05	Constant Power speed range	rpm		
8.06	Constant Torque speed range	rpm		
8.07	Continuous Constant Torque speed range	rpm		
8.08	Variable Torque speed range	rpm		
8.09	Variable Torque speed exponent	-		
8.10	Starting (breakaway) torque	per unit		
8.11	Run up torque	per unit		
8.12	Inching speed	rpm		
8.13	Inching torque	per unit		
8.14	Inching duration	min		

LINE No.	DESCRIPTION	UNITS	SPECIFIED	SELLER PROPOSAL
9.00	**ACCESSORIES**			
9.01	Space Heaters		Required for TEFC 75 kW / 100 hp motors and above	
9.02	Space Heaters Volts	V	220 V	220
9.03	Space Heaters Watts	W	By Seller	60W
9.04	Separate Space Heater Connection	-	Required	Yes
9.05	Space heater terminal box location	-	By Seller	Inside main terminal box
9.06	RTD´s	-	Required for 298 kW / 400 hp motors and above	NA
9.07	Winding Temperature RTD´s (6 - 2 per phase)	-		NA
9.08	Bearing Temperature RTD´s (2 - 1 per bearing)			NA
9.09	Separate RTD box	-	Required	NA
9.10	RTD´s terminal box location	-	By Seller	NA
9.11	Moisture System for Submersible Motors	-	humidity sensor required	NA
9.12	Cable Entry Length for Submersible Motors	-	By Seller	NA
9.13	Ground lugs inside main terminal box	-	Required	Yes
9.14	Ground lugs on frame (2/0 AWG cable)	-	Required	Yes
9.15	Main terminal box location	-	By Seller	Top
9.16	Space heater terminal box location	-	By Seller	Inside the main terminal box
9.17	Motor Manufacturer nameplate with all motor parameters	-	Required	Yes
9.18	Nameplates shall be stainless steel		Required	Yes
9.19	Nameplates shall include operation altitude of 4200 masl indication		Required	Yes
9.20	Lifting lugs or eyesbolts for frames 182 and larger		Required	Yes
10.00	**TESTING**		According to requirements of NEMA MG1 p. 12.55.2	
10.01	ROUTINE TESTS			
10.02	Measurement of Winding Resistance	-	Required	Yes
10.03	No load current and speed at rated voltage and frequency	-	Required	Yes
10.04	Current input at rated frequency with rotor at standstill for squirrel-cage motors	-	Required	Yes
10.05	High-potential test	-	Required	Yes
10.06		-		
10.07	SPECIAL TESTING	-		
10.08	Determination of efficiency at 100%, 75% and 50% of full load	%	Not Required	
10.09	Determination of power factor at 100%, 75% and 50% of full load	%	Not Required	
10.10	Temperature rise test	°C	Not Required	
10.11	Measure locked rotor current	A	Not Required	
10.12	Measure breakdown and starting torques	-	Not Required	
10.13	Sound test per IEEE 85	dBA	Not Required	
10.14	Speed torque test	-	Not Required	
10.15	Bearing Temperature	°C	Not Required	

xstrata copper | metso | ANTAPACCAY PROJECT

BASIC ENGINEERING 60" WIDE APRON FEEDER TAG N° 0240-FEA-0008 ELECTRICAL LOADS' LIST	XSTRATA NUMBER: 25580-220-V1A-MHFA-00194	SHEET	
	METSO NUMBER: 2141020345004	REV. 2	

REV.	DATE	BY	VER.	APR.	AUT	TE	DESCRIPTION
1	6/30/2011	JVC	DHF	RCG	RCG	B	FIRST ISSUE
2	8/3/2011	JVC	DHF	RCG	RCG	E	GRD 25580-220-G26-GPS-06225

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4
Reviewer Name:
Date: 9/5/2011 00:00:00
Discipline: EM - Mechanical
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-MHFA-00194
Subm 002
Equip # 0240-FEA-0008;
Program # GRD-102034-083-11;
Job #
VP #
SEQ #
Equip #

CERTIFIED DOCUMENT

R.C.G. 03/08/11

THIS EQUIPMENT WILL BE CONSTRUCTED ACCORDING TO THIS CERTIFIED DOCUMENT.

TE - TYPE OF EMISSION (by METSO)

A	PRELIMINARY	F	AS PURCHASED
B	FOR APPROVED	G	AS BUILT
C	FOR KNOWLEGDE	H	ELIMINATED
D	TO QUOTE	J	CERTIFIED
E	FOR CONSTRUCTION		

xstrata copper | metso | **LOADS' LIST** | **ANTAPACCAY PROJECT**

BASIC ENGINEERING
60" WIDE APRON FEEDER
TAG N° 0240-FEA-0008
ELECTRICAL LOADS' LIST

XSTRATA NUMBER: 25580-220-V1A-MHFA-00194
SHEET:
METSO NUMBER: 2141020345004
REV. 2

LEGEND:
IN-NOMINAL CURRENT
IP-START CURRENT
TB-LOCKED ROTOR WITHSTAND TIME (s)
SCM-SQUIRREL CAGE MOTOR
MS-SYNCHRONOUS MOTOR
MC-DIRECT CURRENT MOTOR
MA-WOUND ROTOR
ME-SPECIAL MOTOR

IDENTIFICATION TAG	APPLICATION	TYPE	HP	NOMINAL POWER (kW)	POLES NUMBER	NOMINAL VOLTAGE (V) 60hz	PHASE	IN (A)	IP/IN	COS Ø	TB (s)	MOTOR FRAME	PROTECTION CLASS	MANUFACTURER	OBS
0240-FEA-0008-M1	PUMP OF HYDRAULIC MOTOR	SCM	75.00	56.00	4	460	3	89	9.48	0.83		M3BN 405 SMC 4/405	IP55	ABB	
															CANCELED
0240-FEA-0008-M2	COOLER PUMP OF HYDRAULIC UNIT	SCM	3.00	2.20	6	460	3						IP55	HÄGGLUNDS DRIVES	TYPE: HDCA 275-4-X-5-0-0
0240-FEA-0008-HXD	HEATER OF THE HYDRAULIC UNIT		0.90	0.67		460	-		-	-	-	-	-	BACKER	TYPE OE331/K7
0240-FEA-0008-M3	PUMP OF GREASE LUBE SYSTEM	SCM	0.16	0.07		230	1	1.6	1.80	0.75	8	71	IPW55	WEG	
	HEATER OF HYDRAULIC DRIVE MOTOR			0.06	-	230	1								
	HEATER OF THE COOLER FAN MOTOR			0.027	-	230	1								

xstrata copper | metso

ANTAPACCAY PROJECT

BASIC ENGINEERING 60" WIDE APRON FEEDER TAG N° 0240-FEA-0008 INSTRUMENTS' LIST	XSTRATA NUMBER: 25580-220-V1A-MHFA-00192	SHEET
	METSO NUMBER: 2141020345002	REV. 2

REV.	DATE	BY	VER.	APR.	AUT	TE	DESCRIPTION
1	7/1/2011	JVC	DHF	RCG	RCG	B	FIRST ISSUE
2	8/5/2011	JVC	DHF	RCG	RCG	E	GRD 25580-220-G26-GPS-06225

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4
Reviewer Name:
Date: 9/5/2011 00:00:00
Discipline: EM - Mechanical
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-MHFA-00192
Subm 002
Equip # 0240-FEA-0008;
Program # GRD-102034-083-11;
Job #
VP #
SEQ #
Equip #

CERTIFIED DOCUMENT

R.C.G. 05/08/11

THIS EQUIPMENT WILL BE CONSTRUCTED ACCORDING TO THIS CERTIFIED DOCUMENT.

TE - TYPE OF EMISSION (by METSO)			
A	PRELIMINARY	F	AS PURCHASED
B	FOR APPROVED	G	AS BUILT
C	FOR KNOWLEGDE	H	ELIMINATED
D	TO QUOTE	J	CERTIFIED
E	FOR CONSTRUCTION		

xstrata copper	metso	INSTRUMENT LIST	ANTAPACCAY PROJECT	
BASIC ENGINEERING 60" WIDE APRON FEEDER TAG N° 0240-FEA-0008 INSTRUMENTS' LIST			XSTRATA NUMBER: 25580-220-V1A-MHFA-00192	SHEET
			METSO NUMBER: 2141020345002	REV.: 2

TAG IDENTIFICATION	LOCATION	DESCRIPTION (FUNCTION)	MANUFACTURER	MODEL	TYPE	OBSERVATION
HS-01111-01	60" APRON FEEDER 0240-FEA-0008	PULL CORD EMERGENCY STOP	CONVEYOR COMPONENTS	RS-2E	PULLCORD SWITCH	DPDT
HS-01112-01	60" APRON FEEDER 0240-FEA-0008	PULL CORD EMERGENCY STOP	CONVEYOR COMPONENTS	RS-2E	PULLCORD SWITCH	DPDT
LX-01114 / LSH-01114	60" APRON FEEDER 0240-FEA-0008	PLUGGED DISCHARGE CHUTE	HYCONTROL	HYCMWSSTSR110X	MICROWAVE LEVEL SWITCH	SUPPLIED BY BECHTEL
SE/SSL-01113	60" APRON FEEDER 0240-FEA-0008	ZERO SPEED DETECTOR	MILLTRONICS	MSP-12/MF A4P	LIGHT PULSES MEASURE	
YA-01115 / YL-01115	60" APRON FEEDER 0240-FEA-0008	PRE-START WARNING	EDWARDS SIGNALING	B-KM-8130-N5 / 49R-N5-40WH	HORN & BEACON	SUPPLIED BY BECHTEL
PSH-01727	GREASE LUBE SYSTEM	HIGH PRESSURE SENSOR	ASTA	TP AT DA 40 IA	DIAPHRAGM	
LSL-01728	GREASE LUBE SYSTEM	LOW LEVEL SWITCH	KAP	LB305H	LIMIT SWITCH	
KS-01729	GREASE LUBE SYSTEM	CICLE COUNTER	KAP	LB305K	LIMIT SWITCH	
PI	GREASE LUBE SYSTEM	PRESSURE GAUGE	WOERNER	HDB.A		THERE'S NO TAG FOR THIS COMPONENTS AS CUSTOMER SPECS.
PSV	GREASE LUBE SYSTEM	PRESSURE RELIEF VALVE	WOERNER / WIKA	111.16	MANOMETER	
TE-01736	HYDRAULIC DRIVE LUBE SYSTEM	OIL TEMPERATURE SENSOR	INOR	66RNS1011251213	ANALOG TEMPERATURE SENSOR Pt100	BY HÄGGLUNDS
LIT-01737	HYDRAULIC DRIVE LUBE SYSTEM	LOW LEVEL SENSOR	Bühler	63 kN L=370	LEVEL SENSOR	BY HÄGGLUNDS

PDSH-01732	HYDRAULIC DRIVE LUBE SYSTEM	OIL FILTER PRESSURE SWITCH (DRAIN LINE)	Hägglunds Drives	VD 2.2 LE.1/-30C-SO378-03 507800	FILTER INDICATOR	BY HÄGGLUNDS
PDSH-01730	HYDRAULIC DRIVE LUBE SYSTEM	OIL FILTER PRESSURE SWITCH (RETURN LINE)	Hägglunds Drives	VD 2.2 LE.1/-30C-SO378-03 507800	FILTER INDICATOR	BY HÄGGLUNDS
ZS-01733	HYDRAULIC DRIVE LUBE SYSTEM	SUCTION VALVE LIMIT SWITCH (MAIN HYD PUMP)	STEUTE	ES 95 R 1Ö/1S	SUCTION LINE INDICATOR	BY HÄGGLUNDS
PSL-01738	HYDRAULIC DRIVE LUBE SYSTEM	LOW CHARGE PRESSURE SENSOR	HYDAC	EDS 410-060-4-062	PRESSURE SWITCH	BY HÄGGLUNDS
PSL-01739	HYDRAULIC DRIVE LUBE SYSTEM	LOW CHARGE PRESSURE SENSOR (ACCUMULATOR)	HYDROPA	DS-802/M 0,5-15 bar	PRESSURE SWITCH	BY HÄGGLUNDS
PIT-01735	HYDRAULIC DRIVE LUBE SYSTEM	PRESSURE TRANSMITTER	HYDAC	HDA4745-A-400-000	PRESSURE TRANSMITTER	BY HÄGGLUNDS
ZT-01720	HYDRAULIC DRIVE LUBE SYSTEM	SPEED DRIVE SENSOR (ENCODER)	Hägglunds DRIVES	SPDB-3600	SPEED ENCODER	BY HÄGGLUNDS
FY-01741	HYDRAULIC DRIVE LUBE SYSTEM	PROPORTIONAL VALVE (FLOW A-PORT)	Hägglunds DRIVES	577 6216-056	SOLENOID	BY HÄGGLUNDS
FY-01742	HYDRAULIC DRIVE LUBE SYSTEM	PROPORTIONAL VALVE (FLOW B-PORT)	Hägglunds DRIVES	577 6216-056	SOLENOID	BY HÄGGLUNDS
ZS-01743	HYDRAULIC DRIVE LUBE SYSTEM	SHUT-OFF VALVE SWITCH (A-PORT) MOUNTED IN PIPE SYSTEM	REMOTE CONTROL	RCE 4L MEK	LIMIT SWITCH	BY HÄGGLUNDS
ZS-01744	HYDRAULIC DRIVE LUBE SYSTEM	SHUT-OFF VALVE SWITCH (B-PORT) MOUNTED IN PIPE SYSTEM	REMOTE CONTROL	RCE 4L MEK	LIMIT SWITCH	BY HÄGGLUNDS
TE-01745	HYDRAULIC DRIVE LUBE SYSTEM	THERMISTOR HIGH TEMPERATURE MOTOR #1	ABB	3GZF360	PTC	BY HÄGGLUNDS
TE-01746	HYDRAULIC DRIVE LUBE SYSTEM	THERMISTOR HIGH TEMPERATURE COOLING MOTOR	ABB	3GZF360	PTC	BY HÄGGLUNDS

CLIENT:	**XSTRATA TINTAYA S.A.**
PROJECT TITLE:	**ANTAPACCAY PROJECT**
PROJECT LOCATION:	**CUSCO, PERÚ**
P.O.N°:	**25580-220-POA-MHFA-00001**
UNIT:	**LOW VOLTAGE AC INDUCTION MOTORS**
EQUIPMENT TITLE:	**STOCKPILE CRUSHER RECLAIM APRON FEEDER**
EQUIPMENT N°:	**0240-FEA-0008-M1**
REFER TO SPECIFICATION N°: For General Requirements	**25580-220-3PS-MUMI-00001**
APPLICABLE CODES	**NEMA MG 1-2006 Revision 1**
COMMENTS:	
TAG ID's	As per MR.

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 ~~Work may proceed~~
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4
Reviewer Name:
Date: 9/5/2011 00:00:00
Discipline: EM - Mechanical
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-MHFA-0019
Subm 002
Equip # N/A;
Program # GRD-102034-083-11;
Job #
VP #
SEQ #
Equip #

CERTIFIED DOCUMENT

R.C.G. 05/08/11

THIS EQUIPMENT WILL BE CONSTRUCTED ACCORDING TO THIS CERTIFIED DOCUMENT.

Nº Metso: 2141020345005

REV	DATE	REASON FOR REVISION	BY	CHECK	EGS	PE	CLIENT
2	5-Aug-11	GRD 25580-220-G26-GPS-06225	DHF	JVC	RCG		
1	30-Jun-11	FIRST ISSUE	DHF	JVC	RCG		

xstrata copper | metso

DATA SHEET FOR LOW VOLTAGE INDUCTION MOTORS

Sheet 1 of 4

JOB No.	
DATA SHEET No.	REV. No.
25580-220-V1A-MHFA-00195	**2**

Electronic documents, once printed, are uncontrolled and may become outdated
Refer to the electronic documents in Project InfoWorks STOXSTRATA for current revision

CLIENT:	XSTRATA TINTAYA S.A.	EQUIPMENT NO.:	0240-FEA-0008-M1
PROJECT:	ANTAPACCAY PROJECT	P.O. NO.:	25580-220-POA-MHFA-00001
LOCATION:	CUSCO, PERÚ	UNIT:	LOW VOLTAGE AC INDUCTION MOTORS

LINE No.	DESCRIPTION	UNITS	SPECIFIED	SELLER PROPOSAL
1.00	**GENERAL**			
1.01	Manufacturer	-	By Seller	ABB LV Motors
1.02	Address / Location of assembly plant	-	By Seller	Vaasa Finland
1.03	Phone / fax	-	By Seller	+358102211
1.04	email address	-	By Seller	NA
1.05	Proposal No. / Date	-	By Seller	NA
1.06	Location of Assembly Plant	-	By Seller	Vaasa Finland
1.07	Catalog / Serial / Model / No.	-	By Seller	3GBN802230-BDG
2.00	**SITE CONDITIONS (Environment)**			
2.01	Altitude	m.a.s.l.	4200	4200
2.02	Ambient temperature max	°C	22	22
2.03	Ambient temperature min	°C	-10	-10
2.04	Ambient temperature Average	°C	8.3	8.3
2.05	Hazardous Location Motors	-	Not Required	Not Rquiered
2.06	Explosion Proof Class	-	N/A	N/A
2.07	Explosion Proof Group	-	N/A	N/A
2.08	Explosion Proof Division	-	N/A	N/A
3.00	**POWER SYSTEM**			
3.01	Rated Voltage	V	480	460
3.02	Phases	ph	3 ph	3
3.03	Frequency	Hz	60	60
3.04	Short circuit Capacity	kA	65 kA	NA
3.05	Grounding Type	-	Solid	Solid
4.00	**MOTOR STANDARD**		NEMA MG-1 2006	NEMA
5.00	**LOAD MECHANICAL CHARACTERISTICS**			
5.01	Driven equipment	-	As per MR	Hydraulic Motor
5.02	Shaft coupling method	-	As per MR	Torsionally felxible coupling
5.03	Mounting Position	-	As per MR	Vertical
5.04	Speed Type	-	As per MR	
5.05	Speed Range	-	As per MR	
5.06	Duty Type	-	As per MR	
5.07	Locations	Indoor/outdoor	Outdoor	Outdoor
6.00	**MOTOR DATA**			
6.01	Type of Induction Motor	-	SCIM	SCIM
6.02	Power Output	HP/kW	each specific application	75 / 56
6.03	Rated Voltage	V	460	460
6.04	Phases	ph	3	3
6.05	Frequency	Hz	60	60
6.06	Service Factor @ operating altitude	-	1.15	1.15
6.07	Poles	-	By Seller	4
6.08	RPM	RPM	By Seller	1785
6.09	Minimum terminal voltage during starting	per unit	0.85	0.86
6.10	Nema Design	-	B	B
6.11	Insulation Class	-	F	F
6.12	Temperature rise	-	Class B (80°C) at full load	F
6.13	Special insulations considerations	-	Not required	NA
6.14	Enclosure	-	TEFC	TEFC self ventilated
6.15	Frame	-	By Seller	M3BN 405 SMC 4 / 405
6.16	Weight	lb / kg	By Seller	1090 / 495
6.17	Starting Method DOL: Direct On Line SS: Soft Starter AFD: Adjustable Frequency Driver	-	each specific application	DOL

xstrata copper / metso	DATA SHEET FOR LOW VOLTAGE INDUCTION MOTORS Sheet 2 of 4	JOB No.
	DATA SHEET No.: 25580-220-V1A-MHFA-00195	REV. No.: 2

LINE No.	DESCRIPTION	UNITS	SPECIFIED	SELLER PROPOSAL
6.16	Motor Efficiency Type	-	NEMA Premium	HIgh Efficiency (IE2)
6.17	Efficiency at 100% of full load	%	By Seller	94.5
6.18	Efficiency at 75 % of full load	%	By Seller	94
6.19	Efficiency at 50 % of full load	%	By Seller	91.7
6.20	Power Factor at 100% of full load	%	By Seller	0.83
6.21	Power Factor at 75 % of full load	%	By Seller	0.77
6.22	Power Factor at 50 % of full load	%	By Seller	0.68
6.23	Full Load Current	A	By Seller	89
6.24	Locked rotor current @ Full Voltage	A	By Seller	844
6.25	Locked rotor current @ 90% Voltage	A	By Seller	
6.26	Sound Power Level (No Load) @ 1 meter	dBA	90 dBA (Max) - By Motor Manufacturer	70 dBA (at load)
6.27	Allowable Stall Time @ Full Voltage (s)	sec	By Seller	NA
6.28	Allowable Stall Time @ 90 % Voltage (s.)	sec	By Seller	NA
6.29	Starting Torque @ Minimum Starting Voltage	%	120% of driven load	239%
6.30	Winding Connection		Wye	Delta
6.31	Number of starts per hours (cold/hot)	No.	By Seller	375
6.32	Thermal life of insulation at rated load at 40° ambient.	yrs	By Seller	25
7.00	**BEARINGS**			
7.01	Type	-	Anti-friction	Ball Bearings
7.02	Lubrication Method	-	Re-greasable	Re-greasable
7.03	Manufacturer & Number	-	By Seller	6315/C3 - 6316/C3
7.04	Bearing Life. L-10 life, 100,000 hrs for direct coupled; 60,000 hours for conveyor idlers and blower; 80,000 hours for gear drives, reducers and pillow block for conveyor pulleys and 3,000 hours for trolleys and hoists	hrs	By Seller	According ISSO 281
7.05	Bearing Protection	-	Labyrinth type Taconite seal	Labyrinth seal
8.00	**ADDITIONAL REQUIREMENTS FOR AFD SERVICE**			NA
8.01	Inverter Type	-		
8.02	Rated operation modes - VT / CT / CP	-		
8.03	Rated power output at Base Speed	hp		
8.04	Base Speed	rpm		
8.05	Constant Power speed range	rpm		
8.06	Constant Torque speed range	rpm		
8.07	Continuous Constant Torque speed range	rpm		
8.08	Variable Torque speed range	rpm		
8.09	Variable Torque speed exponent	-		
8.10	Starting (breakaway) torque	per unit		
8.11	Run up torque	per unit		
8.12	Inching speed	rpm		
8.13	Inching torque	per unit		
8.14	Inching duration	min		

LINE No.	DESCRIPTION	UNITS	SPECIFIED	SELLER PROPOSAL
9.00	**ACCESSORIES**			
9.01	Space Heaters		Required for TEFC 75 kW / 100 hp motors and above	
9.02	Space Heaters Volts	V	220 V	220
9.03	Space Heaters Watts	W	By Seller	60W
9.04	Separate Space Heater Connection	-	Required	Yes
9.05	Space heater terminal box location	-	By Seller	Inside main terminal box
9.06	RTD´s	-	Required for 298 kW / 400 hp motors and above	NA
9.07	Winding Temperature RTD´s (6 - 2 per phase)	-		NA
9.08	Bearing Temperature RTD´s (2 - 1 per bearing)			NA
9.09	Separate RTD box	-	Required	NA
9.10	RTD´s terminal box location	-	By Seller	NA
9.11	Moisture System for Submersible Motors	-	humidity sensor required	NA
9.12	Cable Entry Length for Submersible Motors	-	By Seller	NA
9.13	Ground lugs inside main terminal box	-	Required	Yes
9.14	Ground lugs on frame (2/0 AWG cable)	-	Required	Yes
9.15	Main terminal box location	-	By Seller	Top
9.16	Space heater terminal box location	-	By Seller	Inside the main terminal box
9.17	Motor Manufacturer nameplate with all motor parameters	-	Required	Yes
9.18	Nameplates shall be stainless steel		Required	Yes
9.19	Nameplates shall include operation altitude of 4200 masl indication		Required	Yes
9.20	Lifting lugs or eyesbolts for frames 182 and larger		Required	Yes
10.00	**TESTING**		According to requirements of NEMA MG1 p. 12.55.2	
10.01	ROUTINE TESTS			
10.02	Measurement of Winding Resistance	-	Required	Yes
10.03	No load current and speed at rated voltage and frequency	-	Required	Yes
10.04	Current input at rated frequency with rotor at standstill for squirrel-cage motors	-	Required	Yes
10.05	High-potential test	-	Required	Yes
10.06		-		
10.07	SPECIAL TESTING	-		
10.08	Determination of efficiency at 100%, 75% and 50% of full load	%	Not Required	
10.09	Determination of power factor at 100%, 75% and 50% of full load	%	Not Required	
10.10	Temperature rise test	°C	Not Required	
10.11	Measure locked rotor current	A	Not Required	
10.12	Measure breakdown and starting torques	-	Not Required	
10.13	Sound test per IEEE 85	dBA	Not Required	
10.14	Speed torque test	-	Not Required	
10.15	Bearing Temperature	°C	Not Required	

BECHTEL / xstrata copper	metso	**ANTAPACCAY PROJECT**

	ANTAPACCAY No.: 25580-220-V1A-MHFA-00038	FOLHA: 1/3
ANTAPACCAY PROJECT APRON FEEDER 0240-FEA-0005@0008 DATA SHEET	METSO No.: 40102034025	REV.: 3

OPERATING REQUIREMENT/CONDITIONS

Material Description: Copper ore

Physical Characteristics:

Bulk density for volume	1.6	t/m^3	Moisture content	5	%
for weight	1.89	t/m^3	Material temperature	NA	° C
Angle of repose	37-40	Degrees	Plant site elevation	4200	m.a.s.l
Ore hardness	Medium hardness				

Particle size distribution:

Size	% passing (Cum.)
305 mm (TBC)	100
168 mm (TBC)	80

Feed hopper capacity: NA (Stockpile) t

Apron feeder location: X Indoor ☐ Outdoor

Operating schedule: 24 hrs. / day 365 days / yr.

DATA BOX

TAG	Op / Stby	Balance, each	Design each	Moisture Content	Bulk density	Plant Site Elevation	Ambient Temp Range
	un.	t/h	t/h	%	t/m^3	m.a.s.l.	°C
0240-FEA-0005 @ 0008	3 op / 1 stby	1 112	1280	3.0 - 5.0	1.6	4 200	-10 to +25

CAPACITY AND POWER REQUIREMENTS

Balance capacity:	1 112	t/h	Installed electrical power	56	kW
Balance capacity speed:	0.15	m/s	Motor Manufacturer	ABB	
Maximum design capacity:	1 280	t/h	Motor Service Factor	1.15	
Maximum design cap. speed:	0.22	m/s	Motor RPM	1785	

* These information will be confirmed after the drive purchase

MODEL AND SIZE

Name : Coarse Ore Reclaim Apron Feeder
Manufacturer : METSO BRASIL INDÚSTRIA E COMÉRCIO LTDA.
Model : AF5-60
Sizes : width: 60" (1 524 mm)
length: 30.67' (9 350 mm)

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 1
Reviewer Name:
Date: 6/16/2011 00:00:00
Discipline: EM - Mechanical
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-MHFA-00038
Subm 003
Equip # 0240-FEA-0005;0240-FEA-0006;0240-FEA-0007;0240-FEA-00
Program # N/A;
Job #
VP #
SEQ #
Equip #

COMPONENTS

DRIVE:

Countershaft ratio	NA	Reducer, MFR.	NA
Chain ratio	NA	Reducer type / model	NA
		Reducer ratio	NA
		V-belt ratio	NA

Variable speed drive
Other: NA
Torque limiting device: NA
Drive Reduction Efficiency: 93%

HEAD SPROCKET

Material	Cast manganese alloy	Pitch diameter	581 mm
Tooth hardness	360 - 440 HB	Type: Segmented [X]	Non-segmented [ ]
Number of teeth	21	Reversible [ ]	Non-reversible [ ]

TAIL WHEEL

Material		Diameter	**558 mm**
Split [ ]	Solid [X]	Type: Segmented [ ]	Non-segmented [X]

HOPPER AND SKIRT

Material	Carbon steel A-36	Liner: Material	**ASTM A 532 Class II Type D**
Thickness	10 mm	Thickness	38 mm
		Hardness	500 - 650 BHN

CARRYING ROLLERS AND SHAFT

Material	Hardened forged steel	Bearing: Type	Not specified
Diameter	203 mm mm	Material	Not specified
No. of rollers	52	Diameter (I.D.)	Not specified mm
Spacing in impact area	330 mm	Lubrication	Lifetime lubrication

RETURN ROLLERS AND SHAFT

Material	Hardened forged steel	Bearing type	Not specified
Diameter	173 mm mm	Bearing: Material	Not specified
No. of rollers / side	14	Diameter (I.D.)	Not specified mm
		Lubrication	Lifetime lubrication

FEEDER PAN

Material	Manganese Steel ASTM A128 gr. B	Height of flange edges	52 mm
Thickness	38 mm	Weight of pans	88 (each) kg
Width of pan	1 524 (60") mm	Deflection limited by (Describe)	2 impact beam (impact rails)

FEEDER CHAINS

Crawler tractor chains [X] Yes [ ] No

Link:	Material	hardened steel	Pitch	171.5 (6.75") mm
	Hardness	Not specified BHN	No. of strands	2
Bushing:	Material	hardened steel	Chain pull, operating:	10826 kgf
	Hardness	Not specified BHN	Max. allowable chain pull	86000 kgf
Pin:	Material	hardened steel	Chain weight	7.6 kg
	Hardness	Not specified BHN		

HEAD SHAFT AND BEARINGS

Shaft, material	C4140 forged steel	Bearing	Spherical roller pillow block
Bearing diameter	220 mm	Lubrication	Automatic lubrication

TAIL SHAFT AND BEARINGS

Shaft, material	NA	Bearing type	Not specified
Bearing diameter	Not specified mm	Lubrication	Lifetime lubrication

INSTRUMENTATION AND CONTROLS

	Yes	No
Pull cord safety switch	X	
Speed detector	X	
Discharge plugged chute detector (tilt switch)		X
Discharge plugged chute detector (microwave switch)	X	
Hydraulic motor control unit	X	
Control Unit	X	

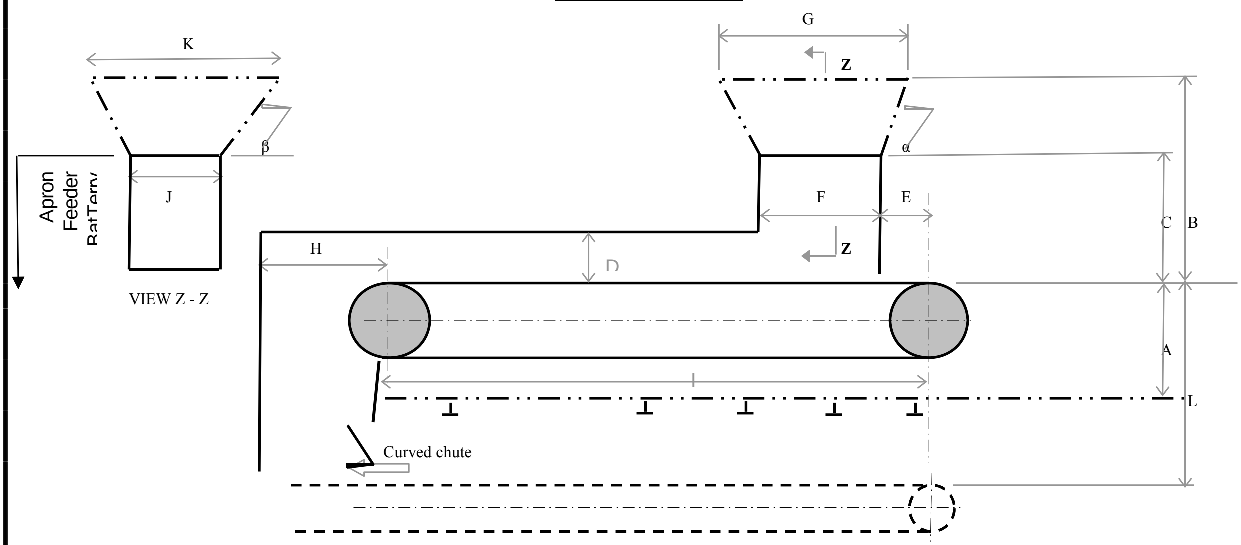
LUBRICATION SYSTEM

Local lubrication system, each bearing fitted with grease fitting for manual lubrication:	[ ]
Automatic central pressure system, manually operated:	[ ]
Automatic central pressure system, electrically operated:	[X] (for head shaft bearing pillow block)

WEIGHTS

Heaviest piece for maintenance	Drive unit		Heaviest piece for erection	Assembled frame	
Weight	1 500	kg	Weight	25 000	kg
Dimensions	2320 x 1500 x 1000	mm x mm x mm	Dimensions	12580 x 2500 x 1590	mm x mm x mm

DIMENSIONAL DATA



A:	1345 mm	F	7106 mm	K	2576 mm
B:	4004 mm	G	8152 mm	L	2600 mm
C:	1969 mm	H	1488 mm	M	*NA mm
D:	998 mm	I	9350 mm	N	*NA mm
E:	742 mm	J	1400 mm		

Inlet Flanged :	[ ] Yes	[X] No
Outlet Flanged:	[X] Yes	[ ] No

Slope angle of feeder:	0 degrees
α	74 degrees
β	74 degrees
γ	*60 degrees

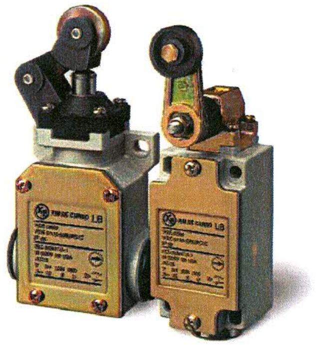
* According to the preliminary data sheet recieved from Bechtel

REV.	DATE	DESCRIPTION	BY	CHECK.	APPROV.
3	3-Jun-11	CT-19569	PRZ	FEZ	ISK
2	4-Nov-10	CT-19086	FEZ	MFR	ISK
1	9-Sep-10	First issued	TOV	MFR	ISK

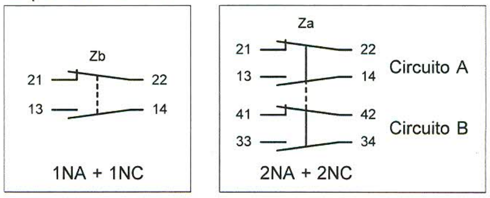
Serie LB

Interruptor de Posición Industrial

- Interruptor metálico para aplicaciones industriales
- 2 opciones de cuerpos: DIN EN 50041 y con 3 entradas de cables
- Grado de Protección IP66
- Cabezales intercambiables entre todos los cuerpos
- Posibilidad de montaje de los cabezales de 90º en 90º
- Circuito con capacidad 10A
- Operación de los contactos con polaridad doble ①
- Ruptura positiva del contacto NC ➔ ①
- Larga vida mecánica de los cabezales ①
- Opción de LED frontal de señalización ①



Esquemas Eléctricos



Sujeto a modificaciones sin previo aviso

Especificaciones

Capacidad Eléctrica	10A en 250Vca	
Corriente nominal termal (Ith)	10A (IEC 60947-5-1)	
Tension de Aislamiento (Ui)	500 Vca (IEC 60947-5-1)	
Resistencia de Contacto	50 mΩ máximo inicial (em 1A 5Vcc)	
Temperatura Ambiente	+85°C máximo	
Grado de Protección	IP66 (EN 60529)	
Interruptor Interno 1NA+1NC	Bipolar. Circuito Forma Zb (IEC 60947-5-1): Contactos NA e NC eléctricamente aislados	
	Con ruptura positiva del contacto NC (IEC 60947-5-1): Garantizado por el curso (➔), decripto en los diagramas	
Interruptor Interno 2NA+2NC	Circuito de Forma Za (IEC 60947-5-1)	
	Contactos NA y NC no aislado eléctricamente	
	Circuitos A y B aislado eléctricamente	
Vida Mecánica	10.000.000 ciclos	
Vida Eléctrica	200.000 ciclos	
Materiales	Cuerpo:	Zamak inyectado pintado
	Cabezales:	Zamak inyectado cincado (cabezales de movimiento angular)
		Termoplástico inyectado (otros cabezales)

① Modelos con interruptor interno 1NA+1NC

KAP COMPONENTES ELÉTRICOS Ltda.

R. Carmo do Rio Verde, 78 S. Paulo - SP 04729-010 Fone: (0XX11) 5641-9898 Fax: (0XX11) 5641-1486 e-mail: export@kap.com.br

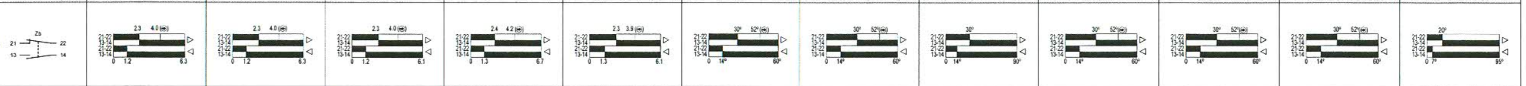
Serie LB

Interruptor de Posición Industrial

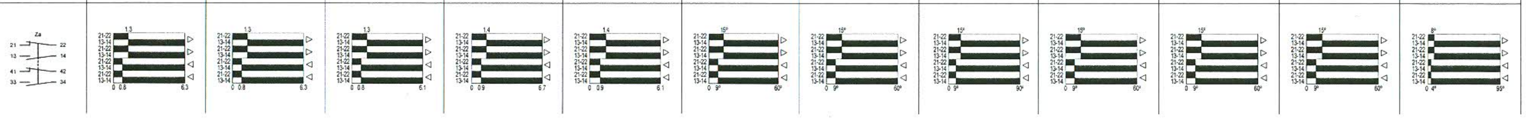
cuerpo **LB30** - contactos 1NA + 1NC	LB30B	LB30K	LB30S	LB30H	LB30V	LB30XJ	LB30YD	LB30YT	LB30YL	LB30YL2	LB30YM	LB30Z
cuerpo **LB305** - contactos 2NA + 2NC	LB305B	LB305K	LB305S	LB305H	LB305V	LB305XJ	LB305YD	LB305YT	LB305YL	LB305YL2	LB305YM	LB30Z

cuerpo **LB41** - contactos 1NA + 1NC	LB41B	LB41K	LB41S	LB41H	LB41V	LB41XJ	LB41YD	LB41YT	LB41YL	LB41YL2	LB41YM	LB41Z
cuerpo **LB415** - contactos 2NA + 2NC	LB415B	LB415K	LB415S	LB415H	LB415V	LB415XJ	LB415YD	LB415YT	LB415YL	LB415YL2	LB415YM	LB415Z

Esquema Eléctrico
Contacto 1NA + 1NC
de acción rápida



Esquema Eléctrico
Contacto 2NA + 2NC
de acción rápida



Rev. 08

Sujeto a modificaciones sin previo aviso

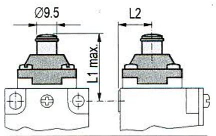
LB2

Serie LB

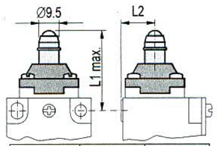
Interruptor de Posición Industrial

Dimensiones

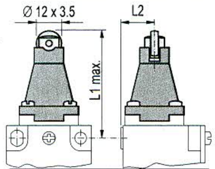
Dimensiones en mm



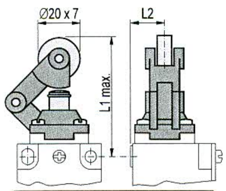
Código	L1(mm)	L2(mm)
LB3_B	31.5	16
LB4_B	30.5	14



Código	L1(mm)	L2(mm)
LB3_K	37.5	16
LB4_K	36.5	14

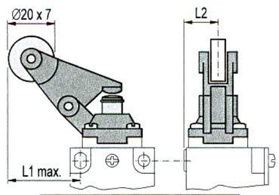


Código	L1(mm)	L2(mm)
LB3_S	50.5	16
LB4_S	49.5	14



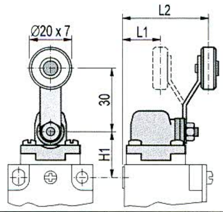
Código	L1(mm)	L2(mm)
LB3_H	56.5	16
LB4_H	55.5	14

Rodete normal en termoplástico
Para rodete metálico sustituir H por H1



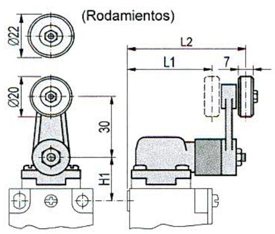
Código	L1(mm)	L2(mm)
LB3_V	30.5	16
LB4_V	25	14

Rodete normal en termoplástico
Para rodete metálico sustituir V por V1



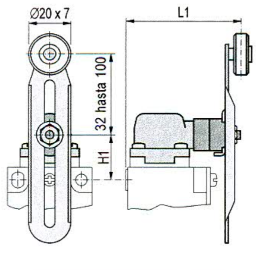
Código	H1(mm)	L1(mm)	L2(mm)
LB3_XJ	21.5	18	41
LB4_XJ	20.5	16	39

Rodete normal en termoplástico
Para rodete metálico sustituir J por J1



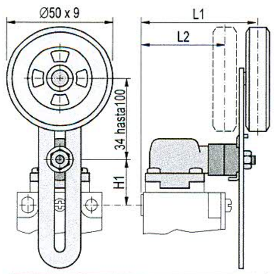
Código	H1(mm)	L1(mm)	L2(mm)
LB3_YD	21.5	40	56
LB4_YD	20.5	38	54

Rodete normal en termoplástico
Para rodete metálico sustituir D por D1
Para rodamiento sustituir D por D2



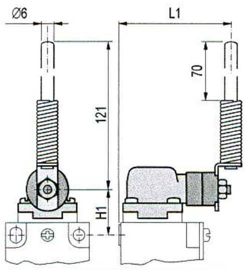
Código	H1(mm)	L1(mm)
LB3_YL	21.5	56
LB4_YL	20.5	54

Rodete normal en termoplástico
Para rodete metálico sustituir L por L1

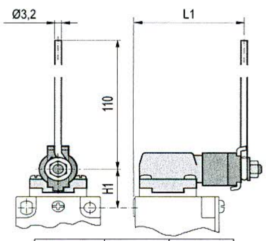


Código	H1(mm)	L1(mm)	L2(mm)
LB3_YL2	21.5	60	56
LB4_YL2	20.5	58	54

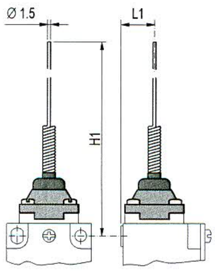
Rodete en termoplástico con anillo externo en goma



Código	H1(mm)	L1(mm)
LB3_YT	21.5	53
LB4_YT	20.5	51



Código	H1(mm)	L1(mm)
LB3_YM	21.5	52
LB4_YM	20.5	50



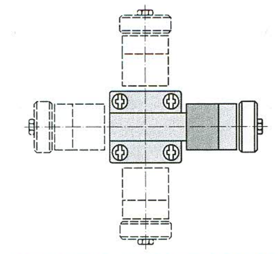
Código	H1(mm)	L1(mm)
LB3__Z	145	16
LB4__Z	144	14

Sujeto a modificaciones sin previo aviso

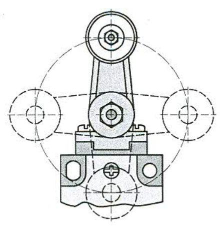
Serie LB

Interruptor de Posición Industrial

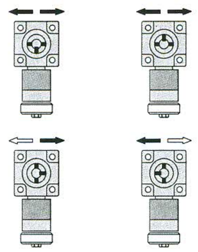
Características



Los cabezales pueden ser montados sobre el cuerpo en cuatro posiciones distintas (de 90 en 90°)



Palanca del cabezal YD regulable de 6 en 6° o de 90 en 90° sobre 360° (conforme DIN 43694)



Los cabezales tipo Y... pueden operar el contacto cuando accionados en los 2 sentidos, o solo cuando accionado en el sentido horario o anti-horario

Recomendaciones de Accionamiento

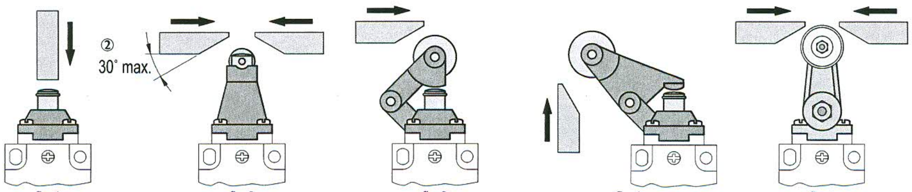


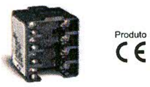
fig 1 fig 2 fig 3 fig 4 fig 5

- En el cabezal de pistón (fig 1), el elemento operador externo debe accionar el centro del pistón y tener movimiento paralelo al eje del mismo non excediendo el curso máximo permitido para el pistón (de tope). Para accionar un cabezal de pistón en el sentido transversal, utilice el tipo S (com rodillo - fig2))
- En los cabezales rotativos con palanca y rodillo (fig 5), el elemento operador externo debe accionar perpendicularmente al eje de rotación de la palanca y de preferencia perpendicular a ella.
- En los cabezales de palanca horizontal e vertical (tipos H y V), se recomienda apenas un sentido de accionamiento (fig 3 y fig 4).
- El elemento operador externo debe ser previsto de tal forma que la posición del curso máximo de operación de los cabezales (de tope) nunca sea alcanzada.
- Recomienda-se ángulo máximo de ataque de 30° para brazo de accionamiento. El elemento operador externo debe prever que, después de operar el cabezal, no haya un distanciamiento repentino en relación a este.

② Típico

Accesorios

- Para modelos con LED de señalización, agregue después del código:
  Q0 p/LED 6Vca/Vcc; **Q1** p/12Vca/Vcc; **Q2** p/24Vca/Vcc; **Q3** p/48Vca/Vcc; **Q5** p/110Vca e **Q6** p/220Vca

Interruptor de Reposición **ME** (p/ LB41) **LB3** (p/ LB30)	Interruptor de Reposición **ME5** (p/ LB415) **LB35** (p/ LB305)	Prensa-Cable (Consulte Catalogo **ZA**)
		

Sujeto a modificaciones sin previo aviso

KAP COMPONENTES ELÉTRICOS Ltda.

R. Carmo do Rio Verde, 78 S. Paulo - SP 04729-010 Fone: (0XX11) 5641-9898 Fax: (0XX11) 5641-1486 e-mail: export@kap.com.br

Instruction Manual • August 2003

milltronics

MFA 4P

SIEMENS

Specifications

Safety

Note: The Milltronics MFA 4p (Motion Failure Alarm) is to be used only in the manner outlined in this manual, otherwise protection provided by the equipment may be impaired.

Power

- 100/115/200/ 230 V AC ±15%, 50/60 Hz, 15 VA

Output

- 2 relays with Form C (S.P.D.T.) fail-safe contacts (relays operate in unison)

Resistive Rating:

- 8 A @ 250 V AC

Repeatability

- ± 1%

Temperature coefficient (setpoint variance)

- 0.018%/ °C (0.01% / °F)

Setpoint adjustment range

- 2 to 3,000 ppm (pulses per minute): standard model
- 0.15 to 15 ppm: slow speed version

Dynamic range

- 0 to 7,200 ppm

Weight

- polycarbonate enclosure: 1.5 kg (3.3 lb.)
- mild steel or stainless steel enclosure: 4.3 kg (9.5 lbs.)

Approvals[1]

- CE, $CSA_{(C/US)}$, FM
- EMC performance available on request

Environmental

- location: Indoor/outdoor
- altitude: 2000 m max.
- ambient temperature: –20 °C to 50 °C (–4 °F to 122 °F)
- relative humidity: suitable for outdoor (Type 4X / NEMA 4X / IP65)*
- installation category: II
- pollution degree: 4

*Type 4/ NEMA 4 /IP65 with mild steel enclosure

Related Equipment	Ambient Temperature Range	Approx wt.
RMA	–40 °C to 60 °C (–40 °F to 140 °F)	2.3 kg (5 lb)
MSP-12	–40 °C to 60 °C (–40 °F to 140 °F)	1.4 kg (3 lb)
XPP-5	–40 °C to 60 °C (–40 °F to 140 °F)	1.8 kg (4 lb)
MSP-1	–40 °C to 80 °C (–40 °F to 180 °F)	0.5 kg (1 lb)
MSP-3	–40 °C to 260 °C (–40 °F to 500 °F)	1.4 kg (3 lb)
MSP-9	–40 °C to 260 °C (–40 °F to 500 °F)	1.8 kg (4 lb)

1. EMC performance available upon request.

Installation

Milltronics MFA 4p

The MFA 4p (and RMA if applicable) must be mounted in a non-hazardous area that is clean, dry, vibration-free, within the ambient temperature range, and non-corrosive to the electronics or its enclosure. The door should be accessible for viewing and to allow calibration of the MFA 4p.

> **Note:** Do not mount MFA 4p in direct sunlight.

Probe

The probe should be mounted onto a vibration free structure using the mounting flange. The gap between probe and target should be large enough to prevent the target from damaging the probe. The probe environment must be within the probe's ambient temperature range and non-corrosive to the probe's body. Refer to Applications drawings on page 23.

The probe design detects a changing magnetic field, typically caused by a ferromagnetic target disturbing the probe's magnetic field. Extremely strong magnetic fields (like those produced by the 30A/m requirements of 1EC 60004-8, Power Frequency Magnetic Field Immunity test) will be detected and will result in loss of functionality.

Functionality loss indicators:

- alarm conditions by relay trip
- false pulse readings in LED1

Consider the probe location carefully before installation. Avoid strong magnetic fields (50/60 Hz) from nearby power transformers, heater elements, or large industrial motors, because these can affect the probe’s performance.

Wiring

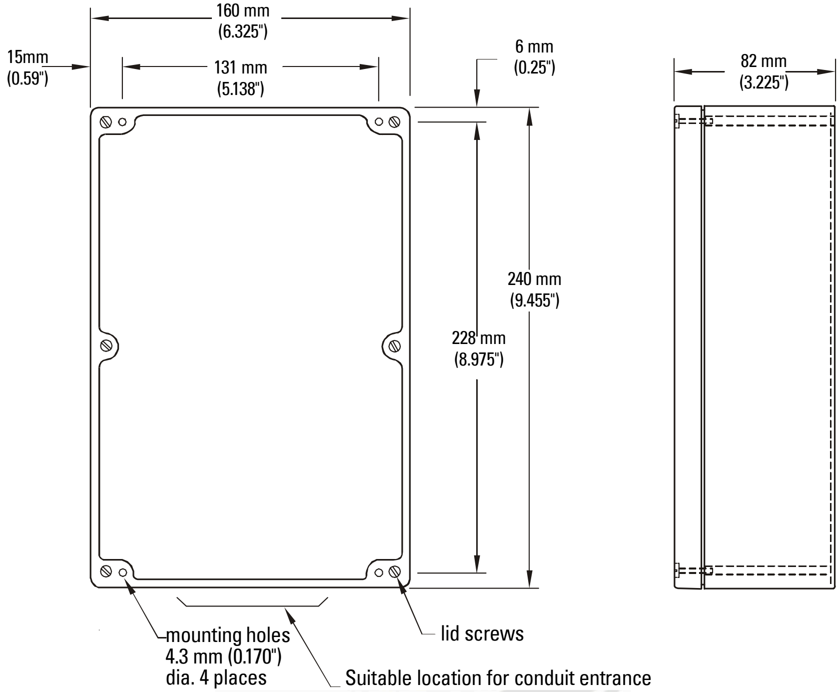
Where possible, the probe components should be interconnected via flexible conduit. This allows for easier removal or adjustment of the probe and mounting flange assembly.

> **Note:** Installation shall only be performed by qualified personnel and in accordance with local governing regulations.

Dimensions

MFA 4p

Type 4X / NEMA 4 / IP65 Polycarbonate Enclosure

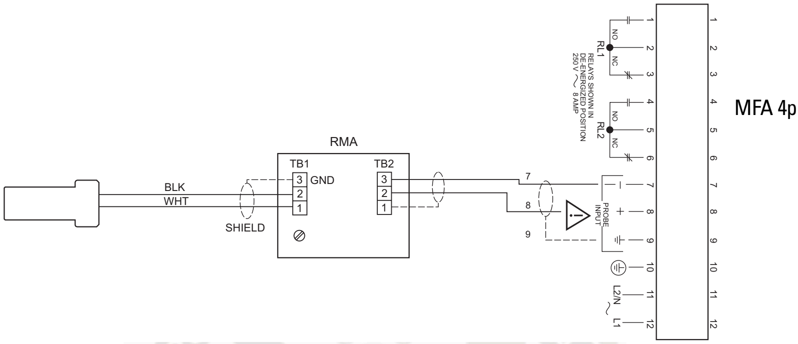


Notes:

- Non-metallic enclosure does not provide grounding between conduit connections: use grounding type bushings and jumpers.
- Use only approved, suitable size hubs for watertight application.

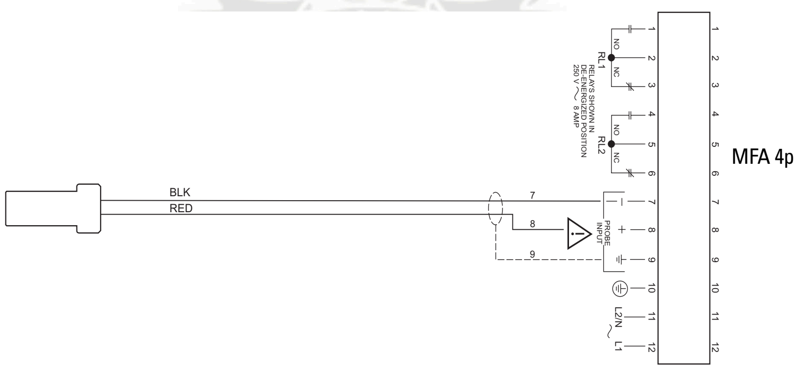
Installation

MSP-1, 3, or 9 Probe with RMA (remote mounted pre-amplifier)



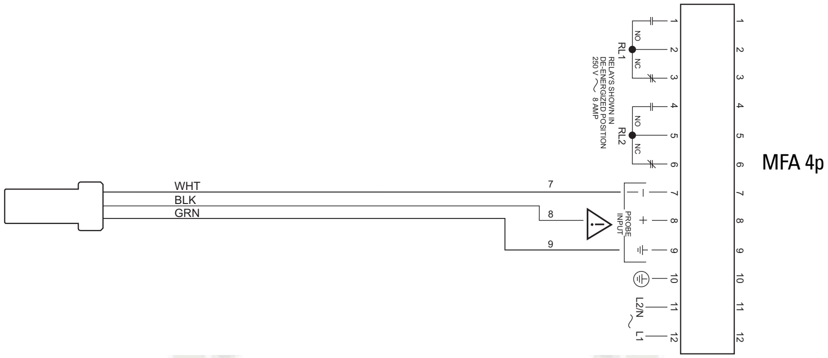
Maximum cable length from probe to RMA is 30 m / 100 ft of shielded cable, 18 ga. wire. See table on page 9 for cable lengths from RMA to main group.

MSP-12 Probe with IMA (internally mounted pre-amplifier)



Wire can be run in conduit common to motor supply or control wiring. Connection to probe leads can be made under probe cap. See table on page 9 for lengths from probe at MFA 4p.

XPP-5 with IMA (internally mounted pre-amplifier)



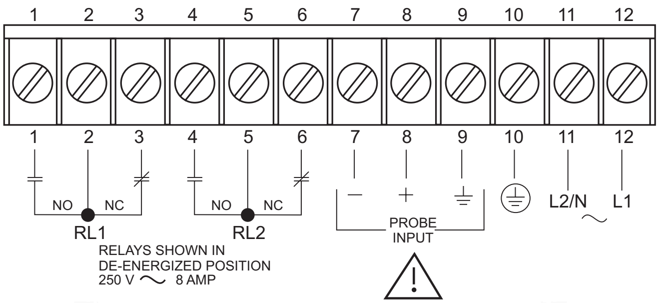
XPP-5 cable must be run in dedicated, approved metal conduit, boxes and fittings and to procedures in accordance with all governing regulations. See table below for lengths from probe at MFA 4p.

Note: Refer to Interconnection Diagram for the XPP-5 (drawing number 23650131) on page 21.

Cable length from RMA or IMA to MFA 4p

Wire gauge	Length in feet	Length in metres
22 AWG ($0.34\ mm^2$)	2500	760
18 AWG ($0.75\ mm^2$)	5000	1520
12 AWG ($4\ mm^2$)	25000	7600

Connection to power:

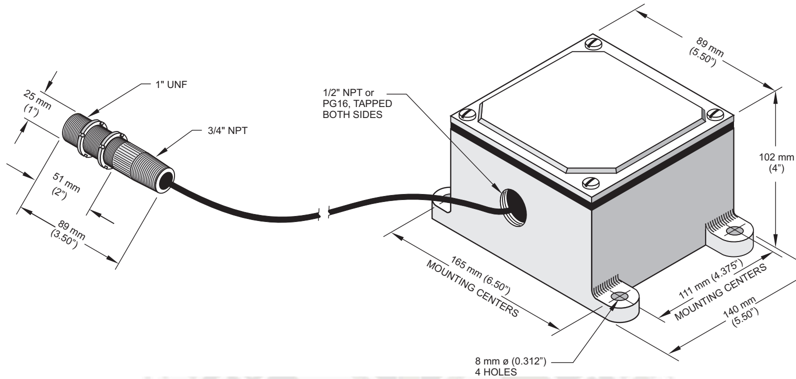


- Terminal 10 ⏚ must be connected to reliable ground.
- The equipment must be protected by a 15A fuse or circuit breaker in the building installation.
- A circuit breaker or switch in the building installation, marked as the disconnect switch, shall be in close proximity to the equipment and within easy reach of the operator.
- AC input circuit, relay circuits, min. 14 AWG copper wire
- Recommended torque on terminal clamping screws, 7 in.lbs. max.

! **WARNING: All field wiring must have insulation suitable for at least 250 V.**

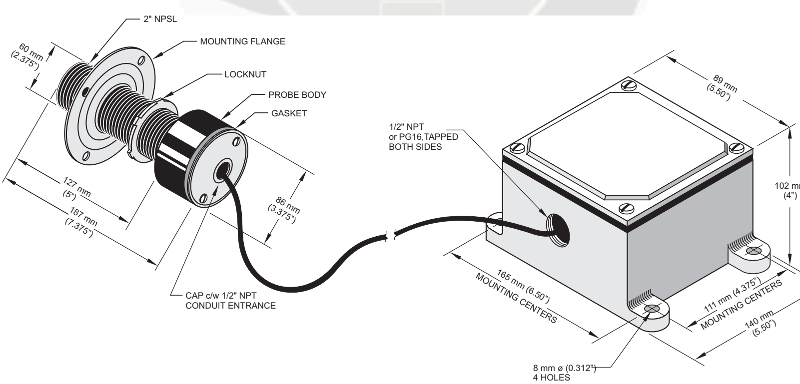
Probes

Mini Sensing Probe MSP-1



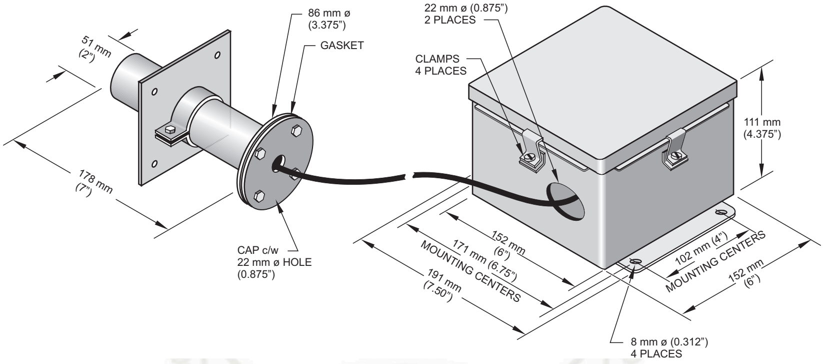
- CPVC body comes with 2 CPVC locknuts
- 180 cm (6 ft.) of Belden 8760 supplied potted in probe
- Remote mounted pre-amp in NEMA 4 cast aluminum enclosure.

High Temperature Probe MSP-3

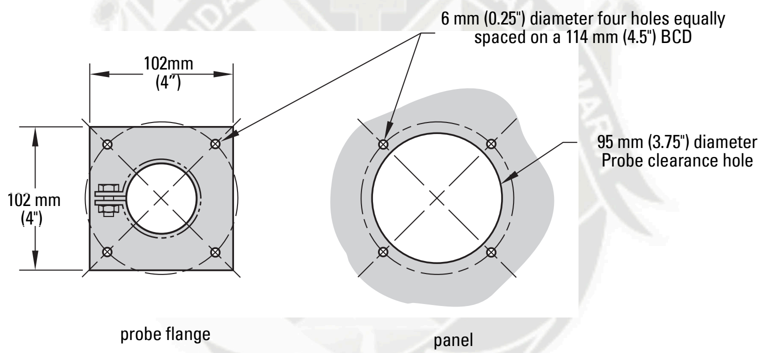


- Cast aluminum body comes with cast aluminum cap and zinc flange, zinc plated locknut, and silicone rubber gasket
- See page 22 for Flange and Mounting Details
- Pre-amp is mounted in a NEMA 4 cast aluminum enclosure

Stainless Steel Probe MSP-9



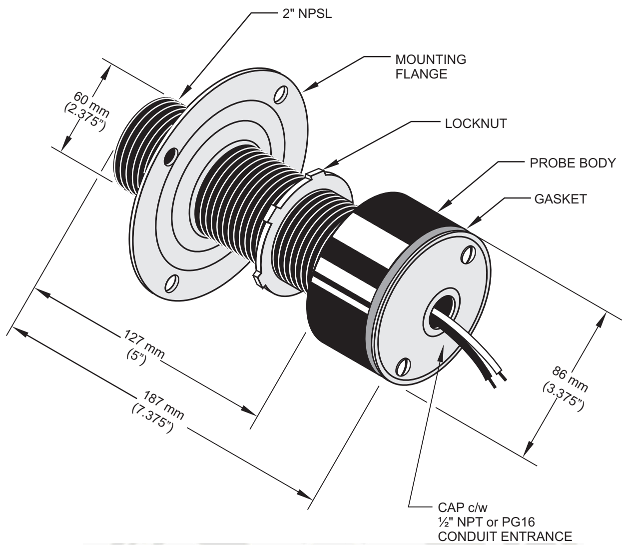
Mounting Details



- For high temperature and corrosion resistance applications
- 304 stainless steel body comes with stainless steel clamp and silicone gasket
- 1.5 m (5 ft.) Belden 83321 Teflon®[1] cable potted in probe
- Pre-amp is mounted in an enamel painted steel Hammond 1414N4E enclosure

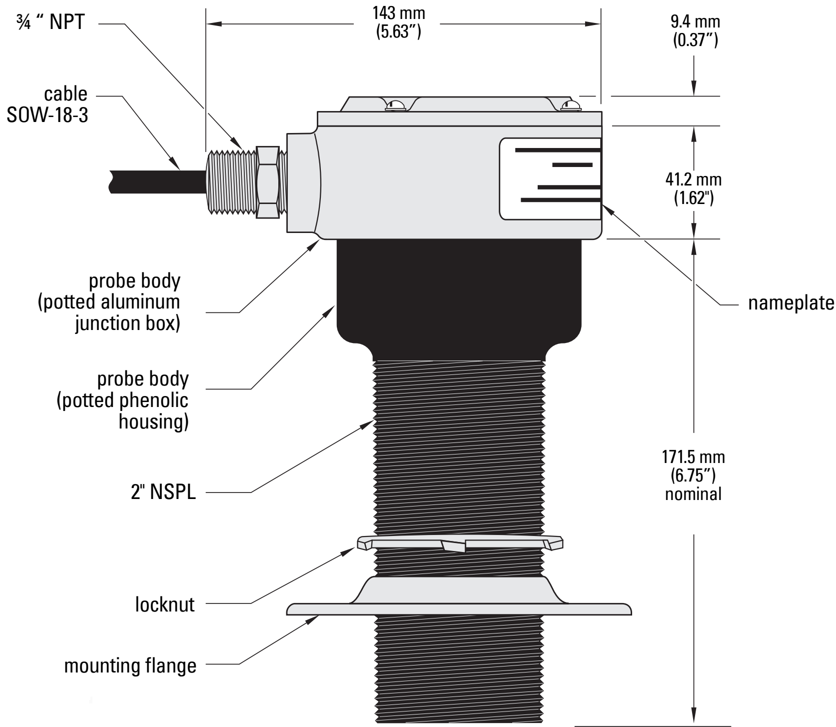
1. Teflon is a registered trademark of E.I. du Pont de Nemours and Company

Standard Probe MSP-12



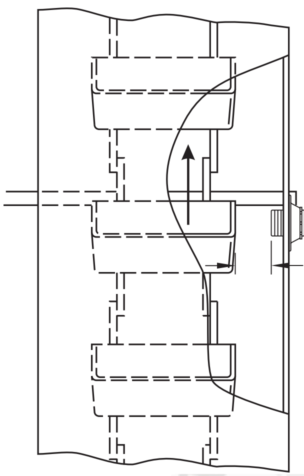
- Phenolic body comes with die-cast aluminum cap and zinc flange, zinc plated locknut, and neoprene gasket
- See page 22 for Flange and Mounting Details
- Pre-amp is potted in the probe body and comes with two 127 mm (5") long hook-up wires

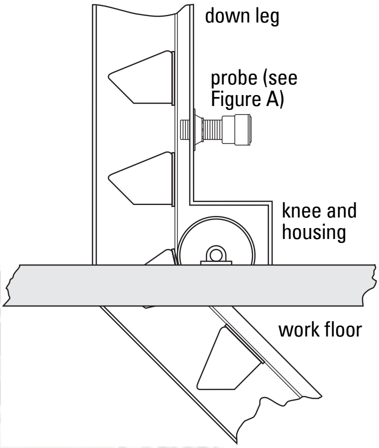
Hazardous Locations XPP-5



- C.S.A Approved for:
  Class I, Div.1, Gr. A, B, C & D
  Class II, Div 1, Gr. E, F & G
  Class III
- phenolic/aluminum body with die-cast flange and zinc-plated locknut
- see page 22 for mounting details, and pages 9 and 21 for interconnection information.
- pre-amp and cable potted in the probe's body

Bucket Elevators



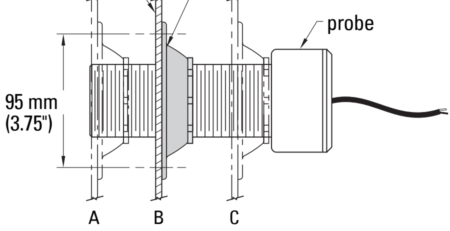


For chain and sprocket drive elevators, place the probe so that the gap between the bucket and the probe does not exceed 102 mm (4"). To prevent damage to the probe from eccentric bucket motion, ensure that the gap is not less than 12.5 mm (0.5") in the worst condition.

Preferred location for belt-driven elevators with ferrous bucket spacing greater than 76 mm (3"), and non-ferrous buckets with ferrous bolts.

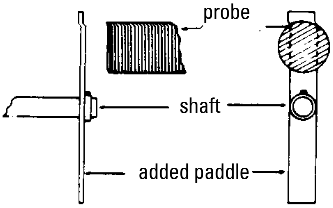
For ferrous buckets with spacings less than 76 mm (3") locate probe on the front of the leg.

Figure A

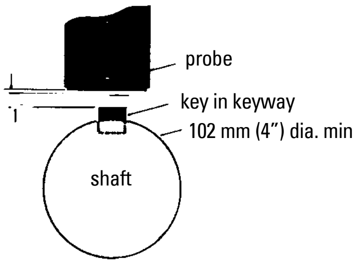


For elevators with ferrous walls, cut 88 mm to 95 mm (3.5" to 3.75") hole in the elevator wall. Any position from A to C may be used to maintain the gap.

Shafts



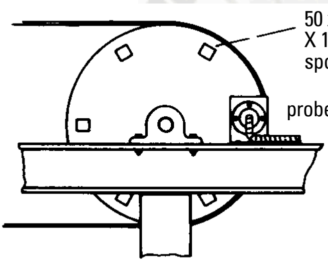
safety shield not shown

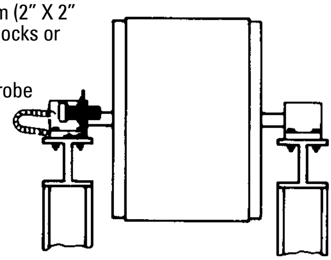


These methods are viable if the speed is such that the blades or key will provide the number of pulses required at a minimum velocity of 1.5 m / minute (5 ft. / minute). In applications where exposed moving parts are required, safety shields and precautions should be applied.

Where conditions prevent the sensing of buckets, a belt pulley or paddle mounted on an exposed shaft end, preferably the tail pulley, may be used.

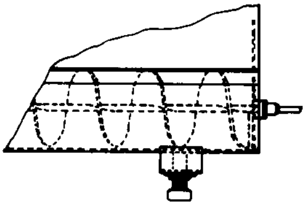
Belt Conveyors



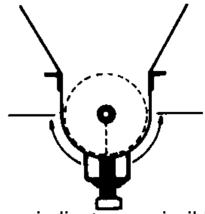


Potential for damage in each application governs the minimum gap allowable. Maximum gap for operation is 102 mm (4"), optimum 25 mm to 50 mm (1" to 2").

Screw Conveyors



The probe should be located at the idler end (usually feed end)



Arrows indicate permissible placement range of the probe

A ferrous mass added behind the flight of a screw conveyor, where it passes the probe aids Borderline Operation. This mass must be added for all non-ferrous screws.

CONVEYOR COMPONENTS COMPANY

130 Seltzer Road, PO Box 167 • Croswell, MI 48422 USA
PHONE: (810) 679-4211 • TOLL FREE (800) 233-3233 • FAX: (810) 679-4510
Email: info@conveyorcomponents.com • http://www.conveyorcomponents.com

MODEL RS: INSTRUCCIONES DE INSTALACIÓN UNIDAD DE CONTROL DE PARADA DE EMERGENCIA

INFORMACION TECNICA

Unidad a Prueba de lluvia (Estandard):

Tipo de Protección 1, 3, 3R, 4 y 4X construcción a prueba de polvo y lluvia, con resistencia a la corrosión.
Empaquetadura selladas para aplicaciones exteriores e interiores.
Cuerpo de Aluminio o opcional de acero fundido con 3 orificios para los cables de conexión en la parte base del equipo.

Unidad Dual:

Tipo de Protección 1, 3, 3R, 4 y 4X construcción a prueba de polvo y lluvia, también para uso en Class II, Groups E, F & G y Class III Localizaciones Peligrosas..
Cuerpo de Aluminio o opcional de acero fundido con 1 orificio para los cables de conexión en la parte base del equipo..

Unidad a Prueba de Explosion:

Protección para uso en Class I, Groups C & D; and Class II, Groups E, F & G, y Class III Localizaciones peligrosas.
Cuerpo de Aluminio o opcional acero fundido con 1 orificio para los cables de conexión en la parte base del equipo.

Capacidad Eléctrica:

SP/DT Micro-Interruptor(es):	DP/DT Mirco-Interruptor(es):
20 Amps, 125/250/480 VAC	15 Amps, 125/250 VAC
10 Amps, 125 VAC Inductivo	N/A
1 hp, 125 VAC	3/4 hp, 125 VAC
2 hp, 250 VAC	1 1/2 hp, 250 VAC
½ Amp, 24 VDC	N/A
½ Amp, 125 VDC	N/A
¼ Amp, 250 VDC	N/A

Micro-interruptor(es) puede ser alambrado para una operación simple, es decir normal mente abierto o normalmente cerrado como se requiera. Ver Figura 1.

Figure 1: Contactos Eléctricos

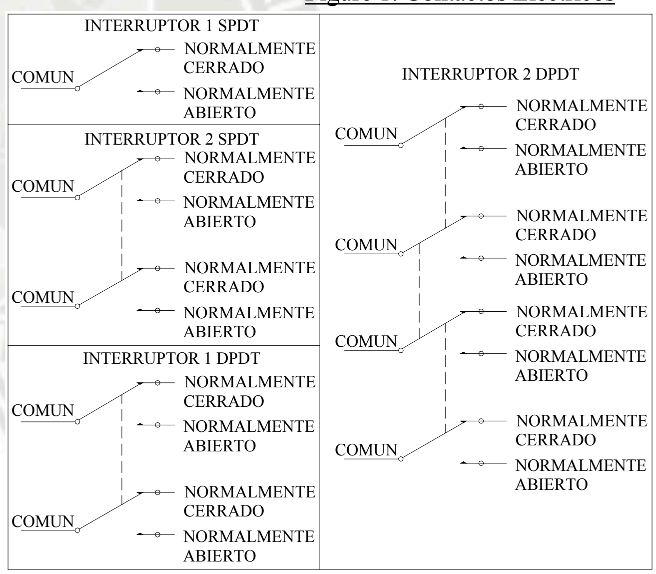
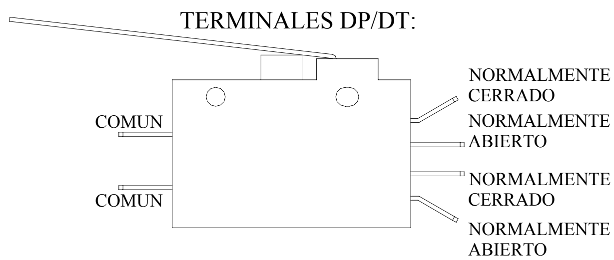


Figure 2: Terminales Eléctricos

TERMINALES SP/DT:

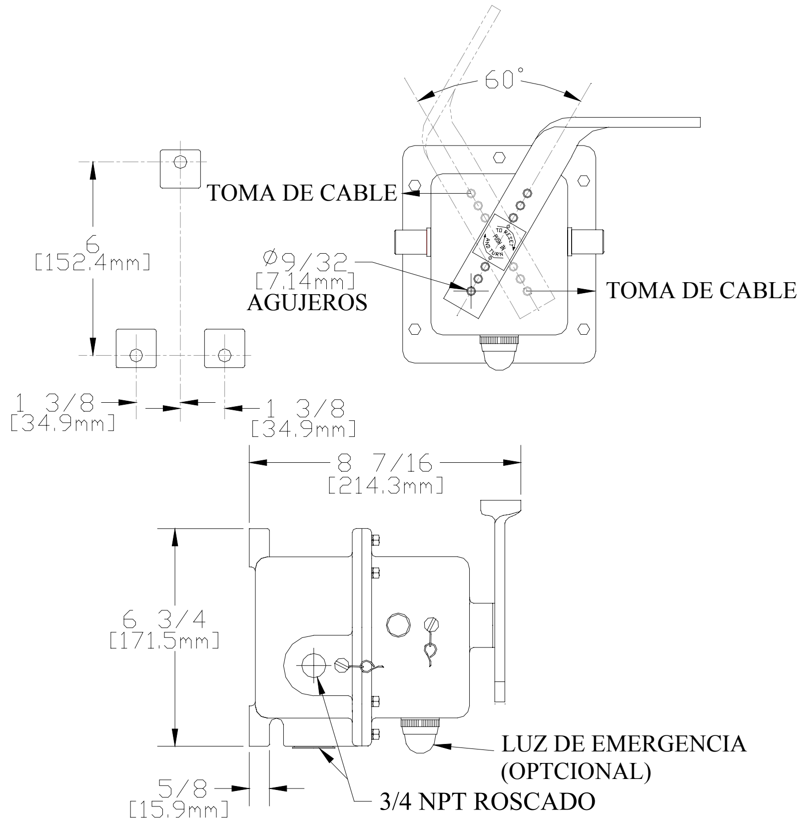
TERMINALES DP/DT:



INSTRUCCIONES DE INSTALACION

1. La base del equipo debe ser montada en una superficie plana usando los tres (3) agujeros de montaje de la base (Ver figura 2). Los agujeros son fabricados para pernos de 3/8".

Figura 3: Dimensiones



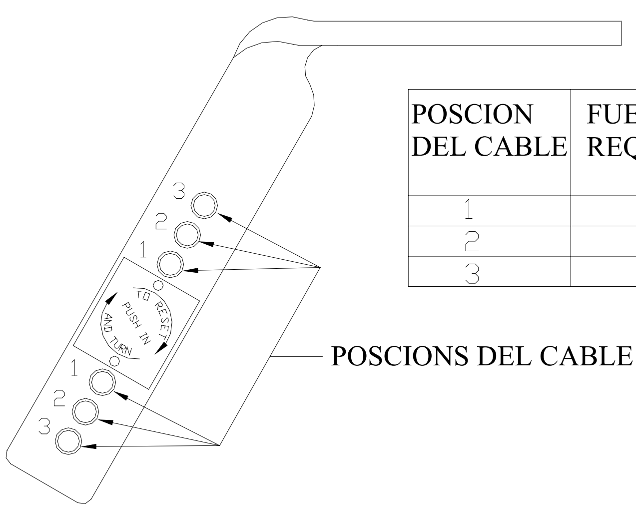
2. Cada unidad puede cubrir un máximo de 200 pies de correa – 100 pies en cada dirección. Consideraciones de seguridad indican que no mas de 100 pies de cable deben ser instalados a cada lado.

3. El perno ojo que soporta el cable debe ser instalado en intervalos entre 8' – 10'. Precauciones deben ser consideradas para que el cable no quede suelto. Sin embargo si el cable esta tirante, operaciones falsas de la unidad pueden ocurrir.

4. Esta unidad esta diseñada para servicio piloto. El circuito de control debe ser alambrado a través del circuito de partida del motor de la correa u otro equipo que será controlado. No alambre la unidad directamente al circuito del motor. Ver información de "Interruptor" en la pagina frontal.

5. El control debe ser chequeado antes de la instalación por accionamiento del cable. El equipo protegido debe parar y las alarmas deben sonar como se requiere con un mínimo esfuerzo en el cable. La tensión del cable puede ser ajustada según lo necesario cambiando la posición del cable en el brazo (ver figura 3).

Figura 4: Posición del Cable



POSCION DEL CABLE	FUERZA TOTAL REQUERIDA (LIBRAS)
1	40
2	28
3	20

Power Unit PEC

PRODUCT MANUAL

HÄGGLUNDS

More than an ordinary drive supplier.

The worse it is, the better equipped we are. After more than four decades of supplying drive systems for heavy industrial applications, Hägglunds is accustomed to difficult demands. We provide what you need to get the toughest jobs done right – no matter how harsh the environment or how specialised the task.

Performance. Flexibility. Security.

Hägglunds unique hydraulic drive systems – combined with our wealth of experience – provide advantages no other drive supplier can match. With Hägglunds drives on your equipment, you receive:

- Maximum torque from zero speed.
- High performance regardless of conditions.
- Precise control of infi nitely variable speed.
- Standardised modules for design freedom.
- Smaller, lighter, more effective installations.
- Superior protection of equipment and processes.

Here. There. Everywhere.

A global leader in industrial drive solutions, Hägglunds has offices in nearly twenty countries and distribution partners in many more. We are where you are – with short lead times and fast, comprehensive service that answers your needs.

Function - This is how it works

A complete hydraulic drive system from Hägglunds Drives comprises the Power unit with electric motor, pump and tank, the control system, the hydraulic motor and the piping system. The power unit type PEC is described in this publication and uses a closed loop hydraulic system to provide a highly dynamic drive system.

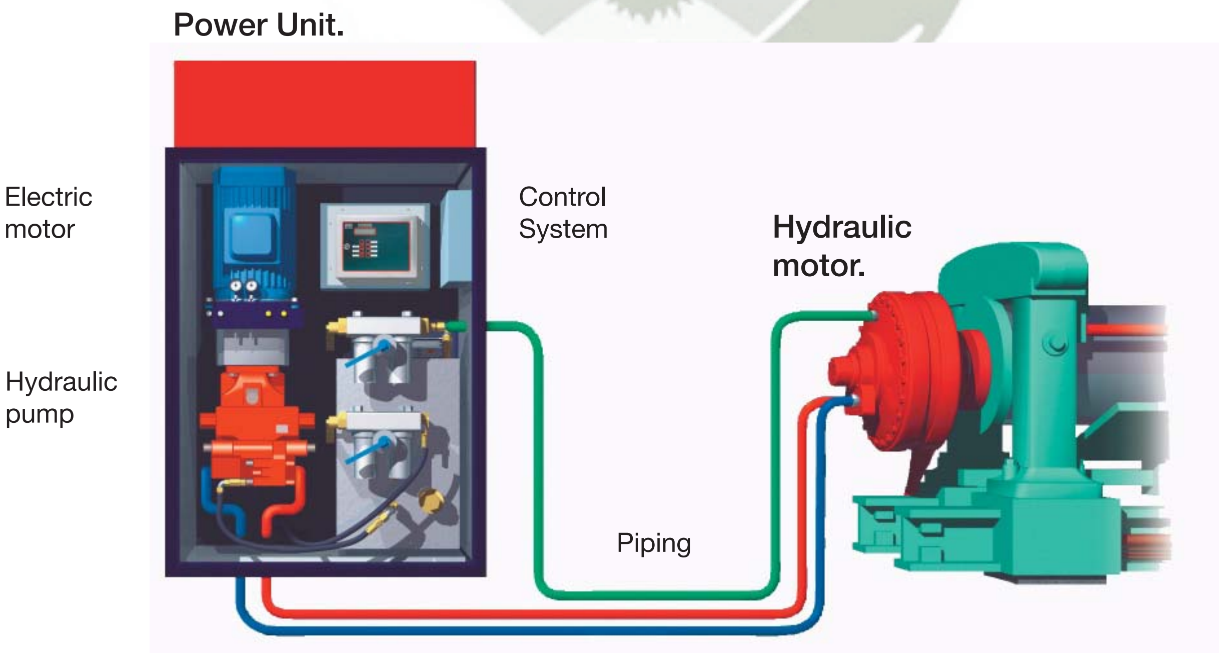
In most offerings, all items except the piping and hydraulic motor are housed in a sound insulated cabinet. The swash plate pump is driven by an electric motor running efficiently at fixed speed.

The oil flow from the pump is determined by the swash-plate angle, which is controlled by a signal from the control system. Starting in an unloaded, neutral condition, the system ramps the flow up to the required direction and rate and pressure is determined by the load up to the limit set at the compensator. If pressure reaches compensator setting the pump will destroke, stopping the drive, so eliminating heat build up but maintaining the set pressure and therefore torque at the drive. The pump will stay in this condition until the system is unloaded whereupon the pump will immediately ramp up to the set flow rate or until the control is adjusted. The pump and the hydraulic motor are connected together by flexible hoses and piping if necessary.

At the motor the oil is distributed through the valve plate to the pistons in the cylinder block 50% of them with high pressure and 50% with charge pressure. The oil pressure forces the piston assemblies radially outwards against the cam-ring. This produces a balanced and smooth rotation with extremely high torque which drives the machine. The speed of the motor is controlled by the flow of oil from the pump. Drive motor speed is therefore proportional to the swash plate angle of the pump. If the swash plate is controlled over-centre, the flow is reversed and the motor direction is therefore reversed.

Both the hydraulic motor and the pump have a very low moment of inertia, which makes it possible to change speed and stop or reverse direction quickly.

A proportion of the return flow is used to provide oil conditioning by cooling and filtering. The oil in the motor and pump case which provides lubrication and local cooling is fed back to tank via an adequately sized drain line.



Main components

Power Unit with one pump.

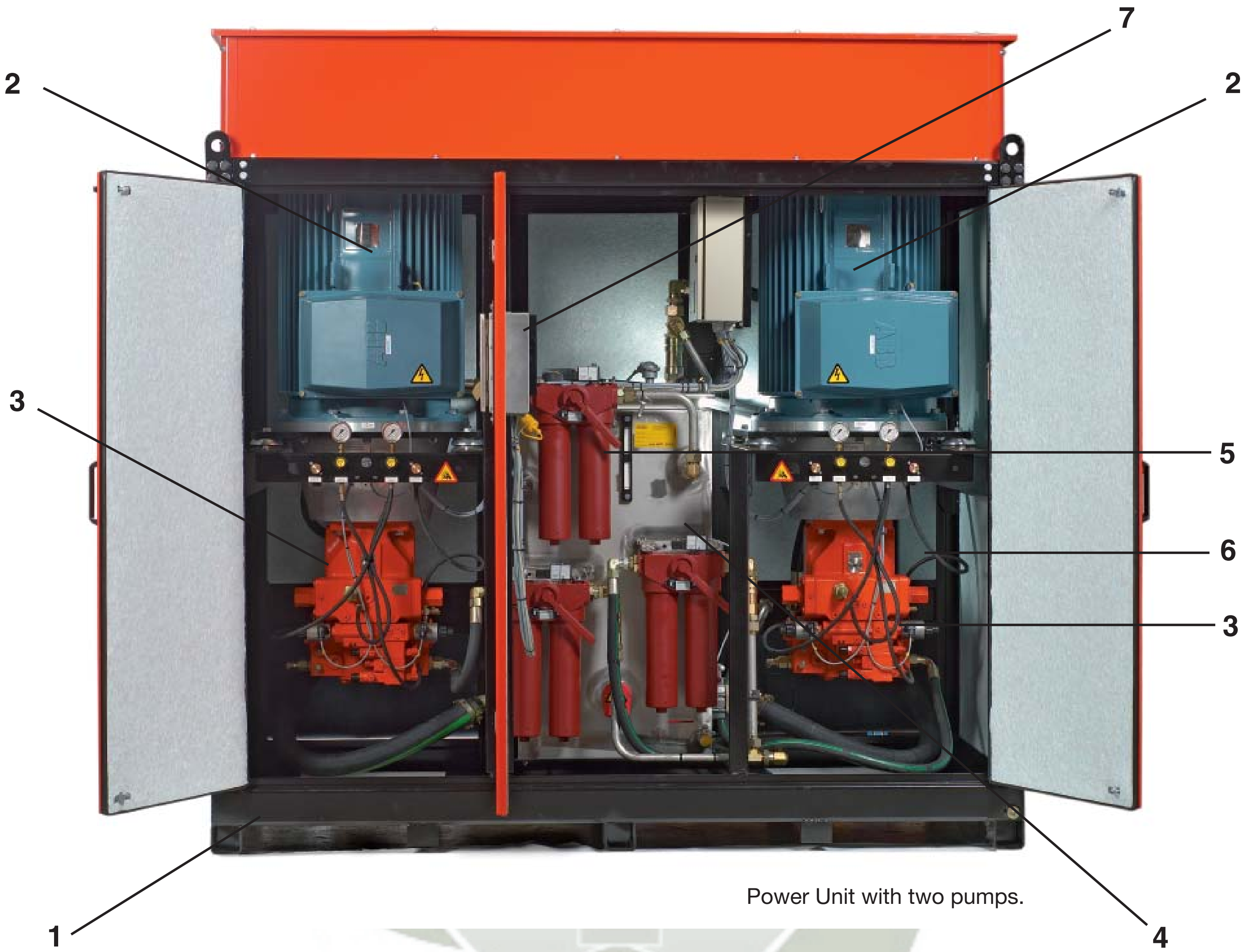
1. The free standing cabinet is built of a robust steel framework with sound insulated doors, panels and cover. It is surface treated to prevent corrosion and ageing in tough process industry environments. The solution is an open one, which simplifies accessibility during maintenance and service.

2. The electric motors that we use have high efficiency and are also extremely reliable. They are started with no load and run optimally at fixed speed.

3. The hydraulic pumps are of the variable displacement axial piston type with very fast acting pressure compensator override. This virtually eliminates overloads and is a major factor in system reliability. All control valves are built in to keep pipe work to an absolute minimum. The electro-hydraulic stroker provides variable flow by smoothly controlling the swash plate and thereby pump displacement.

4. The tank is manufactured in stainless steel to prevent corrosion.

Main components



Power Unit with two pumps.

5. The oil filters are dimensioned for oils with high viscosity and a high degree of contamination separation. Duplex filters can be supplied as an option, allowing you to replace filters during operation.

6. The oil cooler is dimensioned to maintain the oil temperature in the hydraulic system at the correct level. In this way good lubrication characteristics are ensured and the service life of the oil and of the complete drive system will be long.

7. The control system is configurable for different types of applications, providing consistent start and stop sequences. The operation can be controlled by external signals or from the front panel of the control system.

Various operational parameters can be displayed such as speed, pressure, electric motor power and self-diagnostics.

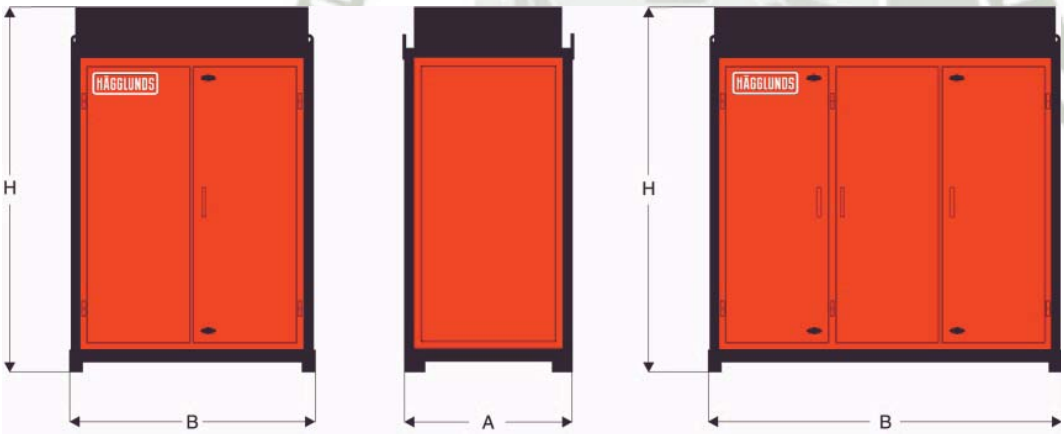
Data PEC Power unit

Data – PEC Power Unit				
Type	Max. installed power (kW)	Max. oll flow* (l/min)	Max. pressure (bar)	Weight (kg)
PEC 102	90	175	350	1500
PEC 202**	90	337	350	1500
PEC 103	90(2x90)	175	350	2300
PEC 203**	180(2x90)	350(2x175)	350	2500
PEC 302**	315	737	350	2900
PEC 402**	355	737	350	2900
PEC 602**	355	737	350	2900
PEC 303**	400(2x200)	674(2x337)	350	3600
PEC 403**	400(2x200)	674(2x337)	350	3700
PEC 603**	630(2x315)	1474(2x737)	350	5100
PEC 702	500	1103	350	4500
PEC 702**	500	1257	350	4500
PEC 803**	710(2x355)	1474(2x737)	350	5500
PEC 1003**	710(2x355)	1474(2x737)	350	5500
PEC 1203	1000(2x500)	2206(2x1103)	350	8600
PEC 1203**	1000(2x500)	2514(2x1257)	350	8600

*) 1470 rpm.
**) Tandem.

PEC cabinet with tandem mounted pumps

Dimensions



Basic dimensions, PEC Power Unit									
Cabinet size	1	2	3	4	5	6	7	6	7
Type* / Dim. mm	PEC 102 PEC 202	PEC 103 PEC 203	PEC 302 PEC 402 PEC 602	PEC 303 PEC 403 PEC 603	PEC 803 PEC 1003	PEC 702	PEC 1203	PEC 702**	PEC 1203**
H	2320	2320	2600/2700[1] 2800/2900	2600/2700[1] 2800/2900	2600/2700/2800[1] 2900/3000	2800/2900 3000/3100	2800/2900[1] 3000/3100	3100/3200[1] 3300/3400	3100/3200[1] 3300/3400
B	1500	2290	1670	2590	3100	1920	3600	1920	3600
A	1000	1000	1250	1250	1250	1850	1850	1850	1850

*) Cabinet designations ending with a 2, represent a two-door cabinet.
Cabinet designations ending with a 3, represent a three-door cabinet.
**) Cabinets suited for tandem mounting of pump.
[1] Size varies with the height of the electric motor.

Features of the PEC Power Unit

Included as standards

- Totally enclosed IP55, squirrel cage, 4-pole electrical motor.
- Axial piston pump with electro-hydraulic control.
- Fast pressure compensator, charge pump and flushing valve.
- Motor/pump set mounted on anti-vibration pads.
- All internal pipe work and wiring included.
- Tandem pump mounting possibilities.
- Stainless steel oil tank with level gauge, breather, drain valve.
- 10 micron return and drain line filters with visual & electrical indication.
- Stainless steel water cooler and water solenoid valve.
- Temperature switch with two switches and temperature indicator.
- Suction line valve with switch.
- Charge pressure switch.
- Oil filling point with quick release connector.
- Electric junction box, IP65.
- Pressure gauges with push to read valve.

Optional extras

- Thermistor protection for electric motor.
- Anti-condensation heaters for electric motors.
- Different pump control.
- Control system Spider.
- Pressure transmitters.
- High pressure switch.
- Cabinet feet, anti vibrating mount.
- Duplex oil filters.
- Oil heater.
- Air blast oil cooler.
- Extra temperature switches and or PT100 temp transmitter.
- Accumulator for shock loadings.
- Prepared for flushing of hydraulic motor case.
- Piping on main lines & isolation valves.
- Prepared for dusty environments.
- Heavy duty epoxy paint system.
- Stainless steel panels and doors
- Low noise option.
- Optional electric motors; high voltage, EX-proof
- Auxiliary hydraulic circuits (e.g. for brakes or cylinders)

Technical data SP pump

The SP pump is designed specifically to Hägglunds specifications to provide a neatly packaged pump with integral boost pump, electro-hydraulic displacement stroker and fast compensator to reduce pressure spikes on tough drives. Maximum volume adjustment screws and a displacement indicator are included. A double shaft seal arrangement is provided to eliminate leakage. The SP has low noise characteristics and is designed to give long trouble free life in line with Hagglunds drives systems generally.

The SP provides a very wide range of pump displacements including the ability to use tandem pumps which on 250 size and above give a very compact solution using an internal gear pump for boost and servo pressures. 180 size and below are also available in tandem but using an external boost and servo pump. Tandem pumps enable one electric motor to load share two drives which can save space, improve efficiency and economy. In some applications however care with emergency stop must be taken when two completely separate drives are being considered. The SP therefore enables very good possibilities to optimize to the most efficient and appropriate drive selection.

Size				**40**	**71**	**125**	**180**	**250**	**355**	**500**	**750**
Displacement	Variable pump	V_{gmax}	cm³	40	71	125	180	250	355	500	750
	Auxiliary pump	V_{gH}	cm³	20	25	38	45	63	80	98	143
Max. speed		n_{max}	rpm	3700	3200	2600	2400	2200	2000	1800	1600
Max. flow	(at n max)	Q_{max}	l/min	148	227	325	432	550	710	900	1200
	(at n_E=1500rpm)		l/min	60	106,5	187,5	270	375	533	750	1125
Max. power Δp=350 bar	(at n max)	$P_{o\ max}$	kW	70	124	190	252	321	414	525	700
	(at nE=1500rpm)		kW	35	62	109	158	219	311	438	656
Max. torque Δp=350 bar	(at V_{gmax})	T_{max}	Nm	223	395	696	1002	1391	1976	2783	4174
Torque Δp=100 bar	(at V_{gmax})	T	Nm	64	113	199	286	398	564	795	1193
Moment of inertia about drive axis		T	kgm²	0,0049	0,0121	0,03	0,055	0,0959	0,19	0,3325	0,66
Filling volume		J	L	2	2,5	5	4	10	8	14	19
Approximate weight		m	kg	77	94	135	150	214	237	350	500
Max. pressure cont.			bar	350	350	350	350	350	350	350	350
Max. pressure peak			bar	400	400	400	400	400	400	400	400

Technical data Gold CUP

The Gold Cup pump is designed specifically to Hagglunds specifications to provide a neatly packaged pump with integral boost pump, electro-hydraulic displacement stroker and extremely fast compensator to reduce pressure spikes on tough drives. Maximum volume adjustment screws and a displacement indicator are included. A double shaft seal arrangement is provided to eliminate leakage and is designed to give long trouble free life in line with Hagglunds drives systems generally.

The Gold Cup has been employed successfully for many years by Hagglunds providing a more limited range of displacements than the SP but provides some useful steps between the SP displacements.

It is a most compact pump with low inertia, excellent servo control and extremely fast acting compensator which is very useful in some applications. It is also user friendly with light weight common controls and valve blocks. Because an external boost pump is always mounted it is relatively easy to add auxiliary circuits to the Gold Cup.

Size				**P6S**	**P7S**	**P11S**	**P14S**	**P24S**	**P30S**
Displacement	Variable pump	V_{gmax}	cm^3	98	119	180	229	403	501
	Auxiliary pump	V_{gH}	cm^3	17,5 + 20,7	17,5 + 20,7	17,5 + 38,2	17,5 + 38,2	17,2 + 79,2	17,2 + 79,2
Max. speed		n_{max}	rpm	3000	3000	2400	2400	2100	1800
Max. flow	(at n max)	Q_{max}	l/min	294	357	432	550	846	902
	(at n_E=1500rpm)		l/min	147	178,5	270	343	604	751
Max. power Δp=345 bar	(at n max)	$P_{o\ max}$	kW	169	205	248	316	486	519
	(at nE=1500rpm)		kW	85	103	155	197	347	432
Max. torque Δp=345 bar	(at V_{gmax})	T_{max}	Nm	538	653	988	1257	2213	2751
Torque Δp=100 bar	(at V_{gmax})	T	Nm	156	189	286	364	641	797
Moment of inertia about drive axis		T	kgm^2	0,027	0,027	0,085	0,085	0,240	0,286
Filling volume		J	L	3,78	3,78	6,6	6,6	11,4	11,4
Approximate weight		m	kg	152	152	220	220	342	357
Max. pressure cont.			bar	345	345	345	345	345	345
Max. pressure peak			bar	420	420	420	420	420	420

Possible pump combinations

Pumps series SP

Cabinet size		1		2		3			4			5		6	7
Power Unit PEC		102	202	103	203	302	402	602	303	403	603	803	1003	702	1203
Electric motor rated power kW. (50 Hz)	500													1	2
	400													1	2
	355						1	1				2	2	1	2
	315					1	1	1			2	2	2	1	2
	250					1	1	1			2	2	2	1	2
	200					1	1	1	2	2	2	2	2	1	2
	160					1	1	1	2	2	2	2	2	1	2
	132					1	1	1	2	2	2	2	2	1	2
	110					1	1	1	2	2	2	2	2	1	2
	90		1		2	1	1	1	2	2	2	2	2		
	75		1		2	1	1	1	2	2	2	2	2		
	55	1	1	2	2	1	1	1	2	2	2	2	2		
	45	1	1	2	2	1	1	1	2	2	2	2	2		
	37	1	1	2	2				2	2	2				
	30	1	1	2	2				2	2	2				
	22,5	1	1	2	2				2	2	2				
	18,5	1	1	2	2				2	2	2				
	15	1	1	2	2				2	2	2				
	11	1	1	2	2										

Pump size	El. motor Power kW min-max	Speed	Oil flow**		1		2		3			4			5		6	7
		rpm	l/min	gpm	102	202	103	203	302	402	602	303	403	603	803	1003	702	1203
SP 40	11-30	1470	59	16	1	1	2*	2										
		1760	70	19	1	1	2*	2										
SP 71	15-55	1470	104	28	1	1	2*	2										
		1760	125	33	1	1	2*	2										
SP 125	30-90	1470	184	49		1		2*				2	2	2				
		1760	220	58		1		2*				2	2	2				
SP 180	37-90	1470	265	70		1		2*				2	2	2				
		1760	317	84		1		2*				2	2	2				
	55-132	1470	265	70					1	1	1	2	2	2				
		1760	317	84					1	1	1	2	2	2				
SP 250	55-200	1470	368	97					1	1	1			2	2	2		
		1760	440	116					1	1	1			2	2	2		
	160-200	1470	368	97														2
		1760	440	116														2
SP 355	75-250	1470	522	138					1	1	1			2	2	2		
		1760	625	165					1	1	1			2	2	2		
	160-250	1470	522	138														2
		1760	625	165														2
SP 500	110-315	1470	735	194						1	1				2	2		
		1760	880	232						1	1				2	2		
	160-355	1470	735	194													1	2
		1760	880	232													1	2

* Only one set of electric motor/pump is permitted to operate, the other set serves as stand by.
** Actual flow = theoretical flow · volumetric efficiency.

Pumps series SP

Pump size	El. motor Power kW min-max	Speed	Oil flow**		1		2		3			4			5		6	7
		rpm	l/min	gpm	102	202	103	203	302	402	602	303	403	603	803	1003	702	1203
SP 750	160-500	1470	1103	291													1	2
		1760	1320	349													1	2
SP 40 + SP 40	15-55	1470	118	31		1		2*				2	2	2				
		1760	141	37		1		2*				2	2	2				
SP 71 + SP 40	30-90	1470	163	43		1		2*				2	2	2				
		1760	195	52		1		2*					2	2				
SP 71 + SP 71	30-90	1470	209	55		1		2*				2	2	2				
		1760	250	66		1		2*					2	2				
	75-110	1470	209	55					1	1	1	2	2	2				
		1760	250	66					1	1	1		2	2				
SP 125 + SP 40	37-90	1470	243	64		1		2*	1	1	1		2	2				
		1760	290	77		1		2*	1	1	1		2	2				
	75-132	1470	243	64					1	1	1		2	2				
		1760	290	77					1	1	1		2	2				
SP 125 + SP 71	45-90	1470	288	76		1		2*	1	1	1		2	2				
		1760	345	91		1		2*	1	1	1			2				
	75-132	1470	288	76					1	1	1		2	2				
		1760	345	91					1	1	1			2				
SP 125 + SP 125	55-200	1470	368	97					1	1	1			2	2	2		
		1760	440	116					1	1	1			2	2	2		
SP 180 + SP 40	45-160	1470	323	85					1	1	1		2	2	2	2		
		1760	387	102					1	1	1			2	2	2		
SP 180 + SP 71	55-200	1470	369	97					1	1	1			2	2	2		
		1760	442	117					1	1	1			2	2	2		
SP 180 + SP 125	75-200	1470	448	118					1	1	1			2	2	2		
		1760	537	142					1	1	1			2	2	2		
SP 180 + SP 180	75-250	1470	529	140					1	1	1			2	2	2		
		1760	634	167					1	1	1				2	2		
SP 250 + SP 40	75-200	1470	426	113					1	1	1			2	2	2		
		1760	510	135					1	1	1			2	2	2		
SP 250 + SP 71	75-250	1470	472	125					1	1	1			2	2	2		
		1760	565	149					1	1	1			2	2	2		
SP 250 + SP 125	75-250	1470	551	146					1	1	1			2	2	2		
		1760	660	174						1	1				2	2		
SP 250 + SP 180	90-315	1470	632	167					1	1	1			2	2	2		
		1760	757	200						1	1				2	2		
SP 250 + SP 250	110-315	1470	735	194						1	1					2		
		1760	880	232							1					2		
	110-355	1470	735	194													1	2
		1760	880	232													1	2
SP 355 + SP 40	90-315	1470	581	153					1	1	1			2	2	2		
		1760	695	184						1	1				2	2		
SP 355 + SP 71	90-315	1470	626	165						1	1				2	2		
		1760	750	198						1	1				2	2		
SP 355 + SP 125	110-355	1470	706	186						1	1				2	2	1	2
		1760	845	223						1	1				2	2	1	2

* Only one set of electric motor/pump is permitted to operate, the other set serves as stand by.
** Actual flow = theoretical flow · volumetric efficiency.

Pumps series SP

Pump size	El. motor Power kW min-max	Speed	Oil flow**		1		2		3			4			5		6	7
		rpm	l/min	gpm	102	202	103	203	302	402	602	303	403	603	803	1003	702	1203
SP 355 + SP 180	110-400	1470	786	208													1	2
		1760	942	249													1	2
SP 355 + SP 250	132-400	1470	889	235													1	2
		1760	1065	281													1	2
SP 355 + SP 355	132-400	1470	1044	276													1	2
		1760	1250	330													1	2
SP 500 + SP 40	110-400	1470	794	210													1	2
		1760	950	251													1	2
SP 500 + SP 71	132-400	1470	839	222													1	2
		1760	1005	265													1	2
SP 500 + SP 125	132-500	1470	919	243													1	2
		1760	1100	291													1	2
SP 500 + SP 180	160-500	1470	1000	264													1	2
		1760	1197	316													1	2
SP 500 + SP 250	160-500	1470	1103	291													1	2
		1760	1320	349													1	2
SP 500 + SP 355	160-500	1470	1257	332													1	2
		1760	1505	398													1	2
SP 500 + SP 500	200-500	1470	1470	388													***	***
		1760	1760	465													***	***
SP 750 + SP 40	160-500	1470	1161	307													1	2
		1760	1390	367													1	2
SP 750 + SP 71	160-500	1470	1207	319													1	2
		1760	1445	382													1	2
SP 750 + SP 125	200-500	1470	1286	340													***	***
		1760	1540	407													***	***
SP 750 + SP 180	200-500	1470	1367	361													***	***
		1760	1637	432													***	***
SP 750 + SP 250	200-500	1470	1470	388													***	***
		1760	1760	465													***	***
SP 750 + SP 355	250-500	1470	1624	429													***	***
		1760	1945	514													***	***
SP 750 + SP 500	250-500	1470	1838	485													***	***
		1760	2200	581													***	***
SP 750 + SP 750	315-500	1470	2205	582													***	***
		1760	2640	697														

Note: Standard design cooling power 25% of installed main electric motor power.

1 = One electric motor/pump.
2= Two electric motors/pumps same or different size can be selected.

* Only one set of electric motor/pump is permitted to operate, the other set serves as stand by
** Actual flow = theoretical flow · volumetric efficiency.
*** Not in PEC, because of height and tank flow.

Possible pump combinations

Pumps series Gold CUP

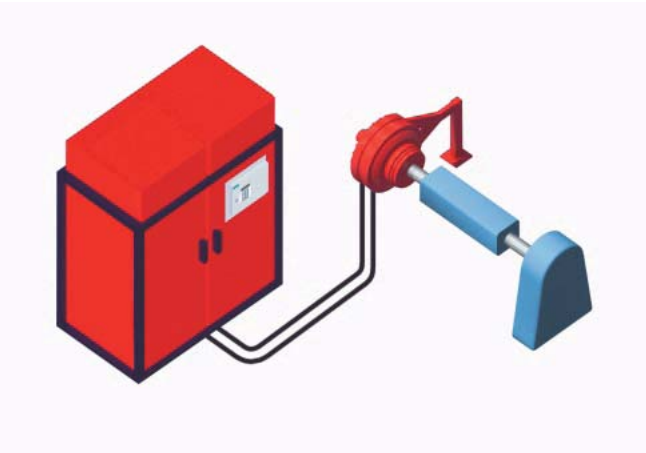
Cabinet size		**1**		**2**		**3**			**4**			**5**		**6**	**7**
Power unit PEC		102	202	103	203	302	402	602	303	403	603	803	1003	702	1203
Electric motor related power *(kw)* (50 Hz)	315					1	1	1			2	2	2		
	250					1	1	1			2	2	2		
	200					1	1	1	2	2	2	2	2		
	160					1	1	1	2	2	2	2	2		
	132					1	1	1	2	2	2	2	2		
	110					1	1	1	2	2	2	2	2		
	90	1	1	2	2	1	1	1	2	2	2	2	2		
	75	1	1	2	2	1	1	1	2	2	2	2	2		
	55	1	1	2	2	1	1	1	2	2	2				
	45	1	1	2	2	1	1	1	2	2	2				
	37	1	1	2	2	1	1	1	2	2	2				
	30	1	1	2	2				2	2	2				
	22	1	1	2	2				2	2	2				
	18,5	1	1	2	2				2	2	2				
	15	1	1	2	2				2	2	2				
	11	1	1	2	2				2	2	2				

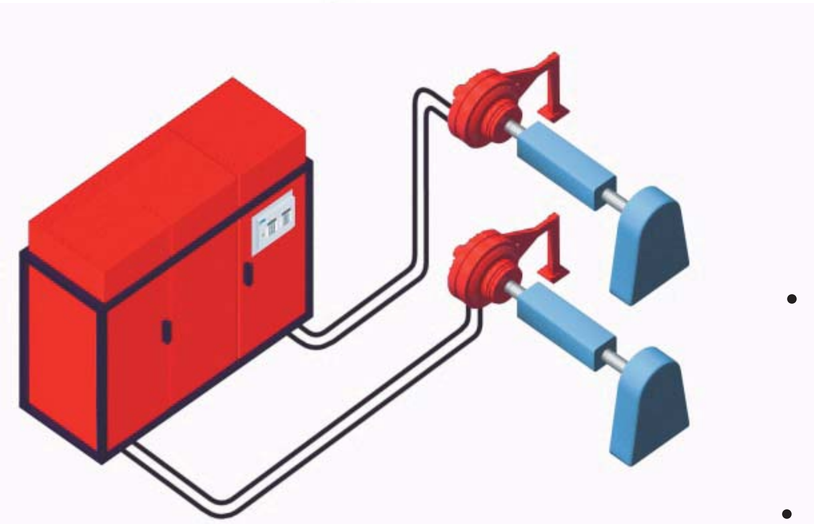
Pump size	**Emotor power** (kW) min/max	**Speed** (rpm)	**Oil flow** (l/min) (gpm)**	**102**	**202**	**103**	**203**	**302**	**402**	**602**	**303**	**403**	**603**	**803**	**1003**	**702**	**1203**
P6S-98	11-90	1470	144(38,0)	1	1	2*	2				2	2	2				
		1770	172(45,4)		1		2*				2	2	2				
P7S-119	18,5-90	1470	175(46,2)		1	2*	2				2	2	2				
		1770	209(55,2)		1		2*				2	2	2				
P11S-180	37-90	1470	264(69,7)		1		2*				2	2	2				
		1770	316(83,4)		1		2*					2	2				
	55-160	1470	264(69,7)					1	1	1	2	2	2	2	2		
		1770	316(83,4)					1	1	1		2	2	2	2		
P14S-229	37-90	1470	337(88,9)		1		2*				2	2	2				
		1770	403(106,4)		1		2*					2	2				
	55-200	1470	337(88,9)					1	1	1	2	2	2	2	2		
		1770	403(106,4)					1	1	1		2	2	2	2		
P24S-403	75-315	1470	592(156,3)					1	1	1			2	2	2		
		1770	663(167,1)					1	1	1			2	2	2		
P30S-501	75-315	1470	737(194,6)					1	1	1			2	2	2		
		1770	881(232,6)					1	1	1			2	2	2		

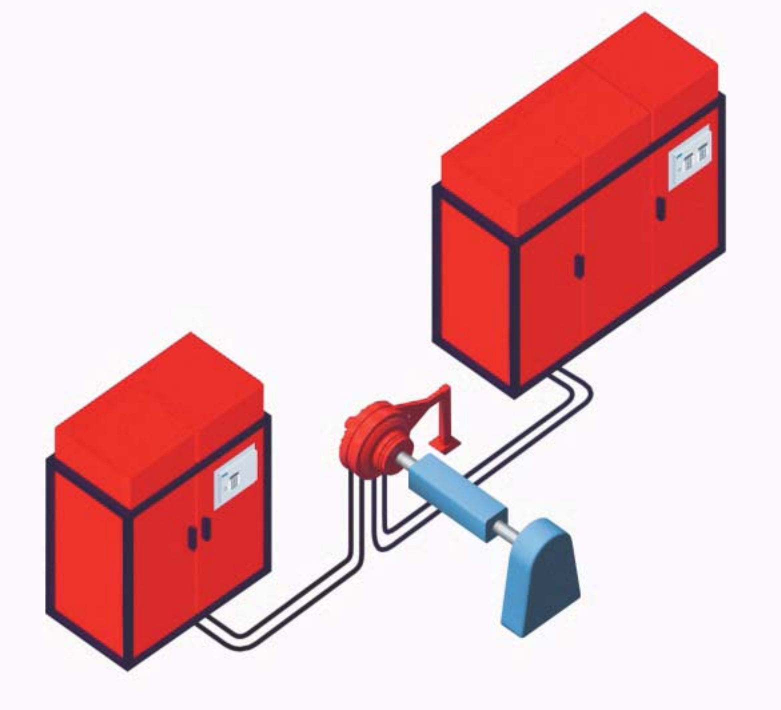
1) = One electric motor/pump.
2)= Two electric motors/pumps same or different size can be selected.

*) Only one set of electric motor/pump is permitted to operate, the other set serves as stand by
**) Actual flow = theoretical flow · volumetric efficiency.

Choose the best solution for your application







- A system of few components, but many combinations and configurations, to provide any solution for the Hägglunds Drives performance range. The perfect load sharing characteristics enables multi-pump and/or multi-motor combinations to suit the application.
- User friendly - pressure and flow and therefore torque, speed and hence power can be adjusted. It is easy to upgrade to suit changing production demands. This versatility can transform a machine into an intelligent high production unit. Features such as extremely fast pump compensators to give fast response and reduce stresses and strains on the machine, load sensing and power limiting enable functionality unavailable from other systems.
- The ability to split the drive from the power unit enables freedom of application, the power unit can be positioned away from the machine without foundation requirements.
- Our drive controller Spider provides all the necessary start/stop logic, system health monitoring and machine control techniques. Usually it is mounted, wired and fully programmed inside the PEC unit prior to delivery.
- The unit is easy to install, it is fully function tested before delivery and takes a short time to commission. Installation can be undertaken usually during a normal shutdown period so no production losses are experienced.
- Customisation is normal e.g. Standby pump sets for critical areas, auxiliary circuits for cylinders and brakes. Provision for working in hostile environments such as dusty mining sites, on ship decks, explosive zone chemical plants and climates with wide temperature variations.

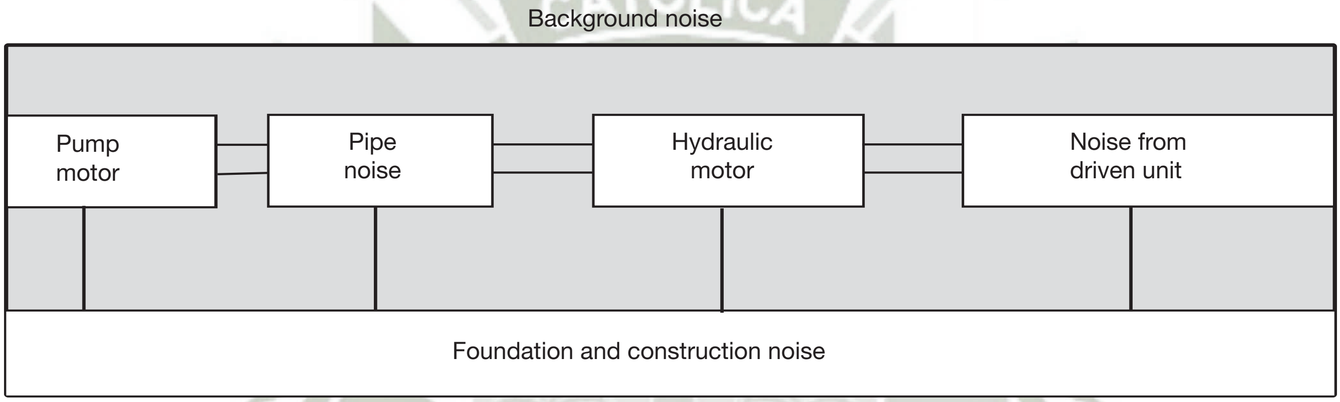
Improving the work environment

In a good work environment the sound levels are important. Environments where the sound levels are kept down, make a difference for operator health and well being. Hägglunds low speed hydraulic motors generate very low sound levels due to the low speed. The dominating sound sources in a hydraulic drive system are the power unit and the piping systems. Hägglunds offers three options with regard to the power unit sound levels.

The sound can be of three basic kinds. Structured borne sound (from for instance a pump), air borne sound (for example from a cooling fan), and fluid borne sound (emitted by the pump or the motor as pulsation in the oil flow). Each of these has to be treated separately to manage the overall sound level and to specify the level, the combined effect must be considered.

The sound power being radiated by a machine is often of more concern than the sound pressure measured at a given distance from the machine. Sound values below are the average LPA surface sound pressure levels according to ISO standards 3746 and doesn't include piping.

Noise from a complete installation



Five Power Unit options to choose between

OPEN UNIT, 90-95 dBA
Standard frame but no panels. Air cooled electric motors. Sound level around 90-95 dBA. For installation in pump rooms or where there are no specific demands regarding sound level or protection

CLOSED UNIT, 75-85 dBA
Standard frame, panels and doors. Air cooled electric motors. Typical sound level 75-85 dBA. For installation with moderate sound level demand and/or with reasons to have protect.

CLOSED UNIT, 72-80 dBA
Standard frame, panels and doors. Pump set mountings and cabinet feet in rubber. Sound dampened air and hose outlet in cabinet. Air cooled electric motors. Typical sound levels 72-80 dBA For installations with high sound level demand.

CLOSED UNIT, 70-75 dBA
Vibration dampened frame. Standard panels and doors. Pump set mountings and cabinet feet in rubber. Typical sound levels 70-75 dBA. For installations with very high sound level demand and/or with reasons to protect involved components from environmental conditions.

OPEN UNIT IN A TOTALLY ENCLOSED COVER 60-65 dBA
Standard frame. Pump set mountings and cabinet feet in rubber . Water cooled electric motors. Sound levels around 60-65 dBA For installations with extremely high sound level demands.

Examples of installation

Pulp & Paper. Wash presses, Finland.

Recycling, Shredder, United Kingdom.

Marine & Offshore, ROV Handling Winch, United Kingdom.

Bulk Materials Handling, Bucket Wheel Reclaimer, China

Sugar. Sugar Mill, Brazil.

Mining & Bulk Materials Handling. Apron Feeder, Australia.

IC Fluid Power Inc.

ON THE LEADING EDGE OF TECHNOLOGY

BUTTERFLY VALVES

HydroWer

1. General

HyrdoWer is a globally recognized manufacturer of power unit accessories. They have become specialists in the design of Butterfly Valves and Hydraulic Compensators.

The shut off valve is installed into the pump suction line. The valve has a SAE (4 - bolt flange) connection, SAE standard J518.

The valve can be actuated with or without the shift handle (option H) and the locking bolt will automatically snap the valve into the open or closed position.

The optional tank flange (T-option) can be welded to the reservior, giving a bolting surface for the butterfly valve. A limit switch (E-option) can be mounted to the top of the valve. Explosion-proof limit switches are available.

2. Technical Data:

Operating Pressures:

Maximum pressure:	232 p.s.i.
Negative pressure:	10 p.s.i.
Pressure difference:	58 p.s.i.
(per side when valve is closed)	

Material:

Body + Shift Handle:	Aluminum
Seals:	NBR
Other Parts:	Steel Galvanized

3. Ordering Code:

AB 16 S [NG] - T H B E , Additional description

Basic equipment item #4

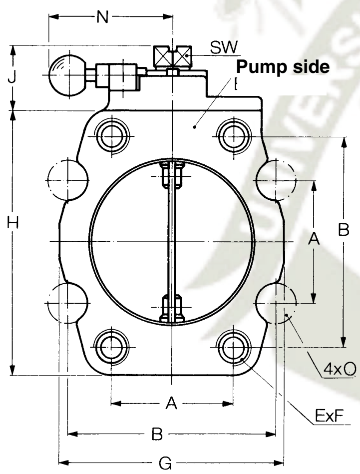
Limit-switch (see option #8)

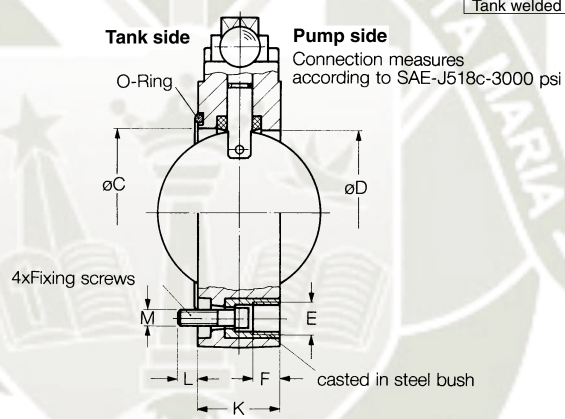
Tapped bushings (see option #7)

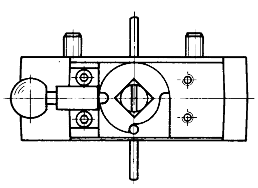
Shifter (see option #6)

Tank welded (see option #5)

4. Butterfly Valve: AB 16 [NG]







Mounting, screws and O-Ring is supplied with valve.

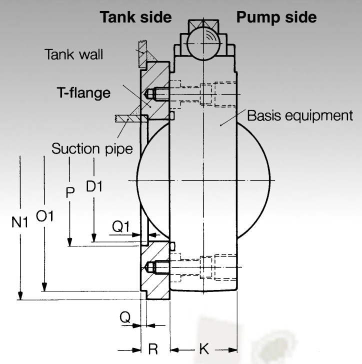
Type [NG]	Size SAE	A (in)	B (in)	D (in)	C (in)	E (mm)	F (mm)	G (in)	H (in)	J (in)	K (in)	L (in)	M (mm)	N (in)	O (mm)	SW (mm)	O-Ring (mm)
AB 16 S 32	1 1/4"	1.19	2.31	1.38	1.42	M12	14	2.24	3.31	1.14	1.38	0.28	M6	2.28	13	9	41x3.5
AB 16 S 40	1 1/2"	1.41	2.75	1.75	1.81	M12	14	2.72	3.74	1.14	1.38	0.28	M6	2.28	13	9	52X3.5
AB 16 S 50	2"	1.69	3.06	2.13	2.20	M12	14	3.15	4.09	1.14	1.38	0.28	M6	2.28	13	9	62X3.5
AB 16 S 63	2 1/2"	2.00	3.50	2.62	2.68	M12	14	3.86	4.53	1.22	1.65	0.31	M6	2.52	13	12	75X4
AB 16 S 80	3"	2.44	4.19	3.25	3.35	M16	16	4.57	5.31	1.22	1.65	0.35	M8	2.52	17	12	92X4
AB 16 S 100	4"	3.06	5.13	4.17	4.17	M16	16	5.39	6.26	1.22	1.65	0.35	M8	2.52	17	12	114X4
AB 16 S 125	5"	3.63	6.00	5.16	5.16	M16	16	6.42	7.13	1.22	1.65	0.35	M8	2.52	17	12	140X4

IC Fluid Power Inc.

ON THE LEADING EDGE OF TECHNOLOGY

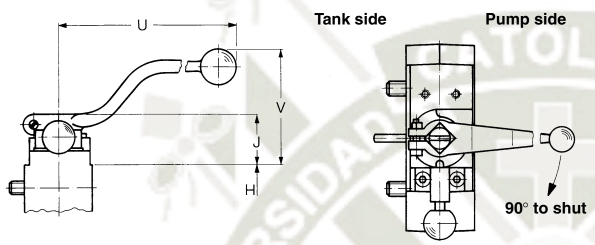
BUTTERFLY VALVES

HydroWer



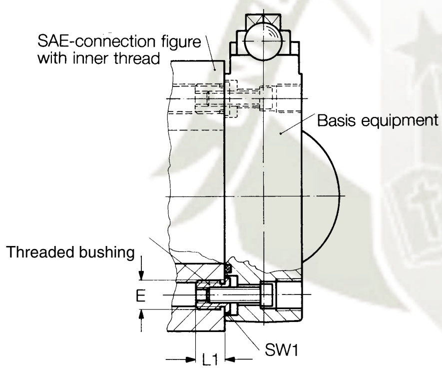
5. Flange - Option "T": The flange can be welded to the reservoir, giving a bolting surface for the butterfly valve.

Type [NG]	Size SAE	ØD1 (in)	ØN1 (in)	ØO1 (in)	ØP (in)	Q (in)	Q1 (in)	R (in)
AB 16 S 32	1 1/4"	1.38	3.54	3.15	1.69	0.12	0.16	0.55
AB 16 S 40	1 1/2"	1.65	3.94	3.54	1.93	0.12	0.16	0.55
AB 16 S 50	2"	2.17	4.33	3.94	2.40	0.12	0.16	0.55
AB 16 S 63	2 1/2"	2.68	4.92	4.53	3.07	0.12	0.16	0.67
AB 16 S 80	3"	3.31	5.71	5.31	3.58	0.12	0.16	0.67
AB 16 S 100	4"	4.13	6.89	6.50	4.57	0.12	0.16	0.67
AB 16 S 125	5"	5.12	7.87	7.48	5.59	0.12	0.16	0.67



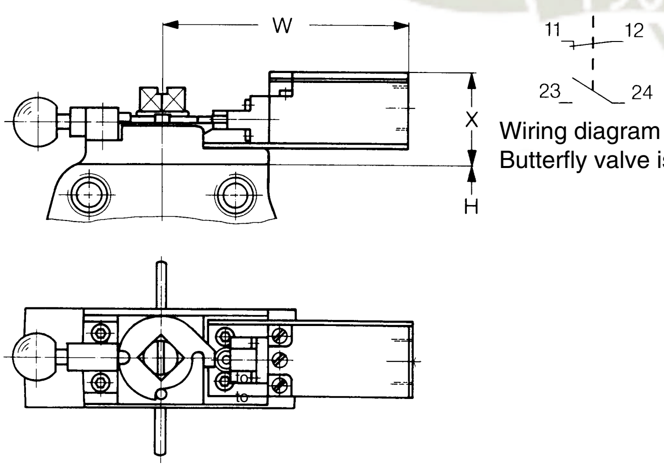
6. Shift Handle Option "H":

Type	W (in)	X (in)
AB 16 S 32 to 50	4.13	1.57
AB 16 S 63 to 125	4.33	1.57



7. Threaded Adapter Bushing Inserts - Option "B"
Threaded busing that adapts to standard SAE tapped holes. With these bushings, it will accept the screws provided with Butterfly valve.

Type	E UNC-2B	L1 in	SW1 mm
AB 16 S 32 to 63	7/16 - 14	0.47	12
AB 16 S 40 to 63	1/2 - 13	0.51	12
AB 16 S 80 to 125	5/8 - 11	0.51	17



Wiring diagram when Butterfly valve is closed

8. Limit switch - option "E"

Type	E UNC-2B	L1 (in)	SW1 (mm)
AB 16 S 32 to 63	7/16 - 14	0.47	12
AB 16 S 80 to 125	5/8 - 11	0.51	17

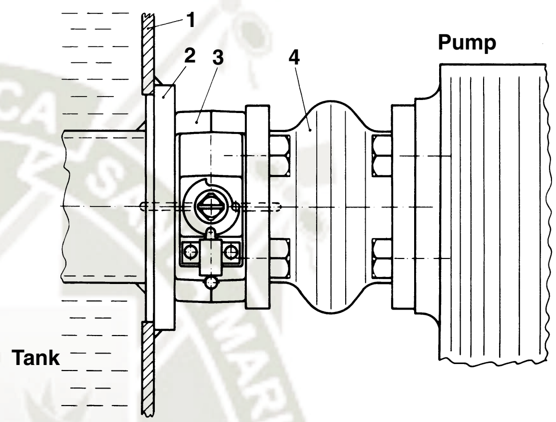
Limit switch to DIN-EN 50047
= thermoplast
glass-fibre reinforced
System of protection: IP 67-DIN 40050
Contact system: 1 Opener / 1 closing
Max. permis. voltage: 380 V WS
Max. permis. perm. current: 6 A
Max. permiss. switch on current: 16 A

COMPENSATORS 1" - 4"

1. General:

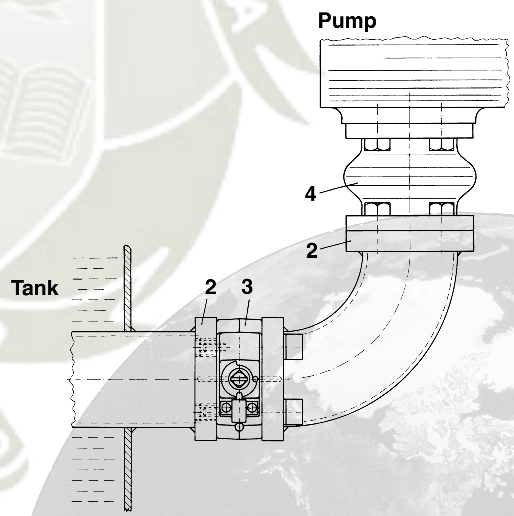
The HydroWer Rubber Compensators is a product that qualifies as one of the best kept secrets of power unit accessories. The Hydrower Rubber Compensators are flexible connectors with SAE-flanges. The oscillation compensators are used for damping of oscillators and vibrations, noises and movements in axial and transversal direction.

The HydroWer Compensator is constructed of an inner liner of a reinforced high strength rubber (Nitril-caoutchouc. Perbunan). The outer and inside layers are smooth and have an aerodynamic design that eliminates cavitation. The outside rubber (neoprene caoutchouc) is weather resistant. Both ends of the Compensators have vulcanized sealing lips. With the vulcanized sealing lips on each end, additional seals are not necessary.



Typical Installation:

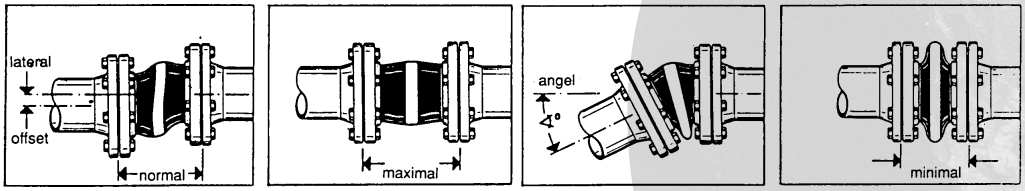
1 - Tank wall
2 - Flange
3 - Butterfly Valve
4 - Compensator



2. Technical Data:

Working Pressure:	87 p.s.i.
Max. Pressure:	174 p.s.i.
Burst Pressure:	290 p.s.i.
Vacuum:	20" Hg
Temperature	-4°F to 176°F

Acceptable Movement



For Acceptable Movements See Tables 1, 2, 3, 4

Toll Free (877) - ICFLUID
www.icfluid.com

COMPENSATORS

Compensator with SAE to SAE Flange connecting sizes after SAE-Standard J 518c

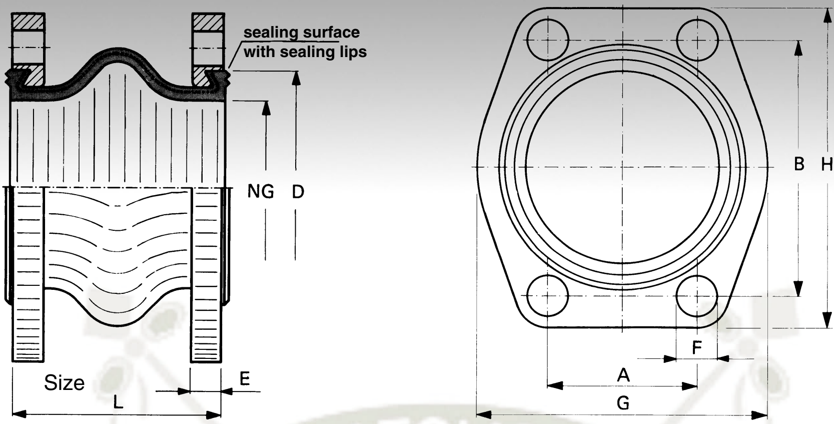


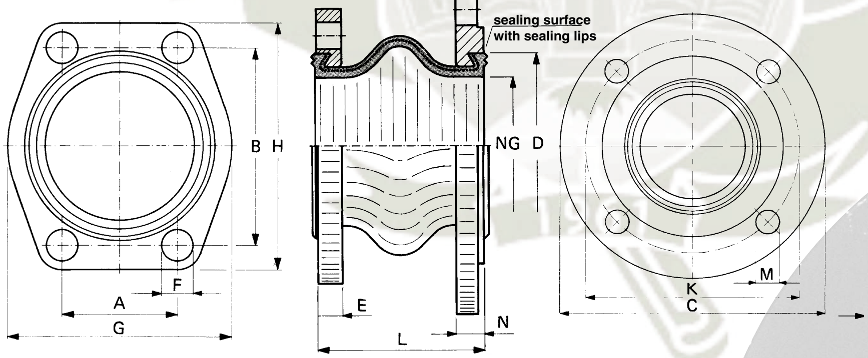
Table 1

Type [NG]	Size	A	B	D	E	F	G	H	L	Acceptable Movement			
	SAE	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	Push/Pull	Offset	Angle(°)	Weight (lbs.)
K 16 S 25	1"	1.03	2.06	1.69	0.43	0.43	2.17	2.76	2.56	±0.20 in	±0.20 in	7.5°	0.8
K 16 S 32	1 1/4"	1.19	2.31	1.97	0.43	0.51	2.76	3.15	2.56	±0.20 in	±0.20 in	7.5°	1.10
K 16 S 40	1 1/2"	1.41	2.75	2.44	0.51	0.51	3.15	3.54	3.94	±0.39 in	±0.39 in	10°	1.76
K 16 S 50	2"	1.69	3.06	2.83	0.51	0.51	3.54	3.94	3.94	±0.39 in	±0.39 in	10°	2.21
K 16 S 63	2 1/2"	2.00	3.50	3.43	0.55	0.51	4.13	4.53	3.94	±0.39 in	±0.39 in	10°	2.65
K 16 S 80	3"	2.44	4.19	4.09	0.55	0.71	4.72	5.20	3.94	±0.39 in	±0.39 in	10°	3.97
K 16 S 90	3 1/2"	2.75	4.75	4.09	0.55	0.71	5.12	5.75	3.94	±0.39 in	±0.39 in	10°	4.19
K 16 S 100	4"	3.06	5.13	5.12	0.63	0.71	5.51	6.14	3.94	±0.39 in	±0.39 in	10°	5.51

Compensator with SAE to DIN-Flange

SAE-Flange

DIN-Flange



connecting sizes
after SAE-Norm
(J 518ci) and
after DIN 2633 - ND 16

Table 2

Type [NG]	Size	A	B	C	D	E	F	G	H	K	L	M	N	Acceptable Movement			
	SAE	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(mm)	(in)	Push/Pull	Offset	Angle (°)	Weight (lbs.)
K16SD- 25	1"	1.031	2.062	4.53	1.69	0.43	0.43	2.17	2.76	3.35	2.56	4x14	0.63	±0.20 in	±0.20 in	7.5°	3.31
K16SD- 32	1 1/4"	1.188	2.312	5.51	1.97	0.43	0.51	2.76	3.15	3.94	2.56	4x18	0.63	±0.20 in	±0.20 in	7.5°	3.97
K16SD- 40	1 1/2"	1.406	2.750	5.91	2.44	0.51	0.51	3.15	3.54	4.33	3.94	4x18	0.63	±0.39 in	±0.39 in	10°	4.85
K16SD- 50	2"	1.688	3.062	6.50	2.83	0.51	0.51	3.54	3.94	4.92	3.94	4x18	0.71	±0.39 in	±0.39 in	10°	6.17
K16SD- 63	2 1/2"	2.00	3.500	7.28	3.43	0.55	0.51	4.13	4.53	5.71	3.94	4x18	0.71	±0.39 in	±0.39 in	10°	7.06
K16SD- 80	3"	2.438	4.188	7.87	4.09	0.55	0.71	4.72	5.20	6.30	3.94	4x18	0.79	±0.39 in	±0.39 in	10°	8.82
K16SD- 90	3 1/2"	2.750	4.750	7.87	4.09	0.55	0.71	5.12	5.75	6.30	3.94	4x18	0.79	±0.39 in	±0.39 in	10°	9.04
K16SD- 100	4"	3.062	5.125	8.66	5.12	0.63	0.71	5.51	6.14	7.09	3.94	4x18	0.79	±0.39 in	±0.39 in	10°	10.58

Compensator with NPT Thread to NPT Thread

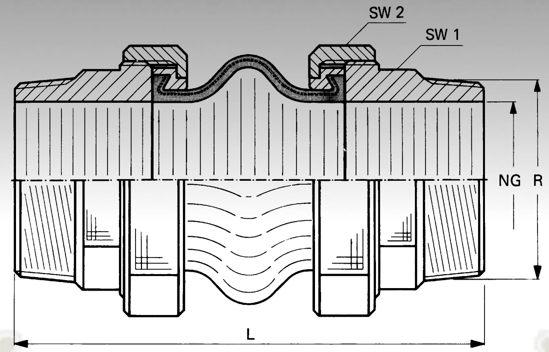


Table 3

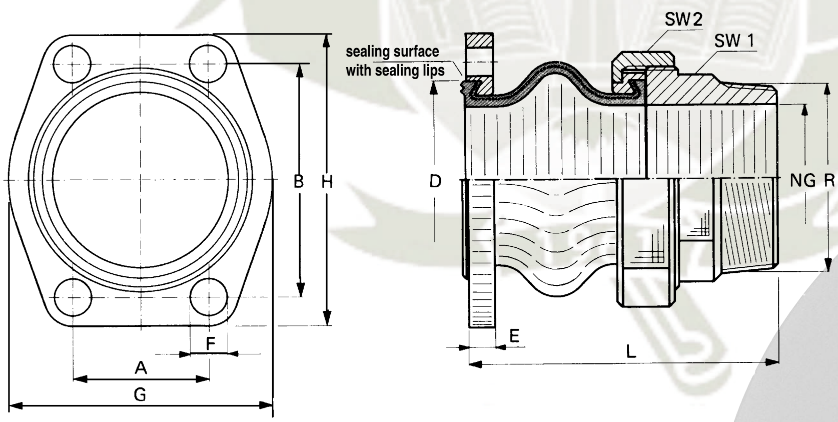
Type [NG]	NG	L	R	SW1	SW2	Acceptable Movement			
	(in)	(in)	(NPT)	(mm)	(mm)	Push/Pull	Offset	Angle(°)	Weight (lbs.)
K 16 R 25	0.98	6.42	1"	35	54	±0.20 in	±0.20 in	7.5°	1.54
K 16 R 32	1.26	6.97	1 1/4"	45	66	±0.20 in	±0.20 in	7.5°	2.43
K 16 R 40	1.57	9.06	1 1/2"	53	73	±0.39 in	±0.39 in	10°	2.87
K 16 R 50	1.97	9.45	2"	66	90	±0.39 in	±0.39 in	10°	3.31

Check when installing
When installing the compensator, it must be in line and maintain the dimension "L" length. For compensators with NPT pipe thread the nut SW2 must only be hand tight.

The movement absorption in static and dynamic loads and the different types of movements must be added together and the totals are not allowed to exceed the data given.

Attention: Pressure spikes are push loads which add to the axial movement. Do not exceed given data!

Compensator with SAE-Flange to NPT Thread



Flange connecting after
SAE-Norm J 518 -
NPT Pipe Thread

Table 4

Type [NG]	Size	A	B	D	E	F	G	H	L	R	SW1	SW2	Acceptable Movement			
	SAE	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(mm)	(mm)	Push/Pull	Offset	Angle (°)	Weight (lbs.)
K16SR- 25	1"	1.03	2.06	1.61	0.43	0.43	2.17	2.76	4.49	1"	35	54	±0.20 in	±0.20 in	7.5°	0.80
K16SR- 32	1 1/4"	1.19	2.31	1.89	0.43	0.51	2.76	3.15	4.76	1 1/4"	45	66	±0.20 in	±0.20 in	7.5°	1.80
K16SR- 40	1 1/2"	1.41	2.75	2.32	0.51	0.51	3.15	3.54	6.18	1 1/2"	53	73	±0.39 in	±0.39 in	10°	2.40
K16SR- 50	2"	1.69	3.06	2.76	0.51	0.51	3.54	3.94	6.42	2"	66	90	±0.39 in	±0.39 in	10°	2.90

IC Fluid Power Inc.

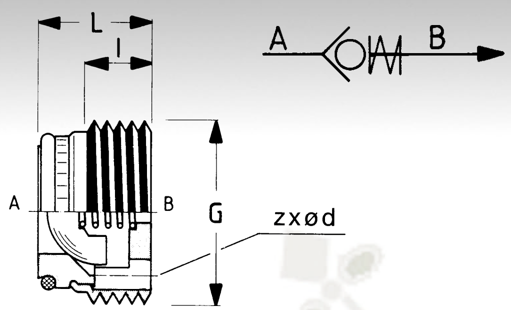
ON THE LEADING EDGE OF TECHNOLOGY

SCREW-IN TYPE CHECK VALVES

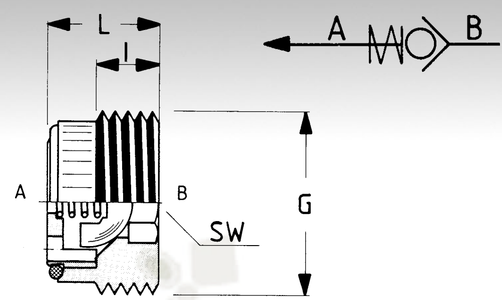
HydroWer

• Ball Type Poppet Design - patent pending • Pressures to 10,000 psi (700 bar) - Flows to 23 gpm (90 l/min)
• Nominal Size: 1/16 - 1/8 - 1/4 - 3/8 - 1/2 - 3/4 • Threads: BSP, Metric, and Inch sizes on request

Type: RVA

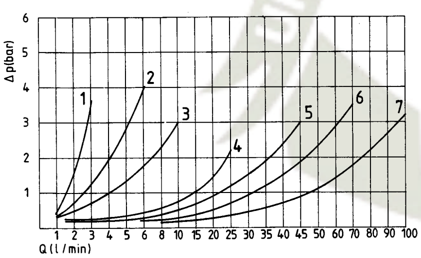


Type: RVB



Type	Max GPM	G	L	l	b	zxød	0-Ring (90 sh)	Curve #
RVA 2-M	0.79	M6	6	3.5	3.5	4x1.2	2.5x1	1
RVA 3-M	1.59	M8x1	6	3.5	5	6x1.6	4x1	2
RVA 4 RVA 4-M	2.64 2.64	G 1/8 M 10x1	6.5	3.5	6	6x1.8	6x1	3
RVA 6 RVA 6-M	6.61 6.61	G 1/4 M 14x1.5	8	4.6	9	8x2.2	9x1	4
RVA 8 RVA 8-M	11.89 11.89	G 3/8 M18x1.5	10	5.5	11	8x3	11x1.5	5
RVA 10 RVA 10-M	18.49 18.49	G 1/2 M22x1.5	11.5	6.5	14.5	8x3.8	14x1.5	6
RVA 16 RVA 16-M	26.42 26.42	G 3/4 M27x2	14	7.5	18.5	8x4.6	18.77x1.78	7

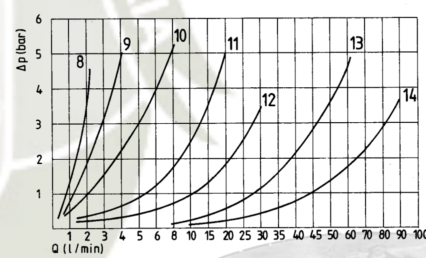
Type	Max GPM	G	L	l	SW	0-Ring (90 sh)	Curve #
RVB 2-M	0.53	M6	6.5	3.5	3	2.5x1	8
RVB 3-M	1.06	M8x1	6.5	3.5	3	4x1	9
RVB 4 RVB 4-M	2.11 2.11	G 1/8 M 10x1	7	4	4	6x1	10
RVB 6 RVB 6-M	4.76 4.76	G 1/4 M 14x1.5	8	4.5	5	9x1	11
RVB 8 RVB 8-M	7.93 7.93	G 3/8 M18x1.5	9.5	5.5	6	11x1.5	12
RVB 10 RVB 10-M	15.85 15.85	G 1/2 M22x1.5	11.5	6.5	8	14x1.5	13
RVB 16 RVB 16-M	23.78 23.78	G 3/4 M27x2	14	8	10	18.77x1.78	14

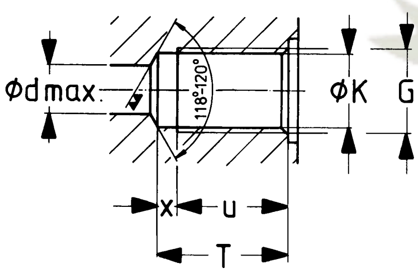


Techincal Data:

Operating Pressure:	10,150 psi (lock pressure)
Proof Pressure:	40,600 psi
Temperature Range:	-40°F to 176°F
Viscosity Range:	5 to 500 c St
Installation Position:	Any direction
Flow Rate:	See section 4

Stainless Steel on Request





It is absolutely necessary to maintain the "x" dimension of the cavity (item #5)

Type	G	K	d	T	U	X
RVA +RVB 2	M6	2	7	5	4.5	2.5
RVA +RVB 3	M8x1	7	3.5	7	4.5	2.5
RVA +RVB 4 RVA +RVB 4	G 1/8 M 10x1	8.7 9	5	8.5	6	2.5
RVA +RVB 6 RVA +RVB 6	G 1/4 M 14x1.5	11.7 12.5	8	9	6	3
RVA +RVB 8 RVA +RVB 8	G 3/8 M18x1.5	15.2 16.5	10	11	6	8
RVA +RVB 10 RVA +RVB 10	G 1/2 M22x1.5	19 20.5	12	13	9.5	3.5
RVA +RVB 16 RVA +RVB 16	G 3/4 M27x2	24.5 25	16	17	12.5	4.5

X - Thread run-out. It can be smaller, but not larger.
T - Minimum depth without plug, thread joint, transverse drill and so on.
In case of stronger impacts and vibration, it is recommended to secure the valves with loctite or similar.
*All dimensions in mm.

Oil viscosity measured at 50 cSt.
Warning: In case of sudden loading of the check-valve in flow direction, for example behind tank or hoses, the specified flow quantity must not be exceeded.

GENERAL	1	Job No.	Customer		25580		Minera Xstrata Tintaya S.A.	
	2	Project Name			Antapaccay - Expansion Tintaya			
	3	Tag Number			0310-FV -01201B			
	4	Service			CAL A CHUTE ALIMENTACION MOLINO SAG			
	5	Line No.	P&ID		1 1/2"-0391-ML-0226-C1E2R		25580-220-M6-0310-00001	
	6	Area Classification	Seismic Norm	Sea Level Alt.	GENERAL PURPOSE		NTE E.030 ZONE 2	4100 m
	7	Ambient Temperature:	Min.	Max.	-5ºC		18ºC	
	8	Allowable dBA			85 dB AT A DISTANCE OF 1 METER			
	9	Avail Air Supply Press:	Min.	Max.	413 kPa-g		690 kPa-g	
	10	Valve Air Failure Position			Close			
PIPE LINE	11	Line Size/Schedule	Inlet	Outlet / Liner Mat/Thick	1 1/2 in	80	1 1/2 in	1 1/2 in
	12	Pipe material class	Pipe material	Pipe insulation	C1E2R	CS ASTM A53-B/API 5L-B GE		
PROCESS CONDITIONS	13	Fluid name	Fluid state		MILK OF LIME		Liquid	
	14	Corrosive	Erosive	Toxic	NO	YES	NO	
	15	Max Shutoff D/P	Critical Pressure		570 kPa		kPa-g	
	16				Units	@ Min. Flow	@ Norm. Flow	@ Max. Flow
	17	Design Pressure			kPa-g		-	
	18	Design Temperature			ºC	-10	-	35
	19	Flow Rate			Am³/h			5.8
	20	Inlet Pressure			kPa-g			570
	21	Pressure Drop			kPa			
	22	Inlet Temperature			ºC	6		
	23	Inlet Density / Specific Gravity			kg/m³		1.16	
	24	Solid Percentage			%		20	
	25	Inlet Viscosity			cP			
	26	Molecular Mass	Inlet Specific Heats Ratio					
	27	Inlet Vapour Pressure			kPa-a		0.935	
CALCULATED RESULTS	28	Flow Coefficient Cv			-			
	29	Travel			%			
	31	Sound Pressure Level			dBA			

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 1
Reviewer Name: Cristian Arancibia Date: 02/Nov/2011
Discipline: EJ - Control Systems Doc Type Code: V2A
Job # 25580-220 VP # 25580-220-V2A-JV01-00003
Subm. 003 Equip # 0310-FV-01201B;
Program # Transmittal # 4;
Job # VP #
SEQ # Equip #

BODY AND TRIM	32	Body Type	Material	DIAPHRAGM	ASTM A126
	33	Body Size	Trim Size	1.5in	NA
	34	Rated Cv	Characteris.	NA	#150 NA
	35	End Connec. & Rating		RF Flange [redacted]	ASME 16.1
	36	Flow Direction		UNIDIRECTIONAL	
	37	Rated Travel		NA	
	38	Sleeve Material		(Note 2)	
	39	Gasket Material		NA	
	40	Wear Sleeves		NA	
ACTUATOR	41	Type		SPRING RET. CYLINDER	
	42	Size	Area	462mm	~~0.14m2~~ 0.01 m²
	43	Max. Allowable Press.		60 psi	
	44	Actuator Failure		FAIL CLOSE	
	45	Handwheel		INCLUDED	
	46	Bench Range		NA	
CONTROL SIGNAL	47	Signal Type		NA	
	48	Comm. Protocol		NA	
	49				

POSITIONER	50	Signal: Inlet	Outlet	NA	
	51	Type		NA	
	52	Bypass	Gauges	NA	
TRANSDUCER	53	Mounting		NA	
	54	Signal Inlet	Outlet	NA	
	55				
SOLENOID VALVE	56	Type		Not required	
	57	When De-Enegr.Valve:		Not required	
SWITCHES	58	Type	Quantity	NO	2
	59	Contacts / Rating		120 VAC, 60 Hz, 130mA	
	60	Switching Position		OPEN / CLOSE	
AIR SET	61	Set Pressure		Not required	
	62	Filter	Gauge	NA	NA
TESTS	63	Hydro. Pressure		NOT REQUIRED	
	64	Cryogenic Test		NA	
	65	ANSI/FCI Leakage Class		ANSI VI (TSO)	
PURCHASE	66	MR No.		25580-220-MRA-JV01-00002	
	67	Item No.		1.02	

1.-Individual SS plate with tag number shall be permanently attached to each valve.
2.-Diaphragm Material: Natural Rubber.
3.-BKS-S 28-03 Connector included.

74	Tag No.	Instrument Type	Manufacturer	Model Number
75	0310-FV -01201B	Control Valve	VALAM	PASO RECTO DN 40
76	---	Positioner	NA	NA
77	---	Solenoid	NA	NA
78	0310-ZSL/H-01201B	Switch	BALLUFF	BES-516-207-S 27-E (Note 3)
79		Actuator	VALAM	ESC-61
80				

No.	By	Chk	Appr	Date	Description
0	MTC	HAM	ROV	2/28/2011	Issued for Purchase
C	CGN	CSN	ROV	10/22/2010	Issued for Bid
B	CGN	CSN	ROV	10/4/2010	Issued for Approval
A	CGN	CSN	ROV	9/3/2010	Issued for Coordination

INSTRUMENT SPECIFICATION

Diaphragm On-Off Valve M&M

xstrata copper

BECHTEL

Client No:
Code: 22199
Sheet 1 of 1
Form Rev.0
DS No: 25580-220-JVD-JV01-00102
Rev: 0

GENERAL	1	Job No.	Customer		25580		Minera Xstrata Tintaya S.A.	
	2	Project Name			Antapaccay - Expansion Tintaya			
	3	Tag Number			0310-FV -01201A			
	4	Service			CAL A CHUTE ALIMENTACION MOLINO SAG			
	5	Line No.	P&ID		1 1/2"-0391-ML-0221-C1E2R		25580-220-M6-0310-00001	
	6	Area Classification	Seismic Norm	Sea Level Alt.	GENERAL PURPOSE		NTE E.030 ZONE 2	4100 m
	7	Ambient Temperature:	Min.	Max.	-5ºC		18ºC	
	8	Allowable dBA			85 dB AT A DISTANCE OF 1 METER			
	9	Avail Air Supply Press:	Min.	Max.	413 kPa-g		690 kPa-g	
	10	Valve Air Failure Position			Close			
PIPE LINE	11	Line Size/Schedule	Inlet	Outlet / Liner Mat/Thick	1 1/2 in	80	1 1/2 in	1 1/2 in
	12	Pipe material class	Pipe material	Pipe insulation	C1E2R	CS ASTM A53-B/API 5L-B GE		
PROCESS CONDITIONS	13	Fluid name	Fluid state		MILK OF LIME		Liquid	
	14	Corrosive	Erosive	Toxic	NO	YES	NO	
	15	Max Shutoff D/P	Critical Pressure		570 kPa		kPa-g	
	16				Units	@ Min. Flow	@ Norm. Flow	@ Max. Flow
	17	Design Pressure			kPa-g		-	
	18	Design Temperature			ºC	-10	-	35
	19	Flow Rate			Am³/h			5.8
	20	Inlet Pressure			kPa-g			570
	21	Pressure Drop			kPa			
	22	Inlet Temperature			ºC	6		
	23	Inlet Density / Specific Gravity			kg/m³		1.16	
	24	Solid Percentage			%		20	
	25	Inlet Viscosity			cP			
	26	Molecular Mass	Inlet Specific Heats Ratio					
	27	Inlet Vapour Pressure			kPa-a		0.935	
CALCULATED RESULTS	28	Flow Coefficient Cv			-			
	29	Travel			%			
	31	Sound Pressure Level			dBA			

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 1
Reviewer Name: Cristian Arancibia — Date: 02/Nov/2011
Discipline: EJ - Control Systems — Doc Type Code: V2A
Job # 25580-220 — VP # 25580-220-V2A-JV01-00002
Subm. 003 — Equip # 0310-FV-01201A;
Program # Transmittal # 4;
Job # — VP #
SEQ # — Equip #

BODY AND TRIM	32	Body Type	Material	DIAPHRAGM	ASTM A126
	33	Body Size	Trim Size	1.5in	NA
	34	Rated Cv	Characteris.	NA	NA
	35	End Connec. & Rating		RF Flange #150 [redacted]	ASME 16.1
	36	Flow Direction		UNIDIRECTIONAL	
	37	Rated Travel		NA	
	38	Sleeve Material		(Note 2)	
	39	Gasket Material		NA	
	40	Wear Sleeves		NA	
ACTUATOR	41	Type		SPRING RET. CYLINDER	
	42	Size	Area	462mm	~~0.1 m2~~ 0.01 m^2
	43	Max. Allowable Press.		60 psi	
	44	Actuator Failure		FAIL CLOSE	
	45	Handwheel		INCLUDED	
	46	Bench Range		NA	
CONTROL SIGNAL	47	Signal Type		NA	
	48	Comm. Protocol		NA	
	49				

POSITIONER	50	Signal: Inlet	Outlet	NA	
	51	Type		NA	
	52	Bypass	Gauges	NA	
TRANSDUCER	53	Mounting		NA	
	54	Signal Inlet	Outlet	NA	
	55				
SOLENOID VALVE	56	Type		Not required	
	57	When De-Enegr.Valve:		Not required	
SWITCHES	58	Type	Quantity	NO	2
	59	Contacts / Rating		120 VAC, 60 Hz, 130mA	
	60	Switching Position		OPEN / CLOSE	
AIR SET	61	Set Pressure		Not required	
	62	Filter	Gauge	NA	NA
TESTS	63	Hydro. Pressure		NOT REQUIRED	
	64	Cryogenic Test		NA	
	65	ANSI/FCI Leakage Class		ANSI VI (TSO)	
PURCHASE	66	MR No.		25580-220-MRA-JV01-00002	
	67	Item No.		1.01	

1.- Individual SS plate with tag number shall be permanently attached to each valve.
2.- Diaphragm Material: Natural Rubber.
3.- BKS-S 28-03 Connector included.

74	Tag No.	Instrument Type	Manufacturer	Model Number
75	0310-FV -01201A	Control Valve	VALAM	PASO RECTO DN 40
76	---	Positioner	NA	NA
77	---	Solenoid	NA	NA
78	0310-ZSL/H-01201A	Switch	BALLUFF	BES-516-207-S 27-E (Note 3)
79		Actuator	VALAM	ESC-61
80				

No.	By	Chk	Appr	Date	Description
0	MTC	HAM	ROV	2/28/2011	Issued for Purchase
C	CGN	CSN	ROV	10/22/2010	Issued for Bid
B	CGN	CSN	ROV	10/4/2010	Issued for Approval
A	CGN	CSN	ROV	9/3/2010	Issued for Coordination

INSTRUMENT SPECIFICATION

Diaphragm On-Off Valve M&M

xstrata copper — BECHTEL

Client No: — Sheet 1 of 1 — Form Rev 0

Code: 22199 — DS No: 25580-220-JVD-JV01-00101 — Rev: 0

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 1
Reviewer Name: Cristian Arancibia — Date: 9/Ene/2012
Discipline: EJ - Control Systems — Doc Type Code: V1A
Job # 25580-220 — VP # 25580-220-V1A-JV01-00110
Subm 003 — Equip # 0310-FV-01202A;
Program #
Job # — VP #
SEQ # — Equip #

metso

NELPROF 6.0

HOJA DE DIMENSIONAMIENTO DE VALVULAS DE CONTROL

Item		Revision		Tag	**0310-FV-01202A**
Cliente					**Control**
Ref. Metso		Contacto Metso		Ref. Cliente	
Proyecto/Unit	**Bechtel - Antapaccay/Area 0310**	Created by	**sample.user**	Fecha	**d/12/10**

DATOS DE PROCESO

Diámetro tub. entrada / salida	in **10 / 10**	Espesor de pared		Schedule	**Std**
Servicio	**Control**			Tipo de fluido	**Liquid**
Descripción de fluido	**Water / AGUA DE PROCESO**				
Densidad	kg/m3 **998**	Presión crítica	barA **221.2**		
Viscosidad	cp				

		Case 1	Case 2	Case 3	Case 4
Caudal	m3/h	**300**	**600**	**900**	
Temperatura entrada	degC	**-10**	**10**	**35**	
Presión entrada	kPaG	**190**	**170**	**141**	
Presión diferencial	kPa	**141**	**102**	**53**	
Presión salida	kPaG	**49**	**68**	**88**	
Presión de vapor	barA	**0.005**	**0.017**	**0.067**	

PRESTACION CALCULADA

		Case 1	Case 2	Case 3	Case 4
Capacidad	Cv	**292.08**	**686.81**	**1429.18**	
Percentaje de abertura	%	**35.8**	**57.3**	**81.6**	
Abertura en grados	deg	**40.1**	**58.5**	**79.3**	
Nivel de ruido	dBA [IEC]	**63**	**57**	**58**	
Vel. de flujo (ent.)	m/s	**1.7**	**3.4**	**5.09**	
Caida de pres. terminal	kPa	**245.55**	**198.8**	**145.66**	
Fl		**0.92**	**0.86**	**0.79**	

SELECCION DE LA VALVULA

Tamano de valvula	mm **250**	Capacidad máxima Cv	**2830**	FpCv	**2830**
Tipo de valvula	**SEGMENT ANSI 150**				
Cód.	**R-SOFT**	**ROTARY CONTROL VALVE, SOFT SEATED, SEGMENT / V-PORT**			

DATOS DE CALCULO DEL ACTUADOR

Presión suministro	barG	**4.2**	Asiento válvula	**std_Soft**
dP máxima de cierre	kPa	**500**	Empaquetadura válvula	**Graphite**
Factor			Cojinetes válvula	**PTFE**

SELECCION DEL ACTUADOR

Cód. **B1J12** **SPRING TO CLOSE CYLINDER ACTUATOR**

Requerido en abertura	Nm	**132**	Requerido en cierre	Nm	**132**
Factor de carga	%	**24**	Factor de carga	%	**40**

		Case 1	Case 2	Case 3	Case 4
Req. control-abrir	Nm	**95**	**92**	**100**	
Factor de carga	%	**22**	**22**	**26**	
Req. control-cerrar	Nm	**86**	**79**	**60**	
Factor de carga	%	**25**	**19**	**13**	

Notas

OC N° 25580-220-POA-JV01-00001 - Proyecto Antapaccay - Bechtel
Item 1.01

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 1
Reviewer Name: Cristian Arancibia — Date: 9/Ene/2012
Discipline: EJ - Control Systems — Doc Type Code: V1A
Job # 25580-220 — VP # 25580-220-V1A-JV01-00111
Subm 003 — Equip # 0310-FV-01202B;
Program #
Job # — VP #
SEQ # — Equip #

metso

HOJA DE DIMENSIONAMIENTO DE VALVULAS DE CONTROL

NELPROF 6.0

Item		Revision		Tag	**0310-FV-01202B**
Cliente					**Control**
Ref. Metso		Contacto Metso		Ref. Cliente	
Proyecto/Unit	**Bechtel - Antapaccay/Area 0310**	Created by	**sample.user**	Fecha	**d/12/10**

DATOS DE PROCESO

Diámetro tub. entrada / salida	in **10 / 10**	Espesor de pared		Schedule	**Std**
Servicio	**Control**			Tipo de fluido	**Liquid**
Descripción de fluido	**Water / AGUA DE PROCESO**				
Densidad	kg/m3 **998**	Presión crítica	barA	**221.2**	
Viscosidad	cp				

		Case 1	Case 2	Case 3	Case 4
Caudal	m3/h	**300**	**600**	**900**	
Temperatura entrada	degC	**-10**	**10**	**35**	
Presión entrada	kPaG	**190**	**170**	**141**	
Presión diferencial	kPa	**141**	**102**	**53**	
Presión salida	kPaG	**49**	**68**	**88**	
Presión de vapor	barA	**0.005**	**0.017**	**0.067**	

PRESTACION CALCULADA

		Case 1	Case 2	Case 3	Case 4
Capacidad	Cv	**292.08**	**686.81**	**1429.18**	
Percentaje de abertura	%	**35.8**	**57.3**	**81.6**	
Abertura en grados	deg	**40.1**	**58.5**	**79.3**	
Nivel de ruido	dBA [IEC]	**63**	**57**	**58**	
Vel. de flujo (ent.)	m/s	**1.7**	**3.4**	**5.09**	
Caida de pres. terminal	kPa	**245.55**	**198.8**	**145.66**	
Fl		**0.92**	**0.86**	**0.79**	

SELECCION DE LA VALVULA

Tamano de valvula	mm **250**	Capacidad máxima Cv	**2830**	FpCv	**2830**
Tipo de valvula	**SEGMENT ANSI 150**				
Cód.	**R-SOFT**	**ROTARY CONTROL VALVE, SOFT SEATED, SEGMENT / V-PORT**			

DATOS DE CALCULO DEL ACTUADOR

Presión suministro	barG	**4.2**	Asiento válvula	**std_Soft**
dP máxima de cierre	kPa	**500**	Empaquetadura válvula	**Graphite**
Factor			Cojinetes válvula	**PTFE**

SELECCION DEL ACTUADOR

Cód.	**B1J12**	**SPRING TO CLOSE CYLINDER ACTUATOR**			
Requerido en abertura	Nm	**132**	Requerido en cierre	Nm	**132**
Factor de carga	%	**24**	Factor de carga	%	**40**

		Case 1	Case 2	Case 3	Case 4
Req. control-abrir	Nm	**95**	**92**	**100**	
Factor de carga	%	**22**	**22**	**26**	
Req. control-cerrar	Nm	**86**	**79**	**60**	
Factor de carga	%	**25**	**19**	**13**	

Notas

OC N° 25580-220-POA-JV01-00001 - Proyecto Antapaccay - Bechtel

Item 1.02

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 1
Reviewer Name: Cristian Arancibia — Date: 9/Ene/2012
Discipline: EJ - Control Systems — Doc Type Code: V1A
Job # 25580-220 — VP # 25580-220-V1A-JV01-00112
Subm 003 — Equip # 0310-FV-01202C;
Program #
Job # — VP #
SEQ # — Equip #

HOJA DE DIMENSIONAMIENTO DE VALVULAS DE CONTROL

NELPROF 6.0

Item		Revision		Tag	**0310-FV-01202C**
Cliente					**Control**
Ref. Metso		Contacto Metso		Ref. Cliente	
Proyecto/Unit	**Bechtel - Antapaccay/Area 0310**	Created by	**sample.user**	Fecha	**d/12/10**

DATOS DE PROCESO

Diámetro tub. entrada / salida	in	**10 / 10**	Espesor de pared		Schedule	**Std**
Servicio	**Control**				Tipo de fluido	**Liquid**
Descripción de fluido	**Water / AGUA DE PROCESO**					
Densidad	kg/m3	**998**	Presión crítica	barA	**221.2**	
Viscosidad	cp					

		Case 1	Case 2	Case 3	Case 4
Caudal	m3/h	**300**	**600**	**900**	
Temperatura entrada	degC	**-10**	**10**	**35**	
Presión entrada	kPaG	**190**	**170**	**141**	
Presión diferencial	kPa	**141**	**102**	**53**	
Presión salida	kPaG	**49**	**68**	**88**	
Presión de vapor	barA	**0.005**	**0.017**	**0.067**	

PRESTACION CALCULADA

		Case 1	Case 2	Case 3	Case 4
Capacidad	Cv	**292.08**	**686.81**	**1429.18**	
Percentaje de abertura	%	**35.8**	**57.3**	**81.6**	
Abertura en grados	deg	**40.1**	**58.5**	**79.3**	
Nivel de ruido	dBA [IEC]	**63**	**57**	**58**	
Vel. de flujo (ent.)	m/s	**1.7**	**3.4**	**5.09**	
Caida de pres. terminal	kPa	**245.55**	**198.8**	**145.66**	
Fl		**0.92**	**0.86**	**0.79**	

SELECCION DE LA VALVULA

Tamano de valvula	mm **250**	Capacidad máxima Cv	**2830**	FpCv	**2830**
Tipo de valvula	**SEGMENT ANSI 150**				
Cód.	**R-SOFT**	**ROTARY CONTROL VALVE, SOFT SEATED, SEGMENT / V-PORT**			

DATOS DE CALCULO DEL ACTUADOR

Presión suministro	barG	**4.2**	Asiento válvula	**std_Soft**
dP máxima de cierre	kPa	**500**	Empaquetadura válvula	**Graphite**
Factor			Cojinetes válvula	**PTFE**

SELECCION DEL ACTUADOR

Cód.	**B1J12**	**SPRING TO CLOSE CYLINDER ACTUATOR**			
Requerido en abertura	Nm	**132**	Requerido en cierre	Nm	**132**
Factor de carga	%	**24**	Factor de carga	%	**40**

		Case 1	Case 2	Case 3	Case 4
Req. control-abrir	Nm	**95**	**92**	**100**	
Factor de carga	%	**22**	**22**	**26**	
Req. control-cerrar	Nm	**86**	**79**	**60**	
Factor de carga	%	**25**	**19**	**13**	

Notas

OC N° 25580-220-POA-JV01-00001 - Proyecto Antapaccay - Bechtel

Item 1.03

NELES RE-SERIES SEGMENT VALVE

Neles RE-Series control valves are economical high performance valves in a quarter-turn design. They are offered with a variety of trim options from standard and low Cv trims for general applications to noise/cavitation Q-Trim® for reducing aerodynamic noise and preventing cavitation. Standard units are equipped either diaphragm or cylinder actuators and ND9000® intelligent valve controllers for precise control, reliability and performance monitoring on-line.

neles

FEATURES

Integral body construction

- Integrally flanged R-Series valves feature one piece body construction with no flange rings, inserts or end caps to create potential leak paths, even if valve is subjected to pipe bending forces. Seating capabilities are totally unaffected by pipeline forces, which assures reliable valve operation.

Accurate Control

- Carefully designed V-ported segmented ball, low torque requirements and clearance-free movement result in good control performance. Design provides steady and gentle contact between the seat and segment at all times to minimize friction while providing tightness. Bearings are located inside the valve body providing larger bearing areas, lower bearing loads and longer bearing life.

Safety and Environment

- Rotary operation reduces fugitive emissions dramatically compared to sliding stem design.

Economical

- Low torque requirements reduce wear, resulting in better reliability. In addition. standard designs carry hard chromium facing on segment and cobalt based alloy seat, which has been designed to avoid flow impingement. Together with low load bearing design and live-loaded packing, operational life is improved and maintenance needs are minimised. Low torque combined with well integrated actuator design provide lower cost valve unit.

Small flow and Low noise/Cavitation Q-Trim® options

- DN25/1" valves feature five different segments. They extend valves' application range to very low-flow high accuracy services, such as additive and colouring lines, pilot plants etc. Cavitation and aerodynamic noise are reduced with the patented Q-Trim® option. This self-cleaning design handles contaminated flows (impure steam, river water, etc.) without plugging.

3 R 24 EN · Issue 12/2007

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 1
Reviewer Name: Cristian Arancibia
Date: 18/Julio/2011
Discipline: EJ - Control Systems
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-JV01-00106
Subm 001
Equip #
Program # NA
Job #
VP #
SEQ #
Equip #

metso
automation

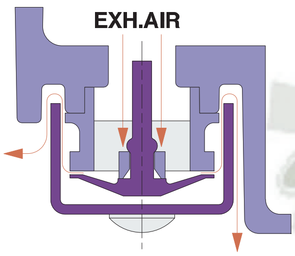
Electro-Pneumatic Positioner/Smart Positioner

(Lever type / Rotary type)

CE

Dustproof / Waterproof

Passed by external organization on **JIS F8007** (conforms to IEC 60529) **IP65**



A centralized exhaust system employs the combination of the check valve and the labyrinth effect enhancing both dustproof and waterproof performance.

Explosion-proof construction

Electro-Pneumatic Positioner	TIIS explosion-proof construction (ExdIIBT5)
	ATEX intrinsically safe explosion-proof construction (II2G Ex ibIICT5/T6)
Smart Positioner	ATEX intrinsically safe explosion-proof construction (II1G Ex iaIICT4/T5/T6)

With internal opening indicator plate (X14 only)

Internal opening indicator plate

Opening indicator plate inside body

Monitoring function

Electro-Pneumatic Positioner

· Opening current transmission analogue (4 to 20 mA DC) continuous output

Smart Positioner

· Alarm point output function (2 points)
· Analogue (4 to 20 mA DC) continuous output

With external scale plate (Rotary type)

External scale plate

Improved visibility of opening indicator

Body with LCD window

(Smart Positioner)

LCD window

Allows checking of control from outside body

Electro-Pneumatic Positioner

Universal mechanically controlled type

Series IP8000/8100

IP8000
(Lever type)

IP8100
(Rotary type)

NEW Smart Positioner

Electronically controlled easy-adjustment transmitting type

Series IP8001/8101

IP8001
(Lever type)

IP8101
(Rotary type)

Series IP8□

SMC

CAT.EUS60-18B-UK

NEW Smart Positioner

Series IP8001/8101 added!

IP8001 (Lever type)

IP8101 (Rotary type)

Built-in microcomputer and sensor allows easy remote parameter change and monitoring.

- Internal push button for easy setting of various parameters (Refer to parameter list)
- Zero point/span adjustment easier than with previous mechanical positioners

Parameter List

Notes	No	Parameter	Description
Standard equipped functions	1	Positive operation/ reverse operation setting	Change operation direction with regard to input signal Change to internal components, piping not possible
	2	Split range setting	Change range of input signal
	3	Preferred zero point/span adjustment setting	Change actuator stroke range with regard to input signal
	4	Forced full close/full open setting	To ensure valve closure, force actuator opening to be 0% or 100% with a preferred input signal.
	5	Valve characteristic setting	Select from these 6 valve characteristics Linear characteristic Equality % characterstic (2 types) Quick open characteristic (2 types) User preferred point setting (11 points)
	6	PID constant setting	Change PID constant
	7	Calibration setting	Zero point/span adjustment, Auto PID constant setting, input signal display value calibration, etc.
Optional equipped functions	8	Alarm 1 output setting	Set upper/lower stroke limits for actuator from which alarm is output
	9	Alarm 2 output setting	
	10	Analogue (4 to 20 mA DC) output setting	Set increase/decrease direction for 4 to 20 mA DC output with regard to actuator stroke

Full Output Functions

Selecting models with output functions by model selection selects with alarm point output function (2 points) and analogue (4 to 20 mA DC) continuous output function. This will allow remote detection of operating abnormalities.

Control State Display

Positioning, deviation, and input value are displayed (numerically) on the internal LCD, allowing visual verification of the control state.

Display example

Positioning (%)	Input value (%)	Deviation (%)
P 50.0	S 60.0	E 10.0

Handles 2-line Input for Exisiting Equipment

Control furnished with conventional 2-line input signal (4 to 20 mA DC) not requiring separate power source.

HART Transmission Function

HART transmission function can be designated by model selection.
Allows remote monitoring and setting change of positioner.

Intercompatible Installation

Dimensions of mounting parts same as previous mechanical series IP6000/IP8000 Electro-Pneumatic Positioner. External feedback lever and fork lever-type fitting for joining actuator and positioner are also the same.

Energy-saving

Lever-type features 60% reduced air flow consumption compared with IP8000.

Specifications Note 1)

Item \ Type	IP8000		IP8100		IP8001	IP8101
	Electro-Pneumatic Positioner				Smart Positioner	
	Lever type lever feedback		Rotary type cam feedback		Lever type	Rotary type
	Single action	Double action	Single action	Double action	Single action / Double action	
Input current	4 to 20 mA DC (Standard) Note 2)					
Min. operating current	—				3.85 mA DC or more	
Intra-terminal voltage	—				12 V DC (equivalent to 600 Ω input resistance, at 20 mA DC)	
Max. supplied power	—				1 W (Imax: 100 mA DC, Vmax: 28 V DC)	
Input resistance	235 ±15 Ω (4 to 20 mA DC)				—	
Supply air pressure	0.14 to 0.7 MPa					0.3 to 0.7 MPa
Standard stroke	10 to 85 mm (Allowable deflection angle 10 to 30°)		60 to 100° Note 3)		10 to 85 mm (Allowable deflection angle 10 to 30°)	60 to 100° Note 3)
Sensitivity Note 4)	Within 0.1% F.S.	Within 0.5% F.S.			Within 0.2% F.S.	
Linearity Note 4)	Within ±1% F.S.	Within ±2% F.S.			Within ±1% F.S.	
Hysteresis Note 4)	Within 0.75% F.S.	Within 1% F.S.			Within 0.5% F.S.	
Repeatability Note 4)	Within ±0.5% F.S.					
Coefficient of temperature	Within 0.1% F.S./°C				Within 0.05% F.S./°C	
Supply pressure fluctuation	Within 0.3% F.S./0.01 MPa				— Note 5)	
Output flow Note 6)	80 ℓ/min (ANR) or more (SUP = 0.14 MPa)				200 ℓ/min (ANR) or more (SUP = 0.4 MPa)	
Air consumption Note 6)	5 ℓ/min (ANR) or less (SUP = 0.14 MPa) 11 ℓ/min (ANR) or less (SUP = 0.4 MPa)				2 ℓ/min (ANR) or less (SUP = 0.14 MPa) 4 ℓ/min (ANR) or less (SUP = 0.4 MPa)	11 ℓ/min (ANR) or less (SUP = 0.4 MPa)
Ambient and fluid temperature	General structure: –20 to 80°C					
	TIIS explosion-proof: –20 to 60°C ATEX intrinsically safe explosion-proof: –20 to 80°C (T5) –20 to 60°C (T6) –40 to 60°C (T6)/-L type low-temperature specification				ATEX intrinsically safe explosion-proof –20 to 80°C (T4/T5) –20 to 60°C (T6)	
Explosion proof construction Note 7)	TIIS explosion-proof construction (ExdIIBT5) ATEX intrinsically safe explosion-proof construction (II2G Ex ibIICT5/T6)				ATEX intrinsically safe explosion-proof construction (II1G Ex iaIICT4/T5/T6)	
ATEX intrinsically safe explosion-proof parameter (current circuit)	Ui ≤ 28 V, Ii ≤ 125 mA, Pi ≤ 1.2 W, Ci ≤ 0 nF, Li ≤ 0 mH				Ui ≤ 28 V, Ii ≤ 100 mA, Pi ≤ 0.7 W, Ci ≤ 12.5 nF, Li ≤ 1.5 mH	
Exterior covering enclosure	JISF8007, IP65 (conforms to IEC Pub.60529)					
Transmission method Note 7)	—				HART transmission	
Air connection port Note 8)	Rc 1/4 female thread, NPT 1/4 female thread, G 1/4 female thread					
Electrical connection port Note 8)	G 1/2 female thread, M20 x 1.5 female thread, NPT 1/2 female thread					
Material/coating	Aluminum diecast body/baking finish with denatured epoxy resin					
Weight	2.4 kg (Without terminal box)/2.6 kg (With terminal box)				2.6 kg	

Note 1) Specification values are given at normal temperature (20°C).
Note 2) 1/2 Split range (Standard)
Note 3) Stroke adjustment: 0 to 60°, 0 to 100°
Note 4) Characteristics relating to accuracy differ depending on combination with other constituent loop equipment, such as positioners and actuators.
Note 5) While there is no output changes due to pressure fluctuations, when the pressure supply setting is changed following calibration, once again adjust balance current and perform calibration.
Note 6) (ANR) indicates JIS B0120 standard air.
Note 7) Model selection required for explosion proof construction and HART transmission.
Note 8) Thread type can be specified by model selection.

Optional Specifications

Item		IP8100-0□1-J/JR (Non-explosion proof)	IP8□01-0□2	52-IP8□01-0□4
		Electro-Pneumatic Positioner	Smart Positioner	
Analogue output	**Wiring**	2-line		
	Output signal	4 to 20 mA DC		
	Power supply voltage	12 to 35 V DC	10 to 28 V DC	
	Load resistance	(Power supply voltage –12 V) ÷ 20 mA DC or less	0 to 750 Ω	
	Accuracy	±2% F.S. or less Note 1)	±0.5% F.S. or less Note 2)	
	Hysteresis	Within 1% F.S.	—	
Alarm output 1, 2	**Wiring**	—	2-line	
	Applicable standards	—	—	DIN19234/NAMUR Standard
	Power supply voltage	—	10 to 28 V DC	5 to 28 V DC
	Load resistance	—	10 to 40 mA DC	(Constant current output)
	Alarm ON	—	R = 350 Ω ±10%	≥ 2.1 mA DC
	Alarm OFF (Leakage current)	—	0.5 mA DC or less	≤ 1.2 mA DC
	Response time	—	50 msec or less	

Note 1) Indicates analogue output accuracy with respect to actuator angle.
Note 2) Indicates analogue output accuracy with respect to LCD display position value (P value).

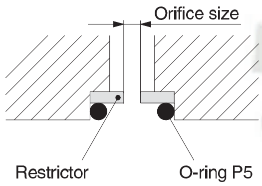
Accessory / Option

Pilot valve with output restriction (IP8000 / 8100)

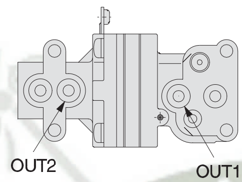
In general, mounting on a small-size actuator may cause hunting. For prevention, a pilot valve with a built-in output restriction is available. The restriction is removable.

Actuator Capacity	Orifice size	Part number	Pilot unit part number	Model selection accessory
90 cm^3	ø0.7	P36801080	P565010-18	A
180 cm^3	ø1	P36801081	P565010-19	B

Note) Output orifice not required for Smart Positioner regardless of actuator capacity.



Restrictor mounting diagram



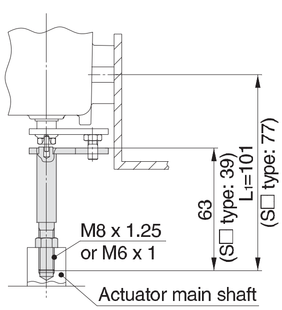
Pilot valve bottom view

Fork lever-type fittings (IP8100 / 8101)

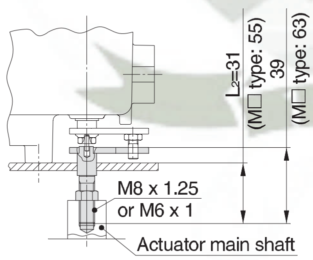
2 types of rotary type IP8100/8101 fork lever-type fittings, that differ by installation dimensions dependent on bracket installation method, and 2 types of installation portion thread sizes, are available.
When installing on the side surface, using fork lever assembly M provides interchangeability with the installation dimensions of SMC IP6100 positioner. When installing on the rear surface, using fork lever assembly S also provides interchangeability with the installation dimensions of SMC IP6100 positioner.

Part name	Unit number	Installation portion thread size	Model selection accessory
Fork lever assembly M	P368010-24	M8 x 1.25	C
Fork lever assembly S	P368010-25		D
Fork lever assembly MX	P368010-36	M6 x 1	C Note)
Fork lever assembly SX	P368010-37		D Note)

Note) Installation portion thread size is M6 x 1 for IP8100-0□0-X14 when accessory C or D are selected.



Side mounting with the fork lever assembly M□



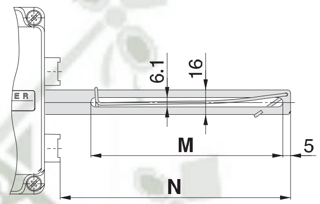
Rear mounting with the fork lever assembly S□

External feedback lever (IP8000 / 8001)

Different feedback levers are available dependent upon valve strokes. Order according to the valve stroke.

Feedback lever types

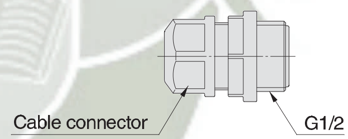
Stroke	Unit number		Size M	Size N	Model selection accessory
	IP8000	**IP8001**			
10 to 85 mm	P368010-20	P565010-323	125	150	Standard accessory
35 to 100 mm	P368010-21	P565010-324	110	195	E
50 to 140 mm	P368010-22	P565010-325	110	275	F
6 to 12 mm	P368010-260	P565010-329	75	75	Available as special order



Resin connector (Non-explosion proof specification)

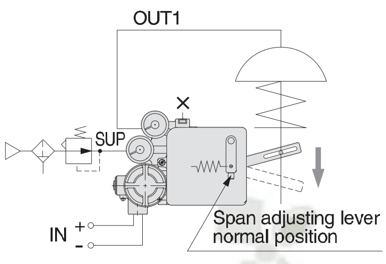
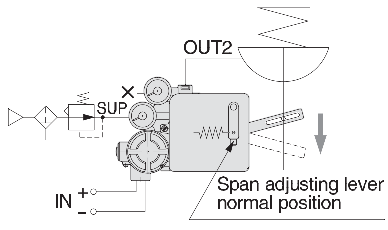
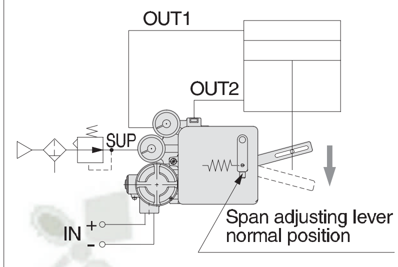
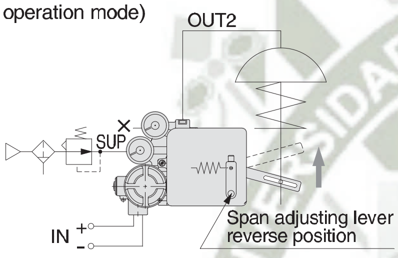
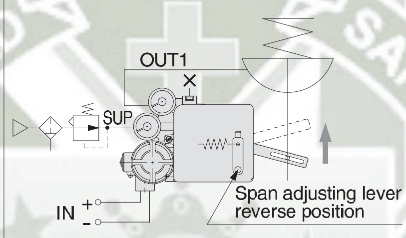
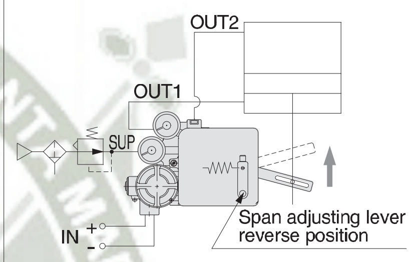
Optional cable connectors are available for different cable sizes. These are not for explosion proof applications. Recommended for use in indoor applications.

Part name	Part number	Suited cable outer diameter
Resin-made cable clamp unit (A)	P368010-26	ø7 to ø9
Resin-made cable clamp unit (B)	P368010-27	ø9 to ø11

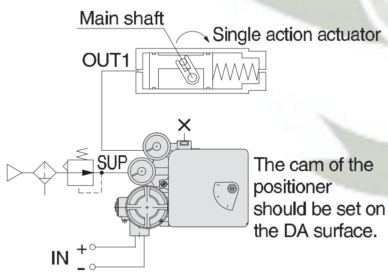
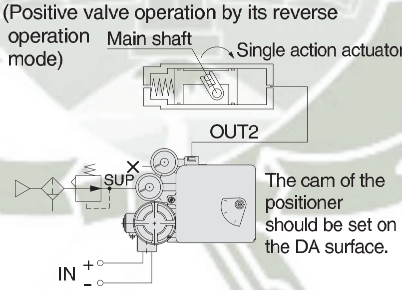
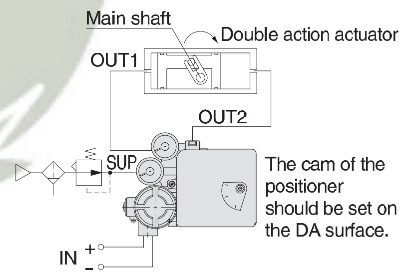
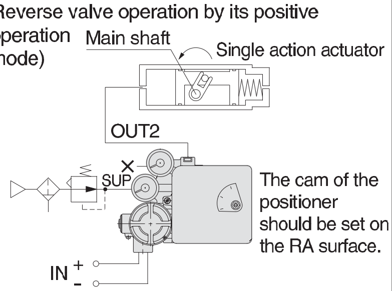
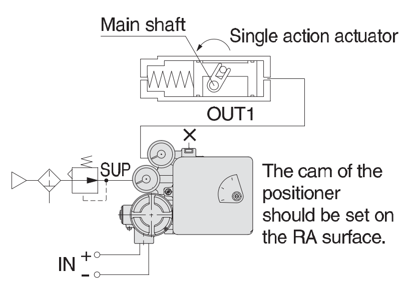
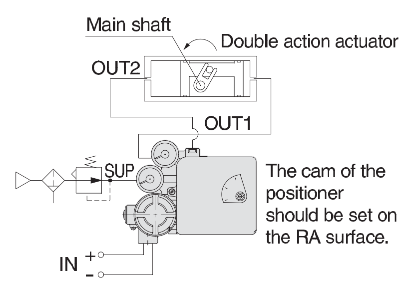


Piping Note) When the input signal is discontinued, the pressure of OUT1 decreases, and the pressure of OUT2 increases.

IP8000 / Lever type

	Single action		Double action
Positive operation	When the input signal is increased, the stem moves as allow mark.  OUT2 is plugged.	When the input signal is increased, the stem moves as allow mark. (Positive valve operation by its reverse operation mode)  OUT1 is plugged.	When the input signal is increased, the cylinder rod moves as allow mark. 
Reverse operation	When the input signal is increased, the stem moves as allow mark. (Reverse valve operation by its positive operation mode)  OUT1 is plugged.	When the input signal is increased, the stem moves as allow mark.  OUT2 is plugged.	When the input signal is increased, the cylinder rod moves as allow mark. 

IP8100 / Rotary type

	Single action		Double action
Positive operation	When the input signal is increased, the actuator shaft rotates in a clockwise direction.  OUT2 is plugged.	When the input signal is increased, the actuator shaft rotates in a clockwise direction. (Positive valve operation by its reverse operation mode)  OUT1 is plugged.	When the input signal is increased, the actuator shaft rotates in a clockwise direction. 
Reverse operation	When the input signal is increased, the actuator shaft rotates in a counter clockwise direction. (Reverse valve operation by its positive operation mode)  OUT1 is plugged.	When the input signal is increased, the actuator shaft rotates in a counter clockwise direction.  OUT2 is plugged.	When the input signal is increased, the actuator shaft rotates in a counter clockwise direction. 

FABRICANTE DE VALVULAS A DIAFRAGMA

VALAM

S.A.I.C.

VALVULAS A DIAFRAGMA TIPO PASO RECTO

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed

2 Revise & Resubmit. Work may proceed subject to incorporation of changes

3 Revise & Resubmit. Work may NOT proceed

4 Review not required. Work may proceed

5 Cancelled / Superseded

Document Status: 1

Reviewer Name: Cristian Arancibia — Date: 8/Sept/2011

Discipline: EJ - Control Systems — Doc Type Code: V2A

Job # 25580-220 — VP # 25580-220-V2A-JV01-00024

Subm 001 — Equip # NA;

Program # NA;

Job # — VP #

SEQ # — Equip #

CERTIFICADO ISO 9001 2000 Sistema de Calidad

Un diseño único para el mejor resultado

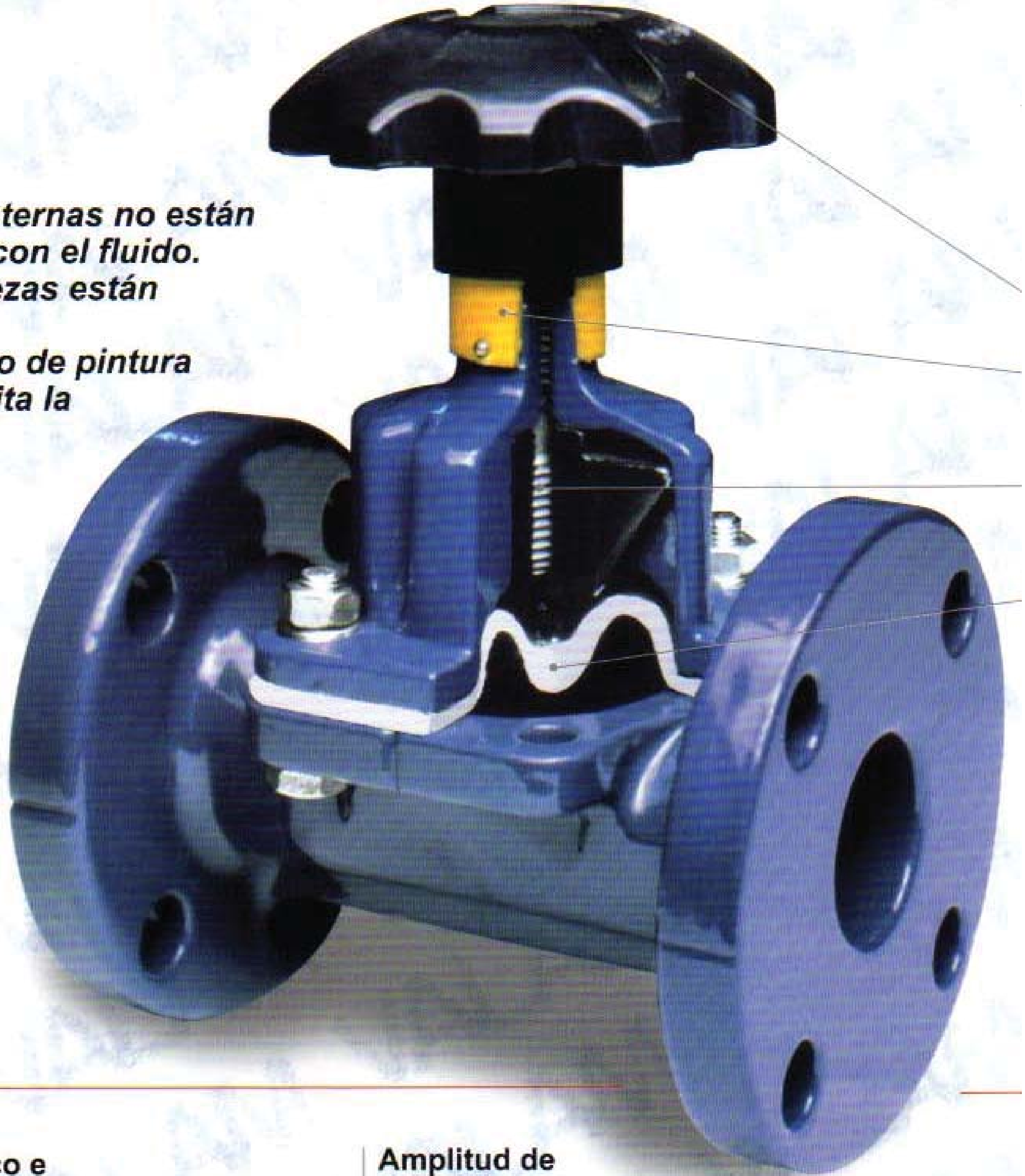
Publ

En s

Válvulas a diafragma Valam®
tipo paso recto.

Hermeticidad y economía en un diseño único para los servicios abrasivos, corrosivos y generales

Las piezas internas no están en contacto con el fluido. Todas las piezas están fosfatizadas. El tratamiento de pintura epoxídica evita la corrosión externa.



Diseño único e inigualable

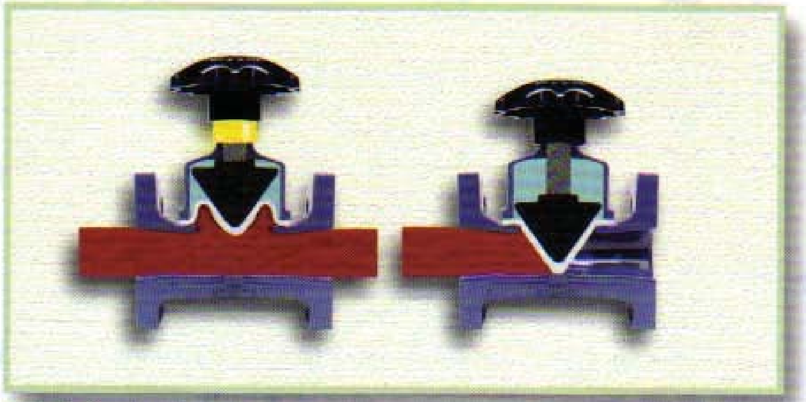
.- Larga vida útil del diafragma por su construcción reforzada.

.- Excelente resultado en lodos abrasivos y polvos secos.

Amplitud de aplicaciones.

.- La gran variedad de materiales, revestimientos, diafragmas y métodos de operación, permite su uso en la mayoría de los fluidos, satisfaciendo sus necesidades.

Publ
En s



Flujo de la válvula.
El diseño sin recesos logra un flujo parejo y aerodinámico, con mínima pérdida de carga.

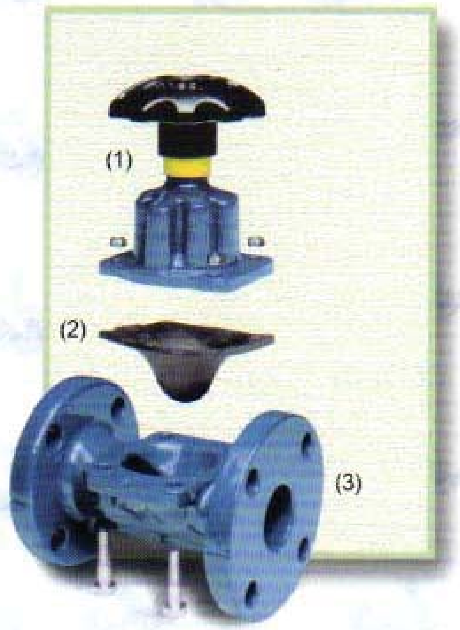
Opciones de cuerpos.
Extremos bridados, roscados.
Variedad de metales,
con revestimiento de cauchos
y polímeros.

Volante.
Cómodo y de rápida operación.

Indicador amarillo
Indica a distancia
la posición de la válvula
sin dificultar la operación de la misma.

Vástago.
Lubricado y aislado del medio ambiente
por el borde sellador del indicador amarillo,
que lo proteje de la contaminación externa.

Diafragma.
Su diseño logra un diafragma fuerte
y reforzado, brindando total hermeticidad,
seguridad y larga vida.
Se ofrece un diafragma apropiado para cada fluido,
a través de una amplia variedad
de cauchos sintéticos y naturales.



Bajo costo de mantenimiento.
Larga vida útil de las tres piezas
(1) Mecanismo.
(2) Diafragma.
(3) Cuerpo.
El reemplazo del diafragma
es rápido, sencillo y sin retirar
la válvula de la cañería.

Flexibilidad operativa.

.- Los mecanismos manuales y automáticos pueden intercambiarse, aún sin retirar el cuerpo de la cañería.

Hermeticidad absoluta.

.- El cierre del diafragma sin roce garantiza hermeticidad absoluta, aún con sólidos en suspensión.

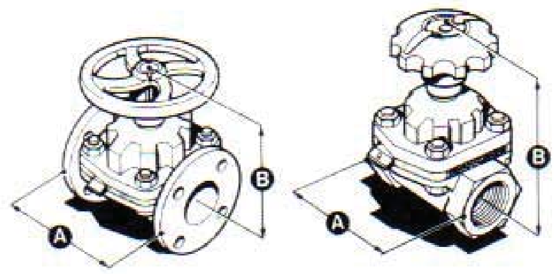
.- Hermética, tanto en presión positiva como en vacío.

Calidad reconocida.

.- Alta tecnología internacional en la fabricación.

.- Uso de normas internacionales de calidad.

Detalles básicos de las válvulas a diafragma tipo paso recto.



DIMENSIONES (mm), PESOS (Kg) y PRESIONES (bar)

Diámetro de la Válvula		Conexiones con Extremos Bridados					Conexiones con Extremos Roscados Hembra			Presión Máxima
(DN)		A (mm)			B (abierta)	Peso	A (mm)	B (abierta)	Peso	
mm	Pulgadas	Metal	Rev. en Polímero o Vidrio	Rev. Caucho		En Kg.			En Kg.	En Bar
15	1/2	108	110	-	106	2,000	64	106	0,790	10
20	3/4	117	119	123	115	2,500	95	120	0,850	10
25	1	127	129	133	160	3,000	111	174	2,050	10
32	1 1/4	146	148	152	160	4,350	124	174	2,250	10
40	1 1/2	159	161	165	182	5,450	143	174	2,750	10
50	2	190	192	196	230	8,000	168	189	4,900	10
65	2 1/2	216	218	222	296	12,100	206	228	8,650	10
80	3	254	256	260	303	21,500	257	302	15,600	10
100	4	305	307	311	324	32,000	-	-	-	10
125	5	356	358	362	346	48,200	-	-	-	6
150	6	406	408	412	470	65,000	-	-	-	6
200	8	521	523	527	640	104,000	-	-	-	3,5
250	10	635	637	641	745	208,000	-	-	-	3,5
300	12	749	751	755	785	306,400	-	-	-	3,5

Volante y vástago ascendente en DN 015-150. Volante no ascendente en DN 200-300.
Las dimensiones dadas son para planificar y no deben ser usadas para fabricación.

PRINCIPALES MATERIALES

Cuerpos
Hierro fundido
Acero inoxidable
Acero al carbono
Bronce

Revestimientos
Ebonita
Butílico
Viton®
Hypalon®
Rilsan®
PFA / ETFE / ECTFE
Caucho blando, para abrasivos

Diafragmas
Butílico
Neoprene®
Hypalon®
Viton®
EPDM
Nitrilo
Caucho natural
Caucho blando, para abrasivos

Nuestro Departamento Técnico de Ventas puede recomendar la válvula apropiada para cada necesidad.

Válvulas VALAM® - Las válvulas disponibles mundialmente.

FO-0002. 07/06


Automáticas


Hidrante


Vertedero


Sanitaria


Retención

Fabrica:
VALAM S.A.I.C.

DISTRIBUIDOR EXCLUSIVO
TRIALLOY INTERNATIONAL S.A.
LIMA: Jr. Chicama 175 Urb. Maranga - San Miguel - Lima 32
Telfs.: (511) 578-3059 - 578-3608 Fax: (511) 578-2449
E-mail: ventas@trialloy.com.pe
Web Site: www.trialloy.com.pe
AREQUIPA: Telf.: (054) 247715 Telefax: (054) 225355
E-mail: arequipa@trialloy.com.pe
CHICLAYO: Cel.: 9907-3337 Nextel: 818*3697
E-mail: chiclayo@trialloy.com.pe

CLIENT:	**XSTRATA TINTAYA S.A.**
PROJECT TITLE:	**ANTAPACCAY PROJECT- TINTAYA EXPANSION**
PROJECT LOCATION:	**CUZCO, PERÚ**
P.O.N°:	**25580-220-MRA-MFSS-00001**
UNIT:	**LOW VOLTAGE AC INDUCTION MOTORS**
EQUIPMENT TITLE:	**Sag Mill Discharge Screen Motor**
EQUIPMENT N°:	**0310-SCR-0001-M1**
REFER TO SPECIFICATION N°: For General Requirements	**25580-220-3PS-MUMI-00001**
APPLICABLE CODES	**NEMA MG 1-2006 Revision 3**
COMMENTS:	
TAG ID's	As per MR.

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 1
Reviewer Name: Daniel Carrasco — Date: 06-Ene-2010
Discipline: EM - Mechanical — Doc Type Code: V1A
Job # 25580-220 — VP # 25580-220-V1A-MFSS-00013
Subm 005 — Equip # 0310-SCR-0001-M1;
Program # NA;
Job # — VP #
SEQ # — Equip #

REV	DATE	REASON FOR REVISION	BY	CHECK	EGS	PE	CLIENT
3	17/Dec/10	Complete Issue	MZ	MD			
2	17/sep/10	Complete Issue	MZ	MD			
1	16/aug/10	Complete Issue	MZ	MD			
0	5/abr/10	Issued for Purchase	FCR	EFR	FLG	CEZ	

XSTRATA BECHTEL ALLIANCE	**DATA SHEET FOR LOW VOLTAGE INDUCTION MOTORS**	JOB No. 25580-220	
xstrata copper / BECHTEL		DATA SHEET No.	REV. No.
	Sheet 1 of 4	25580-220-MFD-MFSS-00002	3

CLIENT:	XSTRATA TINTAYA S.A.	EQUIPMENT NO.:	0310-SCR-0001-M1
PROJECT:	ANTAPACCAY PROJECT- TINTAYA EXPANSION	P.O. NO.:	25580-220-MRA-MFSS-00001
LOCATION:	CUZCO, PERÚ	UNIT:	LOW VOLTAGE AC INDUCTION MOTORS

LINE No.	DESCRIPTION	UNITS	SPECIFIED	SELLER PROPOSAL
1,00	**GENERAL**			
1,01	Manufacturer	-	By Seller	Haver & Boecker
1,02	Address / Location of assembly plant	-	By Seller	Rod. Campinas - Monte Mor , km 20
1,03	Phone / fax	-	By Seller	55 19 - 3879-9186 / 55 19 3879-1410
1,04	email address	-	By Seller	mzarro@haverbrasil.com.br
1,05	Proposal No. / Date	-	By Seller	354-14587/09
1,06	Location of Assembly Plant	-	By Seller	Monte Mor
1,07	Catalog / Serial / Model / No.	-	By Seller	Model 444/5T
2,00	**SITE CONDITIONS (Environment)**			
2,01	Altitude	m.a.s.l.	4200	OK
2,02	Ambient temperature max	°C	22	OK
2,03	Ambient temperature min	°C	-10	OK
2,04	Ambient temperature Average	°C	8,3	OK
2,05	Hazardous Location Motors	-	Not Required	Not Required
2,06	Explosion Proof Class	-	N/A	N/A
2,07	Explosion Proof Group	-	N/A	N/A
2,08	Explosion Proof Division	-	N/A	N/A
3,00	**POWER SYSTEM**			
3,01	Rated Voltage	V	480	480
3,02	Phases	ph	3 ph	3 ph
3,03	Frequency	Hz	60	60 hz
3,04	Short circuit Capacity	kA	65 kA	
3,05	Grounding Type	-	Solid	
4,00	**MOTOR STANDARD**		NEMA MG-1 2006	NEMA MG-1 2006
5,00	**LOAD MECHANICAL CHARACTERISTICS**			
5,01	Driven equipment	-	As per MR	Pulley and belt
5,02	Shaft coupling method	-	As per MR	Flange
5,03	Mounting Position	-	As per MR	Horizontal
5,04	Speed Type	-	As per MR	Rpm
5,05	Speed Range	-	As per MR	1745
5,06	Duty Type	-	As per MR	Continuous
5,07	Locations	Indoor/outdoor	As per MR	Outdoor
6,00	**MOTOR DATA**			
6,01	Type of Induction Motor	-	SCIM	SCIM
6,02	Power Output	HP/kW	each specific application	**100 / 75**
6,03	Rated Voltage	V	460	460
6,04	Phases	ph	3	3
6,05	Frequency	Hz	60	60
6,06	Service Factor @ operating altitude	-	1,15	1,15
6,07	Poles	-	By Seller	4
6,08	RPM	RPM	By Seller	1785
6,09	Minimum terminal voltage during starting	per unit	0,85	0,85
6,10	Nema Design	-	B	B
6,11	Insulation Class	-	F	F
6,12	Temperature rise	-	Class B (80°C) at full load	B
6,13	Special insulations considerations	-	Not required	N/A
6,14	Enclosure	-	TEFC	TEFC
6,15	Frame	-	By Seller	444 / 5T
6,16	Weight	-	By Seller	754 kg
6,17	Starting Method DOL: Direct On Line SS: Soft Starter AFD: Adjustable Frequency Driver	-	DOL	DOL

xstrata copper / BECHTEL	**DATA SHEET FOR LOW VOLTAGE INDUCTION MOTORS** **Sheet 2 of 4**	JOB No. 25580-220	
		DATA SHEET No.	REV. No.
		25580-220-MFD-MFSS-00002	3

CLIENT:	XSTRATA TINTAYA S.A.	**EQUIPMENT NO**	0310-SCR-0001-M1
PROJECT:	ANTAPACCAY PROJECT- TINTAYA EXPANSION	**P.O. NO.:**	25580-220-MRA-MFSS-00001
LOCATION:	CUZCO, PERÚ	**UNIT:**	LOW VOLTAGE AC INDUCTION MOTORS

LINE No.	DESCRIPTION	UNITS	SPECIFIED	SELLER PROPOSAL
6,16	Motor Efficiency Type	-	NEMA Premium	NEMA Premium
6,17	Efficiency at 100% of full load	%	By Seller	95,4
6,18	Efficiency at 75 % of full load	%	By Seller	94,6
6,19	Efficiency at 50 % of full load	%	By Seller	93,8
6,20	Power Factor at 100% of full load	%	By Seller	83
6,21	Power Factor at 75 % of full load	%	By Seller	79
6,22	Power Factor at 50 % of full load	%	By Seller	72
6,23	Full Load Current	A	By Seller	119
6,24	Locked rotor current @ Full Voltage	A	By Seller	762
6,25	Locked rotor current @ 90% Voltage	A	By Seller	-
6,26	Sound Power Level (No Load) @ 1 meter	dBA	90 dBA (Max) - By Motor Manufacturer	90
6,27	Allowable Stall Time @ Full Voltage (s)	sec	By Seller	-
6,28	Allowable Stall Time @ 90 % Voltage (s.)	sec	By Seller	-
6,29	Starting Torque @ Minimum Starting Voltage	%	120% of driven load	-
6,30	Winding Connection		Wye	WYE
6,31	Number of starts per hours (cold/hot)	No.	By Seller	2/1
6,32	Thermal life of insulation at rated load at 40° ambient.	yrs	By Seller	20
7,00	**BEARINGS**			
7,01	Type	-	Anti-friction	Antifriction
7,02	Lubrication Method	-	Self Lubricated	re grease
7,03	Manufacturer & Number	-	By Seller	TBI
7,04	Bearing Life. L-10 life, 100,000 hrs for direct coupled; 60,000 hours for conveyor idlers and blower; 80,000 hours for gear drives, reducers and pillow block for conveyor pulleys and 3,000 hours for trolleys and hoists	hrs	60 000	60 000 with direct conection
7,05	Bearing Protection	-	Labyrinth type Taconite seal	SI
8,00	**ADDITIONAL REQUIREMENTS FOR AFD SERVICE**			
8,01	Inverter Type	-		
8,02	Rated operation modes - VT / CT / CP	-		
8,03	Rated power output at Base Speed	hp		
8,04	Base Speed	rpm		
8,05	Constant Power speed range	rpm		
8,06	Constant Torque speed range	rpm		
8,07	Continuous Constant Torque speed range	rpm		
8,08	Variable Torque speed range	rpm		
8,09	Variable Torque speed exponent	-		
8,10	Starting (breakaway) torque	per unit		
8,11	Run up torque	per unit		
8,12	Inching speed	rpm		
8,13	Inching torque	per unit		
8,14	Inching duration	min		

xstrata copper / BECHTEL	**DATA SHEET FOR LOW VOLTAGE INDUCTION MOTORS**	JOB No. 25580-220	
		DATA SHEET No.	REV. No.
	Sheet 3 of 4	25580-220-MFD-MFSS-00002	3

CLIENT:	XSTRATA TINTAYA S.A.	**EQUIPMENT NO.:**	0310-SCR-0001-M1
PROJECT:	ANTAPACCAY PROJECT- TINTAYA EXPANSION	**P.O. NO.:**	25580-220-MRA-MFSS-00001
LOCATION:	CUZCO, PERÚ	**UNIT:**	LOW VOLTAGE AC INDUCTION MOTORS

LINE No.	DESCRIPTION	UNITS	SPECIFIED	SELLER PROPOSAL
9,00	**ACCESSORIES**			
9,01	Space Heaters		Required for TEFC 75 kW / 100 hp motors and above	Yes
9,02	Space Heaters Volts	V	220 V	220
9,03	Space Heaters Watts	W	By Seller	-
9,04	Separate Space Heater Connection	-	Required	Yes
9,05	Space heater terminal box location	-	By Seller	B3R (D)
9,06	RTD´s	-		
9,07	Winding Temperature RTD´s (6 - 2 per phase)	-	Required for 298 kW / 400 hp motors and above	N/A
9,08	Bearing Temperature RTD´s (2 - 1 per bearing)			N/A
9,09	Separate RTD box	-	Required	N/A
9,10	RTD´s terminal box location	-	By Seller	N/A
9,11	Moisture System for Submersible Motors	-	humidity sensor required	N/A
9,12	Cable Entry Length for Submersible Motors	-	By Seller	N/A
9,13	Ground lugs inside main terminal box	-	Required	Yes
9,14	Ground lugs on frame (2/0 AWG cable)	-	Required	Yes
9,15	Main terminal box location	-	By Seller	B3R (D)
9,16	Space heater terminal box location	-	By Seller	B3R (D)
9,17	Motor Manufacturer nameplate with all motor parameters	-	Required	Yes
9,18	Nameplates shall be stainless steel		Required	Yes
9,19	Nameplates shall include operation altitude of 4200 masl indication		Required	Yes
9,20	Lifting lugs or eyesbolts for frames 182 and larger		Required	Yes
10,00	**TESTING**		According to requirements of NEMA MG1 p. 12.55.2	
10,01	ROUTINE TESTS			
10,02	Measurement of Winding Resistance	-	Required	Yes
10,03	No load current and speed at rated voltage and frequency	-	Required	Yes
10,04	Current input at rated frequency with rotor at standstill for squirrel-cage motors	-	Required	Yes
10,05	High-potential	-	Required	Yes
10,06		-		
10,07	SPECIAL TESTING	-		
10,08	Determination of efficiency at 100%, 75% and 50% of full load	%	Not Required	No
10,09	Determination of power factor at 100%, 75% and 50% of full load	%	Not Required	No
10,10	Temperature rise test	°C	Not Required	No
10,11	Measure locked rotor current	A	Not Required	No
10,12	Measure breakdown and starting torques	-	Not Required	No
10,13	Sound test per IEEE 85	dBA	Not Required	No
10,14	Speed torque test	-	Not Required	No
10,15	Bearing Temperature	°C	Not Required	No

xstrata copper BECHTEL	**DATA SHEET FOR LOW VOLTAGE INDUCTION MOTORS**	JOB No. 25580-220	
		DATA SHEET No.	REV. No.
	Sheet 4 of 4	25580-220-MFD-MFSS-00002	3

MANUFACTURER: HAVER & BOECKER LATINOAMERICANA **SELLER:** HAVER & BOECKER LATINOAMERICANA

OPERATING CONDITIONS (B)*

Service: **SAG MILL DISCHARGE SCREEN**
Material description **COPPER ORE**

Project Name	**ANTAPACCAY**	
TAG	0310-SCR-0001	
Material properties		
ROM Bulk density, dry:		
(for wight purposes / for volume purposes)	1.89 / 1.60	t/m³
Sp. Gr. (solids)	2,62	
Angle of repose (for volume / for area)	NA	°
Material temperature	35	°C
Operating Schedule		
hours/day	24	
days/year	365	
Utilization	92	%
Location	Outdoor	
No. of equipment (Op / Stby)	1 (1 / 0)	
Plant Site Elev.(above masl), m	4 200	
Site Temperature (Min / Max)	-10 / 22	°C
Environment	Wet and Dusty	
Decks Quantity	2	
Top deck aperture	35	mm
Bottom deck aperture	13	mm
Screen size, width x length	3.7 x 7.3	m
	(12 x 24)	ft

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 1
Reviewer Name: fabian riffo Date: 07/10/2010
Discipline: EM - Mechanical Doc Type Code: V1A
Job # 25580-220 VP # 25580-220-V1A-MFSS-00052
Subm 001 Equip # 0310-SCR-0001-M1;
Program # NA;
Job # VP #
SEQ # Equip #

SCREEN FEED (PER SCREEN)	Balance	Design
Solid feed (t/h)	1 408	1 619
Slurry feed (m³/h)	1 112	1 280
Slurry Solids (%) **(Remark 3)**	70,1	70,1
Wash water (m³/h)	300	450

SCREEN FEED SIZE DISTRIBUTION (Remark 2)

Size	%	Size	%	Size	%
4	100	1	81	1/4	66
3	100	7/8	78	1/8	60
2	94	3/4	75	850 µm	42
1 3/4	91	5/8	70	425 µm	32
1 1/2	88	1/2	69	300 µm	27
1 1/4	84	3/8	67	210 µm	22

P 80% = 2.5 - 3.0 (mm)

Remarks
1.- TROMMEL OPENING: 13 x 50 mm
2.- THE SCREEN FEED SIZE DISTRIBUTION IS ONLY FOR REFERENCE, CAN VARY ± 20%
3.- FOR SCREEN FEED DESIGN VALUE MUST BE 80-85%

NOTE:
* **1. (B) INDICATES BUYER. (S) INDICATES SELLER**
2. ALL (B) ITEMS SHALL BE COMPLETED BY BUYER. ALL (S) ITEMS SHALL BE COMPLETED BY SELLER
3. NOT APPLICABLE (NA) SHALL BE ENTERED WHERE INFORMATION IS NOT RELEVANT
4. TBC: TO BE CONFIRMED - TBD: TO BE DEFINED

THIS DATA SHEET SUPERSEDES 25422-220-MFD-MFSS-00001 Rev.C

REV.	DATE	DESCRIPTION	BY	CHECK	EGS	P.E.	CLIENT
1	17-Sep-10	Completed Issue	MZ	OC			
0	1-Apr-10	Issued for Purchase	FCR	MAG	FLG	CEZ	
C	21-Apr-09	Issued for Bid	GT	CM	FC	RH	
B	19-Feb-09	Issued for Approval	GT	CM	EE	RH	
A	28-Nov-08	Issued for Coordination	GT	JLA	EE	RH	

xstrata copper / BECHTEL	Equip. N° 0310-SCR-0001	ANTAPACCAY PROJECT	JOB N° 25580	REV
		SAG MILL DISCHARGE SCREEN DATA SHEET	MR: 25580-220-MRA-MFSS-00001	1
			DS: 25580-220-MFD-MFSS-00001	
			Sheet 1 of 4	

MANUFACTURER: HAVER & BOECKER LATINOAMERICANA **SELLER:** HAVER & BOECKER LATINOAMERICANA

RECOMMENDED SCREEN OPERATION (S)

	Feed (t/h)	Oversize (t/h)	Undersize (t/h)	Selected screen Efficiency (%)
Nominal	**1408**	**634**	**774**	**95-97**
Design (Surge)	**1619**	**951**	**890**	**-**

Calculated power requirements to design capacity **75** kW
Motor required: **75** kW **1745** RPM

SCREEN CONSTRUCTION AND COMPONENTS (S)

Mounting; Base mounted [X] Suspended [ ]

No. of decks	**2**	
Type	**Linear**	
Model	**R-MD**	
Slope **(Remark 1)**	**0**	°
Speed	**800**	rpm
Vibration frequency	**13,3**	Hz
Vibration Strokes:		
Horizontal stroke	**8,9**	mm
Vertical stroke	**8,9**	mm
Total Acceleration	**4,5**	m/s²

Vibrator:

Number of shafts	**2 per exciter**	
Number of bearing per shaft	**2**	
Direction of rotation	**clock wise**	
Depth of bed at discharge end of :		
Top deck	**600**	mm
Second deck	**1005**	mm
Third deck	**N/A**	mm

Vibrating Frame

Construction: [ ] Welded [X] Bolted

Side plates:	Thickness	**13**	mm
	Depth	**8800**	mm
Feed box :	[X] Required	[ ] Not required	
Feed box length		**905**	mm
Discharge lip length		**576**	mm

Cross menbers:	No. per deck	**8**	
	Size	**3658**	mm
Diagonals:	Size	**N/A**	mm
Tension plates:	Material	**ASTM A36**	
	Thickness	**9,53**	mm

Base Frame: [X] Included [ ] Not included

Dust Enclosure: Stationary / Open sided / Hood / Vibrating / None **NONE**

Liners

	Material	Thick. (mm)
Feed box/disch. lips	**Rubber**	/ **50**
Vibrator tube	**N/A**	/ **N/A**
Deck frame menbers	**Rubber**	/ **10**
Tension plates	**N/A**	/ **N/A**

Mounting

Type of spring	**Helical**
Range of slope adjustment	**N/A**
Can slope be changed without shimming?	**N/A**

¨ Yes ¨ No

Screening Surface

	Top Deck		Second Deck		Third Deck	
Screen panel size "width/length" (B)	**304,8 / 609,6**	mm	**304,8 / 609,6**	mm	**N/A**	m
Material of construction	**Polyurethane**		**Polyurethane**		**N/A**	
Screen panel thickness	**~50**	mm	**~40**	mm	**N/A**	mm
Opening size	**35**	mm	**13**	mm	**N/A**	mm
Opening shape	**Rectangular**		**Rectangular**		**N/A**	
Open area	**~35-40**	%	**~35-40**	%	**N/A**	%
Available surface area	**26,76**	m²	**26,76**	m²	**N/A**	m²

Skid bars:

	Top Deck	Second Deck	Third Deck
Material	**ASTM A -36**	**ASTM A -36**	**N/A**
Size and spacing	**304,8 / 12**	**304,8 / 12**	**N/A**
Crown: (single, double, none)	**None**	**None**	**N/A**

	Equip. N°			REV
xstrata copper / BECHTEL	0310-SCR-0001	ANTAPACCAY PROJECT	JOB N° 25580	1
		SAG MILL DISCHARGE SCREEN DATA SHEET	MR: 25580-220-MRA-MFSS-00001	
			DS: 25580-220-MFD-MFSS-00001	
			Sheet 2 of 4	

MANUFACTURER: HAVER & BOECKER LATINOAMERICANA **SELLER:** HAVER & BOECKER LATINOAMERICANA

COMPONENTS cont (S)

Bearings

Type	heavy-duty ball or roller	Bearing fit (Pressed or slip):	**N/A**
Size, ID	**130 mm**	In housing	**-**
Manufacturer and series	**FAG or similar**	On shaft	**-**
Life Rating L_{10}	**60000 h.**		
Seals Type	**-**		

Drive

Reduction / Increase ratio	**-**	Driver pulley P.D.	**240** mm
No. and size of power band V-belts	**08 / 5V 1060**	Driven pulley P.D	**530** mm
Motor base: Pivoted / sliding	**Sliding**	Other	**N/A**
Motor location	**Base Frame**		

Coupling and vibratory units (describe) **Cardan Shaft MU400 Exciter**

Automatic lubricatio system (Describe) **Bath Oil (Exciter)**

Seals (Describe) n **System of multiple mechanical labyrinth seals plus additional felt.**

Special Requirements: **-**

Spray Bar Assemblies

Size of header	**-**	Nozzle type	**PD-9**
Spray pipes number	**10**	Pipes suspended or attached to screen?	**Suspended**
Nozzle number	**55**		

SIZES AND WEIGHTS (S)

General dimensions

Overall Length	**8,8** m
Overall Width	**6,7** m
Overall Height	**5,4** m

Clearances

Deck removal	**-** mm
Motor removal	**-** mm

General Weights

No. Packages in Total Shipment:	**-**
Total weight for shipment	**43 000** kg
Heaviest Piece for Shipping:	**32 000** kg

Weights for Site

Heaviest Piece for Erection:	**32 000** kg
Heaviest Piece for Maintenance	**1 400** kg
Total Weight Screen	**44 000** kg

xstrata copper / BECHTEL	Equip. N°	ANTAPACCAY PROJECT	JOB N° 25580	REV
	0310-SCR-0001	SAG MILL DISCHARGE SCREEN DATA SHEET	MR: 25580-220-MRA-MFSS-00001	1
			DS: 25580-220-MFD-MFSS-00001	
			Sheet 3 of 4	

OTHERS (S)

Utilities Required:

Water:

Top deck flow	**410**	m^3/h	Pressure	**350**	kPa
Second deck flow	**410**	m^3/h	Temperatur	**-**	°C
Third deck flow	**N/A**	m^3/h			

Plant Air:

Flow	**N/A**	m^3/h	Pressure	**N/A**	kPa

Instrumentation Air:

Flow	**N/A**	m^3/h	Pressure	**N/A**	kPa

Notes:

xstrata copper / BECHTEL	**Equip. N°** 0310-SCR-0001	**ANTAPACCAY PROJECT**	**JOB N° 25580**	**REV**
		SAG MILL DISCHARGE SCREEN DATA SHEET	**MR: 25580-220-MRA-MFSS-00001**	**1**
			DS: 25580-220-MFD-MFSS-00001	
			Sheet 4 of 4	

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 1
Reviewer Name: S.labra
Discipline: EM - Mechanical
Date: 4-jan-2011
Doc Type Code: V1A
Job # 25580-220
Subm 001
Program # 420-0099-SAM;
Job #
SEQ #
VP # 25580-220-V1A-MFMS-00120
Equip # N/A;
VP #
Equip #

BILL OF MATERIALS

ITEM	EQUIPMENT	DESCRIPTION	MPL No	DRAWING REFERENCE	POWER SUPPLY	INPUT SIGNALS	OUTPUT SIGNALS	HOUSING	LOCATION	DIMENSIONS W X H X D [3]	MAXIMUM WEIGHT [3]	QUANTITY
1	SENSOR	RIGHT 1 ACOUSTIC SENSOR	IMP-S-R-01	ETT-DW-1447-2010 ETT-DW-1448-2010 ETT-DW-1450-2010	-	SAG MILL AUDIO	≤49 (VDC+VAC) TO MAIN UNIT	PVC FOR HIGH PRESSURE	SUPPORTING TUBE	360mm x 410mm x 130mm	5.5 kg	1
2	SENSOR	LEFT 1 ACOUSTIC SENSOR	IMP-S-L-01	ETT-DW-1447-2010 ETT-DW-1448-2010 ETT-DW-1450-2010	-	SAG MILL AUDIO	≤49 (VDC+VAC) TO MAIN UNIT	PVC FOR HIGH PRESSURE	SUPPORTING TUBE	360mm x 410mm x 130mm	5.5 kg	1
3	SENSOR	RIGHT 2 ACOUSTIC SENSOR	IMP-S-R-02	ETT-DW-1447-2010 ETT-DW-1448-2010 ETT-DW-1450-2010	-	SAG MILL AUDIO	≤49 (VDC+VAC) TO MAIN UNIT	PVC FOR HIGH PRESSURE	SUPPORTING TUBE	360mm x 410mm x 130mm	5.5 kg	1
4	SENSOR	LEFT 2 ACOUSTIC SENSOR	IMP-S-L-02	ETT-DW-1447-2010 ETT-DW-1448-2010 ETT-DW-1450-2010	-	SAG MILL AUDIO	≤49 (VDC+VAC) TO MAIN UNIT	PVC FOR HIGH PRESSURE	SUPPORTING TUBE	360mm x 410mm x 130mm	5.5 kg	1
5	SENSOR	RIGHT 3 ACOUSTIC SENSOR	IMP-S-R-03	ETT-DW-1447-2010 ETT-DW-1448-2010 ETT-DW-1450-2010	-	SAG MILL AUDIO	≤49 (VDC+VAC) TO MAIN UNIT	PVC FOR HIGH PRESSURE	SUPPORTING TUBE	360mm x 410mm x 130mm	5.5 kg	1
6	SENSOR	LEFT 3 ACOUSTIC SENSOR	IMP-S-L-03	ETT-DW-1447-2010 ETT-DW-1448-2010 ETT-DW-1450-2010	-	SAG MILL AUDIO	≤49 (VDC+VAC) TO MAIN UNIT	PVC FOR HIGH PRESSURE	SUPPORTING TUBE	360mm x 410mm x 130mm	5.5 kg	1
7	SENSOR	RIGHT 4 ACOUSTIC SENSOR	IMP-S-R-04	ETT-DW-1447-2010 ETT-DW-1448-2010 ETT-DW-1450-2010	-	SAG MILL AUDIO	≤49 (VDC+VAC) TO MAIN UNIT	PVC FOR HIGH PRESSURE	SUPPORTING TUBE	360mm x 410mm x 130mm	5.5 kg	1
8	SENSOR	LEFT 4 ACOUSTIC SENSOR	IMP-S-L-04	ETT-DW-1447-2010 ETT-DW-1448-2010 ETT-DW-1450-2010	-	SAG MILL AUDIO	≤49 (VDC+VAC) TO MAIN UNIT	PVC FOR HIGH PRESSURE	SUPPORTING TUBE	360mm x 410mm x 130mm	5.5 kg	1
9	MAIN UNIT [1]	MODULE FOR SIGNALS PROCESSING. INCLUDES CABINET, ACCESSORIES, TRANSFORMER, ILLUMINATION, TERMINAL BLOCKS, AND OTHER MINOR ELEMENTS.	I/S- MU-01	ETT-DW-1447-2010 ETT-DW-1448-2010 ETT-DW-1450-2010	120VAC, 60Hz, 1200VA FROM UPS	ACOUSTIC SIGNALS FROM SENSORS. 1 MODBUS TCP CONNECTION [2]	1 ETHERNET CONNECTION, PROTOCOL MODBUS TCP TO PLANT CONTROL SYSTEM [2]	NEMA 12	CONTROL ROOM	620mm x 2150mm x 700mm	200.0 kg	1

1 In plants that have another instrument from the same manufacturer, this item could be shared.
2 OPC, Foundation Fieldbus or Profibus protocols could be used for communication instead MODBUS, depending on the client requirements during engineering stage.
3 Values can vary according to the specific characteristics of each project.

PROJECT: 25422 - STANDARD CONCENTRATOR +
P.O. NUMBER 25422-220-POA-MFMS-00001
EQUIPMENT: SAG MILL
EQUIPMENT NO.: 0310-MLS-0001

Scale: NTS	Signature	GSV	RGN	EPB	GSV	2010-11-30
		Drawn	Chkd.	Appr.	Rvwd.	Appr. Date

ETT Transferencia de Tecnologías
For FLSmidth Inc. Automation Division

BILL OF MATERIALS
SAG MILL, IMPACTMETER
XSTRATA - ANTAPACCAY, PERÚ

FLSMIDTH ETT

FLS No.	FLS Ver.	ETT No.	ETT Ver.
69009980	01	ETT-DW-1449_2010	A

Antapaccay

SIMINE MILL GD

SAG Mill

Date: 09.11.2009
Name: Schiller

ISSUED:	X	C-CERTIFIED
		FA- FOR APPROVAL
		IN- INITIAL
		P- PRELIMINARY
		FO- FOR OFFER

Dazugehörige Zeichnung/ Accompanying drawing: 0D5.0110-586884

				Date: 16.07.2008 Name: Schiller/Schenk	W.-Nr.:/W.-No.: 1501044 Kennwort/Code: Antap_40
C		09.11.2009	Wint	I DT LD SEK3	**Maßbildtext Dimension Drawing Text**
B		18.02.2009	K-G		
A		30.07.2008	Schi		Typ/Type: 1DN8743-8XA44-Z
Stat.	Mitteilung / Notice	Datum/Date	Name	Siemens AG	Page: 0
Proprietary Data, company confidential. All rights reserved					**4D5.0111-586883 C**

Technical data / Technische Daten

Electrical data stated below corresponding to 4200 m.a.s.l

Output Leistung	kW	24000	
Voltage Spannung	V	2x3700	
Current / max. starting current Strom / max. Anfahrstrom	A / A	2x1964 / 2x3044	C
Operating speed / frequency Betriebsdrehzahl / Frequenz	min-1 / Hz	9,04 / 6,629	
Excitation output Erregerleistung	kW	443	
Excitation current / voltage Erregerstrom / -spannung	A / V	1007 / 440	C
Max. excitation rating Max. Erregerleistung	kW	585	C
Max.excitation current/max.excitation voltage Max.Erregerstrom/-spannung	A / V	1157 / 506	C
Starting torque/starting time Anfahrmoment/-dauer	p.u. / sec	1,55 / 60	
cos phi starting/operating cos phi Anfahren/Betrieb		0,950 / 0,970	
Speed range/Drehzahlstellbereich			
at const. torque / bei konst.Moment	min^{-1}	2,71 / 9,04	
at const. power / bei konst.Leistung	min^{-1}	9,04 / 9,76	C
Inching speed / Positionierdrehzahl	min^{-1}	1,00	
Creeping speed / Schleichdrehzahl	min^{-1}	0,30	
Direction of rotation Drehrichtung		clockwise and counter clockwise Rechts- und Linkslauf	
Motor enclosure: Type of construction/Type of protection Bauform/Schutzart		IM5710 / IP55	
Method of cooling Kühlart	IC	IC75W	
Stator Ständer		4 parts 4 -teilig	
Rotor Läufer	88 poles= 88 Pole=	22 segments 22 Segmente	

				Date: 16.07.2008	W.-Nr.:/W.-No.: 1501044	
				Name: Schiller/Schenk	Kennwort/Code: Antap_40	
					Maßbildtext	
C		09.11.2009	Wint	I DT LD SEK3	**Dimension Drawing Text**	
B		18.02.2009	K-G			Page:
A		30.07.2008	Schi		Typ/Type: 1DN8743-8XA44-Z	
Stat.	Mitteilung / Notice	Datum/Date	Name	Siemens AG		3
Proprietary Data, company confidential. All rights reserved					**4D5.0111-586883 C**	

Technical data / Technische Daten

Electrical data stated below corresponding to 4200 m.a.s.l

Air to water cooling / Luft-Wasserkühlung

Required quantity of water / erf. Gesamtwassermenge	m³/h	135	C
Capacity of cooler / Kühlerleistung	Freshwater with 30% glycol kW	1100	C
Max. inlet temperature / max. Eintrittstemperatur	°C	20	
Max. outlet temperature at rated conditions/ max. Austrittstemperatur bei Betrieb	°C	27	
Rated pressure / Betriebsdruck	bar	6	
Pressure drop / Druckabfall	bar	0,7	C
Material of pipes / Material der Rohre		CuNi10Fe	
Material of tube sheets / Material der Rohrböden		Naval Brass	
Material of headers / Material der Kammern		steel resin coating Stahl/Rilsan	
Counterflange, 2 1/2 RF-150 lb ANSI B16.5, Siemens Delivery / Gegenflansch		Steel / Stahl	
1 cooler consists of 4 elements 1 Kühler besteht aus 4 Elementen			
Weight of 1 element / Gewicht für 1 Element	kg	605	C
Installed blowers / eingebaute Lüfter	number / Anzahl	8	
Installed motor power / install. Motorleistung	each kW/je kW	21	C
Nominal motor voltage/ frequency Motor-Anschlußspannung / Frequenz	V/Hz	460 / 60	C
Weight of 1 fan / Gewicht für 1 Lüfter	kg	160	
Anticondensation heating / Stillstandsheizung	kW	30	
Nominal voltage / frequency Anschlußspannung / Frequenz	V / Hz	460 / 60	C

Stat.	Mitteilung / Notice	Datum/Date	Name			
				Date: 16.07.2008	W.-Nr.:/W.-No.: 1501044	
				Name: Schiller/Schenk	Kennwort/Code: Antap_40	
C		09.11.2009	Wint	I DT LD SEK3	**Maßbildtext** **Dimension Drawing Text**	
B		18.02.2009	K-G			Page:
A		30.07.2008	Schi	Siemens AG	Typ/Type: 1DN8743-8XA44-Z	4
					4D5.0111-586883 C	

Three−Phase−Synchronous Motor with Salient Pole Rotor (Ring Motor)

Order No. **585487**
Order Date **26.06.08**
Manuf. No. **D0850104401**

	Type	1DN8743−8XA44−Z	Cooling System	IC75W	Mounting	IM5710
	Unit	1	Cooling Circuit	sec. / prim.	Enclosure	IP55
	Duty	SAG Mill 40ft	Cool. Medium	water / air	Ex−Protection	− −
B	Drive for	Ore Mill	Coolant Flow	m³/h / 42 m³/s	Ex−Standard	−
	Standard	IEC 60034	Inlet Temp.	20 ˚C / 30 ˚C	Insul. System	Micalastic
B	Rotation	cw/ccw	Losses to be dissipated	1100 kW	Thermal Class	F
	Excitation	static	Ventilation System	unilat.	Service Altitude	≤ 4200 m
			Type of Fan	separate		

B Converter **Sinamics SL150 2 * 6**−pulse
2 Systems, **nicht Electr. Displaced**

Load Curve
Part1: **0.30 − 1.00** * NN : **m = const**
Part2: **1.00 − 1.08** * NN : **m = 1/n**

Remarks

QS−Performance

Enclosures

Sheet :

Sheet :

Sheet :

Sheet :

Sheet :

Sheet :

Three−Phase−Synchronous Motor with Salient Pole Rotor (Ring Motor)

Order No. **585487**
Order Date **26.06.08**
Manuf. No. **D0850104401**

Type	**1DN8743−8XA44−Z**	Cooling System	**IC75W**	Mounting	**IM5710**
Unit	**1**	Cooling Circuit	**sec.** **prim.**	Enclosure	**IP55**
Duty	**SAG Mill 40ft**	Cool. Medium	**water** **air**	Ex−Protection	− −
B Drive for	**Ore Mill**	Coolant Flow	m³/h **42** m³/s	Ex−Standard	−
Standard	**IEC 60034**	Inlet Temp.	**20** °C **30** °C	Insul. System	**Micalastic**
B Rotation	**cw/ccw**	Losses to be dissipated	**1100** kW	Thermal Class	**F**
Excitation	**static**	Ventilation System	**unilat.**	Service Altitude	≤ **4200** m
		Type of Fan	**separate**		

B Converter **Sinamics SL150** **2** ∗ **6**−pulse
2 Systems, **nicht Electr. Displaced**

Load Curve Part1: **0.30** − **1.00** ∗ NN : **m = const**
Part2: **1.00** − **1.08** ∗ NN : **m = 1/n**

	Operating Data		**Rated Point**	
	Output	kW/HP	**24000**	
	Voltage	V	**2** ∗ **3700**	⅄
	Frequency	Hz	**6.629**	
	Current	A	**2** ∗ **1964**	
	Speed	min^{-1}	**9.040**	
	Power Factor		**0.970 u**	
A	Exc. Voltage MM at **130** °C	V	**440**	
B	Exc. Current MM	A	**1007**	
	Cooling Temperature sec./prim.	°C	**20** / **30**	
	Stator Winding Temperature	°C	≤ **125**	**(ETD)**
	Field Winding Temperature	°C	≤ **130**	**(R)**
	Duty Type		**S1**	
	Remarks			

Efficiency

Load	Speed	Voltage	P.F.	Efficiency
1.000	**1.000**	**1.000**	**−0.970 u**	**96.9** % +

x Marked Losses are included in the Efficiency

Losses at Rated Load

	Windage		kW
x	Core		kW
x	I^2R_{DC} Stator	**95** °C	kW
x	I^2R_{DC} Rotor	**95** °C	kW
x	Additional		kW
x	Converter Supply		kW
x	Brushes		kW
	Separated Fan		kW

Resistances, Reactances

Ref. Impedance ZN=**0.54** Ω
Ref. Temperature **95** °C

							unsaturated			**saturated**	
						xdu	**0.78**	p.u.	xdg	**0.69**	p.u.
A						xd'u	**0.24**	p.u.	xd'g	**0.24**	p.u.
A	xs1	**0.14** p.u.	r1	**13.30**	‰	xd"u	**0.23**	p.u.	xd"g	**0.23**	p.u.
A	xs2	**0.12** p.u.	r2	**4.60**	‰	xqu	**0.50**	p.u.	xqg		p.u.
A	xs3d	**1.08** p.u.	r3d	**1467**	‰	xq"u	**0.41**	p.u.	xq"g	**0.38**	p.u.
	xs3q	**0.97** p.u.	r3q	**1321**	‰	x0	**0.11**	p.u.	x0g	**0.11**	p.u.
	xsb	p.u.				x2	**0.30**	p.u.	x2g	**0.29**	p.u.

Time Constants

Ref. Temperature **95** °C

TD0'	**3.94**	s	TG	**0.56**	s
TD'	**1.22**	s			
TD0"	**0.02**	s	TQ0"	**0.02**	s
TD"	**0.02**	s	TQ"	**0.02**	s
T(3K)	**1.37**	s	T(2K)	**1.83**	s

Magnetic Forces

B	Pull per pole	FMP	**239** kN
B			
A	Excentric		
B	CM(N=0 *))		**487** kN/mm
	CM(N=0, IF=IF0)		**400** kN/mm
	CM(N=NN, IF=IFN)		**280** kN/mm

*) during excitation−build−up

Short Circuit, Over Load

Short circuit ratio	IK0/IN	**1.46** p.u.
Sudden sc torque	(3−ph)	**3.98** p.u.
	(2−ph)	**6.06** p.u.
Pull−out torque	MK/MN	**1.56** p.u.

Ref. Values

Rated current/syst.	IN	**2** ∗ **1964** A
Rated torque	MN	**25352.1** kNm

Exciting Data	**Voltage**	**Current**
No−load	**438** V	**1001** A
Rated point	**440** V	**1007** A
Air gap line		**845** A

Converter Starting

MA/MN (N=0)	**1.55** p.u.
IA/IN (N=0)	**1.55** p.u.
IFA/IFN (N=0)	**1.15** p.u.

Function Test

Remarks:

* Specified values without tolerance; + Specified values with tolerance acc. to standard; calculated values without mark

A&D LD S	Dep. SEB	Works No. **1501044**	Code **ANTAP_40**	**Electrical Data**	Sheet 2 of 5
Siemens AG	Name GelsPa				
	Phone/Fax	DI1385 I.97 DV−Freigabe		**4D5.0180−585649B**	44666
	Date 12.10.09				

Excitation and regulation data

Regulation for constant value of working flux (resp. max. terminal voltage) and constant inner power factor

Synchronous Motor with Simovert D-Converter

P_N = 24000 kW	N_N = 9.040 min^{-1}	M_N = 25352.1 kNM
U_{N1} = 3700 V	N_{MAX} = 9.763 min^{-1}	M_A = 39295.8 kNm
I_{N1} = 1964 A		

Load condition	M_N			0.750 * M_N			0.500 * M_N		
	1.00 * N_N	0.75 * N_N	0.50 * N_N	1.00 * N_N	0.75 * N_N	0.50 * N_N	1.00 * N_N	0.75 * N_N	0.50 * N_N
Duty Type	S1	S1	S1	S1	S1	S1	S1	S1	S1
P/P_N	1.000	0.750	0.500	0.750	0.563	0.375	0.500	0.375	0.250
M/M_N	1.000	1.000	1.000	0.750	0.750	0.750	0.500	0.500	0.500
U_1/U_{N1}	1.000	0.753	0.506	0.989	0.744	0.499	0.979	0.735	0.493
I_1/I_{N1}	1.000	1.000	1.000	0.750	0.750	0.750	0.501	0.501	0.501
$\cos\varphi$	−0.970	−0.970	−0.971	−0.978	−0.978	−0.978	−0.984	−0.984	−0.985
P kW	24000	18000	12000	18000	13500	9000	12000	9000	6000
V_{Fe} kW	76	55	35	74	53	34	73	52	33
V_z kW	14	9	5	8	5	3	3	2	1
V_{Wg1} kW	322	322	322	181	181	181	81	81	81
V_{W2} kW	403	403	402	369	369	368	349	348	347
V_{ges} kW	814	788	763	632	608	586	506	483	462
P_{Wauf} kW	24412	18385	12361	18263	13739	9218	12157	9135	6115
P_S kVA	25167	18951	12736	18679	14050	9423	12350	9279	6210
U_1 V	3700	2786	1872	3659	2753	1846	3622	2721	1822
I_1 A	3927	3927	3928	2947	2947	2947	1968	1969	1968
U_I/U_{N1}	0.962	0.721	0.481	0.962	0.722	0.481	0.962	0.721	0.481
ϕ_h/ϕ_N	0.962	0.962	0.962	0.962	0.962	0.962	0.962	0.962	0.962
$\cos\varphi i$	−0.994	−0.994	−0.994	−0.994	−0.994	−0.994	−0.994	−0.994	−0.994
I_F A	1007	1007	1006	963	964	962	937	936	935
I_F/I_{FN}	1.000	1.000	0.999	0.957	0.957	0.956	0.930	0.930	0.928

Load condition	Field weak. range	Service Factor	Starting Torque 1.55 * M_N		
	N_{max}=1.08 * N_N	1.00 * M_N; 1.00 * N_N	0.10 * N_N	0.50 * N_N	1.00 * N_N
Duty Type	S1	S1	S2 60s	S2 60s	S2 60s
P/P_N	1.000	1.000	0.155	0.775	1.550
M/M_N	0.926	1.000	1.550	1.550	1.550
U_1/U_{N1}	1.003	1.000	0.120	0.523	1.028
I_1/I_{N1}	1.000	1.000	1.542	1.549	1.550
$\cos\varphi$	−0.967	−0.970	−0.963	−0.952	−0.950
P kW	24000	24000	3720	18600	37200
V_{Fe} kW	71	76	9	37	81
V_z kW	16	14	1	12	33
V_{Wg1} kW	322	322	765	772	772
V_{W2} kW	331	403	529	531	531
V_{ges} kW	739	814	1304	1353	1418
P_{Wauf} kW	24408	24412	4495	19421	38087
P_S kVA	25234	25167	4650	20406	40092
U_1 V	3711	3700	443	1936	3804
I_1 A	3926	3927	6056	6085	6086
U_I/U_{N1}	0.962	0.962	0.096	0.481	0.962
ϕ_h/ϕ_N	0.891	0.962	0.962	0.962	0.962
$\cos\varphi i$	−0.994	−0.994	−0.994	−0.994	−0.994
I_F A	912	1007	1154	1157	1156
I_F/I_{FN}	0.906	1.000	1.146	1.149	1.149

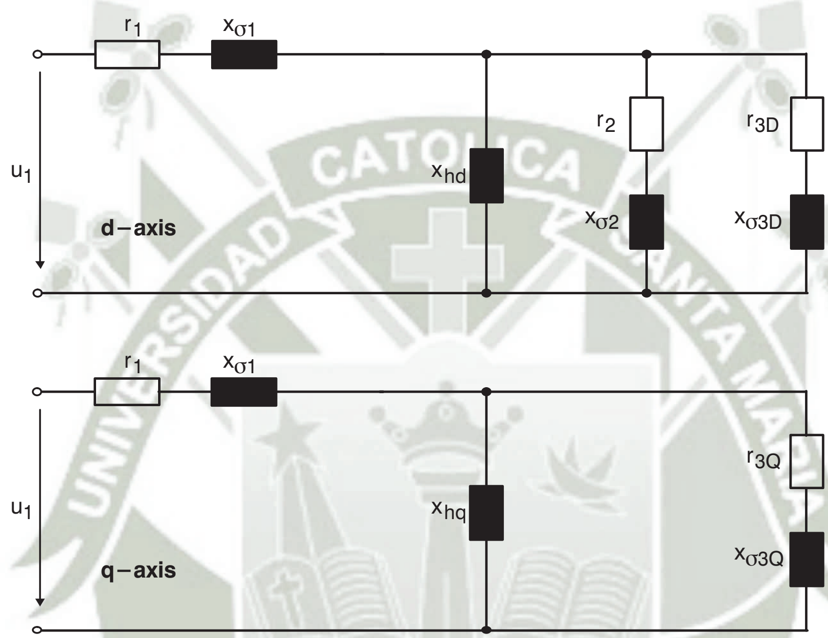
Design Data for Transvector Control System

Synchronous Motor with Simovert–D–Converter

Operating Data

Rated line–to–line voltage per system	**3700**	V	Rated torque	**25352.1**	kNm
Rated current per system	**1964**	A	Starting torque	**39295.8**	kNm
Rated app. power	**25167**	kVA			
Rated active power (shaft ouput)	**24000**	kW	Rated exc. voltage	**440**	V
Rated inner p.f.	**–0.994 u**		Rated exc. current	**1007**	A
Rated p.f.	**–0.970 u**		Exc. voltage during start–up	**506**	V
Rated speed	**9.040**	1/min	Exc. current during start–up	**1156**	A
Max. speed	**9.763**	1/min	No load exc. current	**1001**	A
Rated frequency	**6.629**	Hz			
Max. frequency	**7.160**	Hz	Pole number	**88**	

Equivalent circuit diagram:



Base value of motor impedance **0.54** Ω ; **Reference temperature** **95 °C**

Synchronous resistances			Air gap reactances			Leakage reactances	
				unsaturated	**saturated**		**unsaturated**
DC resistance	**12.80** ‰		xhd	**0.64** p.u.	**0.54** p.u.	xσ1	**0.14** p.u.
AC resistance	**13.30** ‰		xhq	**0.36** p.u.	**0.31** p.u.	xσ2	**0.12** p.u.
r2	**4.60** ‰					xσ3D	**1.08** p.u.
r3D	**1.467** ‰					xσ3Q	**0.97** p.u.
r3Q	**1.321** ‰						

Synchronous, transient and subtransient reactances

	unsaturated	saturated		unsaturated	saturated		unsaturated	saturated
xd	**0.78** p.u.	**0.69** p.u.	xd’	**0.24** p.u.	**0.24** p.u.	xd’’	**0.23** p.u.	**0.23** p.u.
xq	**0.50** p.u.					xq’’	**0.41** p.u.	**0.38** p.u.
						x2	**0.30** p.u.	**0.29** p.u.

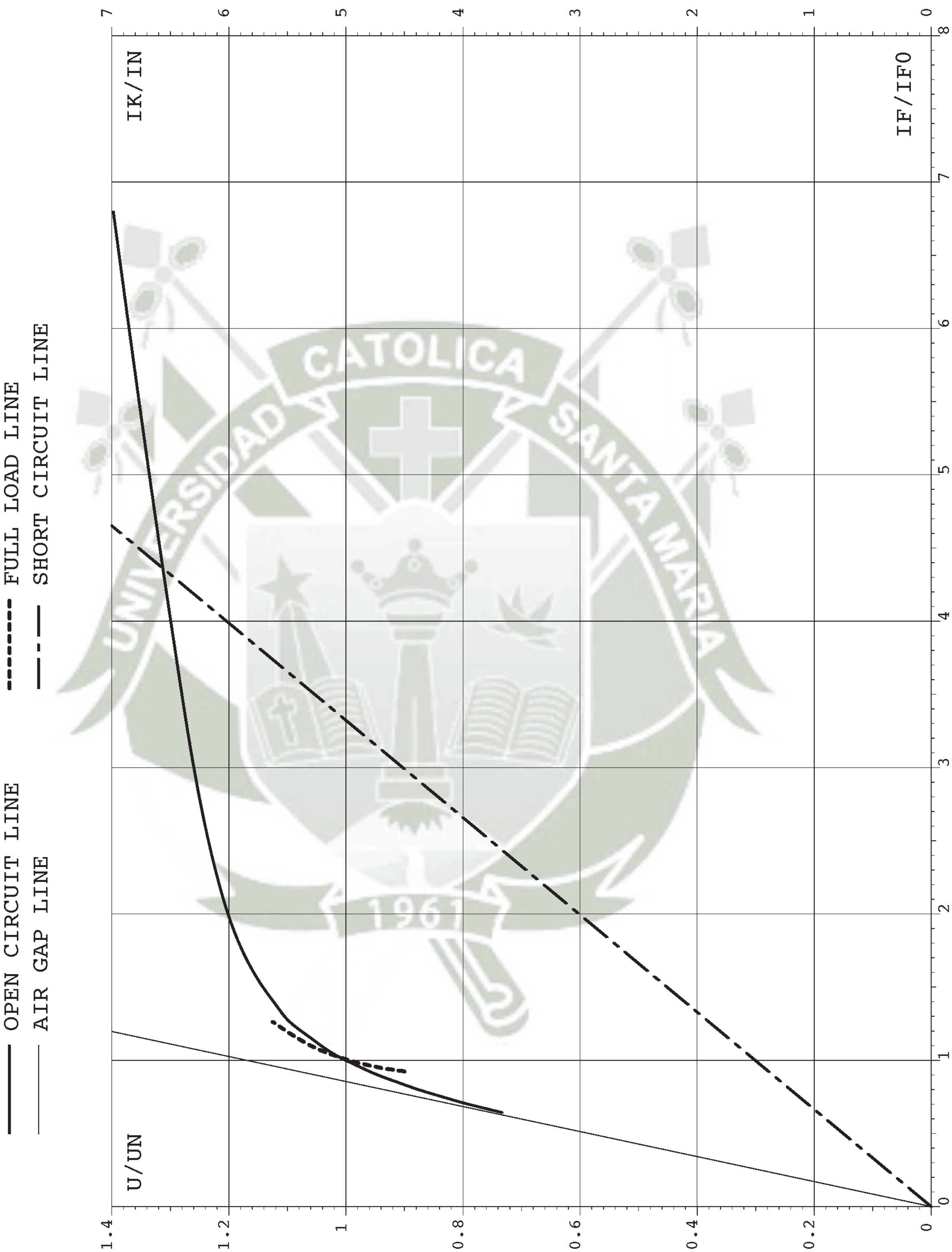
Time constants

	unsaturated	saturated		unsaturated	saturated		unsaturated	saturated
TG	**0.56** s		TD”0	**0.02** s		T(3K)	**1.37** s	
TD’0	**3.94** s	**3.45** s	TD”	**0.02** s		T(2K)	**1.83** s	
TD’	**1.22** s		TQ”0	**0.02** s				
			TQ”	**0.02** s				

Inductivity of field winding		Current ratio	
L2	**1556** mH	XHDG*IF0/IN1SYS	**0.33** p.u.

NO−LOAD SATURATION AND SHORT CIRCUIT CHARACTERISTIC (ACC. TO DESIGN)

PN = 24000. KW   UN = 2* 3700. V   IN = 2*1964. A   P.F. = −0.970U
FN =   6.63 HZ   NN =   9.0 RPM   IF0=   1001. A



A&D LD S	Dep. SEB	Works No. 1501044	Code ANTAP_40	Electrical Data	Sheet 5 of 5
Siemens AG	Name GelsPa				
	Phone/Fax	DI1385 I.97 DV−Freigabe		4D5.0180−585649B	44666
	Date 12.10.09				

Pesaje continuo – No ha de tomarse a la ligera!

Milltronics MSI y MMI

Answers for Industry.

SIEMENS

MSI/MMI

Si busca un sistema de pesaje que reúna alta fiabilidad y resistencia la báscula de cinta de rodillo sencillo Milltronics MSI es la mejor opción que encontrará en el mercado para control de procesos y descarga. Si su aplicación exige aún más precisión, la báscula Milltronics MMI de doble o triple rodillo es idónea para aplicaciones sujetas a verificación, con cintas transportadoras rápidas, estaciones de rodillos poco distanciadas y cargas ligeras o irregulares. Las básculas Milltronics MSI y MMI proporcionan rendimiento superior respecto al de las básculas de cuatro o seis rodillos. En Siemens, no nos tomamos el pesaje continuo a la ligera.

- Precisión y repetibilidad sobresalientes
- Celdas de carga extensométricas tipo paralelogramo con protección de sobrecarga (300%) para respuestas instantáneas a cargas verticales. Idóneas para velocidades de cinta superiores. Estructura triple brazo de acero inoxidable idónea para condiciones extremas; protección duradera contra la humedad y la corrosión
- Equilibrado electrónico de celdas de carga patentado; precisión garantizada aún con cargas descentradas
- Fácil y rápida instalación por inserción con alineación simplificada
- Los integradores Milltronics BW100[2] o BW500 o SIWAREX FTC completan el sistema de pesaje
- Los sistemas Milltronics MSI/BW500 y/o MMI-2/BW500 están homologados por NTEP, Measurement Canada, OIML, MID y SABS para aplicaciones sujetas a verificación

	Milltronics MSI	Milltronics MMI
Modo de operación		
Principio de medida	Medida de carga en transportador de cinta mediante células de carga extensométricas	
Aplicaciones típicas	• Control en túneles de mezcla de piedra triturada • Monitoreo de caudales de alimentación de molinos de molienda • Seguimiento de los totales diarios y de la productividad • Apto para minerales/menas gruesas y finas o áridos • Control de la alimentación en plantas carboeléctricas	• Apto para aplicaciones que requieren verificación oficial • Monitoreo de caudales de transferencia de mina a tolva • Descarga de materiales en camión, barco, buque o ferrocarril • Monitoreo y seguimiento de inventarios • Apto para cintas transportadoras rápidas, espacio limitado entre poleas, cargas livianas o irregulares
Rendimiento		
Precisión	±0,5% de 20-100% del rango de funcionamiento	MMI-2: ±0,25% de 20-100% del rango de funcionamiento (2 básculas MSI) MMI-3: ±0,125% de 25-100% del rango de funcionamiento (3 básculas MSI)
Condiciones de funcionamiento		
Temp. del producto	-40 ... 70 °C (-40 ... 185 °F)	
Cinta transportadora		
Ancho	500 mm ... 2000 mm (18 ... 96" CEMA)	
Velocidad	Máx. 5 m/s (1200 ppm)	
Capacidad		
	Hasta 12000 t/h a la máxima velocidad de la cinta	
Inclinación del transportador		
	• ±20° respecto al plano horizontal, fija • Hasta ±30° con menor precisión[1]	
Rodillos		
Perfil del rodillo	• Plano hasta 35° • 45° con menor precisión[1]	
Diámetro del rodillo	50 ... 180 mm (2 ... 7")	
Espacio entre rodillos	0,5 ... 1,5 m (1.5 ... 5.0 ft)	
Célula de carga		
Características constructivas	Construcción en acero inoxidable 17-4 PH (1.4568) con cubierta en acero inoxidable 304 (1.4301) (protección antihumedad perfeccionada) Caja: IP65	
Excitación	Nom. 10 V DC, máx. 15 V DC	
Salida	Excitación de 2 ±0,02 mV/V a la capacidad nominal de la célula de carga	
No repetibilidad	0,01% de la salida nominal	
No linealidad	0,02% de la salida nominal	
Capacidad	50, 100, 250, 500, 750, 1000, 1250, 1500 lbs	
Sobrecarga	150% de la capacidad nominal, máx. 300% de la capacidad nominal	
Temperatura	• de funcionamiento: 40 ... 75 °C (-40 ... 167 °F) • con compensación -18 ... 65 °C (0 ... 150 °F)	
Interconexiones (al integrador, por báscula MSI)		
	• < 150 m (500 ft) cable de 6 conductores blindado 18 AWG (0,75 mm^2) • > 150 m (500 ft) ... 300 m (1000 ft) cable de 8 conductores blindado 18 - 22 AWG (0,75 – 0,34 mm^2)	
Interfaz		
Salida	Integrador Milltronics BW100[2]: • caudal • peso totalizado • carga en la cinta • velocidad de la cinta Integrador Milltronics BW500: • caudal • peso totalizado • carga en la cinta • velocidad de la cinta • batch/lotes • PID	
Comunicaciones	Con el integrador Milltronics BW500, Modbus® integrado, Allen-Bradley® RIO, PROFIBUS DP, DeviceNetTM con SmartLinx opcional	
Homologaciones		
	FM/CSA Clase II, Div. 1, Grupos E, F, G y Clase III; ATEX II 2D, IEC ExtD A21 IP65 T90°C, CE, C-TICK, Measurement Canada, SABS (Milltronics MSI), NTEP (Milltronics MMI); OIML; MID	

[1] Requiere validación por parte de un Ingeniero de Aplicación Siemens. [2] Integrador Milltronics BW100 no compatible con la báscula Milltronics MMI. Allen-Bradley es una marca registrada de Rockwell Automation. DeviceNet es una marca de Open DeviceNetVendor Association. Modbus es una marca registrada de Schneider Electric. SmartLinx es una marca registrada de Siemens Milltronics Process Instruments Inc. Sujeto a cambios sin previo aviso.

Datos técnicos

	Milltronics MFA 4p
Alimentación auxiliar	
	■ 100/115/200/230 V AC selección por interruptor ■ 50/60 Hz, 15 VA ± 10% de la tensión nominal
Rendimiento	
Repetibilidad	± 1%
Zona de insensibilidad	± 0,25%
Rango dinámico	0 ... 7200 PPM
Temperatura ambiente	
	-20 ... +50 °C (-4 ... +122 °F)
Diseño	
Grado de protección	■ Tipo 4X/NEMA 4X/IP65 (estándar o acero inoxidable opcional) ■ Tipo 4/NEMA 4/IP65 (acero dulce opcional)
Dimensiones de la caja	160 mm x 240 mm x 82 mm (6,3" x 9,5" x 3,2")
Material de la caja	Policarbonato (opcional: acero dulce inoxidable o acero inoxidable)
Salida	
	2 contactos asociados, con 1 contacto tipo C respectivamente (SPDT), 8 A a 250VAC, carga óhmica
Certificados y homologaciones	
	CE, $CSA_{US/C}$, FM

Sensores de movimiento Milltronics

Milltronics MSP-12 estándar	
	■ Sensor de movimiento altamente resistente para uso general ■ Caja fenólica muy duradera, preamplificador integrado ■ Rango de temperatura: -40 ... +60 °C (-40 ... +140 °F)
Milltronics MSP-9 para altas temperaturas	
	■ Sensor de movimiento de acero inoxidable 304 resistente a altas temperaturas de hasta +260 °C (+500 °F) ■ 1,5 m (5 ft) de cable de alta temperatura PTFE proporcionado. Pueden utilizarse hasta 30 m (100 ft) ■ Preamplificador exterior en caja de acero pintada (acero inoxidable 304 opcional)
Milltronics MSP-3 para altas temperaturas	
	■ Sensor de movimiento de aluminio resistente a altas temperaturas de hasta +260 °C (+500 °F) ■ 1,5 m (5 ft) de cable de alta temperatura PTFE proporcionado. Pueden utilizarse hasta 30 m (100 ft) ■ Preamplificador exterior en caja de aluminio fundido NEMA 4 ■ Temperatura de funcionamiento del preamplificador: -40 ... +60 °C (-40 ... +140 °F)
Milltronics MSP-1 sonda en miniatura	
	■ Sensor de movimiento miniatura CPVC para instalaciones con espacios de montaje limitados ■ 1,8 m (6 ft) de cable proporcionado. Pueden utilizarse hasta 30 m (100 ft) ■ Preamplificador exterior en caja de aluminio fundido NEMA 4 ■ Las dimensiones reducidas de la sonda limitan su sensibilidad, máxima distancia 13 mm (0,5") ■ Rango de temperatura: -40 ... +80 °C (-40 ... +180 °F)
Milltronics XPP-5	
	■ CSA entornos peligrosos (Clase I, Div. 1, Grupos A, B, C, y D; Clase II, Div. 1, Grupos E, F, y G; Clase III) ■ Cuerpo fenólico/de aluminio, completamente encapsulado ■ Rango de temperatura: -40 ... +60 °C (-40 ... +140 °F)

Sujeto a cambios sin previo aviso.

Certification NO. 002284

www.siemens.com/processprotection

Million in one

Extensa experiencia en soluciones para la detección de movimiento

Los instrumentos Siemens están respaldados por años de experiencia procedente de un millón de aplicaciones industriales.

Nuestros instrumentos son insensibles a los rigores de la industria pesada y han demostrado su fiabilidad en un amplio abanico de aplicaciones difíciles como la minería, el tratamiento de minerales y la industria cementera. Se usan asimismo de forma generalizada en procesos alimentarios en húmedo y en seco, así como en el sector químico.

Gracias a esta experiencia entendemos la importancia de la fiabilidad, además de ser conscientes de lo que implica tener un instrumento exacto y en el que poder confiar cuando se trata de aplicaciones difíciles.

7ML1996-5FS23 Impreso en Canadá

I/A Series® Hardware

PSS 21H-2Y14 B4

FEM100 Fieldbus Expansion Module

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed

2 Revise & Resubmit. Work may proceed subject to incorporation of changes

3 Revise & Resubmit. Work may NOT proceed

4 Review not required. Work may proceed

5 Cancelled / Superseded

Document Status: 4

Reviewer Name: H. MONTERO — Date: 28/MAR/2012

Discipline: EJ - Control Systems — Doc Type Code: V1A

Job # 25580-220 — VP # 25580-220-V1A-JD01-00042

Subm 001 — Equip #

Program #

Job # — VP #

SEQ # — Equip #

The Fieldbus Expansion Module (FEM100) provides four Expanded Fieldbuses to the Field Control Processor 270 (FCP270). Each of the four Expanded Fieldbuses can accommodate up to thirty-two 200 Series Fieldbus Modules (FBMs).

FEATURES

- Enables a FCP270 to communicate with sixty-four 200 Series FBMs, over four Expanded Fieldbuses for typical control usage
- Additional 200 Series FBMs can be used at slower speeds for data acquisition per sizing guidelines
- Redundancy minimizes communication interruption from Expanded Fieldbus 1 through 4
- Two-Slot and Four-Slot FEM100 Expansion Baseplates both support the 2 Mbps Module Fieldbus for 200 Series (or equivalent) FBMs
- Two-slot Expansion Baseplate accommodates FEM100 modules only, used to upgrade existing FCP270 installations
- Four-slot Expansion Baseplate accommodates two FCP270 control processors and their fiber optic splitter/combiners, plus two FEM100 modules, for new installations.
- Harsh (Class G3 - ISA S71.04) contamination protection.

invensys® FOXBORO®

OVERVIEW

The FEM100 module provides four Expanded Fieldbuses to an I/A Series FCP270 to increase the number of 200 Series (or equivalent) FBMs supported by the FCP270 modules. The FEM100 module supports the 2 Mbps HDLC module Fieldbus for communication between the I/A Series® FCP270 and the 200 Series FBMs (see Figure 3 on page 5).

The FEM100s are installed in a DIN rail mounted Modular Two-Slot or Four-Slot Expansion Baseplate for 2 Mbps communication between the FBMs and FCP270 modules (see Figure 1 and Figure 2).

Figure 1. Redundant FEM100 Modules on DIN Rail Mounted Modular Two-Slot Expansion Baseplate

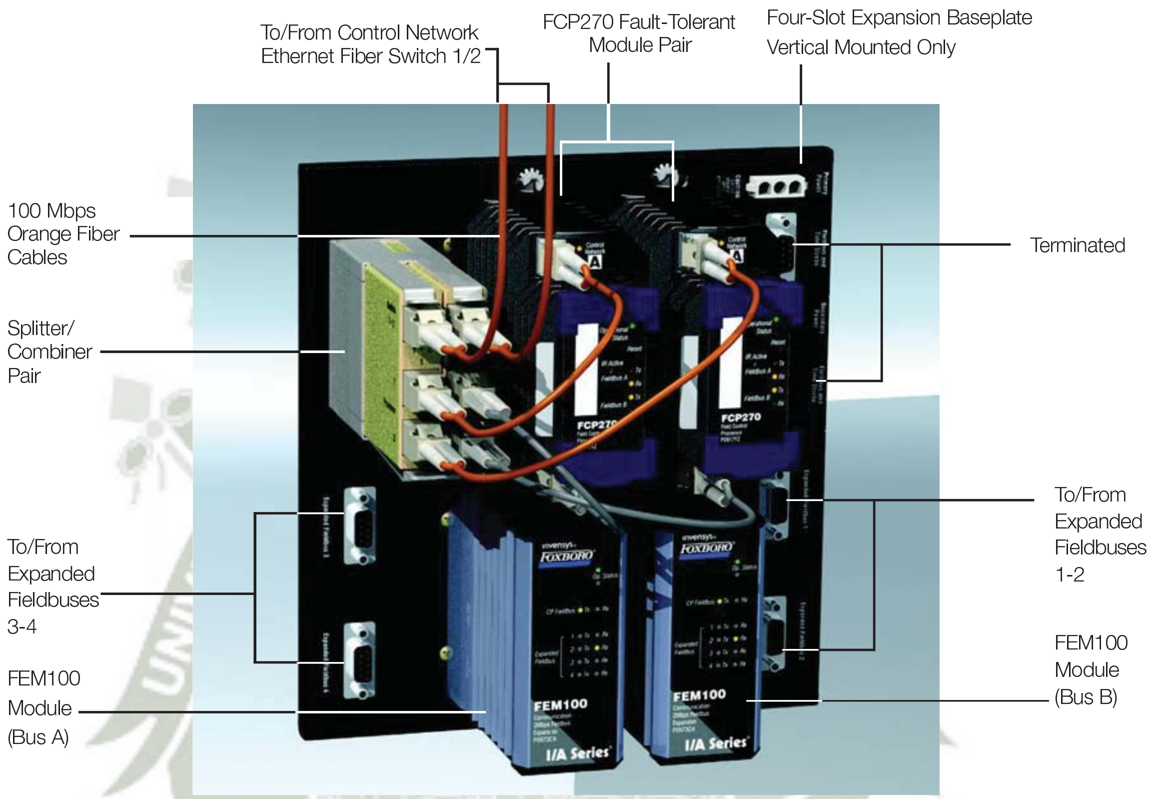


Figure 2. Redundant FEM100 Modules on DIN Rail Mounted Modular Four-Slot Expansion Baseplate

FEM100 MODULE DESIGN

FEM100 modules have a compact design, with a rugged extruded aluminum exterior for physical protection of the electronics. Enclosures specially designed for mounting of DIN rail mounted Fieldbus equipment provide various levels of environmental protection for the FEM100 modules, up to harsh environments per ISA Standard S71.04.

The FEM100 can be removed/replaced from an Expansion Baseplate without removing power. Light-emitting diodes (LEDs) incorporated into the front of the FEM100 indicate module Fieldbus communications activity and module status.

The FEM100 communicates to the FCP270 over the 2 Mbps HDLC Fieldbus, as shown in Figure 3 on page 5.

HIGH AVAILABILITY

A pair of FEM100 modules provides redundancy for the Extended Fieldbuses to maintain very high subsystem availability. When both modules are active, the FCP270 sends and receives communications across both A and B buses. In the case of a FEM100 module failure, the FCP270 switches all traffic to the bus with the available FEM100 module until the failed module is replaced.

Either module may be replaced without upsetting input or output communications to the other module.

EXPANSION BASEPLATE MOUNTING

The FEM100 modules mount on either the Two-Slot or Four-Slot Expansion Baseplate. These baseplates are DIN rail mounted and vertically oriented only. These baseplates include signal connectors for the FEM100s, redundant independent dc power connections, and four cable connections to the 2 Mbps HDLC Expanded Fieldbuses.

The Two-Slot Expansion Baseplate includes a redundant I/O cable connection to the FCP270s. One connector supports both A and B buses, while the other is terminated. Alternatively, both connectors can be used in conjunction with a Fieldbus Splitter/Terminator (P0926KW).

The Four-Slot Expansion Baseplate includes two slots for mounting a fault-tolerant pair of FCP270s and their fiber optic splitter/combiners.

For more information on these baseplates, refer to *DIN Rail Mounted Modular Baseplates* (PSS 21H-2W6 B4).

MODULE FIELDBUS COMMUNICATION

The Expansion Baseplates support the 2 Mbps module Fieldbus. They connect to the 2 Mbps module Fieldbus for communication to all 200 Series DIN I/O FBMs, the Siemens APACS+™ and Westinghouse competitive migration modules (see “Devices Supported” on page 8).

The 2 Mbps module Fieldbus is redundant and all 200 Series modules can receive/transmit messages over both A and B buses.

I/A Series® HARDWARE
Product Specifications

INVENSYS PROCESS SYSTEMS

PSS 21H-2Z7 B4

FBM207/b/c Voltage Monitor/Contact Sense Input Interface Modules

The FBM207/b/c Voltage Monitor/Contact Sense Input Interface Modules function as a 16-channel dc voltage monitor or 16-channel contact sensor.

FEATURES

Key features of the FBM207/b/c modules are:

- Sixteen discrete inputs
- Supports discrete input signals at voltages of:
  - 15 to 60 V dc - contact sense
  - 120 V ac/125 V dc - voltage monitoring or switch inputs
  - 240 V ac - voltage monitoring or switch inputs
- Each input is galvanically isolated. Group isolated with external excitation
- Single or redundant modules
- Compact, rugged design suitable for enclosure in Class G3 (harsh) environments
- Executes programs for Discrete Input, Ladder Logic, Pulse Count, and Sequence of Events with configurable Input Filter Time option
- Termination Assemblies (TAs) for locally or remotely connecting field wiring to the FBM206
- Termination Assemblies for per channel internally and/or externally loop powered devices
- Various Termination Assemblies (TAs) have additional signal conditioning hardware that provides voltage attenuation and optical isolation.

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4
Reviewer Name: H. MONTERO — Date: 28/MAR/2012
Discipline: EJ - Control Systems — Doc Type Code: V1A
Job # 25580-220 — VP # 25580-220-V1A-JD01-00043
Subm 001 — Equip #
Program #
Job # — VP #
SEQ # — Equip #

FOXBORO

OVERVIEW

The FBM207/b/c Voltage Monitor/Contact Sense Input Interface Module functions as a 16-channel dc voltage monitor or 16-channel contact sensor. Each channel accepts a 2-wire input from a dc voltage source (FBM207) or pair of contacts or solid state switches (FBM207b/ FBM207c). Associated termination assemblies (TAs) support discrete input signals at voltages of 60 V dc, 120 V ac/125 V dc, or 240 V ac. For voltages higher than 60 V dc, the TAs have additional signal conditioning hardware that provides voltage attenuation and optical isolation.

The module is available in three distinct types, and each type with its associated TA supports discrete inputs as shown below:

FBM207	Provides voltage monitoring at: –60 V dc –120 V ac/125 V dc –240 V ac Provides switch inputs with: –External 120 V ac/125 V dc –External 240 V ac
FBM207b	24 V dc Contact Sense
FBM207c	48 V dc Contact Sense

Each discrete input is galvanically isolated from other channels and ground. Group isolated when used with external excitation.

The module performs signal conversion required to interface electrical input signals from field sensors to the redundant module Fieldbus. In addition, it executes programs for Discrete Input, Ladder Logic, Pulse Count, and Sequence of Events, with configurable options of Input Filter Time.

The module can be used as a single unit, or as a redundant pair (two FBM207s). When used as a redundant pair, the modules combine to provide redundancy at the Fieldbus Module (FBM) level, with field input signals received from one common termination assembly though a redundant adapter affixed to the FBMs' baseplate. The input current for redundant modules is doubled. A redundant digital input block in the control software validates each input in conjunction with information to/from the module, and selects the input with the highest quality for processing in the control strategy.

In a redundant configuration, contact sense power from each module is diode OR'd together in the redundant adapter to assure redundant power.

A redundant contact input function block, CINR, is used for each redundant pair of inputs. The CINR block handles input reads and initialization logic for the redundant channels. On each execution cycle of the CINR block, identical reads are sent to both modules, fully exercising the fieldbus and the logic circuitry of each module.

COMPACT DESIGN

FBM207/b/c has a compact design, with a rugged extruded aluminum exterior for physical protection of the circuits.

Enclosures specially designed for mounting the FBMs provide various levels of environmental protection, up to harsh environments (Class G3), per ISA Standard S71.04.

VISUAL INDICATORS

Light-emitting diodes (LEDs) incorporated into the front of the module provide visual indication of the Fieldbus Module operational status, as well as the discrete states of the individual input points.

EASY REMOVAL/REPLACEMENT

The module can be removed or replaced without removing field device termination cabling, power, or communication cabling.

When redundant, either module may be replaced without upsetting field input signals to the good module. The module can be removed/replaced without removing field device termination cabling, power, or communications cabling.

SEQUENCE OF EVENTS

The Sequence of Events (SOE) software package (for use with I/A Series v8.x or later software) is used for acquisition, storage, display, and reporting of events associated with digital input points in a control system. SOE, using the optional GPS based time synchronization capability, supports data acquisition across control processors at intervals of up to one millisecond, depending on the signal source.

Refer to PSS 21S-2B9 B4, *Sequence of Events* to learn more about this package, and to PSS 21H-4C2 B3, *Time Synchronization Equipment* for a description of the optional time synchronization capability.

I/A Series systems with software earlier than V8.x can support SOE through ECB6 and EVENT blocks. However, these systems do not support GPS time synchronization and use a timestamp sent by the Control Processor which is only accurate to the nearest second and is not synchronized between different Control Processors.

FIELDBUS COMMUNICATION

A Fieldbus Communications Module or a Control Processor interfaces to the redundant 2 Mbps module Fieldbus used by the FBMs. The FBM accepts communication from either path (A or B) of the 2 Mbps Fieldbus - should one path fail or be switched at the system level, the module continues communication over the active path.

MODULAR BASEPLATE MOUNTING

The module mounts on a DIN rail mounted baseplate, which accommodates up to four or eight Fieldbus Modules. The Modular Baseplate is either DIN rail mounted or rack mounted, and includes signal connectors for redundant module Fieldbus, redundant independent dc power, and termination cables.

Redundant modules must be located in odd and even adjacent positions on the baseplate (positions 1 and 2, 3 and 4, 5 and 6, or 7 and 8). To achieve the redundancy, a redundant adapter module is placed on the two adjacent baseplate termination cable connectors to provide a single termination cable connection. A single termination cable connects from the redundant adapter to the associated TA.

To system configurator applications and monitoring through SMON, System Manager, and SMDH, redundant modules appear to be separate, nonredundant modules. The functional redundancy for these modules is provided by their associated control blocks.

SECURITY

Field power, for contacts or solid-state switches, is current limited.

TERMINATION ASSEMBLIES

Field I/O signals connect to the FBM subsystem via DIN rail mounted TAs. The TAs used with the FBM207/b/c are described in “TERMINATION ASSEMBLIES AND CABLES” on page 8.

FUNCTIONAL SPECIFICATIONS

Communication
Communicates with its associated FCM or FCP via the redundant 2 Mbps module Fieldbus

Input
16 isolated and independent channels

Accuracy
Pulse Count
No missing pulses for pulse rate 0 to 250 Hz

Filter/Debounce Time[1]
Configurable (No Filtering, 4, 8, 16, or 32 ms)

Voltage Monitor Function - Input

INPUT
Logic One, On-State Voltage: 15 to 60 V dc
Logic Zero, Off-State Voltage: 0 to 5 V dc
Current: 1.4 mA (typical) at 5 to 60 V dc

SOURCE RESISTANCE LIMITS
Logic One, On-State: 1 k Ω (maximum) at 15 V dc
Logic Zero, Off-State: 100 k Ω (minimum) at 60 V dc

Contact Sensor Function - Input

RANGE (EACH CHANNEL)
Contact open (off) or closed (on)

OPEN-CIRCUIT VOLTAGE
FBM207b, 24 V dc ±15%; FBM207c, 48V dc ±15%

SHORT-CIRCUIT CURRENT
2.5 mA (maximum)

LOGIC ONE, ON-STATE RESISTANCE
1.0 k Ω (maximum)

LOGIC ZERO, OFF-STATE RESISTANCE
100 k Ω (minimum)

Isolation
Each channel is galvanically isolated from all other channels and earth (ground). The module withstands, without damage, a potential of 600 V ac applied for one minute between any channel and ground, or between a given channel and any other channel.

CAUTION

This does not imply that these channels are intended for permanent connection to voltages of these levels. Exceeding the limits for input voltages, as stated elsewhere in this specification, violates electrical safety codes and may expose users to electric shock.

Power Requirements

INPUT VOLTAGE RANGE (REDUNDANT)
24 V dc +5%, -10%

CONSUMPTION (MAXIMUM)
FBM207, 3 W; FBM207b, 4 W; FBM207c, 5 W

HEAT DISSIPATION (MAXIMUM)
FBM207, 5.5 W; FBM207b, 4 W; FBM207c, 5 W

Loop Power Supply Protection
Current limited at 2.5 mA

Field Terminations Functional Specifications
Refer to “TERMINATION ASSEMBLIES AND CABLES” on page 8.

Calibration Requirements
Calibration of the module and termination assembly is not required.

(1) Digital filtering available for 200 Series FBM or competitive migration modules with version 1.25H or later firmware.

FUNCTIONAL SPECIFICATIONS (CONTINUED)

Regulatory Compliance

ELECTROMAGNETIC COMPATIBILITY (EMC)

European EMC Directive 89/336/EEC
Meets: EN 50081-2 Emission standard
EN 50082-2 Immunity standard
EN 61326 Annex A (Industrial Levels)

CISPR 11, Industrial Scientific and Medical (ISM) Radio-frequency Equipment - Electromagnetic Disturbance Characteristics - Limits and Methods of Measurement
Meets: Class A Limits

IEC 61000-4-2 ESD Immunity
Contact 4 kV, air 8 kV

IEC 61000-4-3 Radiated Field Immunity
10 V/m at 80 to 1000 MHz

IEC 61000-4-4 Electrical Fast Transient/Burst Immunity
2 kV on I/O, V dc power and communication lines

IEC 61000-4-5 Surge Immunity
2kV on ac and dc power lines; 1kV on I/O and communications lines

IEC 61000-4-6 Immunity to Conducted Disturbances induced by Radio-frequency Fields
10 V (rms) at 150 kHz to 80 MHz on I/O, V dc power and communication lines

IEC 61000-4-8 Power Frequency Magnetic Field Immunity
30 A/m at 50 and 60 Hz

Product Safety - Low Voltage Inputs

UNDERWRITERS LABORATORIES (UL) FOR U.S. AND CANADA

UL/UL-C listed as suitable for use in UL/UL-C listed Class I, Groups A-D; Division 2; temperature code T4 enclosure based systems. These modules are also UL and UL-C listed as associated apparatus for supplying non-incendive communication circuits for Class I, Groups A-D hazardous locations when connected to specified I/A Series® processor modules as described in the *I/A Series DIN Rail Mounted Subsystem User's Guide* (B0400FA). Communications circuits also meet the requirements for Class 2 as defined in Article 725 of the National Electrical Code (NFPA No.70) and Section 16 of the Canadian Electrical Code (CSA C22.1). Conditions for use are as specified in the *I/A Series DIN Rail Mounted Subsystem User's Guide* (B0400FA).

EUROPEAN LOW VOLTAGE DIRECTIVE 73/23/EEC AND EXPLOSIVE ATMOSPHERES (ATEX) DIRECTIVE 94/9/EC

CENELEC (DEMKO) certified as EEx nA IIC T4 for use in CENELEC certified Zone 2 enclosure certified as associated apparatus for supplying non-incendive field circuits for Zone 2, Group IIC, potentially explosive atmospheres when connected to specified I/A Series processor modules as described in the *I/A Series DIN Rail Mounted Subsystem User's Guide* (B0400FA).

Product Safety - Termination Assemblies with High Voltage Inputs

UNDERWRITERS LABORATORIES (UL) FOR U.S. AND CANADA

UL/UL-C listed as suitable for use in ordinary locations and compliant with UL 3121, First Edition, and Canadian Standard, C22.2 No.1010.1-92 when connected to specified I/A Series processor modules as described in the *I/A Series DIN Rail Mounted Subsystem User's Guide* (B0400FA).

EUROPEAN LOW VOLTAGE DIRECTIVE 73/23/EEC

Certified for use in ordinary locations and compliant with IEC 61010 when connected to specified I/A Series processor modules as described in the *I/A Series DIN Rail Mounted Subsystem User's Guide* (B0400FA).

ENVIRONMENTAL SPECIFICATIONS(2)

Operating Conditions

TEMPERATURE

FBM207/b/c

-20 to + 70°C (-4 to +158°F)

Termination Assembly

PVC

-20 to +50°C (-4 to +122°F)

PA

-20 to +70°C (-4 to +158°F)

RELATIVE HUMIDITY

5 to 95% (noncondensing)

Storage Conditions

TEMPERATURE

-40 to +70°C (-40 to +158°F)

RELATIVE HUMIDITY

-5 to 95% (noncondensing)

Contamination

Suitable for use in Class G3 (Harsh) environments as defined in ISA Standard S71.04, based on exposure testing according to EIA Standard 364-65, Class III.

Vibration

7.5 m/s^2 from 5 to 500 Hz

(2) The environment ranges can be extended by the type of enclosure containing the module. [Refer to the Product Specification Sheet (PSS) applicable to the enclosure that is to be used.]

FBM214 HART® Communication Input Interface Module

The FBM214 HART® Communication Input Interface Module provides eight input channels, each accepting a 4 to 20mA analog signal or a digital HART signal superimposed on a 4 to 20 mA analog input signal.

FEATURES

Key features of the FBM214 module are:

- Eight analog input channels, each accepting one of the following inputs:
  - Standard 4 to 20 mA analog sensor signal
  - Digital HART Frequency Shift Keying (FSK) signal superimposed on a 4 to 20 mA analog input signal.
- FSK modem dedicated to each input channel for bi-directional digital communications with a HART field device
- Analog to digital conversion of each of the 4 to 20 mA input signals from the HART devices
- Support for the HART universal commands necessary to interface the field device with the I/A Series® system database
- Galvanic isolation of the group of 8 input channels from ground and module logic
- Compact, rugged design suitable for enclosure in Class G3 (harsh) environments
- High accuracy achieved by sigma-delta data conversions for each channel
- Termination Assemblies (TAs) for locally or remotely connecting field wiring to the FBM214
- Termination Assemblies for per channel internally and/or externally loop powered transmitters.

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed.
5 Cancelled / Superseded

Document Status: 4
Reviewer Name: H. MONTERO
Date: 28/MAR/2012
Discipline: EJ - Control Systems
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-JD01-00045
Subm 001
Equip #
Program #
Job #
VP #
SEQ #
Equip #

FOXBORO®

OVERVIEW

The FBM214 HART Communication Input Interface Module contains eight 4 to 20 mA group isolated analog input channels. The FBM214 supports any mix of standard 4 to 20 mA devices and HART devices.

The FBM214 serves as a HART communications field device host, enabling the I/A Series system to request and receive two digital messages per second from the field device. The message pass-through capability can be used to support HART universal, common practice, and device-specific commands, but not the burst communication mode. These commands are implemented using the Intelligent Field Device Configurator (IFDC — refer to PSS 21S-8A3 B3 for details).

The FBM214 provides a common isolated power supply to power all eight channels. Optionally, the channels can be powered by an external power supply. However, when a common external power supply is used with two or more channels, a Cable Balun module is required to prevent channel cross talk.

COMPACT DESIGN

The FBM214 has a compact design, with a rugged extruded aluminum exterior for physical protection of the circuits. Enclosures specially designed for mounting the FBMs provide various levels of environmental protection, up to harsh environments per ISA Standard S71.04.

HIGH ACCURACY

For high accuracy, the module incorporates a Sigma-Delta converter which can provide new analog input values for each channel every 100 milliseconds.

VISUAL INDICATORS

Light-emitting diodes (LEDs) incorporated into the front of the module provide visual indication of the module's operational status, and communication activity on the channels.

EASY REMOVAL/REPLACEMENT

The module can be removed/replaced without removing field device termination cabling, power, or communications cabling.

FIELDBUS COMMUNICATION

A Fieldbus Communication Module or a Control Processor interfaces the redundant 2 Mbps module Fieldbus used by the FBMs. The FBM214 module accepts communication from either path (A or B) of the redundant 2 Mbps fieldbus – should one path fail or be switched at the system level, the module continues communication over the active path.

The use of an external power supply common to two or more loops requires a Cable Balun Module to maintain communication signal line balance.

MODULAR BASEPLATE MOUNTING

The module mounts on a modular baseplate which accommodates up to four or eight FBMs. The modular baseplate is either DIN rail mounted or rack mounted, and includes signal connectors for redundant fieldbus, redundant independent dc power, and termination cables.

TERMINATION ASSEMBLIES

Field input signals connect to the FBM subsystem via DIN rail mounted TAs. The TAs used with the FBM214 are described in "TERMINATION ASSEMBLIES AND CABLES" on page 8.

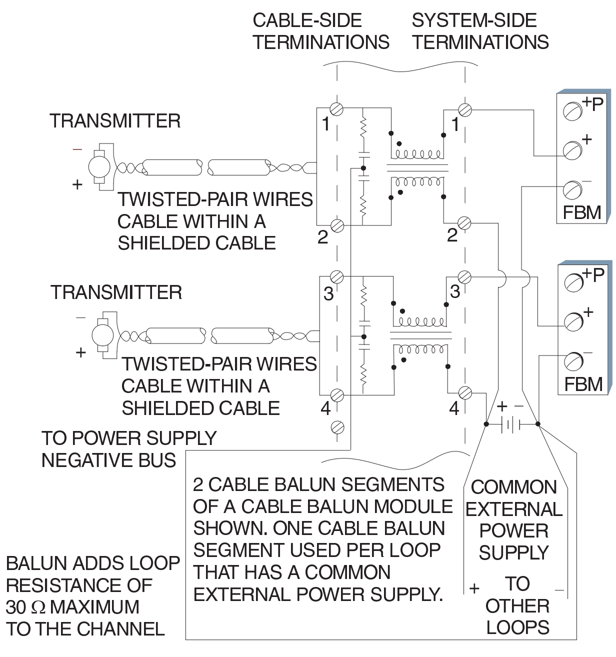
CABLE BALUN MODULE

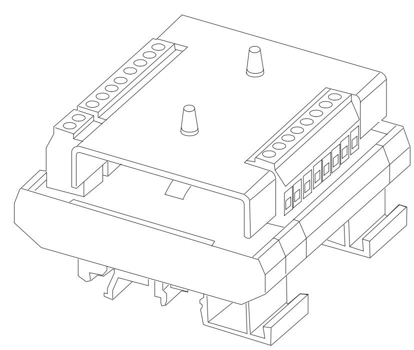
The Cable Balun module is used to maintain digital communication line balance for HART Transmitter to FBM loops that are powered from a common external power supply. This powering effectively connects one line of each loop together. Without the Baluns, in each loop so powered, the common connection at the external power supply, would cause near end crosstalk at the system end of the loop wiring cable. Loops using FBM internal power source do not require Baluns.

The Cable Balun module contains multiple Baluns. One Balun segment is interconnected in each loop powered from an external power supply per the diagram above. There is one Cable Balun module.

Cable Balun Module

Module Model	Module Part No.	No. of Baluns in the Module
CBM-4	P0903SV	4





CABLE BALUN MODULE

Figure 1. Cable Balun Module

FUNCTIONAL SPECIFICATIONS

Field Device Channels

VERSION SUPPORTED
HART Protocol v6

INTERFACE
8 group-isolated channels

COMMUNICATION TO THE DEVICE
Point-to-point, master/slave, asynchronous, half-duplex, at 1200 baud.

ERROR CHECKING
Parity on each byte, and one CRC check byte.

SPEED
2 messages per second

FASTEST ALLOWED ECB BLOCK PERIOD
500 msec

MAXIMUM DISTANCE (FBM214 TO FIELD DEVICE)
Meets HART FSK physical layer specification HCF_SPEC-54, Revision 8.1 [up to 3030 m (10000 ft)](1).

COMPLIANCE VOLTAGE
18 V dc minimum at 20.5 mA

CURRENT INPUTS

Sense Resistor
61.9 Ω nominal

Total Input Resistance
280 Ω minimum

Accuracy (Includes Nonlinearity)
±0.03% of full scale

Temperature Coefficient
50 ppm/ºC

Resolution
15 bits

Update Rate
100 ms

Integration Time
500 ms

Common Mode Rejection
>100 db at 50 or 60 Hz

Normal Mode Rejection
>35 db at 50 or 60 Hz

MAXIMUM LOOP RESISTANCE
280 Ω (not including the field device)(2)

LOOP POWER SUPPLY PROTECTION
Each channel is galvanically group isolated, current limited and voltage regulated. All inputs are limited by their design to less than 30 mA. If the current limit circuit shorts out, the current is limited to about 85 mA.

FBM INPUT IMPEDANCE
280 Ω minimum

FBM INTERNAL POWER FOR FIELD DEVICE
24 V dc ±10% common power supply for all channels. Loop load limited to one device per channel.

ISOLATION
The channels are not galvanically isolated from each other, but are galvanically isolated (both optical and transformer isolation) as a group from ground and module logic. Inputs use an internal FBM isolated power supply for field power. The module withstands, without damage, a potential of 600 V ac applied for one minute between the group-isolated channels and earth (ground).

CAUTION

This does not imply that these channels are intended for permanent connection to voltages of these levels. Exceeding the limits for input voltages, as stated elsewhere in this specification, violates electrical safety codes and may expose users to electric shock.

Fieldbus Communication

Communicates with its associated FCM or FCP via the redundant 2 Mbps module Fieldbus

HEAT DISSIPATION
4 W (maximum)

(1) The maximum allowable distance decreases when the loop is operated through an intrinsic safety barrier. The maximum distance of the field device from the FBM is a function of compliance voltage, wire gauge and voltage drop at the device.
(2) In an intrinsic safety application, if a zener barrier is used between the FBM and the field device, the power supply must be set at 24V dc +5%, -1%. There are no specific constraints with the use of galvanic barriers.

FUNCTIONAL SPECIFICATIONS (CONTINUED)

Power Requirements

INPUT VOLTAGE RANGE (REDUNDANT)
24 V dc ±5%

CONSUMPTION
7 W (maximum)

Regulatory Compliance

ELECTROMAGNETIC COMPATIBILITY (EMC)

European EMC Directive 89/336/EEC
Meets: EN 50081-2 Emission standard
EN 50082-2 Immunity standard
EN 61326 Annex A (Industrial Levels)

CISPR 11, Industrial Scientific and Medical (ISM) Radio-frequency Equipment - Electromagnetic Disturbance Characteristics - Limits and Methods of Measurement
Meets Class A Limits

IEC 61000-4-2 ESD Immunity
Contact 4 kV, air 8 kV

IEC 61000-4-3 Radiated Field Immunity
10 V/m at 80 to 1000 MHz

IEC 61000-4-4 Electrical Fast Transient/Burst Immunity
2 kV on I/O, dc power and communication lines

IEC 61000-4-5 Surge Immunity
2kV on ac and dc power lines; 1kV on I/O and communications lines

IEC 61000-4-6 Immunity to Conducted Disturbances Induced by Radio frequency Fields
10 V (rms) at 150 kHz to 80 MHz on I/O, dc power and communication lines

IEC 61000-4-8 Power Frequency Magnetic Field Immunity
30 A/m at 50 and 60 Hz

PRODUCT SAFETY (FBM AND CABLE BALUN)

Underwriters Laboratories (UL) for U.S. and Canada
UL/UL-C listed as suitable for use in UL/UL-C listed Class I, Groups A-D; Division 2; temperature code T4 enclosure based systems. These modules are also UL and UL-C listed as associated apparatus for supplying non-incendive communication circuits for Class I, Groups A-D hazardous locations when connected to specified I/A Series® processor modules as described in the *I/A Series DIN Rail Mounted Subsystem User's Guide* (B0400FA). Where power is supplied by the FBM, communications circuits also meet the requirements for Class 2 as defined in Article 725 of the National Electrical Code (NFPA No.70) and Section 16 of the Canadian Electrical Code (CSA C22.1). Conditions for use are as specified in the *I/A Series DIN Rail Mounted Subsystem User's Guide* (B0400FA).

European Low Voltage Directive 73/23/EEC and Explosive Atmospheres (ATEX) directive 94/9/EC
CENELEC (DEMKO) certified as EEx nA IIC T4 for use in CENELEC certified Zone 2 enclosure certified as associated apparatus for supplying non-incendive field circuits for Zone 2, Group IIC, potentially explosive atmospheres when connected to specified I/A Series processor modules as described in the *I/A Series DIN Rail Mounted Subsystem User's Guide* (B0400FA). Also, see Table 1 on page 9.

Calibration Requirements

Calibration of the module or termination assembly is not required.

ENVIRONMENTAL SPECIFICATIONS(3)

Operating

TEMPERATURE

Module

-20 to +70℃ (-4 to +158℉)

Termination Assembly

PVC

-20 to +50°C (-4 to +122°F)

PA

-20 to +70℃ (-4 to +158℉)

RELATIVE HUMIDITY

5 to 95% (noncondensing)

ALTITUDE

-300 to +3,000 m (-1,000 to +10,000 ft)

Storage

TEMPERATURE

-40 to +70℃ (-40 to +158℉)

RELATIVE HUMIDITY

5 to 95% (noncondensing)

ALTITUDE

-300 to +12,000 m (-1,000 to +40,000 ft)

Contamination

Suitable for use in Class G3 (Harsh) environments as defined in ISA Standard S71.04, based on exposure testing according to EIA Standard 364-65, Class III.

Vibration

7.5 m/S^2 (0.75 g) from 5 to 500 Hz

(3) The environmental limits of this module may be enhanced by the type of enclosure containing the module. Refer to the applicable Product Specification Sheet (PSS) which describes the specific type of enclosure that is to be used.

FBM215 HART® Communication Output Interface Module

The FBM215 HART® Communication Output Interface Module offers eight output channels, each providing a 4 to 20mA output signal or a digital HART signal superimposed on a 4 to 20 mA analog output signal.

FEATURES

Key features of the FBM215 module are:

- Eight channel-isolated output channels, each providing one of the following outputs:
  - Standard 4 to 20 mA analog output signal
  - Digital HART Frequency Shift Keying (FSK) signal superimposed on a 4 to 20 mA analog output signal.
- FSK modem dedicated to each output channel for bi-directional digital communications with a HART field device
- Galvanic isolation of all output channels from each other, and from ground and module logic
- Support for HART universal commands necessary to interface the field device with the I/A Series® system database
- Compact, rugged design suitable for enclosure in Class G3 (harsh) environments
- Termination Assemblies (TAs) for locally or remotely connecting field wiring to the FBM215.

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analyses, test methods or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4
Reviewer Name: H. MONTERO
Date: 28/MAR/2012
Discipline: EJ - Control Systems
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-JD01-00046
Subm 001
Equip #
Program #
Job #
VP #
SEQ #
Equip #

FOXBORO®

OVERVIEW

The HART Communication Output Interface Module (FBM215) contains eight channel-isolated output channels. The FBM215 supports any mix of standard 4 to 20 mA devices and HART devices.

The FBM215 serves as a HART communications field device host, enabling the I/A Series system to request and receive two digital messages per second from each field device. The message pass-through capability can be used to support HART universal, common practice, and device-specific commands, but not the burst communication mode. These commands are implemented using the Intelligent Field Device Configurator (IFDC — refer to PSS 21S-8A3 B3 for details).

The module provides an isolated power supply for each channel.

COMPACT DESIGN

The FBM215 has a compact design, with a rugged extruded aluminum exterior for physical protection of the circuits. Enclosures specially designed for mounting the FBMs provide various levels of environmental protection, up to harsh environments per ISA Standard S71.04.

VISUAL INDICATORS

Light-emitting diodes (LEDs) incorporated into the front of the module provide visual indication of the module's operational status, and communication activity of the channels.

EASY REMOVAL/REPLACEMENT

The module can be removed/replaced without removing field device termination cabling, power, or communications cabling.

FIELDBUS COMMUNICATION

A Fieldbus Communication Module or a Control Processor interfaces the redundant 2 Mbps module Fieldbus used by the FBMs. The FBM215 module accepts communication from either path (A or B) of the redundant 2 Mbps fieldbus – should one path fail or be switched at the system level, the module continues communication over the active path.

MODULAR BASEPLATE MOUNTING

The module mounts on a modular baseplate, which accommodates up to four or eight FBMs. The modular baseplate is either DIN rail mounted or rack mounted, and includes signal connectors for redundant fieldbus, redundant independent dc power, and termination cables.

TERMINATION ASSEMBLIES

Field output signals connect to the FBM subsystem via DIN rail mounted TAs. The TAs used with the FBM215 are described in "TERMINATION ASSEMBLIES AND CABLES" on page 7.

FUNCTIONAL SPECIFICATIONS

Field Device Channels

VERSION SUPPORTED
HART Protocol v6

INTERFACE
8 isolated output channels

COMMUNICATIONS TO THE DEVICE
Point-to-point, master/slave, asynchronous, half-duplex, at 1200 baud

ERROR CHECKING
Parity on each byte, and one CRC check byte on each message

SPEED
2 messages per second

FASTEST ALLOWED ECB BLOCK PERIOD
500 msec

MAXIMUM DISTANCE (FBM215 TO FIELD DEVICE)
Meets HART FSK physical layer specification HCF_SPEC-54, Revision 8.1 [up to 3030 m (10000 ft)](1)

CURRENT OUTPUTS

Analog Accuracy (Includes Linearity)
±0.05% of span (between 4 mA and 20 mA)

Output Load
750 Ω maximum

Maximum Rate of Change
20 mA in 60 milliseconds

Resolution
13 bits

LOOP POWER SUPPLY PROTECTION
Each channel is channel-to-channel galvanically isolated, current limited, and voltage regulated. All analog outputs are limited by their design to about 25 mA. If the output FET shorts, the output current could increase up to 100 mA. In normal operation the FBM outputs a constant current into a 0 to 750 ohm load.

ISOLATION
The channels are galvanically isolated (both optical and transformer isolation) from each other, and from ground and module logic. The module withstands, without damage, a potential of 600 V ac applied for one minute between the isolated channels and earth (ground).

CAUTION

This does not imply that these channels are intended for permanent connection to voltages of these levels. Exceeding the limits for input voltages, as stated elsewhere in this specification, violates electrical safety codes and may expose users to electric shock.

Fieldbus Communication

Communicates with its associated FCM or FCP via the redundant 2 Mbps module Fieldbus

Power Requirements

INPUT VOLTAGE RANGE (REDUNDANT)
24 V dc ±5%

CONSUMPTION
7 W (maximum)

HEAT DISSIPATION
5 W (maximum)

Calibration Requirements

Calibration of the module and termination assembly is not required.

(1) The maximum allowable distance decreases when the loop is operated through an intrinsic safety barrier. The maximum distance of the field device from the FBM is a function of compliance voltage (19 V dc at 20.4 mA), wire and load resistance, and voltage drop at the field device.

FUNCTIONAL SPECIFICATIONS (CONTINUED)

Regulatory Compliance

ELECTROMAGNETIC COMPATIBILITY (EMC)

European EMC Directive 89/336/EEC
Meets: EN 50081-2 Emission standard
EN 50082-2 Immunity standard
EN 61326 Annex A (Industrial Levels)

CISPR 11, Industrial Scientific and Medical (ISM) Radio-frequency Equipment - Electromagnetic Disturbance Characteristics - Limits and Methods of Measurement
Meets Class A Limits

IEC 61000-4-2 ESD Immunity
Contact 4 kV, air 8 kV

IEC 61000-4-3 Radiated Field Immunity
10 V/m at 80 to 1000 MHz

IEC 61000-4-4 Electrical Fast Transient/Burst Immunity
2 kV on I/O, dc power and communication lines

IEC 61000-4-5 Surge Immunity
2kV on ac and dc power lines; 1kV on I/O and communications lines

IEC 61000-4-6 Immunity to Conducted Disturbances Induced by Radio frequency Fields
10 V (rms) at 150 kHz to 80 MHz on I/O, dc power and communication lines

IEC 61000-4-8 Power Frequency Magnetic Field Immunity
30 A/m at 50 and 60 Hz

PRODUCT SAFETY

Underwriters Laboratories (UL) for U.S. and Canada
UL/UL-C listed as suitable for use in UL/UL-C listed Class I, Groups A-D; Division 2; temperature code T4 enclosure based systems. These modules are also UL and UL-C listed as associated apparatus for supplying non-incendive communication circuits for Class I, Groups A-D hazardous locations when connected to specified I/A Series® processor modules as described in the *I/A Series DIN Rail Mounted Subsystem User's Guide* (B0400FA). Communications circuits also meet the requirements for Class 2 as defined in Article 725 of the National Electrical Code (NFPA No.70) and Section 16 of the Canadian Electrical Code (CSA C22.1). Conditions for use are as specified in the *I/A Series DIN Rail Mounted Subsystem User's Guide* (B0400FA).

European Low Voltage Directive 73/23/EEC and Explosive Atmospheres (ATEX) directive 94/9/EC
CENELEC (DEMKO) certified as EEx nA IIC T4 for use in CENELEC certified Zone 2 enclosure certified as associated apparatus for supplying non-incendive field circuits for Zone 2, Group IIC, potentially explosive atmospheres when connected to specified I/A Series processor modules as described in the I/A Series DIN Rail Mounted Subsystem User's Guide (B0400FA). Also, see Table 1 on page 8.

ENVIRONMENTAL SPECIFICATIONS(2)

Operating

TEMPERATURE

Module

-20 to +70°C (-4 to +158°F)

Termination Assembly

PVC

-20 to +50°C (-4 to +122°F)

RELATIVE HUMIDITY

5 to 95% (noncondensing)

ALTITUDE

-300 to +3,000 m (-1,000 to +10,000 ft)

Storage

TEMPERATURE

-40 to +70°C (-40 to +158°F)

RELATIVE HUMIDITY

5 to 95% (noncondensing)

ALTITUDE

-300 to +12,000 m (-1,000 to +40,000 ft)

Contamination

Suitable for use in Class G3 (Harsh) environments as defined in ISA Standard S71.04, based on exposure testing according to EIA Standard 364-65, Class III.

Vibration

7.5 m/S^2 (0.75 g) from 5 to 500 Hz

(2) The environmental limits of this module may be enhanced by the type of enclosure containing the module. Refer to the applicable Product Specification Sheet (PSS) which describes the specific type of enclosure that is to be used.

PHYSICAL SPECIFICATIONS

Mounting

MODULE
The FBM215 mounts on a modular baseplate. The baseplate can be mounted on a DIN rail (horizontally or vertically), or horizontally on a 19-inch rack using a mounting kit. Refer to PSS 21H-2W6 B4 for details.

TERMINATION ASSEMBLY
The TA mounts on a DIN rail and accommodates multiple DIN rail styles including 32 mm (1.26 in) and 35 mm 1.38 in).

Mass

MODULE
284 g (10 oz) approximate

TERMINATION ASSEMBLY

Compression
181 g (0.40 lb) approximate

Ring Lug
249 g (0.55 lb) approximate

Dimensions – Module

HEIGHT
102 mm (4 in)
114 mm (4.5 in) including mounting lugs

WIDTH
45 mm (1.75 in)

DEPTH
104 mm (4.11 in)

Dimensions – Termination Assembly

See page 9.

Part Numbers

FBM215 MODULE
P0922VU

TERMINATION ASSEMBLIES
See “FUNCTIONAL SPECIFICATIONS – TERMINATION ASSEMBLIES” on page 7.

Termination Cables

CABLE LENGTHS
Up to 30 m (98 ft)

CABLE MATERIALS
Polyurethane or Hypalon®/XLP

TERMINATION CABLE TYPE
Types 1 – See Table 2 on page 8.

CABLE CONNECTION – TA
25-pin male D-subminiature

Construction – Termination Assembly

MATERIAL
Polyvinyl Chloride (PVC), compression PVC, ring lug

FAMILY GROUP COLOR
Green – communication

TERMINAL BLOCKS

Outputs
3 tiers, 8 positions

Field Termination Connections

COMPRESSION-TYPE ACCEPTED WIRING SIZES

Solid/Stranded/AWG
0.2 to 4 mm^2/0.2 to 2.5 mm^2/24 to 12 AWG

Stranded with Ferrules
0.2 to 2.5 mm^2 with or without plastic collar

RING-LUG TYPE ACCEPTED WIRING SIZES
#6 size connectors (0.375 in (9.5 mm))
0.5 to 4 mm^2/22 AWG to 12 AWG

FBM222, Redundant PROFIBUS Communication Interface Module

The FBM222 Redundant PROFIBUS Communication Interface Module provides a reliable, high-capacity interface between PROFIBUS-DP slave devices and the I/A Series® system.

FEATURES

Key features of the FBM222 are:

- Integrates PROFIBUS-DP/PA slave devices into the I/A Series control system
- Conforms to the PROFIBUS-DP Specification IEC61158 Part 3
- Supports up to 125 slave devices per port with full 244 byte data transfer
- Maximizes uptime by providing redundant TAs, hot-swappable redundant FBM modules, and fully redundant communication between the FBM222 and fault-tolerant control processors
- Enables addition, modification and removal of devices without impacting on-going operations
- Propagates the PROFIBUS-PA device values and status to I/A Series control blocks
- Provides a user-selectable status parameter for input data as well as read-back values for output data
- Supports PROFIBUS-DP Class 1 and Class 2 Masters along with multi-master configurations
- Provides two galvanically isolated PROFIBUS channels

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4
Reviewer Name: H. MONTERO Date: 28/MAR/2012
Discipline: EJ - Control Systems Doc Type Code: V1A
Job # 25580-220 VP # 25580-220-V1A-JD01-00048
Subm 001 Equip #
Program #
Job # VP #
SEQ # Equip #

FOXBORO

FUNCTIONAL SPECIFICATIONS

PROFIBUS-DP Communications

INTERFACE

2 communication channels provide interface to 2 galvanically isolated PROFIBUS-DP networks

BUS CHARACTERISTICS

General
Electronic Industrial Association (EIA) RS-485 communications. The physical communication medium consists of twisted-pair shielded copper cable containing a single conductor pair.

Data Transfer Rate (Baud Rate)
Selectable, 9.6 to 12,000 kbit/sec (see Table 1)

Maximum Allowable Bus Length
The maximum allowable length of a PROFIBUS-DP bus segment is a function of the user selected data transfer rate as listed in Table 1 on page 4

Maximum Cable Length, FBM222 to TA
30 m (90 ft) which is not included when determining the bus segment length

Maximum Number of Devices on a Bus
Per EN 50170, for a non-expanded bus (repeaters not used), one master (FBM222) and up to 31 slaves are supported. When repeaters are used, the FBM222 supports 125 devices per port.

FBM222 channel isolation

Each communication channel is galvanically isolated and referenced to earth (ground). The module can withstand, without damage, a potential of 600 V ac applied for one minute between either channel and earth.

CAUTION

This does not imply that the channels are intended for permanent connection to voltages of these levels. Exceeding the limits for input voltages, as stated elsewhere in this specification, violates electrical safety codes and may expose users to electric shock.

Conformance to PROFIBUS-DP Standards

PROFIBUS-DP bus topologies and communications are in accordance with specifications presented in the following standards:

- PROFIBUS Fieldbus standard EN 50170
- EIA standard RS-485.

FBM222 Power Requirements

INPUT VOLTAGE RANGE (REDUNDANT)
24 V dc +5%, -10%

CONSUMPTION
6 W (maximum)

HEAT DISSIPATION
6 W (maximum)

Regulatory Compliance

ELECTROMAGNETIC COMPATIBILITY (EMC)

European EMC Directive 89/336/EEC
Meets: EN 50081-2 Emission standard
EN 50082-2 Immunity standard
EN 61326 Annex A (Industrial Levels)

CISPR 11, Industrial Scientific and Medical (ISM) Radio-frequency Equipment - Electromagnetic Disturbance Characteristics - Limits and Methods of Measurement
Meets: Class A Limits

IEC 61000-4-2 ESD Immunity
Contact 4 kV, air 8 kV

IEC 61000-4-3 Radiated Field Immunity
10 V/m at 80 to 1000 MHz

IEC 61000-4-4 Electrical Fast Transient/Burst Immunity
2 kV on I/O, dc power and communication lines

IEC 61000-4-5 Surge Immunity
2 kV on ac and dc power lines;1 kV on I/O and communication lines

IEC 61000-4-6 Immunity to Conducted Disturbances Induced by Radio-frequency Fields
10 V (rms) at 150 kHz to 80 MHz on I/O, dc power and communication lines

IEC 61000-4-8 Power Frequency Magnetic Field Immunity
30 A/m at 50 and 60 Hz

IEC 61000-4-11 Voltage Dips, Short Interruptions and Voltage Variations Immunity
Compliant

PRODUCT SAFETY

Underwriters Laboratories (UL) for U.S. and Canada
UL/UL-C listed as suitable for use in UL/UL-C listed Class I, Groups A-D; Division 2; temperature code T4 enclosure based systems.
These modules are also UL and UL-C listed as associated apparatus for supplying non-incendive communication circuits for Class I, Groups A-D hazardous locations when connected to specified I/A Series processor modules as described in *InFusion™ Enterprise Control System: Implementing PROFIBUS-DP Networks* (B0750BE). Communications circuits also meet the requirements for Class 2 as defined in Article 725 of the National Electrical Code (NFPA No.70) and Section 16 of the Canadian Electrical Code (CSA C22.1). Conditions for use are as specified in *InFusion™ Enterprise Control System: Implementing PROFIBUS-DP Networks* (B0750BE).

European Low Voltage Directive 73/23/EEC and Explosive Atmospheres (ATEX) Directive 94/9/EC
CENELEC (DEMKO) certified as EEx nA IIC T4 for use in CENELEC certified Zone 2 enclosure certified as associated apparatus for supplying non-incendive field circuits for Zone 2, Group IIC, potentially explosive atmospheres when connected to specified I/A Series processor modules as described in the *I/A Series DIN Rail Mounted Subsystem User's Guide* (B0400FA).

Calibration Requirements

Calibration of the module and termination assembly is not required.

ENVIRONMENTAL SPECIFICATIONS(1)

Operating

TEMPERATURE

FBM222
-20 to +70°C (-4 to +158°F)

Termination Assembly
-20 to +50°C (-4 to +122°F)

RELATIVE HUMIDITY
5 to 95% (noncondensing)

ALTITUDE
-300 to +3,000 m (-1,000 to +10,000 ft)

Storage

TEMPERATURE
-40 to +70°C (-40 to +158°F)

RELATIVE HUMIDITY
5 to 95% (noncondensing)

Contamination

Suitable for use in Class G3 (Harsh) environments as defined in ISA Standard S71.04, based on exposure testing according to EIA Standard 364-65, Class III.

Vibration

7.5 m/S^2 (0.75 g) from 5 to 500 Hz

(1) The environmental limits of this module may be enhanced by the type of enclosure containing the module. Refer to the applicable Product Specification Sheet (PSS) which describes the specific type of enclosure that is to be used.

PHYSICAL SPECIFICATIONS

Mounting

MODULE
The FBM222 mounts on a Modular Baseplate. The Modular Baseplate can be mounted horizontally or vertically on a DIN rail, or mounted horizontally in a 19-inch rack using a mounting kit. Refer to *DIN Rail Mounted Modular Baseplates* (PSS 21H-2W6 B4) for details.

TERMINATION ASSEMBLY
The TA accommodates multiple DIN styles including 32 mm (1.26) and 35 mm (1.38 in) rails.

Mass

MODULE
284 g (10 oz) approximate (each module)

Dimensions

MODULE

HEIGHT
102 mm (4 in)
114 mm (4.5 in) including mounting lugs

WIDTH
45 mm (1.75 in)

DEPTH
104 mm (4.11 in)

TERMINATION ASSEMBLY
See page 11

Part Numbers

FBM222 MODULE
P0926TL

FBM228/FBM222 REDUNDANT ADAPTER
P0922RK

FBM222 REDUNDANT ADAPTER — DUAL NETWORK
P0926XM

TERMINATION ASSEMBLY
P0926TH (PVC)
P0926TJ (Polyamide)

Indicators (mounted on front of each module)

OPERATIONAL STATUS
Red and green light-emitting diodes (LEDs)

MODULE ROLE IN REDUNDANT PAIR
2 amber LEDs to indicate the module's role in a redundant pair, either Master or Tracker

CHANNEL COMMUNICATION ACTIVITY
2 amber LEDs, one per port

Termination Cables

CABLE LENGTHS
Up to 30 m (98 ft)

CABLE MATERIALS
Polyurethane or Hypalon XLP

TERMINATION CABLE TYPE
Type 1 - Refer to Table 2 on page 7

CABLE CONNECTION

Termination Assembly
25-pin male D-subminiature

Modular Baseplate
37-pin male D-subminiature

Termination Assembly Construction Material

MATERIAL
Polypropylene (PVC) Material (P0926TH)
Polyamide (P0926TJ)

FAMILY GROUP COLOR
Green - communication

I/A Series® HARDWARE

Product Specifications

IPS
INVENSYS PROCESS SYSTEMS

PSS 21H-2Z32 B4

FBM232 Field Device System Integrator Module, 10/100 Mbps Ethernet, Single

The FBM232 Field Device System Integrator (FDSI) module provides a single Ethernet interface between single-ported field I/O devices and the I/A Series® system.

FEATURES

Key features of the FBM232 are:

- 10 Mbps or 100 Mbps Ethernet network transmission rate to/from field device
- Communicates with up to 64 field devices
- I/O software driver is downloadable from a library of available protocols
- Up to 2000 DCI block connections
- Integrates field device data into an I/A Series control database using Ethernet connectivity
- Field mounted
- Class G3 (harsh) environments.

OVERVIEW

The FBM232 connects to a single 10 Mbps or 100 Mbps copper Ethernet network to communicate with devices. The FBM232 can be connected directly to a single field device or connected to Ethernet switches or hubs to communicate with up to 64 field devices.

The general network configuration is shown in Figure 1.

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4
Reviewer Name: H. MONTERO
Date: 28/MAR/2012
Discipline: EJ - Control Systems
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-JD01-00049
Subm 001
Equip #
Program #
Job #
VP #
SEQ #
Equip #

FOXBORO

ETHERNET LINK SETUP

Data communication between the FBM232 and field devices are through the RJ-45 connector located on the front of the FBM232 module. The RJ-45 connector of the FBM232 can be connected directly to the field device, through hubs, or through Ethernet switches to the field devices (refer to "ETHERNET HUBS AND SWITCHES" on page 8). Connection of multiple devices to the FBM232 requires a hub or switch. Connection of the FBM232 directly to a device may require a null hub adapter cable.

CONFIGURATOR

The FDSI configurator sets up the FBM232 XML based port and device configuration files. The port configurator allows for easy setup of the communication parameters for each port (such as, Dynamic Host Configuration Protocol (DHCP), IP addresses). The device configurator is not needed for all devices, but when needed it configures device specific and point specific considerations (such as, scan rate, address of the data to be transferred, and the amount of data to be transferred in one transaction).

OPERATIONS

The FBM232 can access up to 64 devices to read or write data. From the I/A Series control station to which the FBM232 is connected, up to 2000 Distributed Control Interface (DCI) data connections can be made to read or write data. Supported data types are determined by the particular driver loaded on the FBM232, which converts the data to the DCI data types listed below:

- An analog input or output value (integer or IEEE single-precision floating point)
- A single digital input or output value
- Multiple (packed) digital input or output values (packed in groups of up to 32 digital points per connection).

Thus an I/A Series control station can access up to 2000 analog I/O values, or up to 64000 digital I/O values, or a combination of digital and analog values using the FBM232. The frequency of access to the FBM232 data by a control station can be as fast as 500 ms. The performance is dependant on each device type and the layout of data in the device.

The FBM232 collects the required data from the devices, performs the necessary conversions, and then stores the converted data in its database for incorporation into the I/A Series plant management functions and operator displays. Data may also be written out to the individual devices from the I/A Series system.

FUNCTIONAL SPECIFICATIONS

Communications

BUS CHARACTERISTICS

Communication Type
Ethernet

Communication Transmission Rate
10 or 100 Mbps

Communication Protocol
UDP/IP or TCP/IP

IP Address
Fixed or DHCP

Note: For driver specific limitations on I/O Capacity and Data Types Transferred, refer to the corresponding driver PSS or User's Guide.

I/O CAPACITY
Up to 64 devices per FBM232 maximum (number of actual devices is performance dependent) with up to 2000 DCI connections.

DATA TYPES TRANSFERRED
2-byte or 4-byte signed or unsigned integers, 4-byte IEEE single-precision floating values, or binary values. Automatic conversion for other types as implemented in the downloadable driver.

FASTEST ALLOWED ECB BLOCK PERIOD
500 msec

MODULE FIELDBUS COMMUNICATION
Communicates with its associated FCM100Et, FCM100E or FCP270 via the redundant 2 Mbps module Fieldbus.

FBM232 Power Requirements

INPUT VOLTAGE RANGE (REDUNDANT)
24 V dc +5%, -10%

CONSUMPTION
7 W (maximum)

HEAT DISSIPATION
7 W (maximum)

FUNCTIONAL SPECIFICATIONS (CONTINUED)

Regulatory Compliance

ELECTROMAGNETIC COMPATIBILITY (EMC)

European EMC Directive 89/336/EEC
Meets: EN 50081-2 Emission standard
EN 50082-2 Immunity standard
EN 61326 Annex A for Industrial Environments

CISPR 11, Industrial Scientific and Medical (ISM) Radio-frequency Equipment - Electromagnetic Disturbance Characteristics - Limits and Methods of Measurement
Meets: Class A Limits

IEC 61000-4-2 ESD Immunity
Contact 4 kV, air 8 kV

IEC 61000-4-3 Radiated Field Immunity
10 V/m at 80 to 1000 MHz

IEC 61000-4-4 Electrical Fast Transient/Burst Immunity
2 kV on I/O, dc power and communication lines

IEC 61000-4-5 Surge Immunity
2kV on ac and dc power lines; 1kV on I/O and communications lines

IEC 61000-4-6 Immunity to Conducted Disturbances Induced by Radio-frequency Fields
10 V (rms) at 150 kHz to 80 MHz on I/O, dc power and communication lines

IEC 61000-4-8 Power Frequency Magnetic Field Immunity
30 A/m at 50 and 60 Hz

PRODUCT SAFETY

Underwriters Laboratories (UL) for U.S. and Canada
UL/UL-C listed as suitable for use in UL/UL-C listed Class I, Groups A-D; Division 2; temperature code T4 enclosure based systems. Communications circuits meet the requirements for Class 2 as defined in Article 725 of the National Electrical Code (NFPA No.70) and Section 16 of the Canadian Electrical Code (CSA C22.1). Conditions for use are as specified in the *I/A Series DIN Rail Mounted Subsystem User's Guide* (B0400FA).

European Low Voltage Directive 73/23/EEC and Explosive Atmospheres (ATEX) directive 94/9/EC
CENELEC (DEMKO) certified as EEx nA IIC T4 for use in CENELEC certified Zone 2 enclosure certified as associated apparatus for supplying non-incendive field circuits for Zone 2, Group IIC, potentially explosive atmospheres when connected to specified I/A Series processor modules as described in the *I/A Series DIN Rail Mounted Subsystem User's Guide* (B0400FA).

Calibration Requirements

Calibration of the module is not required.

ENVIRONMENTAL SPECIFICATIONS

Operating

TEMPERATURE
-20 to +70°C (-4 to +158°F)

RELATIVE HUMIDITY
5 to 95% (noncondensing)

Storage

TEMPERATURE
-40 to +70°C (-40 to +158°F)

RELATIVE HUMIDITY
5 to 95% (noncondensing)

Contamination

Suitable for use in Class G3 (Harsh) environments as defined in ISA Standard S71.04, based on exposure testing according to EIA Standard 364-65, Class III.

PHYSICAL SPECIFICATIONS

Mounting

The FBM232 mounts on a Modular Baseplate. The Modular Baseplate can be mounted horizontally or vertically on a DIN rail, or mounted horizontally in a 19-inch rack using a mounting kit. Refer to PSS 21H-2W6 B4 for details.

Mass

284 g (10 oz) approximate

Part Number

P0926GW

Dimensions

HEIGHT
102 mm (4 in)
114 mm (4.5 in) including mounting lugs

WIDTH
45 mm (1.75)

DEPTH
104 mm (4.11 in)

Cables

FROM MODULE TO HUB/SWITCH/DEVICE
1 m (3.3 ft) up to 100 m (330 ft)

CONNECTORS
RJ-45

NULL HUB ADAPTER CABLE
P0971PK

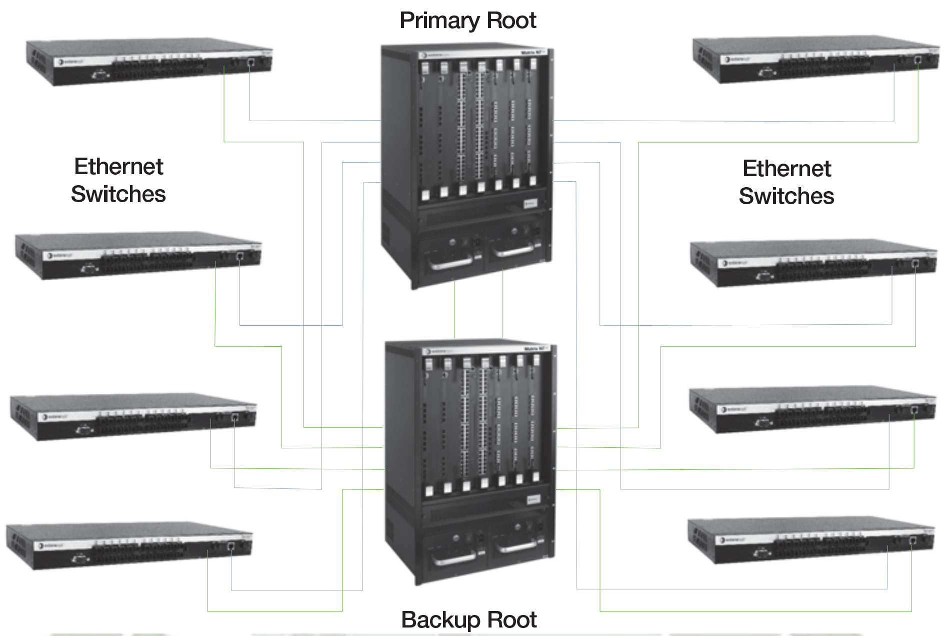
I/A Series® HARDWARE

Product Specifications

INVENSYS PROCESS SYSTEMS

PSS 21H-7C3 B4

The MESH Control Network Ethernet Equipment



The MESH control network utilizes Invensys qualified Ethernet equipment to allow you to configure your system to meet your functional, performance, and plant requirements.

FEATURES

- System scalability by interconnecting Ethernet switches, each having 8-ports or more in various increments
- Support for Fast Ethernet (100 Mbps) and Gigabit (uplink only) Ethernet (1000 Mbps)
- Modular uplinks to high-speed backbones using 1 Gb 1000Base-T, 1000Base-LX/SX, 1000Base-LX/LH and 1000Base-ZX/LH standards
- Full duplex operation based on the IEEE 802.3 standards
- Rapid Spanning Tree Protocol (RSTP), manages redundant paths, prevents loops, and provides high speed convergence time for a network
- System Management software for monitoring the health of the control system and managing equipment in the system
- Network management and configuration via local port

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4
Reviewer Name: H. MONTERO
Date: 28/MAR/2012
Discipline: EJ - Control Systems
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-JD01-00056
Subm 001
Equip #
Program #
Job #
VP #
SEQ #
Equip #

FOXBORO

24-PORT COPPER MANAGED SWITCH (P0973BH)

FEATURES

The 24-Port Copper managed switch features:

- 24-ports of 100Base-TX
- Two fixed RJ-45 10/100/1000 ports, configurable for uplink
- Two 1000Base-X uplink Gigabit (SFP) ports
- Full duplex operation
- Supports VLAN configurations
- Monitoring and configuration tasks via local console port, or any SNMP/RMON based management application.
- Port mirroring technology and diagnostics that allow local network traffic to be redirected to an external probe for detailed analysis
- Compliance with industry standards, including IEEE 802.3u Fast Ethernet, 802.1w Rapid Spanning Tree Protocol (RSTP)
- Optional redundant power supply
- Shelf, desk, or 19-inch rack mounting.

INTRODUCTION

The 24-Port Copper managed switch (P0973BH) provides twenty-four 100Base-TX ports with RJ-45 connectors, two fixed 10/100/1000 uplink ports and two 1000Base-X uplink Gigabit (SFP) ports. The two 1000Base-X uplink Gigabit (SFP) ports can be populated with MGBIC uplink connector modules (P0972WT, P0972WU, P0972YQ, P0972YL or P0973FT).

The switch allows high-performance, full-featured layer-2 Ethernet switching in small to medium-sized network applications, as well as high-performance direct end-station connectivity.

OPTIONAL REDUNDANT POWER SUPPLY

See “REDUNDANT POWER SUPPLY (P0973BP)” on page 20.

FUNCTIONAL SPECIFICATIONS

24-PORT COPPER MANAGED SWITCH (P0973BH)

Power

INTERNAL
ac Input power (auto-sensing)
100 V ac to 240 V ac, 50 to 60 Hz

EXTERNAL
Supports connection for redundant power supply

HEAT DISSIPATION
99 BTU/Hr

POWER CONSUMPTION
29 Watts maximum

MAXIMUM CURRENT
0.5 A at 110 V ac, 0.47 A at 220 V ac

ENVIRONMENTAL SPECIFICATIONS

Operating Conditions

TEMPERATURE
0 to +40°C (32 to +104°F)

RELATIVE HUMIDITY
5 to 95% (noncondensing)

Storage Conditions

TEMPERATURE
-40 to +70°C (-40 to +158°F)

RELATIVE HUMIDITY
5 to 95% (noncondensing)

PHYSICAL SPECIFICATIONS

Mounting
Desk or Enclosure - 48.3 cm (19-inch) equipment rack,1U high

Dimensions - Nominal

HEIGHT
4.4 cm (1.7 in)

WIDTH
44.1 cm (17.36 in)

DEPTH
21.0 cm (8.3 in)

Mass - Approximate
2.61 kg (5.8 lb)

Cable Connectors

SWITCH PORTS
RJ-45

UPLINK PORTS
RJ-45 copper and LC fiber

Vibration
Vibration - IEC 68-2-36, IEC 68-2-6
Shock - IEC 68-2-29
Drop - IEC 68-2-32

REGULATORY COMPLIANCE AND CERTIFICATION

Electromagnetic Compatibility (EMC)
Industry Canada Class A, EN55022 and EN55024 (CISPR 22) Class A, EN61000-3-2/3, FCC Class A, VCCI V-3 Class A, C-Tick-AS/NZS CISPR 22 Class A, 47 CFR Parts 2 and 15 Class A, CSA C108.8 Class A, 89/336/EEC Class A

Product Safety
UL 60950, CSA C22.2 No. 60950, 73/23/EEC, EN 60950, IEC 60950, EN 60825, 21 CFR 1040.10

Location
UL/UL-C listed as suitable for use in ordinary locations and meets ordinary safety standards for fire and shock hazards.

Contamination
Class G1 (Mild) as defined in ISA Standard S71.04

24-PORT FIBER MANAGED SWITCH (P0973BJ)

FEATURES

The 24-Port Fiber managed switch features:

- 24-ports of 100Base-FX
- Two fixed RJ-45 10/100/1000 ports, configurable for uplink
- Two 1000Base-X uplink Gigabit (SFP) ports
- MT-RJ connectors on switch ports
- Full duplex operation
- Supports VLAN configurations
- Monitoring and configuration tasks via local console port, or any SNMP/RMON based management application.
- Port mirroring technology and diagnostics that allow local network traffic to be redirected to an external probe for detailed analysis
- Compliance with industry standards, including IEEE 802.3u Fast Ethernet, 802.1w Rapid Spanning Tree Protocol (RSTP)
- Optional redundant power supply.

INTRODUCTION

The 24-Port Fiber managed switch (P0973BJ) provides twenty-four 100Base-FX ports with MT-RJ connectors, two fixed 10/100/1000 ports for uplink and two 1000Base-X uplink Gigabit (SFP) ports. The two 1000Base-X uplink Gigabit (SFP) ports can be populated with Mini-GBIC uplink connector modules (P0972WT, P0972WU, P0972YQ, P0972YL, or P0973FT).

The switch allows high-performance, full-featured layer-2 Ethernet switching in small to medium-sized network applications, as well as high-performance direct end-station connectivity.

OPTIONAL REDUNDANT POWER SUPPLY

See “REDUNDANT POWER SUPPLY (P0973BP)” on page 20.

UPLINK/SWITCH INTERFACES

Table 4 lists the 24-Port Fiber switch and the uplink interfaces that can be added to the switch. The uplink connectors are added to specific uplink interfaces.

Table 4. 24-Port Fiber Managed Switch (P0973BJ) Interfaces

Switch		Uplink Ports (on Switch)	Uplink Connectors (Add to Interfaces)	
Description	Invensys Part No.	Description	Description	Invensys Part No.
24-Port Fiber managed switch with two RJ-45 ports for uplink and two ports for Mini-GBIC modules	P0973BJ	Two 1 Gb uplink RJ-45 ports, 1000Base-T for Cat5 copper cables	n/a	
		Two 1 Gb uplink ports, 1000Base-X, for Mini-GBIC modules	Uplink module 1000Base-SX with LC connector	P0972WT - 550 m (1804 ft) with MMF
			Uplink module 1000Base-LX with LC connector	P0972WU - 10 km (6.2 mi) with SMF
			Uplink module 1000Base-LX/LH with LC connector	P0972YQ - 2 km (1.25 mi) with MMF
			Uplink module 1000Base-ZX with LC connector	P0973FT - 80 km (49.6 mi) with SMF
			Uplink module 1000Base-T with RJ-45 connectors	P0972YL - 100 m (330 ft)

FUNCTIONAL SPECIFICATIONS

24-PORT FIBER MANAGED SWITCH (P0973BJ)

Power

INTERNAL
ac Input power (auto-sensing)
100 V ac to 240 V ac, 50 to 60 Hz

EXTERNAL
Supports connection for redundant power supply

HEAT DISSIPATION
174 BTU/Hr

POWER CONSUMPTION
29 Watts

MAXIMUM CURRENT
0.5 A at 110 V ac, 0.47 A at 220 V ac

ENVIRONMENTAL SPECIFICATIONS

Operating Conditions

TEMPERATURE
0 to +40°C (32 to +104°F)

RELATIVE HUMIDITY
5 to 95% (noncondensing)

Storage Conditions

TEMPERATURE
-40 to +70°C (-40 to +158°F)

RELATIVE HUMIDITY
5 to 95% (noncondensing)

PHYSICAL SPECIFICATIONS

Mounting
Desk or Enclosure - 48.3 cm (19-inch) equipment rack,1U high

Dimensions

HEIGHT
4.4 cm (1.7 in)

WIDTH
44.1 cm (17.36 in)

DEPTH
21.0 cm (8.3 in)

Mass - Approximate
2.7 kg (5.95 lb)

Cable Connectors

SWITCH PORTS
MT-RJ fiber

UPLINK PORTS
RJ-45 copper and LC fiber

Vibration
Vibration - IEC 68-2-36, IEC 68-2-6
Shock - IEC 68-2-29
Drop - IEC 68-2-32

REGULATORY COMPLIANCE AND CERTIFICATION

Electromagnetic Compatibility (EMC)
Industry Canada Class A, EN55022 and EN55024 (CISPR 22) Class A, EN61000-3-2/3, FCC Class A, VCCI V-3 Class A, C-Tick-AS/NZS CISPR 22 Class A, 47 CFR Parts 2 and 15 Class A, and CSA C108.8 Class A

Product Safety
UL 60950, CSA 60950, EN 60950, EN 60825, IEC 60950, EN 60825, 21 CFR 1040.10

Location
UL/UL-C listed as suitable for use in ordinary locations and meets ordinary safety standards for fire and shock hazards.

Contamination
Class G1 (Mild) as defined in ISA Standard S71.04

HAVER SCREENING GROUP

SELLER DOCUMENT REVIEW

Permission to proceed does not constitute acceptance or approval of design detail, calculations, analysis, test methods, or materials developed or selected by SELLER, and does not relieve SELLER from full compliance with contractual obligation.

1 Work may proceed
2 Revise & Resubmit. Work may proceed subject to incorporation of changes
3 Revise & Resubmit. Work may NOT proceed
4 Review not required. Work may proceed
5 Cancelled / Superseded

Document Status: 4
Reviewer Name: Fabian Riffo
Date: 13/08/2010
Discipline: EM - Mechanical
Doc Type Code: V1A
Job # 25580-220
VP # 25580-220-V1A-MFSS-00051
Subm 001
Equip # 0310-SCR-0001;
Program # N/A;
Job #
VP #
SEQ #
Equip #

SKF

DESCRIPTION LITERATURE

PO nº: 25580-220-POA-MFSS-00001

Nº TAG: 0310-SCR-00001

ANTAPACCAY PROJECT

XSTRATA

REVISION						
	00	For information	23-July-10	MZ		
	#	DESCRIPTION	DATE	PREPARED BY	APPROVER 1	APPROVER 2

Rod. Campinas/ Monte Mor, km20
C.P. 20 • CEP 13190-000 • Monte Mor - SP • Brasil
Tel.: 55 19 3879 9100 • Fax: +55 19 3879-141

SKF Copperhead

SKF® Copperhead Transmitter Unit CMPT CTU for machinery fault detection

– *Instruction Manual*

This Instruction Manual provides detailed wiring connection and configuration information for the CMPT CTU vibration and temperature transmitter. The CMPT CTU is configured by SKF when it is part of an assembled CMPT enclosure. The CMPT CTU must otherwise be properly installed and configured by the user. This instruction manual provides the user with information to properly install and configure the CTU and change the default configuration settings.

Please read this Instruction Manual and the cautionary notes thoroughly.

For technical assistance contact SKF at skfcopperhead@skf.com or contact your local SKF representative.

Visit also www.skf.com/copperhead for more information

The SKF Copperhead Transmitter Unit (CTU) is a digital vibration and temperature transmitter. It can be used as part of a machinery fault detection system. The CTU performs three types of vibration signal process analysis – SKF Acceleration Enveloping (gE), Acceleration (g), or Velocity (mm/s or inch/s). The type of vibration analysis is user configurable. The CTU has analog output signals proportional to processed vibration analysis and temperature for connection to automation systems and SKF CPHD DCL monitors. The CTU is user configurable to process vibration signals from the SKF CMPT family of sensors or other industrial accelerometers. Acceleration Enveloping vibration analysis is used to identify repetitive impact type vibrations generated by machinery faults due to loose components, gear faults, lack of lubrication and rolling bearing faults. The acceleration vibration analysis is used to monitor overall machinery and structural vibration, including machinery having journal bearings. It can also be used to measure the overall operation of vibrating screens and other vibrating equipment. The velocity vibration analysis is used to identify overall machinery vibration levels such as looseness and unbalance, including machinery support by journal bearings.

The CMPT CTU has unique features to monitor both high speed and low speed machinery (n < 40 r/min).

® SKF is a registered trademark of the SKF Group.

Publication 4954 EN-20 12/2005

Contents

Note.
The page references are linked to corresponding pages in this PDF document

Features

- Suitable with accelerometer sensors (10 mV/g to 230 mV/g).
- Temperature converter for accelerometers with integral temperature sensors.
- Three user selectable vibration process analyses①:
  - SKF Acceleration Enveloping, gE
  - Acceleration, g
  - Velocity, mm/s (inch/s).
- Front panel user configurable for:
  - Vibration
  - Output Range
  - Optional sensor input or buffered vibration output input
  - Optional signal decay for Acceleration Enveloping Peak hold
  - Optional output signal averaging.
- Analog output signals - Processed vibration and temperature for interface with PLC/DCS and CPHD DCL alarm/display monitors.
- 35 mm DIN rail mounted with rugged steel retainer clip.
- Front panel mounted BNC connector for buffered vibration and temperature measurements.
- Front panel sensor OK/Overload lamp for detection of sensor and CTU faults.
- CAN-bus interface for connectivity of multiple numbers of CTU and remote monitoring via computer.
- Internal isolated DC/DC converter for grounding loop and reverse polarity protection.
- Auxiliary 24 V DC voltage output for optional powering of other sensor types (tachometer).

The software to process the vibration and temperature signals is embedded into the Digital Signal Processing (DSP) card in the CTU. Calibration of the CTU is part of the embedded software.

The CTU unit has two front panel rotary switches to set the configuration. There is no need to open the CTU enclosure to adjust pins or jumpers. The BNC connector is front panel switchable (BNC switch) to measure either the accelerometer sensor buffered (not processed) vibration output or the sensor temperature output. The buffered vibration output can be monitored with an SKF Mircolog or equivalent device.

The CTU has a user configurable option to average the analog output signals so that rapid changes in vibration input do not cause annoying fluctuations in PLC/DCS or digital displays.

The CTU has a user configurable option 1 second or 10 second signal decay time for Acceleration Enveloping Peak hold. The 10 second signal decay time is recommended for low speed ($n < 40$ r/min) applications where the frequency of the mechanical impact vibration is low. Normal operation of the CTU is with the 1 second signal decay time.

The CTU can be user configured to accept a constant current signal from another CTU operating with an accelerometer sensor. This enables two CTUs having different configurations (i.e. one Acceleration Enveloping and one Velocity) to monitor the same accelerometer sensor signal.

The CTU has a front panel mounted OK lamp to indicate that the sensor is correctly connected to the CTU and that the sensor (accelerometer and temperature) and the CTU are operating correctly. Green indicates the system is OK (Correct). Red indicates the system has a fault with the sensor or CTU, or that the vibration level or temperature exceeds the set RANGE (overload).

The CTU can be located up to 100 m (330 feet) from the sensor with suitable shielded cabling. The CMPT DCL display / alarm module can be used along with the CMPT CTU module to have a stand-alone monitoring of processed vibration. A second DCL module can be used to optionally monitor temperature from a CTU connected to a CMPT 2310T or CMPT 2323T sensor. The CMPT DCL display / alarm module is a single channel digital front panel programmable monitor having digital display and a single alarm function and relay contacts for independent monitoring of the processed signals from the CTU. See the CMPT DCL data sheet.

① only Acceleration Enveloping (ENV3). Acceleration (RMS and Peak Hold), and Velocity ISO are enabled on initial CPHD CTU modules.

Each CTU has a CAN-bus interface for remote communication with an industrial PC using an SKF protocol software. This enables remote configuration and monitoring of the CTU, and remote vibration condition monitoring (spectrum analysis) when used with the SKF Machinery Analyst software. The CAN-bus allows multiple numbers of CTU modules to be joined by a common CAN-bus connecting cable. This greatly reduces the wiring connections needed compared to the analog output signal cable requirements.

The CTU has an auxiliary 24 V DC power output for optional use to energize alternative sensors (20 mA maximum).

The CTU has an internal isolated DC/DC converter to avoid grounding loop problems. This isolates the 24 V power supply and the CAN-bus from the sensor input circuitry and the analog sensor output circuitry. The power input is protected from reverse polarity connections.

Specifications

Input signals

Industrial accelerometer	(2 wire, constant current source with voltage output)
Accelerometer sensitivity:	10 to 230 mV/g
Bias voltage:	12 V DC +/– 1 V
Supply current:	4 to 8 mA
Buffered acceleration signal output from another CTU:	Buffered signal input mode
Supply voltage:	5 to 19 V
Temperature:	0 to 1,2 V DC @ 0.01 mV/°C

Environmental

Operating temperature:	0 to 70 °C (32 °F to 160 °F)
Storage temperature:	–40 °C to 85 °C (–40 °F to 185 °F)
Humidity:	95% maximum
IP rating:	IP20
Vibration:	IEC68-2-6
Shock:	IEC68-2-27
Bump:	IEC68-2-29

Mechanical

Weight:	0,225 kg (0.102 lbs)
Enclosure:	Thermoplastic ABS
Color:	Gray
Connectors:	Two 8-pole pluggable screw clamp type
Wiring:	0,2 mm to 2,5 mm (24 to 12 AWG)
Mounting:	35 mm DIN-rail type EN50022 with steel retaining clip
Dimensions:	45 x 75 x 118 mm (W x H x D) (1.77inch x 2.95inch x 4.65 inch)

Electrical

Power:	24 V DC (22 V to 28 V DC) 250 mA current, maximum CTU is reverse power protected

Power consumption:	6 W

Vibration process analysis

Acceleration Enveloping,gE

ENV3 ①:	500 Hz – 10 kHz

Acceleration, g

Accel RMS ①:	2 Hz – 20 kHz
Accel Peak Hold ①:	2 Hz – 20 kHz

Velocity, mm/s (inch/s)

ISO ①:	10 Hz – 1 kHz

Processed analog output signals

Vibration:	4 to 20 mA; 0 to 10 V DC Proportional to the input sensitivity of the accelerometer and the user defined signal processing method (Acceleration Enveloping, Acceleration, or Velocity) and RANGE. See Section 3.
Temperature:	4 to 20 mA / 0 to 10 V DC Proportional to 0 °C to 120 °C

Analog signal less than 4 mA or greater than 20 mA indicates a system fault.

Auxiliary power: +24 V DC / 20 mA maximum

Approvals: CE
Emission 50081-2
Immunity 50082-2

① Only Acceleration Enveloping (ENV3). Acceleration (RMS and Peak Hold), and Velocity ISO are enabled on initial CPHD CTU modules.

Dimensions • Front panel • Terminals

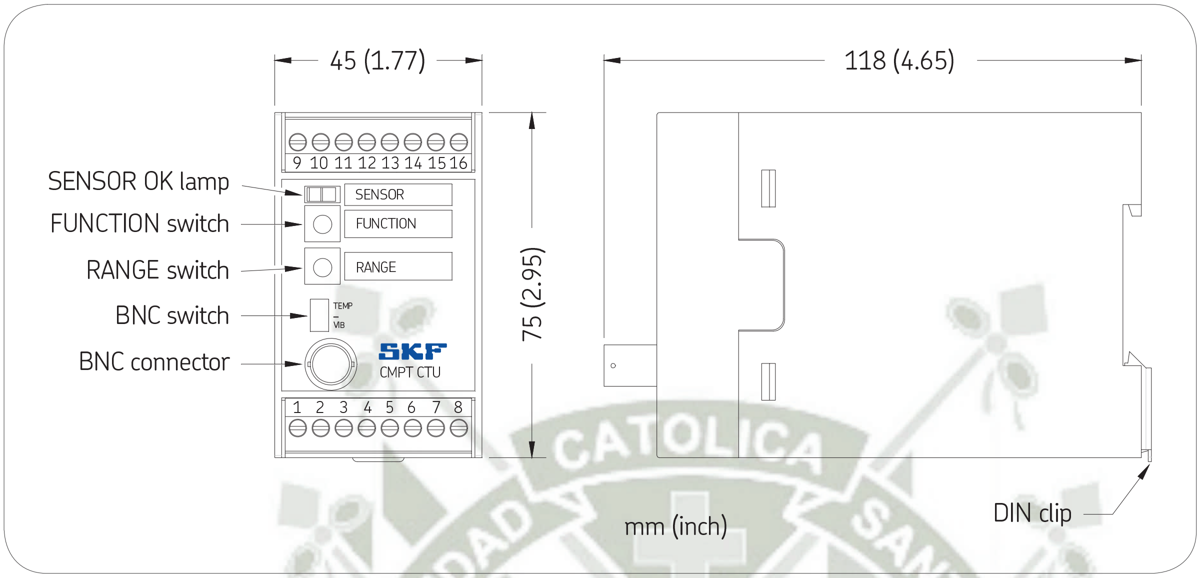
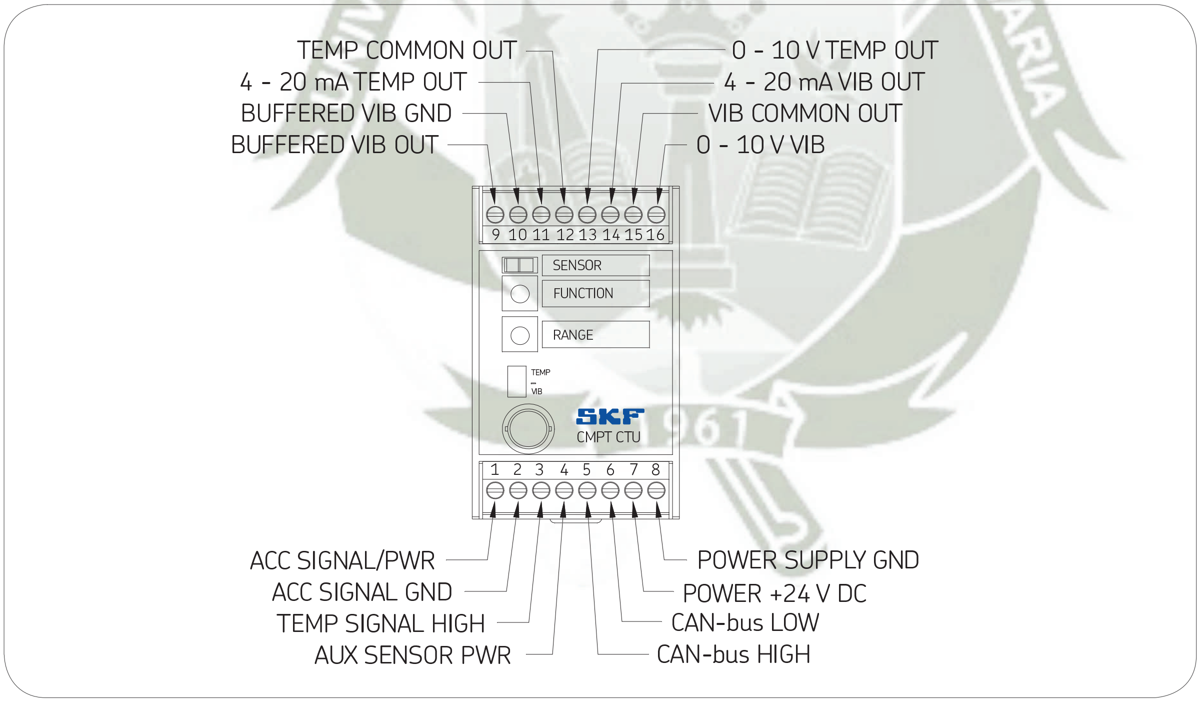


Figure 1 Dimensions and front panel

Figure 2 CMPT CTU connector assignment



Title

PULLSWITCH

TYPE ESS1

TRAINING AND OPERATIONAL MANUAL

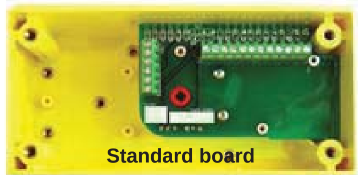
Document Number

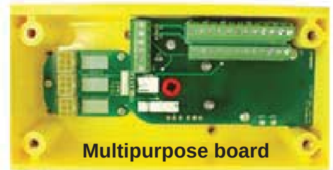
75-658-39

Issue

07

1. INTRODUCTION





Interior of pullswitch available as Standard or Multipurpose board

1.1. Austdac has released its new pullswitch designed to meet harsh environments and utilizing the latest high tech material to ensure strength, high impact resistance, durability and yet still maintaining its small compact size and weight.

1.2. The material is UV stabilized and flame retardant.

1.3. The pullswitch is designed with a new multipurpose internal pcb to reduce installation time and includes a plug and socket connection for up to three transmitters, when used with the Silbus signal line systems.

1.4. The pullswitch uses sealed micro switches and has been fully tested to IP65.

1.5. certified (Australia), certified (Europe), FCC certified (USA).

1.6. Designed with the new safety colours in order to promote a new level of safety to operational personnel.

1.7. The pullswitch is available in taut or slack rope configuration and can be fully integrated with the Austdac signal line system.

1.8. The installation of the pullwire cable is now simplified by providing a single cable tensioner on each pullswitch to reduce time and allow a one man installation.

2. GENERAL DESCRIPTION

2.1. The pullswitch is designed to be placed at regular intervals along a conveyor belt or similar distributed plant, connected to lanyards or pull-cords to provide emergency stop facilities along the entire length of the conveyor belt.

2.2. The pullswitch provides two lanyard operated actuators, one on each side, that operate one front panel centrally located indicator / control knob. The knob has unique 'cat's-eye' passive indication of an actuated switch allowing operational staff to locate the source of the emergency in the shortest possible time.

2.3. The interval between pullswitches is typically 100m – 200m but may be changed to suit site conditions and lanyard mass / tension considerations. Austdac belt control and monitoring systems typically use an armored system cable as the pull-cord or lanyard. This improves reliability and reduces cost.

2.4. The photograph below shows the standalone pullswitch. The standalone pullswitch is used when pre-start alarm and voice communications are not required but emergency stop facilities are still required.

2.5. Access to the switch terminal connectors are made by removing the 4 front cover screws. The cover lifts off. Replace the cover ensuring the red selector knob is positioned correctly into the switch housing. Ensure all cover screws are securely tightened.

3. OPERATION

3.1. The front of the pullswitch consists of a centrally located control / indication knob that is used to both indicate a lockout and reset the switch after a lanyard initiated emergency stop. The front panel of the pullswitch provides the following control and indication features:

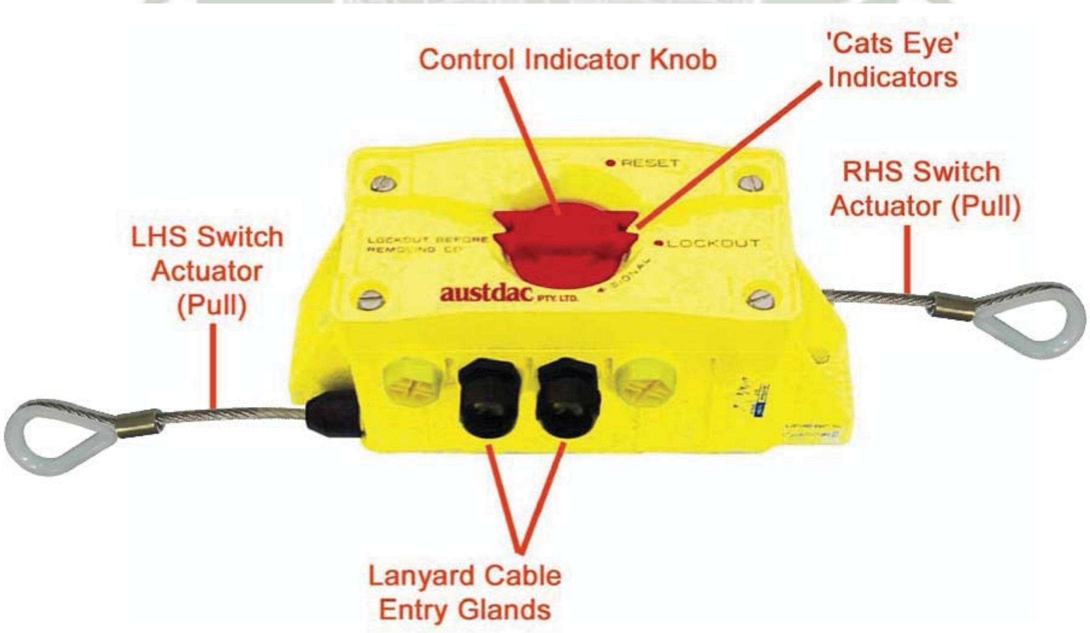
3.1.1. One centrally located large red control knob that may be used to stop the conveyor by rotating the knob clockwise until the arrow points to '⬣ LOCKOUT'.

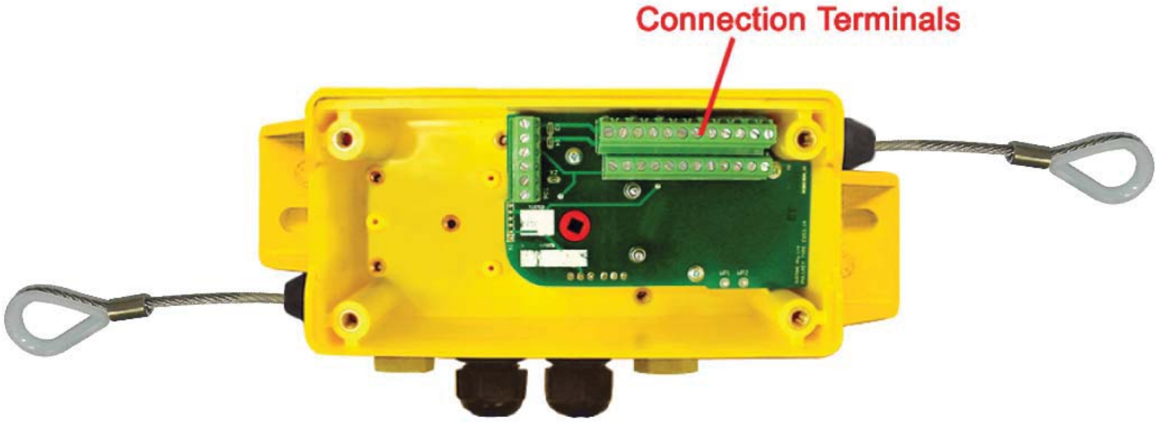
3.1.2. The same centrally located large red knob that rotates to the '⬣ LOCKOUT' position in response to lateral movement of either of the lanyard actuators.

3.1.3. The same centrally located large red knob that may be used to reset the lockout (allow conveyor to run) by rotating the knob anti-clockwise until the arrow points to '⬣ RESET'

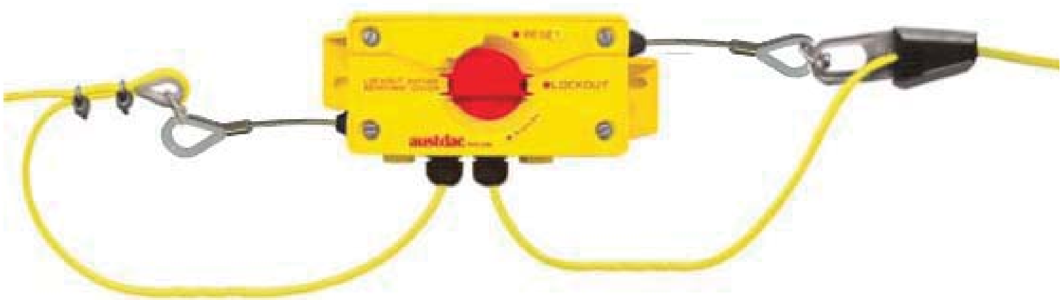
3.1.4. Two red reflecting 'cats eyes' located at both ends of the control knob finger bar that are obscured when the switch is in the ⬣ RESET position and visible along the conveyor when in the ⬣ LOCKOUT position. This feature allows tunnelling staff to use their cap lamps to find a locked out switch from up to 500 metres away.

3.1.5. The signalling position of the centrally located red control knob can optionally be used to activate a microswitch to connect into signalling systems. The signalling position is a spring return to the lockout position.





3.2. The system cable is designed to act as the emergency stop lanyard for the conveyor. The system cable should be adjusted and coupled to the pullswitch actuators as shown in the photograph below. The photograph below shows two different methods of securing the system lanyard cable, the left shows the shackle method while the right shows the wedge method. The wedge method allows regular re-tensioning to be carried out without the use of special tools.



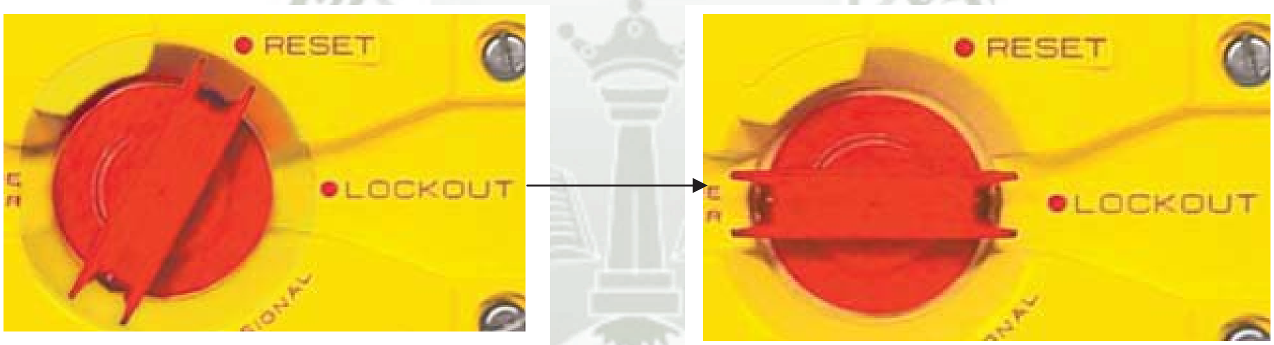
4. OPERATION OF PULLSWITCH STATION

Controlled Stop

There are two different operating methods that can be used to stop the conveyor.

1) The conveyor can be stopped by pulling firmly on the pullwire cable.

2) The conveyor can be stopped by turning the RED LOCKOUT switch located on the front of the pullswitch, from the RESET (RUN) position to the LOCKOUT position.



CONVEYOR RUNNING **CONVEYOR STOPPED**

6. SPECIFICATIONS

6.1. Material — Non-rust Polycarbonate

6.2. Dimensions

Standalone pullswitch — **275mm (W) x 100mm (H) x 120mm (D)**

6.3. Mass

Standalone pullswitch — **1.8kg**

6.4. Electrical Specifications

Microswitches: — **Burgess type VCSP-GP, Single pole, Double throw**

Microswitches maximum contact ratings			
	Voltage	**Resistive Load**	**Inductive Load**
AC	**125V**	**10A**	**10A**
	250V	**10A**	**10A**
DC	**Up to 15V**	**15A**	**15V**
	30V	**10A**	**10A**
	50V	**3A**	**2.5A**
	75V	**1A**	**0.5A**
	125V	**0.5A**	**0.07A**
	250V	**0.25A**	**0.03A**

6.5. Temperature Range — -40°C to + 50°C

6.6. Pullswitches can be manufactured by Austdac for taut wire or slack rope installations (tensioned or non tensioned switches). To be advised on order.

6.7. Certifications

Rated IP65 ITACS TR 3341 IEC60529:2001 AS60529:2004

Certified (Australia)

Certified (Europe)

FCC Certified (USA)