
ESCOLA POLITÉCNICA DA UNIVERSIDADE DE SÃO PAULO

Departamento de Engenharia Mecânica

***Desenvolvimento de um Processo de Montagem para
Motores Diesel***

Trabalho de Formatura em Engenharia Mecânica

Marco Alexandre Manha Infantozzi

São Paulo

1998

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Ênfase: Projeto e Fabricação

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À minha família e à minha namorada Adriana que, durante toda a realização deste trabalho, me motivaram e me apoiaram.

Marco Alexandre Manha Infantozzi

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RESUMO

Este trabalho foi realizado juntamente com o aluno Carlson Érico Peixoto de Oliveira. Possui dois volumes similares, denominados "Projeto de uma Linha de Montagem de Motores Diesel" e "Desenvolvimento de um Processo de Montagem para Motores Diesel", sendo o primeiro destinado à formatura do meu colega Carlson e o segundo destinado à minha formatura.

O trabalho apresenta o processo de projeto de uma linha de montagem de motores diesel realizado na Engenharia de Montagem de uma montadora de veículos pesados.

Após a descrição dos motores produzidos pela empresa e da área de montagem de motores, são feitas considerações a respeito da metodologia de projeto utilizada e são descritas as etapas de levantamento da necessidade, estudo prévio e estudo de viabilidade para a linha de montagem.

O projeto básico da linha, resultado da modelagem do problema sob os seus aspectos mais relevantes, e as atividades que levaram à implementação do produto final são apresentados em seqüência.

ABSTRACT

This volume presents the project process of an assembly line for diesel engines that took part in the Assembly Engineering of a heavy vehicles manufacturer.

After describing the engines produced by the company and the engine assembly area, considerations about the project methodology used are made and the steps of assessment of needs, previous study and feasibility study for the assembly line are described.

The basic project of the line, result of the problem modeling under its most relevant aspects, and the activities that led to the implementation of the final product are presented in the end.

1. Introdução

1.1 Motores Diesel para Aplicação em Transporte Pesado

A SLA é uma empresa que atua no campo de veículos pesados para transporte de bens e passageiros na América Latina. As atividades estão centralizadas no desenvolvimento, produção, *marketing* e serviço de pós-vendas. O objetivo da empresa é ter o desenvolvimento, a produção e a distribuição de seus produtos controlados pela demanda de mercado.

A unidade industrial está organizada em fábricas interdependentes que produzem subconjuntos. Esses subconjuntos são enviados à fábrica que monta o produto final. As fábricas que compõem a unidade industrial são as seguintes:

- Fábrica de Motores;
- Fábrica de Cabinas;
- Fábrica de Eixos e
- Fábrica de Chassis.

O quadro de funcionários conta com 2.700 trabalhadores divididos entre as funções de produção direta e administrativa.

PROJETO DE UMA LINHA DE MONTAGEM DE MOTORES DIESEL

Capítulo 1

INTRODUÇÃO

- 1.1 MOTORES DIESEL PARA APLICAÇÃO EM TRANSPORTE PESADO*
- 1.2 MONTAGEM DE MOTORES NA SLA*
- 1.3 OBJETIVOS DESTA TRABALHO*

A seguir, são descritos os motores que equipam os caminhões e ônibus da SLA. Todos os motores operam em ciclo diesel com ar de admissão turbocomprimido resfriado (*intercooler*), para melhor eficiência e redução da formação de NO_x .

- **Motor 9 litros (D9):**

Especificação:

Cilindrada: 9 litros

Cilindros: 6, em linha

Cabeçotes: 6

Válvulas por cilindro: 2

Diâmetro x curso: 115 x 144 mm

Taxa de compressão: 18:1

Controle de injeção de combustível: mecânico

Faixa de potência: 220 a 310 hp @ 2.000 rpm

Faixa de torque: 1.005 a 1.355 Nm @ 1.350 rpm

Consumo específico de combustível: 196 g/kWh @ 1.200 rpm

Combustível: diesel ou etanol

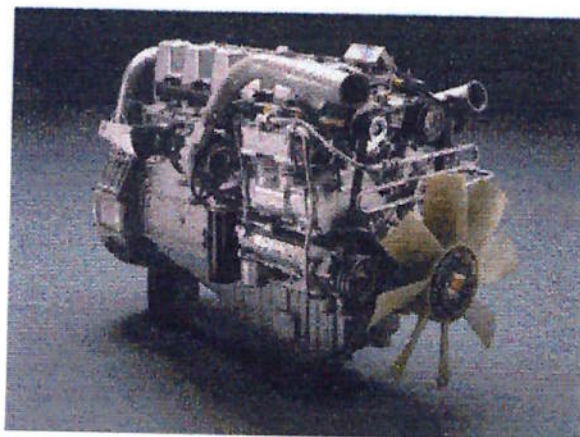


Figura 1-1 Motor 9 litros.

Descrição:

O projeto básico é de um bloco de cilindros em ferro fundido com camisas substituíveis, cabeçotes individuais e um eixo-comando posicionado acima da árvore de manivelas com hastes curtas para o controle das válvulas. O motor tem um lado quente e um frio, com todos os componentes do sistema de combustível agrupados no lado esquerdo "frio" e o sistema de escape no lado direito "quente".

Os pistões têm anéis de compressão montados em sua parte superior para reduzir o "volume morto" na câmara de combustão.

Um dispositivo de partida por chama é utilizado para melhorar a partida a frio e reduzir emissões de fumaça branca. As tampas dos cabeçotes são montadas sobre borrachas para reduzir o ruído.

A bomba injetora é montada sobre flange e a injeção é controlada mecanicamente.

O ventilador é montado no eixo da árvore de manivelas. O óleo lubrificante é filtrado por um filtro de papel, suplementado por um filtro centrífugo.

- **Motor 11 litros (D11):**

Especificação:

Cilindrada: 11 litros

Cilindros: 6, em linha

Cabeçotes: 2

Válvulas por cilindro: 2

Diâmetro x curso: 127 x 145 mm

Taxa de compressão: 17:1

Controle de injeção de combustível: mecânico

Faixa de potência: 320 a 360 hp @ 1.900 rpm

Faixa de torque: 1.385 a 1.600 Nm @ 1.250 rpm

Consumo específico de combustível: 201 g/kWh @ 1.200 rpm

Combustível: diesel

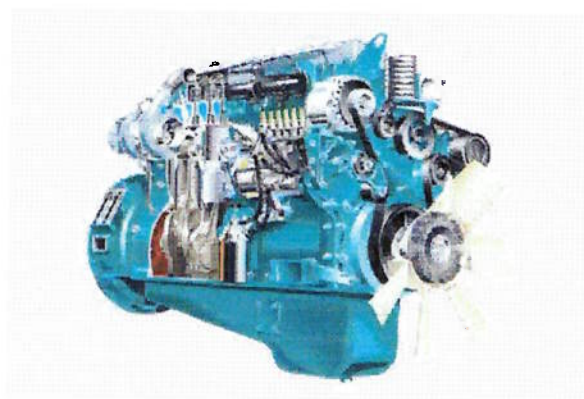


Figura 1-2 Motor 11 litros.

Descrição:

O motor é adequado para transporte de carga pesada em torno de 40 ton.

Em relação ao motor 9 litros, além da cilindrada, a principal diferença é a existência de dois cabeçotes apenas, um para cada três cilindros.

A bomba injetora é posicionada do lado direito do motor. O ventilador é montado no eixo da árvore de manivelas e uma correia poli-V com tensionador automático aciona a bomba d'água, o alternador e o compressor de ar condicionado.

O óleo lubrificante é filtrado por um filtro de papel, suplementado por um filtro centrífugo.

- **Motor 12 litros (D12):**

Especificação:

Cilindrada: 11,7 litros

Cilindros: 6, em linha

Cabeçotes: 6

Válvulas por cilindro: 4

Diâmetro x curso: 127 x 154 mm

Taxa de compressão: 18:1

Controle de injeção de combustível: mecânico ou eletrônico

Faixa de potência: 360 a 420 hp @ 1.800 rpm

Faixa de torque: 1.665 a 1950 Nm @ 1.500 rpm

Consumo específico de combustível: 189 g/kWh @ 1.200 rpm

Combustível: diesel



Figura 1-3 Motor 12 litros.

Descrição:

As principais diferenças em relação aos outros tipos de motores são a adoção de 4 válvulas por cilindro e a possibilidade de controle de injeção eletrônico por unidades injetoras em cada cilindro. Além disso, o conjunto de engrenagens da árvore de manivelas e do eixo-comando é posicionado na parte posterior do motor.

Como no motor 9 litros, há um lado quente e um frio, com todos os componentes do sistema de combustível agrupados no lado esquerdo “frio” e o sistema de escape no lado direito “quente”.

São usados pistões de alumínio articulados com uma coroa de aço na seção inferior. Os pistões têm anéis de compressão montados em sua parte superior para reduzir o “volume morto” na câmara de combustão. Os pistões são resfriados por óleo injetado por bicos posicionados na parte inferior de cada cilindro.

1.2 Montagem de Motores na SLA

A Fábrica de Motores da SLA está dividida em termos de estrutura organizacional em quatro grandes áreas:

- Usinagem de Motores 11 litros;
- Usinagem de Motores 12 litros;
- Montagem de Motores e
- Logística e Abastecimento.

A seguir, são apresentadas as seções que compõem a Montagem de Motores e suas principais atividades:

- **Engenharia de Montagem:**

A Engenharia de Montagem é formada por 11 pessoas. Suas principais atividades são:

Verificar tecnicamente a introdução de mudanças nos motores:

As modificações nos motores, provenientes de problemas verificados no campo ou na montagem, são comunicadas à Engenharia de Montagem por um sistema de informação denominado *ECO-System* (de *Engineering Change Order*). Esse sistema serve como documentação de todo o processo de desenvolvimento de um tipo de motor. Cabe à Engenharia de Montagem verificar as modificações que se aplicam aos motores que são montados na SLA e elaborar no sistema a ordem que dará impulso à introdução dessas modificações (novas peças, nova estrutura de montagem) nos processos utilizados nas linhas de montagem.

Desenvolver processos de produção:

Os processos de produção são desenvolvidos com o auxílio de um sistema de informação denominado *Mona-Assembly*. Nesse sistema, estão concentradas todas as informações relativas aos processos de montagem de todos os tipos de motores. Essas informações são trabalhadas a nível de manutenção pela Engenharia de Montagem e a nível de consulta pelos operadores em terminais ao longo das linhas, substituindo as folhas de processo.

Desenvolver o arranjo físico e o endereçamento de peças:

O desenvolvimento do arranjo físico está intimamente ligado ao desenvolvimento de processos e é realizado com o auxílio da ferramenta *LayPla* instalada em estações de trabalho.

O endereçamento de peças é um trabalho feito em conjunto com a área de Logística e Abastecimento.

Desenvolver o balanceamento das linhas, estudo de tempos e métodos:

O balanceamento das linhas é feito de forma tradicional, com a cronometragem dos tempos de processo ao lado dos operadores. Como suplemento a esse procedimento, estuda-se a possibilidade de instalação de uma ferramenta de modelagem e simulação de processos.

Especificar equipamentos e projetar novas linhas de montagem:

É função da Engenharia de Montagem levantar necessidades e motivar investimentos de forma a incluí-los no plano de investimento da empresa, o qual prioriza o destino de verbas para projetos que visam a substituição de máquinas e equipamentos desgastados e/ou ultrapassados, racionalização/economia com a introdução de mudanças nos processos de produção e métodos de trabalho, aumento da capacidade de produção, melhoria da qualidade do produto, melhoria da segurança de operação e da qualidade ambiental.

Projetar dispositivos:

Os dispositivos de manuseio de peças (MH's) e de pré-montagem de componentes (VR's) são projetados pela Engenharia de Montagem, que tem profundo conhecimento das operações de montagem e contato direto com os operadores. Dessa forma, geralmente consegue solucionar os problemas com dispositivos bastante simples.

Dar suporte à produção:

É também responsabilidade da Engenharia de Montagem dar suporte às linhas de montagem, verificando e solucionando pontos falhos nas operações e nos equipamentos. Com a crescente automação dos processos de produção, cabe à Engenharia de Montagem auxiliar no desenvolvimento e na solução de problemas em CLP's, robôs, estações automáticas de montagem e sistemas de aquisição de dados.

- **Montagem de Motores 11 litros:**

A Montagem de Motores 11 litros é baseada numa linha bastante flexível e pouco automatizada com 30 postos de montagem. Cerca de 25 pessoas trabalham na linha.

Os motores são transportados sobre paletes em um transportador de corrente e as montagens são predominantemente manuais com auxílio de alguns dispositivos.

As peças são distribuídas ao longo da linha em prateleiras horizontais com cinco níveis.

Talhas e pontes *KBK* são ligadas à estrutura das prateleiras.

A predominância de operações manuais e o grande número de prateleiras conferem alta flexibilidade à linha no que diz respeito à montagem de todos os tipos de motores 11 litros para caminhões e ônibus, além de motores de aplicação industrial (geradores) e motores marítimos. Entretanto, como os paletes mantêm uma distância fixa entre eles, existe um sério problema de balanceamento, uma vez que há postos em que a operação demanda menos tempo e outros em que a operação demanda mais tempo que o tempo de andamento da linha, ou de troca de postos, que está em torno de oito minutos. Dessa forma, alguns operadores ficam ociosos, enquanto outros têm que “correr” com o seu trabalho para terminá-lo no tempo da linha ou “correr” atrás do motor quando este muda de posto ao fim de oito minutos.

- **Montagem de Motores 12 litros:**

A Montagem de Motores 12 litros é baseada numa linha bastante automatizada, que pode ser dividida em duas partes:

Linha de montagem inicial (24 postos):



Figura 1-4 Montagem Inicial.

É uma linha não muito flexível, onde é realizada a montagem automática das principais peças usinadas como bloco de cilindros, camisas, pistões, bielas, árvore de manivelas, eixo-comando, cabeçotes e carcaça do volante.

Os motores são transportados em um transportador por rolos de atrito.

A existência de estações automáticas projetadas para a montagem do motor 12 litros dificulta a entrada de outros tipos de motores nessa linha, o que representa uma perda em termos de flexibilidade. Por outro lado, o sistema de transporte por rolos de atrito facilita o balanceamento e a distribuição de operações ao longo da linha, já que os postos trabalham independentes uns dos outros, podendo haver um acúmulo de motores entre um posto e outro.

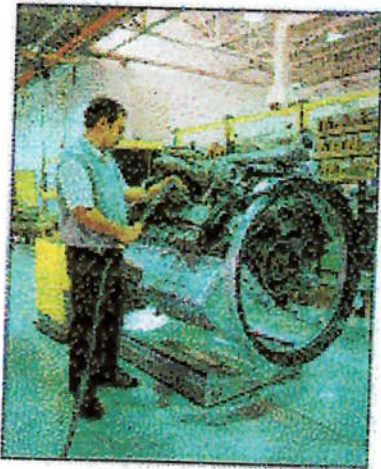
Linha de montagem final (10 postos):

Figura 1-5 Montagem Final.

É uma linha muito flexível, onde os motores são fixados em carros guiados automaticamente por *LASER* (AGV's, de *Automatic Guided Vehicles*).

Esses carros permitem que o operador gire, incline ou levante o motor, atingindo posições que facilitam a montagem dos componentes, proporcionando a ele uma boa ergonomia, já que a maioria das montagens nessa parte da linha são manuais.

Cerca de 20 operadores trabalham na linha inteira.

As peças são distribuídas ao longo da linha em prateleiras inclinadas com 2 níveis.

Talhas e pontes *KBK* são ligadas à estrutura do teto.

- **Teste de Motores:**



Figura 1-6 Teste de Motores.

O teste de motores é composto por sete bancos de teste onde se verifica a potência máxima e o consumo específico de combustível, de acordo com um procedimento de teste especificado pela Engenharia de Montagem.

Todos os motores, ao final do processo de montagem, são abastecidos com óleo lubrificante SAE 15W40 e são enviados para as células de teste. Esse transporte é feito por paleteiras operadas manualmente.

Na célula de teste, o motor é conectado às tubulações de ar de admissão, *intercooler*, ar de escape, entrada e saída de água, alimentação e retorno de combustível.

Existem dois tipos de banco de teste: três bancos possuem equipamento de controle e aquisição de dados operado manualmente, enquanto os outros quatro bancos possuem equipamento de controle e aquisição de dados automático com o uso de microcomputadores com interface gráfica.

No primeiro caso, o operador segue a seqüência de teste manualmente e anota os valores obtidos numa ficha de teste. No segundo caso, a seqüência de teste é executada automaticamente por um programa e os resultados são armazenados em um banco de dados.

Após o procedimento de teste, os motores são despreparados e enviados a uma área de resfriamento antes de entrarem na linha de complementação e pintura.

- **Complementação e Pintura:**

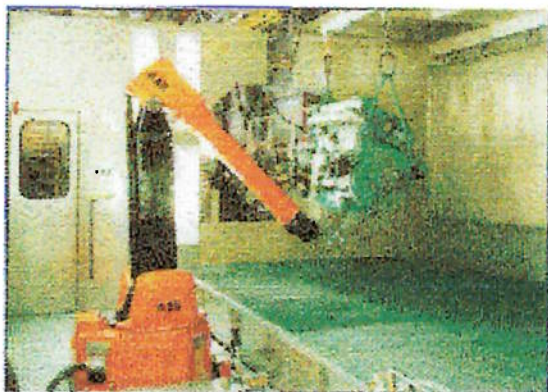


Figura 1-7 Pintura de Motores.

A complementação de motores é composta basicamente pela montagem da caixa de câmbio e das tubulações de ar, água e óleo lubrificante, bem como dos cabos elétricos (chicotes).

A linha é composta por 6 postos de montagem, sendo três antes e três após a cabina de pintura.

Os motores são transportados sobre paletes em um transportador de corrente antes e após a cabina de pintura. Esse transportador permite o avanço dos motores sem a necessidade de que a linha inteira se mova.

As peças são distribuídas ao longo da linha em prateleiras inclinadas com dois níveis.

Na região da cabina de pintura, há um transportador aéreo do tipo monovia circular com sistema *power & free*. A pintura dos motores é realizada por robô, proporcionando economia de tinta e solvente. Além disso, há um sistema de cortina d'água para a eliminação da borra de tinta.

Cerca de 20 pessoas trabalham nessa área.

1.3 Objetivos deste Trabalho

Este trabalho tem como objetivo apresentar todas as etapas do projeto de uma linha de montagem de motores diesel para aplicação em transporte pesado de bens e passageiros.

A partir do levantamento de uma necessidade, pretende-se seguir uma metodologia específica, mostrando o estudo de viabilidade e o desenvolvimento do produto até sua implementação.

Este trabalho será dividido em duas partes:

- Na primeira parte, será apresentado o estudo de viabilidade para o produto;
- Na segunda parte, o produto será definido e implementado até sua configuração final, quando estará pronto para entrar em funcionamento.

O produto final, ou seja, a linha de montagem de motores, deverá ser apresentado através da definição de um processo de montagem, de um arranjo físico, da especificação de equipamentos e do projeto de dispositivos de montagem.

Além disso, pretende-se simular a linha de montagem como um sistema dinâmico com o auxílio de um programa de simulação de sistemas de eventos discretos disponível no mercado.

PROJETO DE UMA LINHA DE MONTAGEM DE MOTORES DIESEL

Capítulo 2

METODOLOGIA DE PROJETO

2. Metodologia de Projeto

A metodologia de projeto utilizada é a mesma adotada pela SLA, que não difere muito da metodologia de projeto apresentada no curso de Engenharia Mecânica da Escola Politécnica.

A seguir, são apresentadas as definições de *projeto*, *processo* e *produto*:

- **Projeto**

Projeto é uma organização temporária a qual estabelece um objetivo a ser atingido. Esse objetivo deve ser atingido dentro de um prazo determinado e com a utilização de recursos disponíveis.

Dessa forma, um *projeto* pode ser visto como um conjunto de atividades às quais são atribuídos prazos e definidos recursos, tanto técnicos como econômicos. As atividades são designadas a pessoas responsáveis que, em conjunto, empregam os recursos disponíveis para atingir um objetivo comum, que é o *produto* final.

- **Processo**

O *processo* são os meios pelos quais se chegam aos objetivos. Podem-se distinguir dois tipos de *processo*: o *processo* de *projeto*, que são as etapas a serem seguidas para a solução do problema, e o *processo* de produção, que se caracteriza por ser repetitivo e conter instruções de COMO fazer determinada tarefa.

- **Produto**

O *produto* final nada mais é que a resposta ou solução de um problema verificado no início do *processo* de *projeto*, dando origem a este.

A etapas descritas a seguir constituem a primeira parte deste trabalho:

- **Estabelecimento da Necessidade:**

Dá início ao processo de projeto. Na SLA, as necessidades surgem de modificações na demanda de mercado, problemas de qualidade no campo, nova legislação e/ou regulamentação, surgimento de novas tecnologias de produção, sugestões de melhoria, propostas de fornecedores ou idéias de funcionários e clientes.

- **Estudo Prévio ou Síntese das Necessidades:**

O objetivo do estudo prévio é definir o projeto de forma a proporcionar uma base de decisão clara para que se possa prosseguir com a seqüência de projeto. Na SLA, o estudo prévio é realizado em um nível organizacional mais alto, ou seja, a nível de diretoria e/ou gerência. Neste caso, o estudo prévio foi realizado pela Gerência da Fábrica de Motores e foi passado para a Engenharia.

- **Estudo de Viabilidade:**

Durante o estudo de viabilidade, ou fase inicial de desenvolvimento, o produto é pré-definido, um grupo de projeto é criado e soluções gerais ou alternativas são geradas.

O capítulo 1 trata do estudo de viabilidade, que foi desenvolvido pela Engenharia de Montagem. Entretanto, a título de informação e para uma melhor compreensão do problema, foram apresentadas nos dois primeiros sub-itens do capítulo as etapas de estabelecimento da necessidade e de síntese das necessidades.

A segunda parte do trabalho será composta pelas seguintes etapas:

- **Projeto Básico:**

O ponto de partida dessa etapa são as alternativas de solução propostas no fim da fase de estudo de viabilidade e a escolha da melhor solução. Daí são elaborados os modelos para a compreensão do funcionamento do sistema. Na etapa de projeto básico, ou desenvolvimento de produto propriamente dito, o objetivo é o de se chegar à definição final do produto, de forma que se possa passar à etapa de implementação. Essa etapa é apresentada no capítulo 4.

- **Projeto Executivo:**

Nessa fase, o produto definido na etapa de projeto básico é convertido em realidade. As atividades necessárias para a implementação do produto são executadas pelas pessoas responsáveis seguindo um cronograma pré-estabelecido. O resultado dessa etapa é o produto final em funcionamento. Essa etapa é descrita no capítulo 5.

Capítulo 3

ESTUDO DE VIABILIDADE

3.1 ESTABELECIMENTO DA NECESSIDADE

3.2 SÍNTESE DAS NECESSIDADES

3.3 FORMULAÇÃO DAS CARACTERÍSTICAS DO PRODUTO E DEFINIÇÃO DO GRUPO DE PROJETO

3.4 SÍNTESE DE SOLUÇÕES

3. Estudo de Viabilidade

3.1 Estabelecimento da Necessidade

A crescente demanda por motores diesel com faixa de potência que atenda o mercado de caminhões para transporte em rotas de múltiplas paradas, dentro e em torno de cidades, bem como para transporte coletivo urbano, motiva a indústria automobilística nacional a investir em linhas de montagem de motores com as seguintes características:

- Potência adequada a esse tipo de transporte;
- Menor consumo específico de combustível;
- Baixo ruído;
- Menor quantidade de emissão de poluentes;
- Menor preço;
- Baixo custo de operação.

Neste caso, a SLA supre as necessidades de seus clientes com motores importados, montados em suas unidades de produção na Europa.

Os custos de transporte e as taxas de importação dificultam a comercialização em larga escala desses motores.

Portanto, tem-se a necessidade de se desenvolver um sistema de produção nacional baseado em uma linha de montagem que exija baixo investimento e que resulte no atendimento da demanda de mercado com um baixo custo de produção para a empresa.

3.2 Síntese das Necessidades

Verificou-se a necessidade do desenvolvimento de um novo processo de produção de motores diesel para caminhões e ônibus urbanos para atender a crescente demanda de mercado. Esse processo de produção deve se basear em uma linha de montagem.

Atualmente, o mercado desse tipo de caminhão e ônibus é dominado por empresas concorrentes e a SLA pretende aumentar sua participação nesse mercado.

A forte identificação que a empresa tem com o mercado de caminhões pesados e ônibus interurbanos é um fato que contribui para o sucesso do projeto, tanto na área técnica, como na área comercial.

A previsão é de que essa linha de montagem tenha uma vida em torno de cinco anos, que, normalmente, é o tempo de desenvolvimento de novos caminhões e ônibus dentro da SLA.

Acredita-se que esse tempo é suficiente para manter a produção em conformidade com as normas de qualidade, que estão em constante desenvolvimento e cada vez mais restritas.

Essa linha de montagem deve atingir os seguintes objetivos:

- Os índices de rejeição dos motores montados devem atingir os seguintes resultados: nenhuma ocorrência crítica por mês, no máximo uma ocorrência média por mês, no máximo três ocorrências simples por mês;

- A linha de montagem deve ser projetada para alta flexibilidade e disponibilidade;
- A linha de montagem deve ser instalada na área atual da fábrica de motores destinada a montagem;
- A capacidade de produção em primeira fase deve atingir 10 motores por dia em um turno de produção;
- O tempo de produção por motor deve ser de no máximo 6 horas;
- O esforço físico dos operadores deve estar em conformidade com as normas de segurança no trabalho;
- O índice de peças nacionais utilizadas no motor deve ser de no mínimo 39% do custo total das peças;
- O período de desenvolvimento do processo de produção não deve se estender por mais de 6 meses;
- O processo de instalação da linha de montagem não deve interferir na produção de outras linhas de montagem da fábrica de motores;
- O retorno do investimento deve acontecer em menos de três anos;
- O início de produção deve ocorrer em Novembro de 1998.

3.3 Formulação das Características do Produto e Definição do Grupo de Projeto

3.3.1 Características do Produto

O produto final deste projeto deve atender às seguintes características, que irão compor suas especificações técnicas:

Tabela 3-1 Características do Produto.

Característica	Especificação
Produto	Linha de montagem de motores diesel de 9 litros com 6 cilindros em linha turbocomprimidos
Área disponível	Área atual da fábrica de motores destinada a montagem
Especificações ambientais	De acordo com ISO 14001 (Sistema de Gerenciamento Ambiental)
Referência de qualidade	ISO 9002 (Qualidade Assegurada em Processo)
Fornecimento de energia elétrica	220 V, 60 Hz (tensão de operação) 440 V, 60 Hz (tensão de distribuição) 220 V, 60 Hz, 24 V CA ou 24 V CC (tensão de controle)
Fornecimento de energia pneumática	6,0 bar, sem óleo
Tempo de ciclo máximo da linha	8,0 min
Disponibilidade da linha	96%

Característica	Especificação
Número máximo de motores em montagem na linha	30
Número máximo de operadores na linha	40 por turno
Base de mercado	Caminhões de distribuição e ônibus urbanos

Especificações gerais considerando:

- Ambiente de trabalho e segurança;
- Interfaces entre equipamentos;
- Manutenção preventiva;
- Equipamento elétrico/eletrônico;
- Equipamento pneumático e
- Sistema de lubrificação

são encontradas no Apêndice 1.

3.3.2 Grupo de Projeto

Tabela 3-2 Grupo de Projeto.

Função / Atividade	Responsável
Líder do Projeto	Chefe Eng. de Montagem de Motores
Elaboração da Especificação Técnica	Carlson E. P. de Oliveira Marco A. M. Infantozzi
Desenvolvimento de Produto	Analista de Estrutura de Produto Carlson E. P. de Oliveira Marco A. M. Infantozzi
Desenvolvimento de Processos de Produção	Analista de Processos de Produção Carlson E. P. de Oliveira Marco A. M. Infantozzi
Estudo do Arranjo Físico e Endereçamento de Peças	Analista de Arranjo Físico e Endereçamento de Peças Carlson E. P. de Oliveira
Instalações Industriais	Eng. de Instalações Industriais Depto. de Suporte Industrial
Projeto de Ferramentas e Dispositivos	Projetista Eng. de Montagem de Motores Marco A. M. Infantozzi
Estudo de Tempos e Métodos de Trabalho	Analista de Tempos e Métodos Carlson E. P. de Oliveira Marco A. M. Infantozzi
Especificação de Equipamento de Produção	Analista de Processos de Produção Carlson E. P. de Oliveira Marco A. M. Infantozzi Depto. de Suporte Industrial

Função / Atividade	Responsável
Compra de Equipamento de Produção	Depto. de Compras: Equipamento de Produção
Compra de Material Direto de Produção	Depto. de Compras: Material Direto de Produção
Logística	Depto. de Logística e Abastecimento de Motores
Acompanhamento de Custos	Controle Econômico de Motores

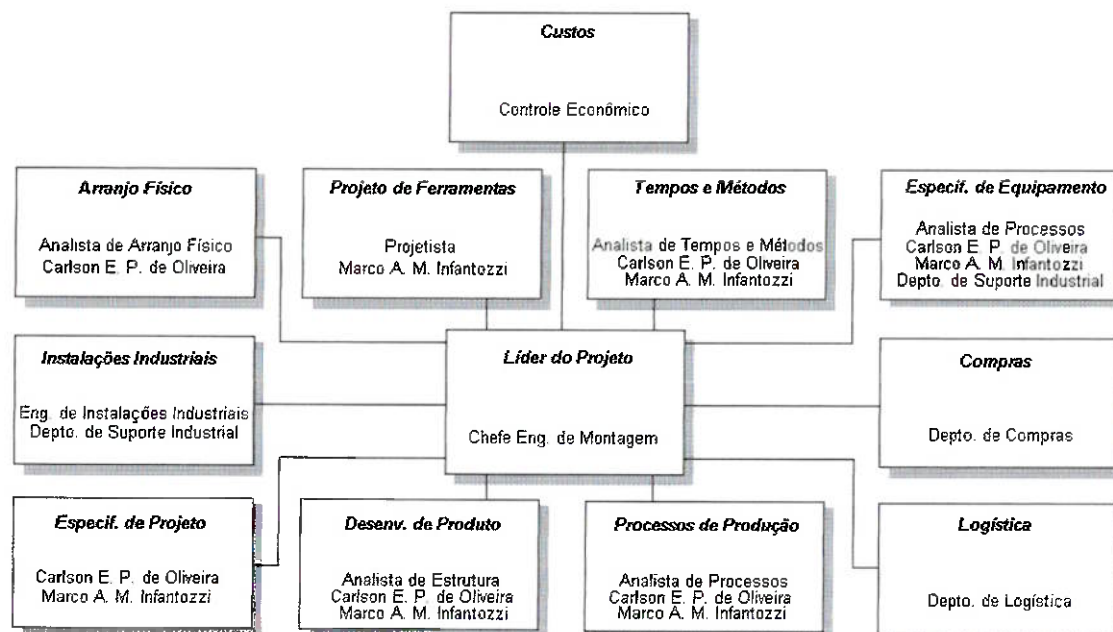


Figura 3-1 Grupo de Projeto.

3.4 Síntese de Soluções

A seguir, são apresentadas alternativas de processos de produção, arranjos físicos e equipamentos que poderão compor a linha de montagem de motores de acordo com suas especificações técnicas. Ao lado das alternativas, são descritos os prós e contras de cada uma delas, no que se refere a sua exeqüibilidade física, valor econômico e viabilidade financeira.

3.4.1 Alternativas de Processos de Produção

A. Importação do motor montado e testado; complementação de montagem e pintura realizadas no Brasil.

- **Exeqüibilidade Física:**

Essa alternativa representa a situação atual: os motores são importados restando somente a fase de complementação compreendida pelas seguintes operações: montagem da caixa de câmbio e da embreagem, pintura e montagem de peças complementares (cabos elétricos; tubulações de água, ar e óleo lubrificante).

Sendo esta a situação atual, não se observam problemas em sua execução, uma vez que o sistema descrito acima já se encontra implantado na SLA.

- **Valor Econômico:**

Por se tratar de um motor produzido no exterior, o custo da mão-de-obra utilizada em sua montagem contribui para que seu valor econômico seja bastante alto, quando comparado com o de motores similares produzidos na SLA.

As taxas de importação atuais dificultam a importação desses motores e há uma previsão do aumento dessas taxas a partir do ano 2000, com o fim do regime automotivo de importação.

Esse sistema gera um alto custo de estocagem dos motores. Os motores são transportados em grandes lotes com o objetivo de minimizar os gastos com o transporte e atender a demanda interna. Assim, tem-se a necessidade de uma grande área, destinada somente para o armazenamento desses motores.

- **Viabilidade Financeira:**

Do ponto de vista de viabilidade financeira, verifica-se que a situação atual é viável, porém representa uma solução instável já que depende de inúmeros fatores externos: custo da mão-de-obra estrangeira, política de importação nacional, variação cambial, dentre outros. Além disso, essa alternativa apresenta falhas quanto ao atendimento da demanda interna, já que os lotes de motores levam dois meses para serem transportados.

B. Montagem do motor completo com peças nacionais.

- **Exeqüibilidade Física:**

Para a produção do motor completo com peças nacionais, há necessidade do desenvolvimento de fornecedores de peças, dispositivos e equipamentos, além do projeto da linha e dos processos de usinagem e montagem. Assim, tendo em vista o espaço físico disponível e o prazo determinado para a conclusão do projeto, essa solução se torna inexecutável.

- **Valor Econômico:**

Do ponto de vista do valor econômico, essa alternativa garante que os motores produzidos tenham um baixo custo de produção, em virtude da utilização de peças e mão-de-obra nacionais, eliminando completamente os custos de importação.

- **Viabilidade Financeira:**

Essa alternativa apresenta um investimento que supera os recursos destinados a este projeto.

C. Montagem do motor completo com as principais peças usinadas sendo importadas da Europa.

- **Exeqüibilidade Física:**

Neste caso, temos uma situação similar à anterior sem a necessidade de desenvolvimento de processos de usinagem para as seguintes peças: bloco de cilindros, eixo-comando, camisas, pistões, bielas, árvore de manivelas e cabeçotes, que serão importadas.

- **Valor Econômico:**

Por se tratar de uma solução onde ocorre a importação das peças de maior custo, há um acréscimo razoável no custo final do motor em relação à alternativa anterior.

- **Viabilidade Financeira:**

Esta é uma alternativa que necessita de consideráveis investimentos no projeto da linha e dos processos de montagem. Entretanto, em uma primeira análise, ela se apresenta viável financeiramente, tendo em vista os recursos destinados a este projeto.

D.Importação do bloco do motor com as principais peças usinadas montadas incluindo a carcaça do volante; montagem final, teste, complementação de montagem e pintura realizados no Brasil.

- **Exeqüibilidade Física:**

A idéia dessa alternativa é aproveitar parte da linha de montagem existente atualmente nas unidades européias da SLA. A montagem das principais peças usinadas citadas no item anterior será de responsabilidade dessas unidades. A unidade brasileira será responsável pela montagem final, teste e complementação dos blocos pré-montados na Europa.

Sem a necessidade do desenvolvimento de um centro de usinagem, de fornecedores de peças e equipamentos mais complexos, essa solução se torna perfeitamente exeqüível, tendo em vista o espaço físico disponível e o prazo determinado para a conclusão do projeto. A unidade brasileira pode se concentrar em desenvolver um processo de montagem final que otimize o atendimento da demanda.

- **Valor Econômico:**

Essa solução é um meio termo entre as alternativas apresentadas nos itens A e B. O custo da mão-de-obra européia utilizada é reduzido ao mínimo necessário para a montagem das principais peças usinadas no bloco.

Proporcionalmente, os custos com taxas de importação e transporte são menores, em comparação com os custos do motor completo sendo importado, além da vantagem de que os blocos pré-montados ocupam menos espaço e podem ser transportados em lotes com maior quantidade de itens.

- **Viabilidade Financeira:**

Essa solução apresenta-se viável financeiramente, representando um real avanço em relação à situação atual, já que os blocos pré-montados ocuparão bem menos espaço de armazenamento dentro da fábrica e a sua configuração permite o atendimento da demanda com bastante flexibilidade, uma vez que motores para diversos tipos de aplicação podem ser montados a partir de um mesmo tipo de bloco.

E. Importação do bloco do motor com as principais peças usadas montadas excluindo a carcaça do volante; montagem final, teste, complementação de montagem e pintura realizados no Brasil.

- **Exeqüibilidade Física:**

A análise dessa alternativa quanto à exeqüibilidade física leva em consideração os mesmos fatores do item anterior.

- **Valor Econômico:**

O valor econômico agregado ao motor no fim desse processo é ligeiramente inferior ao do item anterior. A passagem da carcaça do volante de item importado pré-montado no bloco para item nacional montado na linha no Brasil tem influência na redução dos custos com taxas de importação e transporte dos blocos pré-montados.

- **Viabilidade Financeira:**

Da mesma forma que na alternativa anterior, essa solução apresenta-se viável financeiramente para a empresa.

3.4.2 Alternativas de Arranjos Físicos

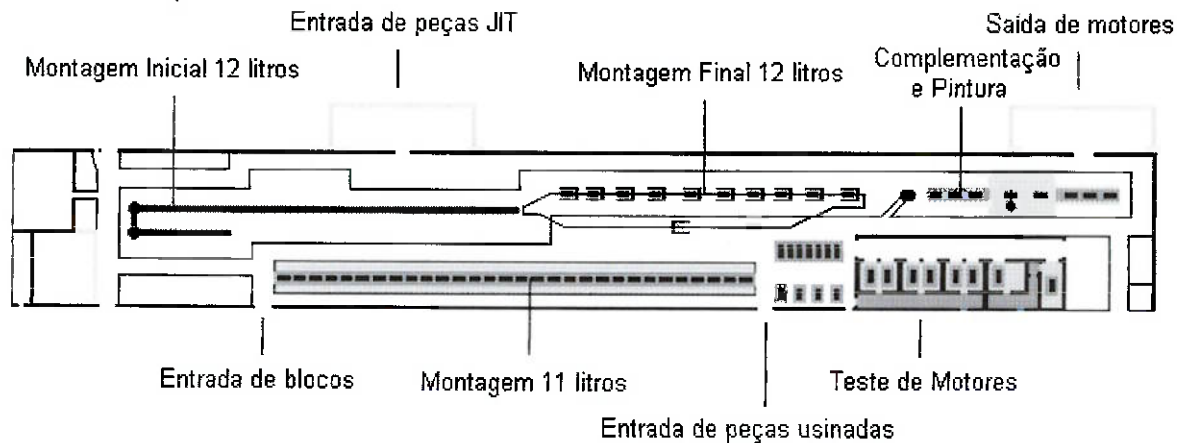


Figura 3-2 Arranjo Físico Atual.

A. Instalação da linha na área atual da linha de montagem de motores de 11 litros; os motores de 9 e 11 litros seriam montados na mesma linha com pequenas alterações na linha de montagem atual em termos de equipamento e com um trabalho de balanceamento de linha.

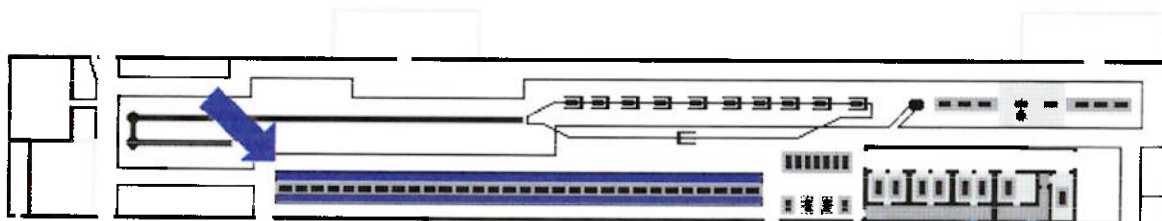


Figura 3-3 Instalação da linha na área de montagem 11 litros.

- **Exeqüibilidade Física:**

Com o lançamento do motor de 12 litros pela SLA, a demanda por motores de 11 litros teve uma queda significativa. Assim, por se tratar de uma linha com alta flexibilidade, a linha de montagem do motor de 11 litros pode

atender perfeitamente à produção não só destes últimos como também do motor de 9 litros. Dessa forma, pode-se unificar a produção de motores 9 e 11 litros sem problemas de atendimento da demanda desses motores e aproveitando o mesmo local que hoje é destinado somente à montagem de motores 11 litros.

- **Valor Econômico:**

A análise de valor econômico está mais relacionada com as alternativas de processo de produção. As alternativas de arranjo físico envolvem principalmente a análise de investimentos iniciais, que é feita no item seguinte.

- **Viabilidade Financeira:**

Essa solução não exige espaço extra e também minimiza os custos com equipamentos de montagem como: apertadeiras, pontes *KBK*, balancins, talhas, bem como equipamentos diversos para manuseio das peças já existentes na área de montagem. Dessa forma, essa solução se apresenta viável financeiramente.

- **Vantagens:**

Baixo custo de instalação;

Maior número de prateleiras disponível;

Curta interrupção da produção quando da introdução dos novos motores.

- **Desvantagens:**

Linha estática: o avanço da linha se dá ao mesmo tempo em todos os postos;

Há a necessidade de mais operadores na linha;

O tempo de montagem fica muito próximo do limite: 6 horas por motor.

B. Instalação de uma linha comum para montagem das principais peças usinadas nos blocos de 9 e 11 litros. Unificação das linhas de montagem final para motores de 9, 11 e 12 litros.

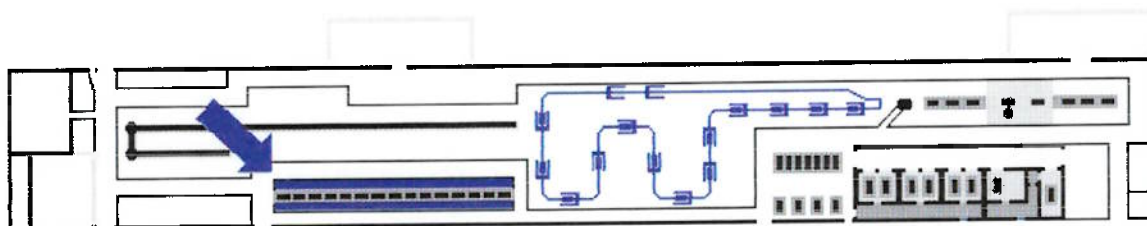


Figura 3-4 Unificação das linhas de montagem final para motores de 9, 11 e 12 litros.

- **Exeqüibilidade física:**

O conceito da linha unificada para os motores de 9, 11 e 12 litros segue o mesmo princípio da linha de montagem final do motor 12 litros. Por ser um sistema já implantado na SLA, verifica-se que o mesmo é exeqüível.

- **Valor Econômico:**

Aplica-se o comentário feito no item anterior.

- **Viabilidade Financeira:**

Essa solução se apresenta viável financeiramente, pois apresenta como principal investimento inicial a compra de novos AGV's e o rearranjo de seu trajeto.

- **Vantagens:**

Melhor utilização dos postos de trabalho;

Melhor ambiente de trabalho para o operador;

Possibilidade de redução do tempo de montagem: 4,4 horas por motor.

- **Desvantagem:**

Custo de instalação mais alto em relação à alternativa anterior.

C. Unificação das linhas de montagem final para motores de 9 e 12 litros.

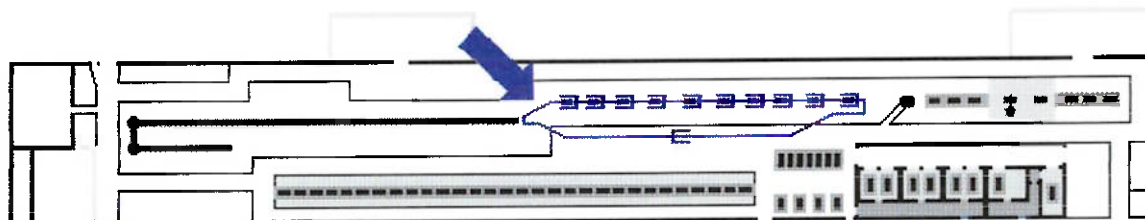


Figura 3-5 Unificação das linhas de montagem final para motores de 9 e 12 litros.

- **Exeqüibilidade Física:**

Por ser uma linha onde o motor é transportado através de carros guiados automaticamente por *LASER* (AGV's), a linha de montagem final dos motores 12 litros também é extremamente flexível e somente será necessário o desenvolvimento de suportes para o acoplamento do novo motor aos carros.

- **Valor Econômico:**

Esta é uma alternativa de arranjo físico. Portanto, envolve principalmente a análise de investimentos iniciais, que é feita no item seguinte.

- **Viabilidade Financeira:**

Em termos de viabilidade financeira, o equipamento necessário para a fixação do novo motor nos AGV's não gera investimentos significativos.

- **Vantagens:**

Baixo custo de instalação;

Curta interrupção da produção quando da introdução dos novos motores;

Melhor utilização dos postos de trabalho;

Melhor ambiente de trabalho para o operador.

- **Desvantagem:**

Necessidade de importação do bloco pré-montado com carcaça do volante.

D. Instalação da linha na área atual da linha de montagem de motores de 11 litros; os motores de 9 litros entrariam na linha a partir do ponto em que se inicia a montagem final; essa montagem seria feita na mesma linha para motores de 9 e 11 litros.

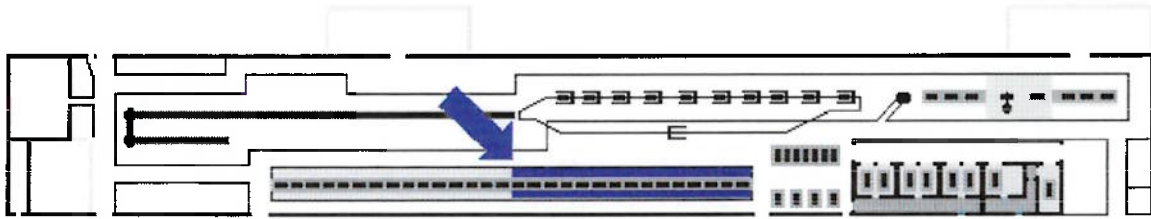


Figura 3-6 Instalação da linha na área de montagem final 11 litros.

- **Exeqüibilidade Física:**

Essa solução se assemelha muito com a solução proposta no item A, porém neste caso o motor é importado com parte de suas peças montadas (bloco de cilindros, camisas, pistões, bielas, cabeçotes, árvore de manivelas e eixo-comando de válvulas) das unidades européias. Na SLA, são montados os outros componentes do motor.

A idéia é de entrar com o bloco pré-montado do motor 9 litros na linha de montagem do motor 11 litros no ponto onde se inicia a montagem final deste último. Dessa maneira, evita-se a interferência na montagem dos dois tipos de motores.

Essa solução é exeqüível fisicamente, porém têm-se alguns problemas no balanceamento da linha e no projeto do transportador utilizado para a entrada do bloco pré-montado do motor de 9 litros na metade da linha.

- **Valor Econômico:**

Como alternativa de arranjo físico, essa solução não será analisada em termos de valor econômico.

- **Viabilidade Financeira:**

Como a maior parte dos equipamentos já utilizados na montagem do motor 11 litros são utilizados para o motor 9 litros, os investimentos para a execução dessa solução não são grandes a ponto de inviabilizar o projeto.

- **Vantagens:**

Baixo tempo de produção do motor;
Menor número de postos de montagem;
Maior número de prateleiras disponível.

- **Desvantagens:**

Linha estática: o avanço da linha se dá ao mesmo tempo em todos os postos;
Problemas com o balanceamento da linha.

3.4.3 Alternativas de Equipamentos

Sistemas de transporte:

A. Transportadores montados na estrutura do teto.

Adequados para a montagem final de componentes.

- **Vantagens:**

Alta flexibilidade de produção: aumento do potencial de capacidade de produção no nível do chão de fábrica;

Suporta larga faixa de carga;

Economia de espaço: libera área no chão de fábrica para outras atividades produtivas;

Economia de custos: possibilita o manuseio de mais volumes usando menos mão-de-obra;

Economia de tempo: possibilita um melhor fluxo de produção e melhor manuseio de material;

Ergonomia: elimina a necessidade de curvamento e estiramento do operador;

Cria um ambiente de trabalho mais confortável.

- **Desvantagens:**

Alto custo inicial;

Necessita de reforço na estrutura do teto da fábrica.

B. Transportadores montados sobre o piso.

Alternativas: transportadores por rolos de atrito ou transportadores com paletes.

Adequados para a montagem do bloco, árvore de manivelas, cabeçotes, eixo-comando e equipamento de injeção de combustível.

- **Vantagens:**

Baixo custo de manutenção;

Longa vida útil.

- **Desvantagens:**

Baixa flexibilidade de produção: dificuldade de adaptação com a evolução dos motores;

Mau fluxo de produção: dificuldade de adequar o tempo da linha com o tempo das diversas operações de montagem;

Mau manuseio de material: os componentes precisam ser alocados na medida do possível ao longo da linha;

Mau fluxo de pessoal: há a necessidade de escadas cruzando a linha;

Necessita de *pits* para retorno dos paletes, se essa alternativa for utilizada.

C. Carros guiados automaticamente por LASER.



Figura 3-7 Carros guiados automaticamente por *LASER*.

Adequados para a montagem de componentes como motor de partida, alternador, coletores de admissão e de escape.

- **Vantagens:**

Alta flexibilidade de produção;

Tempo de instalação reduzido;

Poucos problemas com possíveis defeitos;

Alta confiabilidade;

Suporta larga faixa de carga;

Ergonomia: elimina a necessidade de curvamento e estiramento do operador;

Cria um ambiente de trabalho mais agradável: o chão de fábrica fica livre.

- **Desvantagens:**

Alto custo de manutenção;

Precisão de posicionamento não tão boa quanto a de transportadores convencionais;

Necessita de melhoria nas condições do piso.

Prateleiras

A. Prateleiras horizontais com 5 níveis.

Este é o tipo de prateleiras presente atualmente na linha de montagem do motor 11 litros. Por possuir um maior número de níveis, estas proporcionam maior espaço para a alocação de peças e para uma linha de menor extensão é a mais indicada.

Assim, utilizando-se as prateleiras horizontais com 5 níveis, não há grandes problemas na sua adaptação para a alocação das peças novas.

B. Prateleiras inclinadas com 2 níveis.

As prateleiras inclinadas com 2 níveis apresentam maior ergonomia para o trabalhador, porém necessitam de grandes espaços para a alocação de peças.

Assim, se a linha de montagem a ser utilizada for de pequena extensão, têm-se grandes problemas na alocação das peças novas e necessita-se de áreas destinadas à separação de peças em *kits* para que estas, transportadas em carrinhos operados manualmente, supram a deficiência das prateleiras.

PROJETO DE UMA LINHA DE MONTAGEM DE MOTORES DIESEL

Capítulo 4

PROJETO BÁSICO

4.1 SELEÇÃO DA MELHOR ALTERNATIVA

4.2 MODELOS A SEREM ELABORADOS E DESENVOLVIDOS

4.3 RESULTADOS

4. Projeto Básico

4.1 Seleção da Melhor Alternativa

Na etapa de estudo de viabilidade, foram levantadas alternativas levando-se em consideração, basicamente, os aspectos de processo de produção, arranjos físicos e equipamentos. As possíveis soluções para o problema serão baseadas na combinação dessas alternativas.

Tabela 4-1 Quadro de Soluções.

Solução 1	Solução 2	Solução 3	Solução 4	Solução 5	Solução 6
Montagem do motor completo com peças usinadas importadas	Montagem do motor completo com peças usinadas importadas	Montagem do motor completo com peças usinadas importadas	Importação do bloco pré-montado com carcaça do volante	Importação do bloco pré-montado sem carcaça do volante	Importação do bloco pré-montado sem carcaça do volante
Área atual da linha de montagem do motor de 11 litros	Nova linha de montagem final p/ motores de 9,11 e 12 litros	Nova linha de montagem final p/ motores de 9,11 e 12 litros	Linha de montagem final p/ motores de 9 e 12 litros	Área atual da linha de montagem do motor de 11 litros	Linha de montagem final p/ motores de 9 e 11 litros
Transportador de corrente montado no piso	Transportador montado na estrutura do teto	Carros guiados automaticamente por <i>LASER</i>	Carros guiados automaticamente por <i>LASER</i>	Transportador de corrente montado no piso	Transportador de corrente montado no piso

A tabela 4-1 apresenta as soluções que se mostraram mais promissoras. A alternativa de importação do motor montado e testado foi descartada por representar a situação atual. A montagem do motor completo com peças nacionais foi considerada inviável, uma vez que envolveria custos elevados e demandaria um tempo maior que o estabelecido para a conclusão do projeto. Verifica-se que foram descartadas as soluções extremas, ou seja, a permanência da importação do motor completo e, por outro lado, a nacionalização completa do mesmo.

Para a escolha da solução que será implementada, será utilizada uma matriz de decisão, onde as soluções apresentadas na tabela 4-1 serão avaliadas quanto aos critérios de projeto apresentados na tabela 4-2.

Tabela 4-2 Critérios de Projeto.

Critério	Descrição	Peso (1-5)
Flexibilidade	A linha de montagem não deve sofrer alterações nas especificações dos equipamentos quando houver mudança no tipo de motor. Não há produção em lote. Não deve haver tempo de <i>setup</i>	3
Disponibilidade	A linha de montagem não deve parar por mais de 4% do tempo total disponível para a produção	4
Ergonomia	Os equipamentos da linha devem oferecer condições de trabalho adequadas ao operador	3
Segurança	Os equipamentos da linha devem apresentar condições de segurança exigidas pela legislação atual	4
Tempo para conclusão do projeto	O projeto deve estar concluído no final do tempo estabelecido	5
Custo da linha de montagem	O investimento para a implementação do projeto deve estar dentro do limite previsto	5
Custo do motor	O processo de produção elaborado deve garantir um custo do motor aceitável pelo mercado	4
Adequação ao arranjo físico atual	A linha de montagem não deve ocasionar mudanças nas instalações civis da fábrica	4
Facilidade de manutenção	Os equipamentos da linha devem permitir manutenção preventiva e facilidade de manutenção e/ou reposição no caso de falha	3

A matriz de decisão é apresentada na tabela 4-3.

Tabela 4-3 Matriz de Decisão.

Critério de projeto	Peso (1-5)	Soluções					
		1	2	3	4	5	6
		nota	nota	nota	nota	nota	nota
Flexibilidade	3	7	8	8	8	8	7
Disponibilidade	4	8	6	7	7	8	8
Ergonomia	3	6	8	9	9	6	6
Segurança	4	6	7	8	8	6	6
Tempo para conclusão do projeto	5	6	4,5	5	7	9	9
Custo da linha de montagem	5	8,5	4,5	6,5	8,5	9	8
Custo do motor	4	7	7	7	6	8	8
Adequação ao arranjo físico atual	4	9	4	5	9	9	8
Facilidade de manutenção	3	8	6	6	7	8	8
Média Ponderada→		7,3	5,9	6,7	7,7	8,0	7,6

A solução que deve ser implementada, portanto, é a solução 5, de acordo com a matriz de decisão.

4.2 Modelos a serem Elaborados e Desenvolvidos

Para a modelagem da solução obtida no item anterior, serão definidos conceitos de tipo de produção, funções a serem desempenhadas pelo produto e tipos de arranjo físico. Além disso, serão apresentados modelos matemáticos, como forma de se avaliar o desempenho desejado antes da implementação do produto.

4.2.1 Tipos de produção

Pode-se classificar tipos de produção de acordo com a quantidade de produtos fabricados e de acordo com a distribuição dos diversos tipos de produtos dentro de um programa de produção.

Seguindo essa classificação, pode-se destacar o seguinte:

- Produção especializada: para pequenos volumes e com grande variedade de produtos;
- Produção em lote: para volumes médios e com menos diferenciação entre os produtos;
- Produção em massa: para grandes volumes e com pouca ou nenhuma variedade de produtos.

No caso, a linha de montagem proposta deve apresentar um compromisso entre a produção de um volume médio de motores com relativa flexibilidade na distribuição dos mesmos no programa de produção. Isto se torna ainda mais importante, na medida em que haverá a produção de dois tipos de motores na mesma linha (D9 e D11) e que esses dois tipos apresentam variações de acordo com a sua aplicação. Vale ressaltar que essas variações apresentam oscilações no que se refere à demanda de mercado, daí a necessidade de um sistema de produção flexível.

4.2.2 Funções do processo de produção

Para os tipos de produção definidos no item anterior, existem funções básicas que devem ser seguidas para o processamento de tarefas que resultam no produto final. Essas funções são:

- Processamento;
- Montagem;
- Logística e manuseio de materiais;
- Inspeção e teste;
- Controle.

A linha de produção proposta requer o desenvolvimento das funções de montagem, logística e manuseio de materiais.

Montagem:

Em processos de montagem ou união de peças, a característica principal é que dois ou mais componentes separados são unidos. Nessa categoria, estão incluídas as operações de fixação mecânica que fazem uso de parafusos, porcas, rebites e assim sucessivamente e os processos de união, tais como solda e adesivos. Geralmente, na fabricação de um produto, as operações de montagem seguem operações de processamento (p. ex. usinagem).

Logística e manuseio de materiais:

Um meio de se movimentar e armazenar materiais antes, durante e após as operações de montagem deve ser providenciado. Na maioria das fábricas, os materiais levam mais tempo sendo movidos e armazenados do que sendo processados. Em alguns casos, a maior parte do custo de trabalho na fábrica é consumido no manuseio, movimentação e armazenamento de materiais. É importante que essa função seja executada da maneira mais eficiente possível.

4.2.3 Tipos de arranjo físico

O termo arranjo físico refere-se à disposição dos equipamentos na fábrica. Um arranjo físico adequado ao tipo de produção em massa não será apropriado para uma produção especializada e vice-versa. Existem três tipos principais de arranjos físicos:

- Arranjo físico de posição fixa;
- Arranjo físico por processo;
- Arranjo físico de fluxo de material.

Por se tratar de uma linha de montagem, este projeto será baseado em um arranjo físico de fluxo de material. Isto se deve ao fato de que os motores são conjuntos com montagens complexas realizadas em uma longa seqüência de operações. Nesse tipo de arranjo físico, os equipamentos de montagem são posicionados ao longo de uma linha de forma a realizar um processo de montagem “aditiva”. Nesse processo, uma série de peças discretas são adicionadas a uma outra em uma seqüência específica. A falta de qualquer componente ou a montagem indevida de componentes fora dessa seqüência ou fora de uma relação física adequada com outros componentes significa que o motor se torna imediatamente defeituoso.

4.2.4 Modelos de avaliação de desempenho

Lead time de manufatura (MLT):

Considerando as funções de montagem e manuseio de materiais dentro do tipo de produção e arranjo físico propostos, pode-se dizer que há uma distinção entre as funções produtivas e as funções não produtivas. Explica-se: entre as operações produtivas de montagem acontecem movimentações de materiais, armazenagens, inspeções e outras operações não produtivas. As atividades de produção efetiva acontecem quando a peça ou conjunto está sendo processado no equipamento ou estação de montagem. Define-se tempo operacional T_o o tempo por operação num equipamento ou estação de montagem e tempo não-operacional T_{no} o tempo não produtivo associado ao mesmo equipamento ou estação. Além disso, considera-se que existem n_m máquinas ou operações através das quais o motor deve passar até ser completamente montado e uma situação de produção em regime permanente, onde tem-se Q unidades de produção em processo. Desconsidera-se o tempo de *setup*, ou seja, não deve haver necessidade de se preparar cada unidade produtiva para cada tipo de motor que entre na linha.

Dessa maneira, pode-se definir o *lead time* de manufatura como o tempo total requerido para processar um motor ao longo da linha de montagem. A expressão resultante é da forma:

$$MLT = \sum_{i=1}^{n_m} (Q \cdot T_{oi} + T_{noi}) \quad \text{Equação 4-A}$$

onde i indica o número sequencial da estação de montagem; $i=1, 2, \dots, n_m$. A equação do *MLT* não leva em consideração o tempo em que as peças brutas ou desmontadas passam armazenadas antes de participarem do processo produtivo.

Para a linha de montagem de motores, considerando o tipo de produção e o arranjo físico a ser implementado, tem-se que todos os motores serão deslocados de um posto de montagem para o posto seguinte ao mesmo tempo. Assim, o tempo não-operacional entre os processos de montagem consiste simplesmente no tempo de transferência do motor de uma estação de trabalho para a seguinte. Como as estações de trabalho são integradas de maneira que os motores são processados simultaneamente em cada estação, a estação com maior tempo operacional definirá o valor de MLT . Daí, tem-se que:

$$MLT = n_m (\text{tempo de transferência} + m \times T_o) \quad \text{Equação 4-B}$$

Neste caso, n_m representa o número de postos de trabalho na linha de montagem.

Taxa de produção (R_p):

A taxa de produção para um processo de manufatura individual ou operação de montagem é frequentemente expressa como uma taxa horária (i.e. unidades de produto por hora).

A partir da equação 4-2, tem-se o tempo por unidade de produto T_p da linha de montagem:

$$T_p = \frac{MLT}{n_m} \quad \text{Equação 4-C}$$

A taxa de produção para a mesma linha é simplesmente o inverso do tempo por unidade de produto:

$$R_p = \frac{I}{T_p} \quad \text{Equação 4-D}$$

O problema que ocorre em linhas de produção desse tipo é a interdependência entre as estações de trabalho da linha. Se uma estação quebra, a linha inteira pára.

Componentes do tempo operacional:

Agora, serão considerados os componentes do tempo operacional T_o . O tempo operacional é o tempo que um componente leva em determinada estação. Entretanto, mesmo o tempo operacional, não é inteiramente produtivo. No caso de uma linha de montagem o tempo operacional engloba o tempo de manuseio de peças T_{mp} , o tempo de montagem propriamente dito T_{mpd} e o tempo de manuseio das ferramentas T_{mf} . Daí, tem-se:

$$T_o = T_{mp} + T_{mpd} + T_{mf} \quad \text{Equação 4-E}$$

O tempo de manuseio de ferramentas pode ser tanto o tempo de troca de ferramentas desgastadas ou defeituosas, como também o tempo de manuseio para levar a ferramenta até o local de execução da tarefa de montagem. Daí a importância de se ter ferramentas dispostas de uma maneira racional ao longo da linha.

Capacidade (PC):

O termo capacidade é usado para definir a máxima taxa de produção que uma planta é capaz de gerar dentro de um conjunto de condições operacionais assumido. A capacidade está intimamente relacionada à taxa de produção. As condições operacionais assumidas referem-se ao número de turnos diários, número de dias na semana que a planta está ativa, quantidade de força de trabalho e número de horas disponíveis por turno com ou sem horas extras. No

caso da linha de montagem de motores, tem-se a capacidade definida por turno de trabalho, o que é praticamente um padrão na indústria automobilística.

A medição quantitativa da capacidade de uma planta pode ser feita baseada nos modelos de produção descritos anteriormente. Seja PC a capacidade de produção da linha de montagem. A capacidade será medida como o número de motores produzidos por turno como dito anteriormente. Considera-se que a linha de montagem é capaz de produzir a uma taxa de produção R_p . Cada estação de trabalho opera durante H horas por turno. H é uma média que exclui o tempo de falhas e reparos, manutenção preventiva, atrasos provocados pelo operador e assim por diante. O tempo de *setup* é, mais uma vez, desconsiderado.

Esses parâmetros podem ser usados para calcular a capacidade de produção da linha de montagem como segue:

$$PC = H \cdot R_p \quad \text{Equação 4-F}$$

O modelo de capacidade de produção elaborado assume que não há gargalos que comprometam o fluxo de produção ao longo da linha de montagem. Isto se deve à própria concepção da linha em termos do tipo de produção e do arranjo físico. Para evitar que alguns postos de trabalho sejam sobrecarregados, enquanto outros permanecem em estado de espera, é necessário, para o caso da linha de montagem, um trabalho de distribuição de tarefas de maneira que os recursos produtivos sejam perfeitamente balanceados, com o objetivo de otimizar a capacidade de produção.

Utilização e disponibilidade:

Utilização U é o termo referente à razão entre a quantidade de produtos efetivamente produzidos e a capacidade total de produção:

$$U = \frac{\text{produção}}{\text{capacidade}} \quad \text{Equação 4-G}$$

O termo acima definido pode ser aplicado à linha inteira, a um equipamento da linha ou a qualquer outro recurso produtivo (i.e. força de trabalho). Por conveniência, a utilização é quase sempre definida como a proporção do tempo em que a linha está ativa em relação ao tempo disponível usado na definição de capacidade.

O termo disponibilidade é, às vezes, usado como uma medição da confiabilidade do equipamento. A disponibilidade é definida usando dois outros termos de confiabilidade, o tempo médio entre falhas $MTBF$ e o tempo médio de reparo $MTTR$. O $MTBF$ indica o tempo médio entre quebras de um equipamento. O $MTTR$ indica o tempo médio requerido para reparar o equipamento e colocá-lo de volta em operação:

$$\text{Disponibilidade} = \frac{MTBF - MTTR}{MTBF} \quad \text{Equação 4-H}$$

Estoque em processo (WIP):

Estoque em processo *WIP* é a quantidade de produtos dentro da fábrica que estão ou sendo processados, ou entre operações de processamento. Uma medição aproximada de estoque em processo pode ser obtida pela seguinte expressão:

$$WIP = \frac{PC.U}{H} . MLT \quad \text{Equação 4-1}$$

onde *WIP* representa o número de unidades em processo. A equação acima indica que o nível de estoque em processo será igual a taxa na qual os produtos fluem ao longo da fábrica multiplicada pelo tempo que os produtos passam na mesma.

4.3 Resultados

Os resultados da aplicação dos modelos elaborados no item anterior à solução escolhida podem ser vistos no Apêndice 7.

Foram feitas simulações para diversos valores dos parâmetros de avaliação de desempenho com o auxílio do aplicativo *Arena 3.0*, Systems Modeling, 1992-97.

Dessa forma, conseguiu-se verificar, antes da implementação do produto, a validade dos modelos elaborados e a adequação do desempenho da linha de montagem de motores aos critérios de projeto estabelecidos.

O disquete anexo contém o arquivo *projeto.avf* e o programa de visualização *Arena Viewer* para que a simulação seja reproduzida.

Vale ressaltar que a versão disponível do programa de simulação é uma versão acadêmica que, apesar de possuir todos os recursos da versão profissional, não permite a simulação de modelos de grandes proporções. Isto exigiu uma simplificação ainda maior da linha de montagem como, por exemplo, a redução do número máximo de postos de montagem de 30 para 15 sem, no entanto, comprometer os resultados obtidos.

Dentre os resultados obtidos pode-se destacar os seguintes:

- O *Lead Time* de manufatura foi de 163,55 minutos para os 15 postos de montagem simulados, para 30 postos seu valor seria de 327,10 minutos o que é inferior ao limite estabelecido de 360 minutos;

- Através de algumas atividades de cronometragem das operações de montagem observou-se que o tempo de ciclo da linha era inferior ao limite estabelecido de 8 minutos;
- Observa-se também que a capacidade da linha excede a demanda inicial fixada em 10 motores/turno. A capacidade observada na simulação foi de 36 motores, porém como haverá a produção de dois tipos de motores na linha de montagem tem-se uma divisão desta capacidade para cada um dos tipos de motor;
- Através do relatório emitido pelo programa de simulação utilizado pode-se observar, através da análise dos dados de fila antes de cada posto de trabalho, a ocorrência de gargalos na linha de montagem. Isto pode servir de ponto de partida para um trabalho de otimização no balanceamento da linha.

PROJETO DE UMA LINHA DE MONTAGEM DE MOTORES DIESEL

Capítulo 5

PROJETO EXECUTIVO

- 5.1 CRONOGRAMA DE ATIVIDADES*
 - 5.2 PROCESSOS DE PRODUÇÃO*
 - 5.3 ESTUDO DO ARRANJO FÍSICO E ENDEREÇAMENTO DE PEÇAS*
 - 5.4 ESPECIFICAÇÃO DE EQUIPAMENTO DE PRODUÇÃO*
 - 5.5 ESTUDO DE TEMPOS E MÉTODOS DE TRABALHO*
-

5.2 Processos de Produção

De acordo com os modelos utilizados para a linha de montagem no capítulo 4, será desenvolvido um processo de produção baseado na montagem “aditiva”.

Na elaboração do processo de montagem na linha de motores, foram seguidos os passos descritos abaixo:

- Análise do processo de montagem realizado na unidade europeia da SLA para o motor completo;
- Análise da estrutura de peças do motor;
- Desmontagem de um motor completo até o nível de bloco com peças usinadas e posterior montagem em separado (i.e. fora da linha).

O grande número de peças existente na estrutura de um motor e de suas variantes não deve gerar uma sequência de montagem complexa. Esta é a razão pela qual foi desenvolvido um trabalho de criação de conjuntos de peças a fim de que a sequência de montagem se tornasse viável quanto aos seguintes aspectos envolvidos no desenvolvimento deste projeto:

- Aspectos de arranjo físico e logística;
- Aspectos de investimentos em equipamentos e dispositivos.

Esses conjuntos são apresentados na tabela 5-1.

Tabela 5-1 Conjuntos Pré-montados.

Conjunto	Descrição
01	Turbocompressor
02	Freio motor
03	Filtro de óleo
04	Filtro de combustível
05	Bomba injetora
06	Compressor de ar
07	Motor de partida
08	Tubo d'água
09	Coletor de admissão
10	Bomba d'água
11	Cárter de óleo
12	Carcaça das engrenagens do motor

Vale ressaltar que o processo de produção proposto deve manter o equilíbrio entre a produção de parte do motor na Europa, a facilidade do transporte desse conjunto, o aproveitamento do equipamento já existente, a facilidade no desenvolvimento de fornecedores no Brasil e a adequação do arranjo físico atual à produção de dois tipos de motores.

A tabela 5-2 mostra o resultado da sequência resultante para as principais tarefas de montagem.

Tabela 5-2 Sequência de Montagem.

Atividade	Descrição	Observação
01	Montagem da carcaça de distribuição	Junta/vedação aplicada
02	Montagem da engrenagem do eixo-comando	
03	Montagem da engrenagem intermediária de transmissão	
04	Montagem da carcaça do volante	Dep. montagem anterior
05	Montagem do volante	Dep. montagem anterior
06	Montagem da bomba injetora	
07	Montagem da tampa de distribuição	Junta/vedação aplicada
08	Montagem dos balancins	Pré-montados
09	Regulagem da folga das válvulas	
10	Montagem dos bicos injetores	
11	Montagem de tubo de retorno de combustível	
12	Montagem das tampas dos cabeçotes	Dep. montagem anterior
13	Montagem da bomba d'água	Pré-montada
14	Montagem do coletor de escape	
15	Montagem do compressor de ar	Pré-montado Dep. montagem anterior
16	Montagem do turbocompressor	Pré-montado Dep. montagem anterior
17	Montagem do freio motor	Dep. montagem anterior
18	Posicionamento do alternador	Não dar aperto
19	Montagem da bomba hidráulica	

Atividade	Descrição	Observação
20	Montagem do amortecedor de vibrações	
21	Montagem da suspensão dianteira do motor	
22	Montagem da serpentina do motor	
23	Montagem do coletor de admissão	
24	Montagem do filtro centrífugo	
25	Montagem do motor de partida	
26	Montagem de tubulação de pressão de combustível	
27	Montagem da correia do motor	
28	Montagem do cárter de óleo	

A seqüência acima será alocada na linha de montagem, de modo a manter, na medida do possível, tarefas semelhantes para os dois tipos de motores num mesmo posto, com o objetivo de reduzir custos com equipamentos e dispositivos de montagem.

As montagens das peças pequenas serão distribuídas ao longo dos trinta postos da linha atual, a fim de se obter um balanceamento mais próximo do ideal para a linha de montagem.

A seqüência completa de montagem para os motores de 9 litros encontra-se no Apêndice 3.

Os desenhos de montagem/listas de peças encontram-se no Apêndice 6.

5.3 Estudo do Arranjo Físico e Endereçamento de Peças

O arranjo físico adotado foi o que é descrito no sub-item A de 3.4.2. A linha foi instalada na área da linha de montagem de motores 11 litros.

O Apêndice 3 apresenta o endereçamento de peças para cada posto de montagem e o Apêndice 4 mostra em detalhes o arranjo físico definitivo.

5.4 Especificação de Equipamento de Produção

A especificação do equipamento de produção teve por base os documentos mostrados no Apêndice 1 e 2.

A desmontagem de um motor completo até o nível de bloco com peças usinadas e posterior montagem em separado como mencionado no item 5.2 serviu para definir grande parte dos dispositivos e ferramentas a serem utilizados.

A relação completa das ferramentas de montagem encontra-se no Apêndice 3.

O Apêndice 5 mostra parte de um catálogo da *Atlas Copco* utilizado para a escolha das ferramentas.

5.5 Estudo de Tempos e Métodos de Trabalho

O estudo de tempo e métodos de trabalho teve por base o tempo padrão do motor D11.

Esse estudo permitiu o cálculo da mão-de-obra a ser utilizada na linha de montagem.

Em virtude do processo não ter sido completamente assimilado pelos operadores, não é possível que a tomada de tempo nessa etapa de início de produção produza valores confiáveis.

Entretanto, os primeiros resultados da linha de montagem permitem dizer que o tempo médio com a mão de obra disponível garante os objetivos propostos de volume e custo de produção estabelecidos no início do projeto.

Capítulo 6

RESULTADOS E DISCUSSÃO

6.1 RESULTADOS

6.2 DISCUSSÃO

6. Resultados e Discussão

6.1 Resultados

A chegada dos blocos pré-montados ocorreu dentro do prazo estabelecido e desta forma o novo processo de produção dos motores de 9 litros teve seu início na data programada. Deve-se salientar que na primeira quinzena de produção registrou-se um volume de produção inferior ao esperado devido aos seguintes fatores:

- Falta de orientação dos operadores com relação aos processos de montagem;
- Falhas no endereçamento e na alocação das novas peças.

Em virtude disso, a Engenharia de Montagem teve que realizar um trabalho de acompanhamento da montagem dos primeiros motores juntamente com os operadores da linha. Dessa forma, realizou-se um processo de treinamento em paralelo com a produção dos motores. Isso pode ser tomado como um ponto falho no processo de projeto da linha de montagem que não previu um período de treinamento do pessoal de produção.

Apesar disso, os resultados obtidos a partir da segunda quinzena permitem dizer que o novo processo de produção é capaz de atender aos objetivos propostos no início do processo de projeto.

6.2 Discussão

As falhas observadas no item anterior poderiam ter sido evitadas se os atividades de elaboração dos processos de montagem e de endereçamento de peças fossem realizadas com maior antecedência e em conjunto com os próprios operadores.

A introdução do novo processo de produção dos motores de 9 litros se deu em uma época em que a produção do motor de 11 litros apresentava baixos volumes. A não ocorrência de problemas no balanceamento da linha nesse período deve ser encarada com cuidado, pois o aumento no volume de produção esperado para os motores de 11 litros no ano de 1999 deve causar interferência nos resultados de produção destes motores.

Com isso deve-se realizar um trabalho de otimização da produção, desenvolvendo não só um balanceamento de linha mais adequado, como também obtendo uma seqüência de montagem de produtos que seja eficiente para uma grande variação da programação de produção, que é dirigida pelo mercado.

Capítulo 7

CONCLUSÕES

7. Conclusões

As conclusões obtidas e o conhecimento adquirido como o término deste projeto são mostradas a seguir:

- O objetivo do presente projeto foi alcançado, porém serão necessárias atividades de melhoria contínua do processo para que este atenda aos planos de produção para o ano de 1999;
- Os problemas ocorridos na primeira quinzena de produção poderiam ser evitados através de um programa de treinamento ministrado aos operadores da linha de montagem antes da data de introdução do projeto;
- As atividades de endereçamento de peças e de elaboração dos processos deveriam envolver os operadores da linha de montagem para uma maior familiarização destes com o novo produto e com o processo de produção;
- A simulação da linha de montagem no software ARENA teve que ser bastante simplificada e, com isso, não foi possível a determinação de problemas de endereçamento de peças e de desbalanceamento da linha observados nos primeiros dias de produção.

Referências Bibliográficas

- _____. *Assembly Automation*. Bradford, MCB University Press, 1996-97.
- _____. *Automotive Handbook*. Stuttgart, Robert Bosch, 1996.
- _____. *Industrial Robot*. Bradford, MCB University Press, 1996-97.
- _____. *Material Handling News*. London, Reinhold Publishing, 1997-98.
- ALVES, M. A. L.; KAMINSKI, P. C.; MASSARANI, M.; RAMOS Jr., R.; SALVAGNI, R. de B. *Metodologia de Projeto*. São Paulo, EPUSP-PMC, 1997.
- CHANG, T. C. & WYSK, R. A. *An Introduction to Automated Process Planning Systems*. Englewood Cliffs, Prentice Hall, 1991, pp. 291-331.
- FRANCIS, R. L. & WHITE, L. F. *Facility Layout and Location: an Analytical Approach*. Englewood Cliffs, Prentice Hall, 1992.
- GROOVER, P. *Automated Production Systems and Computer Integrated Manufacturing*. Englewood Cliffs, Prentice Hall, 1986, pp. 1-41.
- MUNDEL, M. E. *Motion and Time Study: Improving Productivity*. Englewood Cliffs, Prentice Hall, 1991.
- TURTLE, Q. C. *Implementing Concurrent Project Management*. Englewood Cliffs, Prentice Hall, 1994.
- WANG, H-P & LI, J-K *Advances in Industrial Engineering*. Amsterdam, Elsevier, 1991.
- OLIVEIRA, C.E.P. *Projeto de uma Linha de Montagem para Motores Diesel*, EPUSP, 1998.

APÊNDICE 1

Especificação de Equipamento de Produção

**SCANIA**

TECHNICAL REQUIREMENTS FOR PRODUCTION EQUIPMENT

Introduction

This document is intended to form the basis for tenders and procurement of production equipment. In the context of inviting tenders, it shall be regarded as a complement to the specifications for the equipment in question.

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A GENERAL

A 1 OBJECTIVE

The objective of this document is to ensure that the equipment in question is reliable and safe to personnel by virtue of its ergonomically correct design, while affording a high level of availability and low maintenance costs. The equipment shall be designed to facilitate fault tracing, repair, status inspection and cleaning.

A 2 VALIDITY

The document is valid within Scania Trucks & Buses, Scania-Bussar AB, Sweden and Saab Automobile AB, Södertälje, and comprises a supplement to the standards and requirements quoted herein.

A 3 PROCUREMENT

A 3.1 NON-CONFORMITY

Any deviations from these requirements must be stated in the tender. If not, it will be assumed that all costs necessary to achieve compliance with Scania's requirements are included in the tender.

A 3.2 SUB-CONTRACTORS

The requirements also apply to sub-contractors to the main bidder.

A 3.3 PRELIMINARY INFORMATION

The following preliminary information shall be included in the tender:

- Dimensions
- Weights
- Specification of services
- Foundation requirements
- Layout
- Single-line diagram of electrical supply system
- Description of operation
- Machining layout
- Fixture drawings
- Chemicals e.g. lubricants, cutting fluids
- Machine accuracy test, example (H 3)

A 3.4 BINDING INFORMATION

Binding information as listed in A 3.3 above shall be supplied prior to delivery, at a date to be determined during procurement. The fuse rating required for the incoming power supply shall be specified.

A 3.5 SPARE PARTS

The tender shall include a list of recommended spare parts.

A 3.6 CONNECTION OF SERVICES

The complete installation shall be designed for connection to a single supply point in respect of each service.

A 4 MISCELLANEOUS

A 4.1 PAINTING

The equipment shall be primed and finished with impact-resistance machine paint capable of withstanding the process environment (e.g. emulsions), in a light colour as agreed.

A 4.2 LEAKAGE

The equipment shall be enclosed and sealed to prevent the escape or leakage of machining chips, cutting fluids, lubricants etc. onto the floor or into the atmosphere.

B WORKING ENVIRONMENT AND SAFETY

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B WORKING ENVIRONMENT AND SAFETY

B 1 MACHINE SAFETY - ERGONOMICS

Basic requirements are contained in the regulations of the Swedish National Board of Occupational Safety and Health (ASS) and in Swedish standards.

The following regulations represent the minimum acceptable standard from the safety aspect, and are intended as a complement to statutory regulations, standards and recommendations.

Appendices B2 and B3 contain information on current legislation, standards etc.

N.B. Other standards etc., if adopted, shall be approved by the Manufacturing/Assembling Manager responsible, following consultation with the maintenance manager and safety engineer.

B 1.1 GENERAL

B 1.1.1 Automated equipment

Special attention shall be paid to the following in the case of mechanical equipment which includes industrial robots, gantry robots or other automated equipment:

- Location and layout of operating stations
- Location and layout of necessary observation stations, access ways, observations windows etc.
- Physical definition of working area
- Need for fault diagnostic systems, with the aim of reducing risk of incorrect action following machine stoppage or operating disturbance
- Design and location of barriers/fencing

Starting and stopping functions

- Selection of operating mode

N.B. A layout drawing showing the safety zone classification shall be submitted!

B 1.1.2 Delineation of working area

Equipment must not be capable of movement outside the designated working area. Mechanical stops or adjustable, forced-operation limit switches shall be installed as required. Protective devices of this nature shall be enclosed/protected to eliminate any risk of damage.

B 1.1.3 Stored energy

Energy stored in compressed air systems, spring-loaded parts, hydraulic systems or capacitors shall not be capable of dangerous movement or otherwise presenting a risk of injury to personnel.

B 1.2 OBSERVATION AND ACCESS

In automated production plants, it is frequently necessary to observe machine movements at close range. Such observation shall be feasible from outside the danger area and may be achieved by providing observation windows or suitable platforms, or by installing pressure-sensitive mats, safety light curtains etc.

- Walkways in or adjacent to the machine shall be at least 0.7 m in width, except in the vicinity of robots, where 0.5 m will be acceptable. The height of an access way shall be at least 2.1 m. The same requirements shall apply, for example, to the space between two units of a machine group, transfer machine etc.
- Access ways shall, as far as possible, be arranged at floor level.

B 1.3 OBSERVATION WINDOWS - LIGHTING - VDU

Observation windows:

- shall be positioned so as to satisfy viewing requirements;
- shall be of adequate strength (mountings included);
- shall be washable and scratch-resistant.

Machine lighting:

- shall be installed on the inner side of barriers and observation windows;
- shall be non-reflective and cleanable;
- shall withstand liquids and dust particles from the prevailing environment.

A VDU comprising part of the production equipment:

- shall be located with its horizontal centre line 1.4-1.6 m above the floor/working platform if the operator is standing and 1.1-1.3 m above if the operator is seated;
- shall, if movable, be easily adjustable at least within the above heights.

B 1.4 LIFTING EQUIPMENT

Lifting equipment supplied with the production equipment/machine shall, in all cases, be accompanied by a certificate of approval issued by a notified body.

Automatically operated lifting tables, turning tables, elevators and other transport equipment shall be enclosed/protected to eliminate the risk of injury by crushing and prevent access to hazardous areas.

B 1.5 CONTROL - OPERATION

B 1.5.1 Safety system - general

The system used to ensure the safety of personnel shall, as far as possible, be designed to suit production requirements. Among other factors, this means that it shall be possible to restart the equipment quickly and safely.

Personnel safety shall take precedence over production requirements at all times!

The **personnel safety** system shall consist of **safety stop** and **emergency stop** devices. Safety circuits for these functions shall be **described and shown by the supplier** in separate drawings/descriptions.

Safety stop functions, such as limit switches in safety circuits, light curtains etc., as well as **emergency stop** and **machine stop** functions are to be **hardware-based**. In other words, a device of this type shall provide a physical break by operating a relay, switch etc. This means that these functions must not be software-based or otherwise dependent on electronic circuits.

Safety circuits shall be based on relays of a design such that the function is self-monitoring. All safety circuits shall be based on relay logic and standing current connection (opening when deenergised).

The activation of safety stop or emergency stop devices shall interrupt all existing program signals. However, due allowance shall be made for ease of restarting.

B 1.5.2 External signals

Control signals to or from other machines must not give rise to dangerous or unexpected movements of the machine or equipment, regardless of the manner of stoppage, or when operating in the manual mode.

B 1.5.3 Safety stop in section of equipment

The machine control system shall incorporate means of implementing a **safety stop** in one section of the equipment while other sections continue in operation.

- This applies to items such as gantry robots vis-à-vis the machines which they serve, individual stations in transfer machines and robot-charged machine groups. Adjacent equipment which may create a hazard in a safety stop zone shall be interlocked on a 'hardware' basis (mechanically or electrically).

B 1.5.4 Selection of operating mode

The operating mode shall be selected by means of a rotary switch with clearly legible positions.

- Starting and stopping devices must be activated to start and stop the various operating modes.
- The current stage in the sequence shall be displayed.

Manual operation

- All sub-movements shall be started/controlled by manual activation of the controller for the movement in question.
- Manual operation shall be carried out from a control panel, apparatus cubicle door or a portable control device (e.g. pendant). However, starting shall be possible from only one point at any time.
- A sub-movement likely to present a risk of injury to personnel must not be designed for starting by a signal from a device such as a time-delay relay or by activation of a limit switch by the workpiece.

Automatic operation

Overriding of a safety function shall not be permissible, except as described under 'Overriding with hold-to-run control device' as per B 1.8.

semi-automatic/setting-up mode

- To be installed only as required.
- When a sub-sequence is started, its extent must be clearly apparent and the sequence shall be visible from the operating station if it involves a risk of injury to personnel. The danger zone must be inaccessible from the operating station.

B 1.5.5 Operating station

Control cubicles and operating devices for automatic operation **must** be located outside safety devices/barriers, if installed.

- This shall also apply to operating devices and equipment which may require service or inspection (where feasible).
- A device is allowed to be operated from a location inside a safety screen/barrier if each individual movement is started manually.

B 1.5.6 Resetting and restarting

The control equipment shall include provision for safe, rapid restarting after an emergency stop or activation of a stop device, regardless of the point in the program at which the machine was stopped.

Restarting following activation of a safety device shall be possible only when the reset pushbutton has been operated in acknowledgement. This pushbutton shall be located in a position which is inaccessible to an individual inside a barrier or in the danger zone and affords a satisfactory view of that zone.

B 1.6 STARTING - STOPPING

B 1.6.1 Starting

Starting of the equipment and the initiation of automatic operation shall be performed by manual operation of the starting device.

B 1.6.2 Stopping

A stopping device shall be provided at every starting device.

- A stopping device shall consist of a flat, red pushbutton, which must not be recessed.

B 1.7 EMERGENCY STOP - FREEING OF TRAPPED INDIVIDUAL

B 1.7.1 Emergency stop - general

An emergency stop shall be operative regardless of the operating mode, even when part of the equipment is disabled or shut down.

- In addition to stopping the equipment in a safe manner, activation of an emergency stop shall relieve or isolate stored energy.

B 1.7.2 Emergency stop - machine

An individual machine or station within a machine group shall be equipped with an individual emergency stop as follows:

- The device shall consist of a red, hemispherical pushbutton with a maximum diameter of 40 mm.
- The location of the pushbutton shall be such that no confusion can exist regarding the operating station, for example, with which it is associated.

B 1.7.3 Emergency stop - machine group

An emergency stop for a machine group consisting of several individual machines, whether interconnected or comprising a single unit, as well as for transfer machines and similar equipment, shall be arranged as follows:

- The device shall consist of a red, hemispherical pushbutton with a minimum diameter of 60 mm and/or, if considered appropriate, a clearly marked emergency wire.
- The device(s) shall be located at strategic points outside the working area.
- All machines in the group shall be stopped when an emergency stop device is actuated.

B 1.7.4 Freeing of trapped individual

Provision shall be made for freeing an individual trapped in the machine, even if a safety or emergency stop has been operated.

- This may require certain machine elements to be manually reversible or the direction of movement to be reversible.
- Reversing instructions shall be supplied.

B 1.8 SAFETY DEVICES - HOLD-TO-RUN DEVICE/ENABLING DEVICE

A simple hold-to-run control device may be mounted on the control panel or incorporated in a portable control or programming unit. These must be used only in combination with enabling device in the 'manual' or 'semi-automatic/setting-up' mode.

- Operation using a hold-to-run device control may be carried out only with hazardous machine movements operating at reduced speed to reduce stopping times/distances.

An enabling device used in a danger zone during automatic operation shall be of the **three-position type**. A safety stop impulse shall be transmitted when the button is released from the distinct mid-position.

- Entry to the danger zone during automatic operation shall be permissible only when absolutely necessary as part of installation, setting-up and fault tracing activities.
- A three-position enabling device shall be housed in a special holder with a key function. Alternatively, a key switch may be used to switch in the three-position enabling device.
- Overriding of an interlock to permit entry and exit through a safety gate shall be permissible for a period of 5 seconds. A longer period may be permitted only in special circumstances.

B 1.9 SAFETY DEVICES - TWO-HAND CONTROLS

Two-hand controls used to protect personnel shall be of a type approved for presses or shall be of an equivalent safety class.

- The control shall be placed within normal reach of the operator, subject to a sufficient safety distance, $S (= 1.6 \text{ m/s} \times \text{stopping time})$.

B 1.10 SAFETY DEVICES - MACHINE TOOLS

A rotating spindle on drilling, threading or milling machines with manual charging facilities shall be equipped with a device which stops the spindle automatically in the retracted (charging) position.

Jigs and fixtures shall be equipped with two-hand controls or other, equivalent safety devices, such as physical enclosure, if there is a risk of injury by crushing.

B 1.11 SAFETY DEVICES - BARRIERS

A dangerous machine area shall be protected by a mechanical barrier or non-contact safety device. The following shall apply if barriers are used:

- The barrier shall comply with the relevant standards specified in Appendix B3.
- The minimum height shall be 1400 mm.
- The clearance between the barrier and floor shall be a maximum of 300 mm.
- The distance between the barrier and a moving machine component shall be at least 500 mm. A distance of 200 mm may be accepted in exceptional cases following consultation with the safety engineer and the safety officer responsible.

- A barrier shall, if possible, be of a transparent material or provided with observation windows. The material shall be scratch-resistant and washable.
- Wire mesh may be used only up to a height of 1400 mm or if there is no 'good visibility' requirement.

B 1.12 SAFETY DEVICES - GATES/HATCHES - INTERLOCKS

Gates/hatches in barriers and machine doors/hatches which can be opened or removed easily without tools shall be interlocked with the safety stop function.

- If the door or hatch is used very seldom, a lock or bolted joint may be used as an alternative to an interlock.

Switches shall be of the forced-operation type and type certification shall be supplied. A switch shall also be designed and installed so that it can not easily be bypassed or disabled.

B 1.13 SAFETY DEVICES - NON-MECHANICALLY ACTUATED SAFETY DEVICES

Non-mechanically actuated safety devices shall be type-approved or shall be of an equivalent safety class.

- Automatic restarting may be permitted only when an individual cannot enter or be present in the danger zone without triggering the safety device. This shall be approved, in each individual case, by the Manufacturing/Assembling Manager responsible for the area, following special risk analysis. Risk analysis reports shall be documented and filed together with other documentation.

B 1.14 SAFETY STOP DEVICES

Devices such as limit switches in safety gates, safety strips, light curtains, hold-to-run control device and similar stopping devices shall be connected to the safety circuit for interrupting dangerous machine movements.

B 1.15 OVERRIDING OF SAFETY FUNCTION

A safety function may need to be overridden in extremely special circumstances. Such provision may be made by decision of the Manufacturing/Assembling Manager responsible, following special risk analysis. Risk analyses shall be documented and filed with other documentation.

- The function may be overridden only in the 'manual' and 'semi-automatic/setting-up' mode, except when operating with a three-position enabling device.

- Rotary switches for overriding safety functions shall be lockable by means of a key unique to the equipment or machine.
- The sections of the safety function which are overridden shall be clearly evident.
- Starting impulses for sections of the automatic program, which are issued prior to overriding of a safety function, must be cancelled when the function is overridden.

B 1.16 OPERATION AND MAINTENANCE

Production equipment shall be designed to facilitate maintenance, for example by providing access ways of suitable design and location, as well as adequate space.

- Access ways are dealt with in B 1.2.
- Working space shall be at least 1.0 m in depth.
- Service access in front of an openable HT electrical cubicle shall be at least 1.2 m.
- Equipment which requires frequent inspection and/or service, such as checking of level gauges, shall be installed in an easily accessible location, preferably outside the danger zone.

B 2 NOISE - VIBRATIONS

B 2.1 NOISE IN WORKING AREAS

The following requirements shall apply:

- Specified noise levels include machining noise as measured over at least one representative working cycle.
- The maximum permissible equivalent noise level, L_{eq} , under normal production requirements shall be 75 dB(A).

If the concept of 'normal production' cannot be established, the equipment shall be operated at maximum load (max. feed and max. speed without machining in the case of a machine tool).

- A value of L_{max} 65 dB(A) shall not be exceeded in the case of equipment, such as pumps and process ventilation equipment, which continuously generates the same noise level. This shall also apply to idling noise from ancillaries, such as hydraulic equipment, which continuously generates the same noise level.

- Maximum noise level, L_{max} : 85 dB(A)
- A value of $L_{eq} = 90$ dB(C) shall not be exceeded.

Measurement points, numbering at least four, shall be located as specified in Appendix B1.

The measurements shall be performed with IEC 651, type 1 sound level meter using setting "Fast".

Soundproofing material:

- shall consist of fireproof or fire-resistant material;
- shall not contain chlorine or other substance which may form products hazardous to humans and/or buildings/equipment in the event of fire.

B 2.2 VIBRATIONS

Vibrations, if any, from floors, platforms etc., which may affect personnel, shall be reported in accordance with Swedish standards.

- Unless otherwise agreed, the machine shall be supplied with vibration insulators.

Vibrations, if any, transmitted to the hand shall be reported in accordance with ASS regulations and as per Swedish standard.

- The weighted square mean of the acceleration shall be specified if the value exceeds 2.5 m/s^2 . If the acceleration is less than this value, this fact shall be stated.

B 2.3 EXTERNAL NOISE

External industrial noise shall not exceed the values specified for new plant in Swedish National Environment Protection Board publication RR 1978:5. Furthermore, the sound level outside an office building shall not exceed 55 dB(A).

The following requirements shall also apply:

- Equipment (such as e.g. a mobile boiler unit) installed at ground level: 70 dB(A) at a distance of 1 m in any direction
- Equipment installed on a building roof: 85 dB(A) at a distance of 1 m in any direction. However, a higher level is permissible in the case of certain roof-mounted fans, provided that the value is not in conflict with the aforementioned RR 1978:5 or does not give rise to other nuisance.
- The sound level in dB(C) must not exceed the guideline values specified above by more than 20 dB, or exceed 90 dB(C).

B 3 AIR POLLUTION - CHEMICALS - HEAT

B 3.1 AIR POLLUTION

The following requirements shall apply:

- Effective means of extraction shall be provided if the machining operation or process gives rise to air pollution.
- A suitably designed extraction hood or enclosure shall be included in the supply. The connection size and required air flow shall be specified.
- The dust separation requirement (if any) shall be specified.
- Details of any of the above measures to be carried out by the purchaser shall be specified in the tender.

B 3.2 CHEMICALS

Any proposal by a supplier to introduce a special chemical product shall be examined by the Scania chemicals group before its introduction is approved.

- The supplier shall provide a contents declaration for the purposes of such examination.

B 3.3 HEAT

The temperature of a larger exposed machine surface shall not exceed 40°C.

B 3.4 AIRBORNE AND WATER-BORNE EFFLUENTS

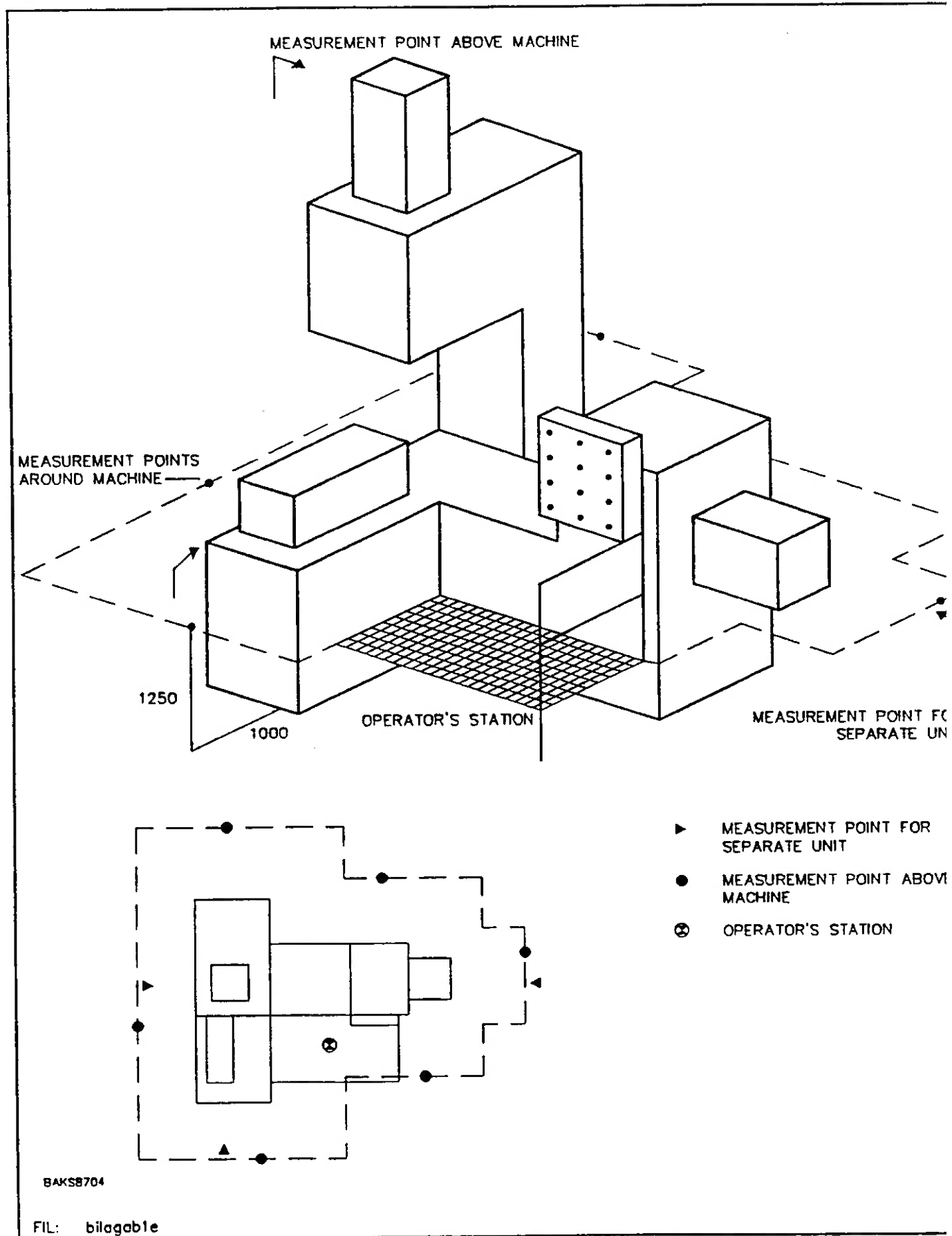
Basic requirements are laid down in official regulations, in general recommendations and in licences granted under the Environmental Protection Act. Special consultation with the purchaser and inspection authority will be required if any significant health or environmental nuisance is likely to occur. The internal requirements may be summarised as follows:

All reasonable precautions shall be taken to prevent pollution. Even if anti-pollution equipment is not included in the supply, the equipment shall be designed to facilitate the limitation of effluent discharges. In particular, the magnitude of such discharges in terms of constituent levels and flows shall be clearly specified.

B 3.5 WASTE

The equipment shall be designed to minimise the amount of waste generated. If such waste is environmentally hazardous, the quantities shall be clearly specified and suitable methods of processing indicated.

SCHEMATIC SHOWING NOISE MEASUREMENT POINTS



SWEDISH NATIONAL BOARD OF OCCUPATIONAL SAFETY AND HEALTH (ASS) REGULATIONS

ASS Publications Catalogue ADI 100 contains a list of current publications. The more important of these relating to the design of machinery and production equipment include:

AFS 1986:21	Machinery
AFS 1993:10	Machinery and some other technical equipment
AFS 1987:15	Presses
AFS 1987:18	Grinding machines and tools
AFS 1985:13	Lifting tables
Anv. 128	Conveyors
Anv. 134	Stacking cranes
AFS 1990:15	Pressure vessels
AFS 1991:6	Maintenance of technical equipment
AFS 1983:6	Work postures and movements
AFS 1991:8	Lighting
AFS 1992:10	Noise
AFS 1986:7	Vibrations from hand-held machines
AFS 1980:11	Anti-pollution measures
AFS 1985:17	Hazardous substances
AFS 1990:5	Power shears
AFS 1992:14	Work on VDUs

EC MACHINERY DIRECTIVES AND STANDARDS

- EC Machinery Directive 89/392/EEC
- Supplementary Directive 91/368/EEC
- Supplementary Directive 93/44/EEC

EN 292.1	Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology
EN 292.2	Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles and specifications
EN 414	Safety of machinery - Rules for the drafting and presentation of safety standards
EN 294	Safety of machinery - Safety distances to prevent danger zones being reached by the upper limbs
EN 418	Safety of machinery - Emergency stop equipment, functional aspects - Principles for design
EN 349	Safety of machinery - Minimum distances to avoid crushing of parts of the human body
EN 60204	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN 775:1992	Manipulating industrial robots - Safety (ISO 10218:1992 Modified)
ISO 11161	Safety of Integrated Manufacturing Systems, Basic req.
SS-IEC 73	Colours of indicator lamps and pushbuttons
SS-IEC 651	Acoustics - Sound level meters
SS-ISO 2631	Vibration and shock - Guide for the evaluation of human exposure to whole-body vibration
SS-ISO 5349	Vibration and shock - Guidelines for the measurement and the assessment of human exposure to hand-transmitted vibration
IKH (Swedish Academy standards of Engineering Sciences) crane and lift standards	Design instructions for lifting equipment, lifting tools etc.

C INTERFACES

C 1 GENERAL

C 1.1 This chapter specifies production equipment functions which are mandatory in designing standard systems incorporating signal interchange and operator support functions.

C 1.2 The following recommendations comprise a complement to this section:

- Signal interchange between part loading equipment and machine
- MMS services
- Operator support and operational information
- Guidelines for automated cell control
- X-Windows terminal emulation for displaying working instructions

C 2 OPERATING FUNCTIONS

C 2.1 INTERFACES WITH DECENTRALISED ACTUATORS AND SENSORS

Control system interfaces with decentralised actuators and sensors should comply with a specified standard. Signal transmission in accordance with DIN 19245 is recommended.

C 2.2 MESSAGE INTERCHANGE

The interchange of messages with surrounding equipment shall be carried out in accordance with ISO 9506 (MMS) over an IEEE 802.3 (Ethernet) network, or in accordance with DIN 19245, parts 1 and 2 (PROFIBUS) over an RS485 (two-wire) network.

C 2.3 OPERATING STATUS

A light column shall be installed in a clearly visible position on or near the machine. Machine operating status shall be indicated by a steady light as defined below:

RED	Stopped	Machine fault preventing production has occurred. Examples: - Motor protection tripped - Water/oil level indication - Water/oil/air pressure indication - Servo fault - Safety gate open
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YELLOW	Warning	Warning of imminent stop which will permit machine to continue in production. Examples: - Buffer stock almost empty - Tool approaching wear limit - Warning limit for machining tolerance reached
GREEN	Waiting	External condition preventing production has occurred. Examples: - Inward conveyor empty - Outward conveyor full
WHITE	Automatic	Machine operating in automatic mode. No RED faults present.

YELLOW and GREEN status may occur independently of WHITE and RED status. WHITE and RED are mutually exclusive.

C 3 MACHINE MANAGEMENT FUNCTIONS

C 3.1 MANAGEMENT OF PROGRAMS AND PARAMETERS

Backup copying of programs shall be feasible. The appropriate methods and functions shall be specified. The feasibility of making backup copies shall be verified as part of installation. The backup and restore of system parameters and programs shall be performed on equipment used by Scania. The system memory shall be cleared after backup copying prior to re-entry of data. In addition shall battery backup be disconnected when clearing the memory. All functions shall be reset on completion of verification. Reconfiguration of hard disk systems shall also be feasible.

The system shall be provided with an extra serial port for backup copying.

C 3.2 STRUCTURING OF CONTROL PROGRAM

The program shall be structured in well-documented and easily comprehensible program sequences. Sections of programs which control component forming shall be separable. Programs which describe equipment status shall be structured in terms of states and transition requirements.

C 3.3 CONNECTION FLANGE FOR ROBOT GRIPPING DEVICE

A standard flange as per ISO 9409-1 shall be used.

C 3.4 OFF-LINE PROGRAMMING OF ROBOTS

RobCad software can be used for graphical off-line programming of robots.

C 3.5 PCs IN WORKSHOP ENVIRONMENT

The need for real-time and multi-tasking features shall be taken into account when PC control is adopted.

IP 54 shall be the minimum degree of protection used to protect PCs against environmental influences. This may be achieved by enclosure of the equipment or by 'industrial adaptation'.

PCs installed in the workshop shall be provided with interference suppression. In production-sensitive applications, the equipment may be provided with a non-interruptible power supply; in other words, the supply will remain available until sufficient time has elapsed for the computer to shut itself down. In this case, the software shall be designed for this mode of operation. In addition, disk duplication (two hard disks storing data in parallel) should be used in particularly sensitive operating situations.

D PREVENTIVE MAINTENANCE

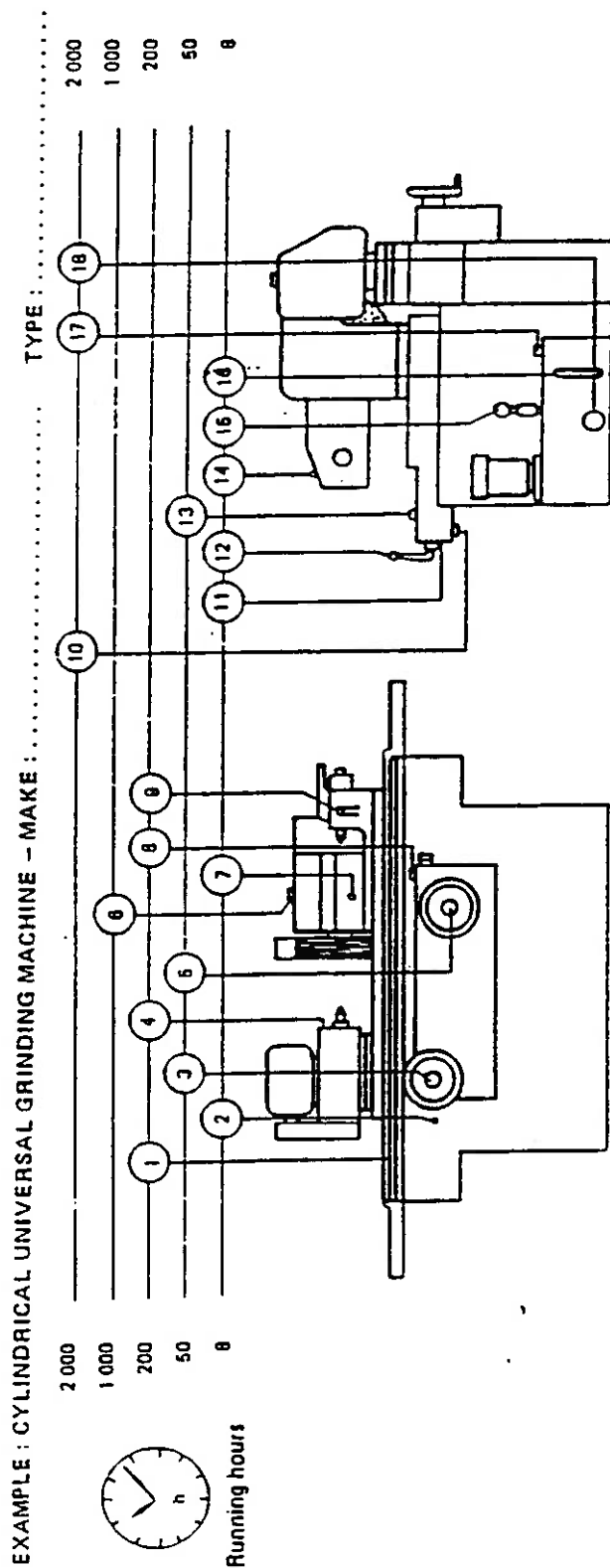
D 1 GENERAL

- D 1.1** A preventive maintenance programme consisting of a schedule of all recommended measures and intervals, shall be supplied in the form of complete software programs, not later than the equipment delivery date.
- D 1.2** Preventive maintenance shall, as far as possible, be based on status checks.
- D 1.3** The recommended preventive maintenance programme shall be structured as described in D 2, to permit Scania to implement the proposed measures in a rational manner as part of its own preventive maintenance system.

D 2 PREVENTIVE MAINTENANCE MEASURES

- D 2.1** Tidying and cleaning of machine (Where, when, how)
- D 2.2** Status check of machine functions and individual components (What, where, when, how)
(Limiting values)
- D 2.3** Programmed replacement of components
- In instances in which the programmed replacement of a component is unavoidable, details of what, where, when and how the component shall be replaced must be specified.
- Component and part numbers shall be specified in the preventive maintenance programme.
- D 2.4** Lubrication
- A lubrication schedule, including an illustration of all lubrication points as per ISO standards, shall be supplied. See Fig. 1.
- All filters, including details of filter elements, shall be specified.
- Suitable lubricants shall be specified in accordance with the appropriate ISO standard.
- Alternative and/or special lubricants shall be specified.

ANNEX



CAUTION, CLEAN ALL POINTS BEFORE LUBRICATING

Machine component	Table slideways	Table traverse mechanism	Work head spindle	Wheel feed system	Wheel spindle	Wheel flange feed system	Tailstock	Wheelhead slideways	Internal grinding spindle	Hydraulic unit
Action point No.	1 2	3	4	5 6	6 7	8	9	10 11 12 13	14	15 16 17 18
Nature of action										
Check										
Check and fill if necessary	8				8					
Operate										
Replenish	200	60	200	60	1 000	200	200	8 50	8	
Clean or replace								2 000		
Change										
Lubricant designation	G 68	A 68	XM 2	A 68	FD 10	A 68	G 68	G 68	FD 6	HM 68
Reservoir capacity (l)	2	0.3	0.1	0.3	1.5	0.1	0.1	4	0.2	75

E ELECTRICAL EQUIPMENT FOR INDUSTRIAL MACHINES

Contents

E 1	GENERAL
E 4	GENERAL REQUIREMENTS
E 5	INCOMING SUPPLY CONDUCTOR TERMINATIONS AND DEVICES FOR DISCONNECTING AND SWITCHING OFF
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E 13	CONTROLGEAR: LOCATION, MOUNTING AND ENCLOSURES
E 14	CONDUCTORS AND CABLES
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E 16	ELECTRIC MOTORS AND ASSOCIATED EQUIPMENT
E 17	ACCESSORIES AND LIGHTING
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E 19	TECHNICAL DOCUMENTATION
E 20	TESTING

Appendix E1	Wiring diagram: Power supply
Appendix E2	Wiring diagram: Marking of conductors inside enclosures
Appendix E3	Wiring diagram: Marking of cables and cores

E ELECTRICAL EQUIPMENT FOR INDUSTRIAL MACHINERY

E 1 GENERAL

- E 1.1** This section of these requirements is based on Swedish Stand./European Stand. SS-EN 60204-1:1992, which shall be valid for the delivery.

The paragraph numbers in this section of the requirements correspond to the paragraph numbers given in SS-EN 60204. The text below will serve to clarify or supplement our requirements in each paragraph.

E 4 GENERAL REQUIREMENTS

E 4.2 SELECTION OF EQUIPMENT

Recommended Manufacturers

Signal lamps and actuators	Telemecanique
Light columns	Telemecanique Sirena
Personnel safety limit switches	Telemecanique XCK-J 767 EJA Engineering Rotacam
Motors (servo and spindle motors shall be designed for a.c. operation)	Siemens Indramat Bosch
Servo systems (a.c. version of digital type with transistor pulse static converters for four-quadrant operation)	Siemens Indramat Bosch
Frequency changers for induction motors	Siemens ABB Danfoss
NC/CNC systems	Fanuc Siemens
PLC systems	Siemens (min. CPU 100 or CPU 103 for 100U) Modicon family
Control units for lifting equipment	Mannesmann Demag Type DSK 3 DO2

Note If another make of component is specified, it shall be approved by the Manufacturing/Assembling Manager

Digital input and output printed circuit boards for PLC systems shall be potential-free. Output boards shall be short-circuit proof.

Program memories shall, where possible, be of the EEPROM or EPROM type. Battery back-up shall be provided for volatile semiconductor memories.

Non-contact switches shall be of the LED type. The switches shall be of the plug-in type if access to wiring is difficult.

Floor-mounted cubicles shall be provided with bases.

Plug-in relays shall be provided with an 11-pin base and a position indication facility.

E 4.3 ELECTRICAL SUPPLY

The supply voltage shall be as follows:

Katrineholm, Luleå, Oskarshamn and Sibbhult:	400/230 V, 50 Hz
Södertälje and Falun:	525 V, 50 Hz

The networks are connected directly to earth.

The use of an "adapting transformer" to obtain supply voltage 525/400 V must be approved by the customer.

A five-conductor system is to be used where the supply voltage is 400/230 V.

The supply voltage for lifting equipment shall be 400 V in all places.

E 5 INCOMING SUPPLY CONDUCTOR TERMINATIONS AND DEVICES FOR DISCONNECTING AND SWITCHING OFF

E 5.1 INCOMING SUPPLY CONDUCTOR TERMINATIONS

The supply cable shall normally be run from above and shall be connected directly to the main breaker switch. The main switch is to be fitted with the control lever on the outside of the box-on the side, or on a securely mounted plate on the front of the box.

It must be possible to padlock control levers for main breaker switches, safety switches and safety-mode selector switches. The hole for attaching the padlock shall be at least 5 mm in diameter.

E 5.3.5 Excepted circuits

A floor-mounted switch box shall be provided with lighting (230V) which switches on when the switch box door is opened. The lighting is to be connected to a contact-proof connector. The customer will provide the power supply to the connector. See Appendix E1.

E 5.4 DEVICES FOR SWITCHING OFF FOR PREVENTION OF UNEXPECTED START-UP

Each motor is to have a safety switch in the main circuit unless an agreement to the contrary is reached.

Safety switches >16 A shall be provided with auxiliary contacts to interlock the supply contactor.

E 6 PROTECTION AGAINST ELECTRIC SHOCK

E 6.2.1 Protection by enclosure

Protection by means of enclosure shall be provided as in SS-EN 60204-1:1992 with paragraphs a) and c).

Electrical components and controlgear assemblies are to be mounted inside a switch box whose door can be closed by means of a permanently mounted knob or handle.

Switch box, switch gear and control panel doors shall be lockable with a padlock. The hole diameter for fitting the padlock shall be at least 5 mm.

Normal and slow-blow Diazed fuses up to and including 63 A, circuit breakers and motor protection breakers are to be fitted in a separate unlocked space. A motor safety switch setting shall be proof against interference by unauthorised personnel. Door handles must be permanently mounted.

E 7 PROTECTION OF EQUIPMENT

E 7.1 GENERAL

To protect conductors and equipment, circuit breakers and current-limiting motor protection breakers shall be used unless an agreement to the contrary is reached.

Fuses may be used for motor groups not fitted with current-limiting motor protection breakers, and where special fuses are required, such as in thyristor units, etc.

Fuses with rated current up to and including 63 A shall be of Diazed type, thread II and III. Fuses over 63 A must be of knife type.

Base contacts for plug fuses shall be of screw type.

E 8 EQUIPOTENTIAL BONDING

E 8.2 PROTECTIVE BONDING CIRCUIT

All exposed metal parts, such as doors, pivot frames and covers housing electrical equipment, shall be provided with protective earthing by means of separate earth conductors connected to the earth bus. The complete machine shall be earthed as a unit.

The neutral conductor must never be used for protective earthing purposes.

Conductive structural components of the electrical equipment or machine must never be used as an earth current path.

E 9 CONTROL CIRCUITS AND CONTROL FUNCTIONS

E 9.1 CONTROL CIRCUITS

One DC unit and transformer secondary pole shall be earthed.

The supply voltage shall be 230 VAC, 24 VAC or 24 VDC.

E 9.4.2 Measures to minimize risk in case of failure

If used in safety circuits, intermediate relays shall be approved by a certification body. The relay function shall be duplicated and monitored. Certified relays with force operation contacts shall be used as auxiliary relays in circuits of this type.

E 12 ELECTRONIC EQUIPMENT

E 12.2 BASIC REQUIREMENTS

A switch box housing electronic equipment shall be provided with a separate 2 A fused outlet for a programming unit (230 V, 50 Hz). See Appendix E1 of this document.

E 12.3.1 Programmable controllers

Interference suppression shall be provided if the machine is equipped with programmable controllers.

The control system memory to be used 75% maximum.

E 13 CONTROLGEAR: LOCATION, MOUNTING AND ENCLOSURES

29

E 13.2 LOCATION AND MOUNTING

Surplus space of approx. 20% shall be available in enclosures when the plant has been commissioned. (This shall also apply to terminal blocks and cable ducts.)

E 15 WIRING PRACTICES

E 15.1 CONNECTION AND ROUTING

A single cable should not be used for different system voltages or separate supply groups. System voltages of less than 50 V may not be mixed with system voltages greater than 50 V in the same cable.

Exceptions may be made in the case of auxiliary signals from safety switches.

E 15.2 IDENTIFICATION OF CONDUCTORS

Phase and polarity markings shall be provided to the maximum possible extent i.e. also after fuses and emergency trip devices, but not after switches which operate according to equipment operating status. See Appendix E1 of this document.

In the case of conductor markings inside an enclosure, each conductor shall be marked with an individual designation.
See Appendix E2 of this document.

Each cable of the equipment shall be marked with an individual designation. Each cable core shall be assigned the same marking as the terminal to which it is connected on the terminal board, and shall also be assigned an individual core marking if the cores cannot be distinguished in any other way. See Appendix E3 of this document.

E 15.4 WIRING OUTSIDE ENCLOSURES

Cable shall be used for all wiring outside enclosures.

Cable drag chains which can be opened must be used for moving cables. In item, cables of different diameters shall be separated by partitions. No more than two layers of cable may be placed in a cable drag chain.

Movably installed cables shall be provided with an outer sheath of polyurethane (PUR).

The minimum bending radius for flexible cable is 15 times the diameter. Cables shall be run in the floor or not less than 200 mm above floor level.

E 16 ELECTRIC MOTORS AND ASSOCIATED EQUIPMENT

E 16.1 GENERAL REQUIREMENTS

The maximum permissible on-line starting power of three-phase, squirrel-cage motors shall be 100 kW. The purchaser must be consulted if the power demand is higher.

E 16.2 MOTOR ENCLOSURES

The degree of protection shall be at least IP44 in all cases. Terminal boxes shall be of metal.

E 16.3 MOTOR DIMENSIONS

The motors must be sized for AC3 operation as a minimum.

E 16.6 CRITERIA FOR SELECTION

Servo and spindle motors are to be for alternating current operation. They must be equipped with built-in temperature sensors in the stator, and they shall be of insulation class F.

E 18 WARNING SIGNS AND ITEM DESIGNATIONS

18.4 MARKING OF CONTROL EQUIPMENT

On equipment group stations, fuse boxes and equivalent equipment, signs must be set up which:

- Indicate in plain language which objects they serve.
- Indicate for each fuse group the maximum permissible rated current per fuse and the cross-section of all conductors with a cross-section $> 1.5 \text{ mm}^2$.

Plates may be replaced by a group list.

18.5 ITEM DESIGNATIONS

Exposed equipment must be provided with engraved marking plates which have been screwed or riveted to the equipment.

All plates shall be two-coloured (white plate with black text) and shall be mounted in a clearly visible position beside the apparatus. A marking plate shall also be attached to the apparatus if required.

Marking plates for apparatus in enclosures shall not be attached to the cable duct covers.

E 19 TECHNICAL DOCUMENTATION

See Section K of this document regarding scope and special requirements.

E 20 TESTING

All of the tests specified in SS-EN 60204, paragraph 20, shall be performed and reported. The reports are to be turned over to the customer at the latest when the inspection is carried out. The customer shall be notified before the supplier performs any tests or measurements, and he shall be given the opportunity to participate.

[illegible]

WIRING DIAGRAM: MARKING OF CONDUCTORS INSIDE ENCLOSURES

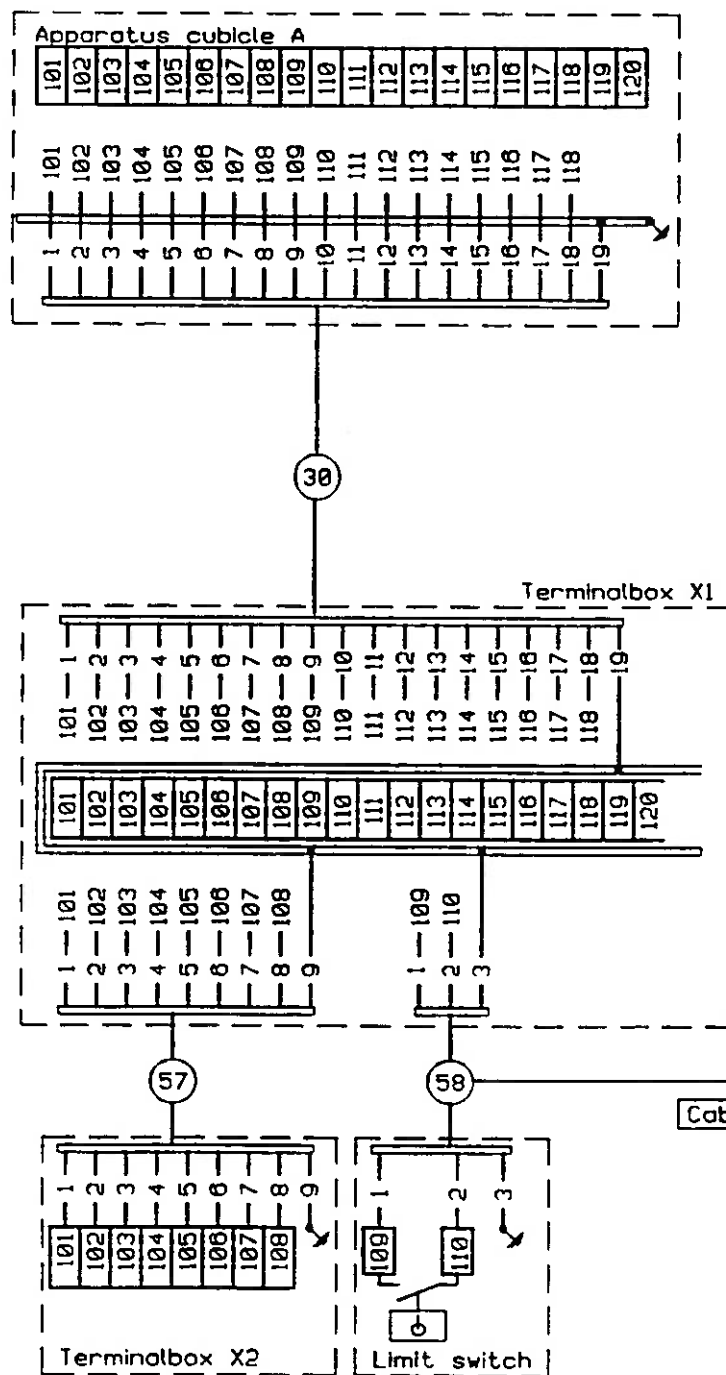
Example of marking in apparatus cubicles, panels, control desks and similar enclosures.

Fig.	Remarks	Diagram	Arrangement
1	Conductor connected to connection unit terminals.		
2	Two conductors connected to same terminal on connection unit.		
3	Conductor between two terminals on connection unit.		
4	Conductor between apparatus terminals inside connection unit.		
5	Conductor connected to current transformer L1 phase.		
6	Conductor between terminals on same apparatus.		
7	Conductor connected to voltage transformer L2 phase.		
8	Conductor connected to positive terminal of d.c. supply.		

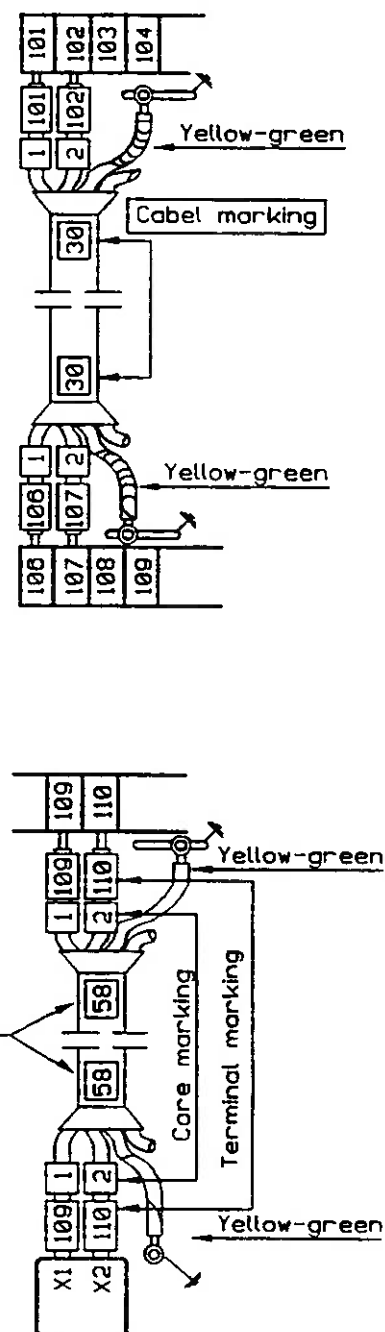
See 15.2

WIRING DIAGRAM: MARKING OF CABLES AND CORES

Typical diagram



Typical arrangement



See 15.2

F HYDRAULIC AND PNEUMATIC EQUIPMENT

Contents

F 1 HYDRAULIC EQUIPMENT

- F 1.1 System design**
- F 1.2 Tanks**
- F 1.3 Piping**
- F 1.4 Pumps**
- F 1.5 Filters**
- F 1.6 Cylinders**
- F 1.7 Valves**
- F 1.8 Accumulators**
- F 1.9 Pressure measurement**
- F 1.10 Marking**

F 2 PNEUMATIC EQUIPMENT

- F 2.1 System design**
- F 2.2 Quick-release couplings**
- F 2.3 Filters**
- F 2.4 Cylinders**
- F 2.5 Valves**
- F 2.6 Marking**

Appendix F1 Recommended manufacturers

F HYDRAULIC AND PNEUMATIC EQUIPMENT

F 1 HYDRAULIC EQUIPMENT

F 1.1 SYSTEM DESIGN

- A safety function, such as a pressure limiting valve in the line from the piston rod side of a double-acting cylinder, shall be provided if a dangerous pressure can occur in a component and/or circuit.
- The oil temperature shall be less than +50°C.

F 1.2 TANKS

- Isolating valves shall be installed to facilitate dismantling. Pump replacement shall be feasible without draining the system.
- A tank shall be equipped with:
 - a) a baffle plate with a number of openings in the bottom between the suction and return sides;
 - b) a sloping bottom;
 - c) feet providing a minimum free clearance of 300 mm underneath the tank;
 - d) a sight glass;
 - e) temperature alarm switches and minimum level alarm switches with an opening function;
- A spill tray shall be provided for collecting spillage, for example when changing filters.
- All tank spaces shall be accessible for cleaning.
- Filler connection: G 3/4"/Tema 7520

F 1.3 PIPING

- Hydraulic piping as per SS2353 (DIN 2391 I/C).

F 1.4 PUMPS

- Leakage oil lines from pumps and motors, if installed, shall be led to a drain tank at atmospheric pressure and shall discharge below the minimum liquid level to avoid foaming.
- The direction of rotation of a pump shall be clearly marked.

F 1.5 FILTERS

- Filters shall be specified in accordance with Appendix F1.

F 1.6 CYLINDERS

- Cylinders shall be specified in accordance with Appendix F1.
- Cylinders shall comply with applicable DIN standards or, in the absence of same, with CETOP recommendations.

F 1.7 VALVES

- Valves shall be specified in accordance with Appendix F1.
- Valves shall be designed for flat mounting in accordance with relevant ISO standards or, in the absence of same, in accordance with CETOP recommendations.
- Solenoid valves shall be manually operable, if not in conflict with safety regulations.
- Solenoid valves shall be fitted with plugs to DIN 43650.
- Solenoid valve contacts shall be provided with LED indication that the coil is energised.
- A drip tray shall be installed underneath the valve assembly.

F 1.8 ACCUMULATORS

- Accumulators shall be approved and certificates to this effect supplied.
- Non-return valves shall be installed between accumulators and pumps.
- Piston-type and blower-type accumulators shall be installed vertically.
- Only nitrogen (N^2) may be used for charging.

F 1.9 PRESSURE MEASUREMENT

- Instrument tapings shall be specified in accordance with Appendix F1.
- Instrument tapings shall be installed at all pressure reduction and back-pressure valves, and in pressure and return lines. Instrument tapings shall be marked.
- Permanently installed pressure gauges shall be pressure-relieved.

F 1.10 MARKING

- Hydraulic system components shall be provided with permanent markings corresponding to the designations in the hydraulic diagram.
- All markings shall be located in a clearly visible position beside the components in question.

F 2 PNEUMATIC EQUIPMENT

F 2.1 SYSTEM DESIGN

- Components shall be designed for a pressure of at least 10 bar.
- A system pressure variation between 5 and 7 bar shall be assumed for the purpose of calculating forces due to components such as cylinders.
- The supply air shall be supplied through valves designed for rapid venting and controlled (slow) charging, provided that this is not in conflict with other safety provisions.
- Exhaust air containing oil shall be discharged through a filter with provision for oil separation.

F 2.2 QUICK-RELEASE COUPLINGS

- Quick-release couplings shall be of TEMA manufacture, type 1300 or 1800.

F 2.3 FILTERS

- Filters shall be specified in accordance with Appendix F1.
- Filters, water traps and isolating valves shall be installed.

F 2.4 CYLINDERS

- Cylinders shall be specified in accordance with Appendix F1.
- Cylinders shall comply with applicable ISO standards or, in the absence of same, with CETOP recommendations.

F 2.5 VALVES

- Valves shall be specified in accordance with Appendix F1.
- Valves shall be designed for flat mounting in accordance with relevant ISO standards or, in the absence of same, in accordance with CETOP recommendations.
- Solenoid valves shall be manually operable if not in conflict with safety regulations.
- Solenoid valve contacts shall be provided with LED indication that the coil is energised.
- Solenoid valve servos shall be supplied separately. The supply shall be independent of the charging valve, if fitted.

F 2.6 MARKING

- Pneumatic system components shall be provided with permanent markings corresponding to the designations in the pneumatic diagram.
- All markings shall be located in a clearly visible position beside the components in question.

APPENDIX F1

RECOMMENDED MANUFACTURERS

HYDRAULICS

Pumps

Bosch
Herion
Hydraulik Ring
Imo
Kracht
Rexroth

Filters

EPE (Eppensteiner)
Hydac
Pall
Mahle Industrifilter

Cylinders

Bosch
Mecman
Parker Hannifin
Rexroth

Valves

Bosch
Hydraulik Ring
Mecman
Rexroth

Instrument tappings

Hydrotechnik Minimes 1620 G1/4"

PNEUMATICS

Filters and air treatment units

Atlas Copco
Mecman
Norgren

Cylinders

Atlas Copco
Bosch
Mecman

Valves

Atlas Copco
Bosch
Herion
Mecman
Parker Hannifin

Note

If another make of component is specified, it shall be interchangeable with the recommended make. The complete type designation of the recommended component shall be stated.

G LUBRICATION SYSTEM

G 1 SYSTEM DESIGN

- G 1.1** Lubrication for components such as machine slides shall be supplied by automatic, central systems of the high-pressure type, operating intermittently at a minimum pressure of 20 bar. In addition, lubrication systems shall either be progressive or designed for parallel operation, with a piston-type metering valve and indicator for each lubrication point.
- G 1.2** Pneumatically driven spindle units shall be equipped with individually adjustable lubrication systems with piston-type metering.
- G 1.3** All automatic lubrication systems shall be monitored to ensure that a new working cycle cannot be started if the lubricant level is low or if the lubricant pressure is incorrect. A lubrication fault shall initiate an alarm.
- G 1.4** Lubrication and drain points shall be easily accessible and clearly marked.
- G 1.5** In filtered, circulation-type systems, such as those used to lubricate spindle heads, the filter rating shall be stated both on the housing and the drawings. Simple means of checking the circulation shall be provided.
- G 1.6** A central lubrication system shall be provided with a TEMA type 100 instrument tapping, No. 120 G1/8" R or No. 121 G1/4" R.
- The instrument tapping shall be located in the pump discharge line or, if the lubrication system incorporates a directional valve, in each discharge line from the valve.

G 2 RECOMMENDED MANUFACTURERS

Central lubrication systems

Willy Vogel
Trabon

Lubrication systems for pneumatically driven units

Dosol

H ACCEPTANCE TEST

Contents

- H 1 OBJECTIVE**
- H 2 SPECIFICATION OF REQUIREMENTS**
- H 3 MACHINE ACCURACY TEST**
- H 4 FUNCTION TESTS**
- H 5 CAPABILITY TEST**
- H 6 AVAILABILITY GUARANTEE**

H 1 OBJECTIVE

The objective of these guidelines is to enable production equipment to be tested and compared in a systematic manner, in order to achieve guaranteed quality and reliability.

Testing of production equipment before and after delivery shall be carried out in accordance with the guidelines, to the extent which is optimum in each particular case.

H 2 SPECIFICATION OF REQUIREMENTS FOR ACCEPTANCE TESTING OF PRODUCTION EQUIPMENT

The following test shall be carried out in conjunction with delivery by the supplier and/or on handover of the equipment in question, to ensure that it meets the agreed performance specifications.

H 3 MACHINE ACCURACY TEST

One of the following alternatives should be carried out as a test at the supplier's premises prior to delivery and/or as a test prior to handover of the equipment to Scania.

H 3.1 ALTERNATIVE I

The machine accuracy test shall be carried out in accordance with the supplier's standard procedure, details of which shall be submitted with the tender.

H 3.2 ALTERNATIVE II

Machine geometry

Dimensions to be observed, measured and reported are detailed in the relevant ISO and DIN standards. Measurement shall be carried out in accordance with one of the methods specified in ISO 230.

Positioning and repeatability accuracy

Positioning and repeatability accuracy shall be measured in accordance with VDI DGQ 3441.

Machine performance test

Tests shall be carried out to measure and evaluate spindle speeds, working feeds, high-speed conveyor performance, idling powers and stability.

H 3.3 ALTERNATIVE III

This is a combination of alternatives I and II.

H 4 FUNCTION TESTS

These tests shall be carried out at the supplier's premises prior to delivery and at Scania's premises after installation.

Alternatives to the following tests may be agreed at the procurement stage depending on circumstances such as component availability etc.

H 4.1 Idle operation for a minimum of 20 hours continuously without stoppages other than those required by work time scheduling.

The operating cycle shall include all machine functions, including those of ancillaries.

H 4.2 Production operation under the agreed production conditions and quality for 4 or 8 hours, with a maximum production stoppage of 0.3 or 0.5 hours respectively and not more than 2 or 4 stops respectively due to problems with the method or equipment.

Set-up changes shall be included as applicable.

H 5 CAPABILITY TEST

In general, the following test shall be carried out at the supplier's premises prior to delivery and shall be repeated at Scania's premises after installation and adjustment of the equipment.

It is envisaged that the test will be repeated by Scania immediately prior to expiry of the guarantee period, preferably in collaboration with the supplier.

H 5.1 (E.g. 50) components of each type shall be produced in succession under agreed production conditions. See Appendix H1, Table 4 regarding sample sizes.

H 5.2 The capability index (C_{mk}) must not be less than (1.4). See Appendix H1, Table 4 regarding minimum requirements. The index shall be calculated as shown in Appendix H2.

H 5.3 Dimensions and tolerances to be measured, as well as the measurement procedures, are shown in the attached inspection instruction.

H 5.4 See Appendix H1 regarding the test procedure.
Function tests as per 4.2 and a capability test as described above may be combined in a single test.

APPENDIX H1

Table 4

Sample size	Required Cmin for different numbers of measurements		As alt. to C as per H2: All measured values shall be within max. X% of tolerance range
	Cm alt. Cmk	Cpk	
25	1,5	1,33	67
50	1,4		71
500	1,35		74

The sample size should normally not be less than 25 in capability testing.

Definitions

Capability requirement	Test procedure
Delivery test, Cm	a) The number of components specified in Table 4 is produced and measured successively b) Holding and cutting tools, measurement control etc. are included c) No tool changes or adjustments are permitted d) Machine running at operating temperature e) Adjustments (if any) of equipment required to achieve objective shall be carried out prior to delivery
Handover test, Cmk	As delivery tests a) b) c) d)
Status inspection, Cpk (during guarantee period)	Components are selected at specified intervals and measured under normal operating conditions. Normal tool changes and adjustments are permitted, subject to a maximum of three per hour.

Deviations from above may be permitted in exceptional cases if justified by particular reasons. PC or BLQ should be informed if lower requirements are proposed.

CAPABILITY TEST

The capability, C, shall be calculated on the basis of dimensions measured either on successive components during production or, in the case of C_{pk} , on several groups of samples. The value of C shall be equal to or greater than that stated in Appendix H1, Table 4 for the number of measurements concerned. At demand for runout, surface and other requirements with 0 as the best value can as alternative for C, percentages apply as shown in Table 4.

C_{mk} alternatively C_{pk} shall be compared with the smallest of the values (C1 and C2) calculated from the formulae below.

1 Capability formula

$$C1 = \frac{T_o - \bar{X}}{3 \cdot \delta} \quad C2 = \frac{\bar{X} - T_u}{3 \cdot \delta}$$

$$Cm = \frac{T_o - T_u}{6 \cdot \delta}$$

T_o and T_u are the upper and lower tolerance limits respectively. The standard deviation δ , is calculated as shown below.

2 Standard deviation formula

$$\delta = \sqrt{\frac{\sum (X_i - \bar{X})^2}{(n - 1)}}$$

$\bar{X}$ is the mean of all measured values and is calculated as described below.

3 Mean value formula

$$\bar{X} = \frac{\sum_{i=1}^n (X_i)}{n}$$

X_i is dimension No. i and n is the total number of measurements included in the calculation.

H 6 AVAILABILITY GUARANTEE

During the guarantee period, the availability of the equipment/machine, limited by machine faults and service, shall be a minimum of X% of the total production time. For the purpose of reliable calculation, the production time shall be a minimum of 130 hours per month.

Unless otherwise specified, shall, as required, control measurement of the availability and production time be carried out between the third and twelfth guarantee months inclusive.

An interrupted production time and downtime log shall be kept as required. The log results shall be submitted to the purchaser every second month.

If the mean downtime over a two-month period is such that the guaranteed availability specified above cannot be maintained, a new control period shall be initiated and the guarantee period shall be extended automatically by two months, subject to a maximum extension of six months.

If the mean availability remains below the guaranteed value despite the aforementioned extension, negotiations regarding the consequences of the deficiency shall be initiated without prejudice.

< **DOCUMENTATION**

Contents

< 1 **DOCUMENTATION - GENERAL REQUIREMENTS**

< 2 **DOCUMENTATION FOR SEPARATE PARTS OF EQUIPMENT**

< 3 **SCOPE OF DOCUMENTATION**

< 1 **DOCUMENTATION - GENERAL REQUIREMENTS**

< 1.1 Drawings and descriptions shall be relevant to the equipment supplied. Non-relevant information shall be deleted.

< 1.2 A parts catalogue listing all equipment components shall be supplied. This shall include mechanical, electrical, hydraulic and pneumatic components, complete with the designations shown on the appropriate diagrams, as well as details of manufacturers and manufacturers' type designations (apparatus lists).

< 1.3 Tables shall be supplied as follows:

- Overall dimensions in mm, total weight and, if applicable, sub-assembly weights in kg
- Water demand in m³/h, water pressure in kPa and pump characteristic
- Compressed air requirement in m³/h at s.t.p. and water pressure in kPa
- Ventilation and dust extraction requirements in m³/h and pressures in kPa

< 1.4 Machine layout and foundation drawings indicating the dimensions and positions of machine units, as well as the electrical, compressed air, water, effluent, dust extraction and machining waste discharge connections, shall be supplied.

< 1.5 A machine layout drawing showing the location of the various electrical, hydraulic and pneumatic components shall be supplied.

< 1.6 The supplier shall submit one set of copies of current drawings and program printouts incorporating all modifications not later than the date that the equipment is commissioned in service.

< 2 **DOCUMENTATION FOR SEPARATE PARTS OF EQUIPMENT**

< 2.1 **FIXTURES AND TOOLS**

Scania's tool number (VR number) shall be specified in the bottom right-hand corner of all drawings. The VR No. may be obtained from Scania. Fixtures and tools shall be marked with the VR No.

The documentation shall comprise the following:

- Assembly drawing and parts list of workpiece-related tools
- Detailed drawings of wearing components
- Cutting tool schedule and tool list
- Cutting tool (special) drawings
- Drawings of lifting equipment specifying material grades and welding information and also calculation basis in accordance with IKH crane and lift standards
- Drawing of chucking arrangement and specified type of spindle nose
- Dimensions of connecting rod and its position with respect to spindle nose
- The scope of drawings shall be as defined as 3.

We use the Cimlinc CAD system running on Sun Sparc work stations with a UNIX operating system.

If the drawings are produced by CAD, the CAD files shall be supplied as a complement.

Files may be supplied in accordance with the following alternatives:

- File format
 - Cimcad - specify version No.
 - IGES - specify version No.
 - DXF - specify version No.
- Media

		Alt. entry commands
Tape	Quick 150	tar, bar
Tape	Exabyte (2.3 GB)	tar, bar
Diskette	3 1/2"	tar, bar, DOS format

The following information shall also be supplied:

- File format and version No.
- Complete copying command used for entry
- List of file names and corresponding drawing numbers

K 2.2 PNEUMATIC, HYDRAULIC AND LUBRICATION SYSTEMS

Diagrams shall be provided with symbols in accordance with applicable ISO standards.

Wiring diagrams shall include current settings, following adjustment.

Lubrication instructions shall include details of lubricant grades and quantities.

Accumulator certificates shall be supplied.

↳ 2.2.1 Scania's item number (SV number) and sheet No. shall be specified in the lower right-hand corner of every drawing. The SV No. may be obtained from Scania. In addition, the machine type, serial number, designer's name and drawing title shall be stated on each sheet.

↳ 2.2.2 The supply shall include the specified number of transparencies in A3 format and copies as specified in K 3. However, program printouts shall not be supplied as transparencies.

As an alternative to transparencies, the information may be stored on 5 1/4" or 3 1/2" diskettes, in which case the following shall apply:

- The drawing files shall be in AUTOCAD's 'dwg' format.
- The file name shall be stated in the drawing title block.
- A set of copies in A4 format shall be supplied.

A file name may occur only ONCE within the same SV No. Where supplier-specific shapes or menus are used to develop all drawing information, these shall also be supplied.

The supplier shall supply a test diskette for compatibility testing on request.

↳ 2.3 ELECTRICAL EQUIPMENT

The documentation shall comply with SSEN 60 204-1:1992.

Safety systems for personnel protection shall comprise both safety stop and emergency stop devices. Safety circuits for these stop functions shall be described by the supplier and shown on separate drawings/descriptions.

Each relay coil shall be shown with a description of its function in the equipment in plain text.

Wiring diagrams shall be drawn in free form.

↳ 2.3.1 See K 2.2.1.

↳ 2.3.2 See K 2.2.2.

K 2.3.3 Robot documentation

If robot system I/O points are wired to separate terminal blocks or intermediate relays, the arrangement shall be shown on a separate sheet.

K 2.3.4 Program documentation

A set of program documentation printouts, together with two 3.5" diskettes containing the program, shall be submitted to the purchaser as part of equipment handover.

K 2.3.4.1 PLC documentation

PLC documentation relating to equipment of the same make shall comprise the following:

- Program overview
- Program printout with network comments in ladder logic
- List of addresses used with functional description of inputs, outputs, auxiliary memories, counters, times and registers
- Conference list

SIEMENS manufacture:

The program shall be documented in the form of STEP 5, GRAPH 5 or KOMDOK under S5DOS and shall be stored on floppy disk. The program shall be accompanied by instructions for initiating data blocks, if any, in the RAM sector.

MODICON manufacture:

The program shall be documented in the form of MODSOFT or DMC LADDERMASTER software.

K 2.3.4.2 NC documentation

NC documentation shall comprise:

- All NC programs and comments
- System programs, machine and PC parameters
- Programming instructions, complete with a description of all machine-related functions, codes and parameters
- Instructions for installing and copying programs

K 2.3.4.3 Robot documentation

Robot documentation shall comprise robot programs and parameter settings, complete with text comments and instructions for installing and copying programs.

K 3 SCOPE OF DOCUMENTATION

- A: In Swedish
B: In English or German if Swedish is not original language
C: In original language if not Swedish, English or German
D: One set of transparent drawings, diagrams

Type of documentation	Copies			Originals	
	Number of sets			One set	
	A	B	C	D	Language
◁ 3.1 LIFTING INSTRUCTIONS	1				A
◁ 3.2 INSTALLATION AND COMMISSIONING INSTRUCTIONS	1	1	1		A
◁ 3.3 OPERATING INSTRUCTIONS	1	1	1		A
◁ 3.4 DESCRIPTION OF OPERATION	1	1	1		A
◁ 3.5 PREVENTIVE MAINTENANCE INSTRUCT. as per sect D	1	1	1		A
◁ 3.6 DISMANTLING AND ADJUSTING INSTRUCTIONS	1	1	1		A
◁ 3.7 COMPLETE SET OF ASSEMBLY DRAWINGS		1	1		B
◁ 3.8 TABLES as per K 1.3		1			B
◁ 3.9 FOUNDATION AND ERECTION DRAWINGS as per K 1.4		1			B
◁ 3.10 LAYOUT DRAWINGS as per K 1.5		1			B
◁ 3.11 HYDRAULIC, PNEUMATIC AND LUBRICATION SYSTEM DIAGRAMS as per K 2.2		1	1	B or diskette	
◁ 3.12 LUBRICATION SCHEDULE as per K 2.2	1	1	1		A
◁ 3.13 FIXTURES AND TOOLS as per K 2.1		1		B	
◁ 3.14 ELECTRICAL DOCUMENTATION as per K 2.3	1	1	1	A or diskette	
PLC/NC and ROBOT PROGRAM	1			2 disk.	A
◁ 3.15 FAULT-TRACING INSTRUCTIONS FOR machine and control system	1	1	1		A
◁ 3.16 PARTS CATALOGUE as per K 1.2		1	1		B
◁ 3.17 TEST REPORTS, CERTIFICATES		1	1		B

APÊNDICE 2

Especificação de Produto - Torques de Aperto



Approved by
Sven Åke Edström
Issued by
Owe Salven

TDMBC

Date
1996-08-30

Info class
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Status
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TIGHTENING TORQUES FOR VERY SPECIAL SCREW JOINTS D9 ENGINES

The specified tightening torques in the table underneath replaces STD 2368-2 for very special screw joints in the D9 engines (concerning only the 104-series). The specified tightening torques are valid with a tolerance of $\pm 15\%$ unless otherwise specified. For other joints in the D9 engines the tightening torques are specified in STD 3637 and STD 3874. Regarding checking methods and checking torques STD 3874 is applied (see page 22, HB 2) unless otherwise specified.

JOINTS (joined parts, dimens., mech. prop, part number)	TIGHTENING TORQUES (Nm)	DRAWING (specifying tightening torques)	CHECKING TORQUES (Method)
--	-------------------------------	---	---------------------------------

ENGINE STRUCTURE:

Cylinder block:			
Piston cooler nozzle (banjo screw 278082)	23	place:1371147 sheet 7, C:2	15-28 (2)
Main bearing cap-block (screw M20, 225594)	290		
Flywheel housing:			
Flywheel housing-cylinder block(screw M12,8.8)	90		55-108 (2)
Engine suspension:			
Front bracket (screw M12, 10.9)	115 $\pm$ 5%		

CYLINDERHEAD AND VALVE SYSTEM:

Cylinder head:			
Cyl.head-cyl.block (screw M16 & M18, 10.9)		365768	
Valve cover:			
Valve cover-cylinder head (screw M10)	20 $\pm$ 5		8-25 (2)
Valve mechanism:			
Support bracket-cylinder head (screw M14)	150		
Adjusting screw rocker arm (nut M10)	40		

CRANK MECHANISM:

Flywheel:			
Flywheel-crankshaft (screw M14,10.9)		1385069 , D:5	130-216 (2)
Crankshaft damper:			
Hub-crankshaft (screw M26)		1373156 , C:8 1371434 , C:8	600-938 (2)
Damperhub (screw M12, 10.9)		1373156 , C:8	

B	251284	Union oil pipe introduced	97 06 17	BJn	
A	97206	Concerns turbo-exhaust manifold. Assy drawing 1402478 introduced including stud+nut. Was 40 Nm.	96 11 20	OWS	
Change	PDM No.	Nature of change	Date	Sign	Pho
----	46676	Introduced	96 03 18	OWS	

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96-08-30

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		1371434, C:8 ✓	
Connecting rod:			
Bearing cap-rod (screw M12, 10.9)		338253, C:8 ✓	82.5-132(2)

TIMING GEAR:

Gear:			
Camshaft gear (nut M40)		1373156, E:7 ✓	
Injection pump gear (screw M12, 10.9, 394587)		1397425 F	
Intermediate gear (M10, 10.9)		1373156, D:7 ✓	

LUBRICATION SYSTEM:

Oil pan:			
Thread insert for magnetic drain plug		1384548, D:5 ✓	
Magnetic drain plug (1381957)	80±24		48-116 (2)
Oil pump:			
Intermediate gear (screw M10x1)		1369981, E:1 ✓	
Oil cleaner:			
Axle		383864, E:6 ✓	
Outer cover (screw M10)		383864, D:6 ✓	
Lubrication oil pipe:			
Block- power take off (Banjoscrew M10x1)		1371434, C:2 ✓	

COOLING SYSTEM:

Underneath thermostat housing:			
Drain tap (1/2-14NPTF)		1374551, B:5 ✓ 1377796, B:5 ✓	
Oil cooler			
Nipple for coolant filter		1392756, C:7 ✓	
Coolant filter (assembly instructions)		372175 ✓	

EXHAUST SYSTEM:

Exhaust manifold:			
Manifold-cyl.head (screw M10)	59		30-75 (2)
Turbo-exhaust manifold (screw M10) (nut+stud M10)		1402478 ✓	
Exhaust pipe from turbo:			
Pipe-turbo (V-clamp)	8±2		
Turbo			
Union, turbo oil feed pipe	55Nm±3%		
Union nut, turbo oil feed pipe	45Nm±3%		

FUEL SYSTEM:


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96-08-30

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Injection equipment:

Injection pump-cyl.block (mounting instructions)		1397424 F	
Nozzle body-nozzle holder (nozzle nut, SW19)		drw:1339918 ✓	
Injector-cylinder head (cap nut M28x1.5)		1379460 ✓	45-84 (2)
Pressure pipe nut-Injector (M14x1.5)		1383222 ✓	12-29 (2)
Leak-pipe (banjo screw M8x1)	11		
Pipe, smoke lim.-intake man. (banjo M12x1.5)	28		
Overflow valve (banjo screw M14x1.5)	45±5		
Fuel pipe, filter-inj.pump (banjo screw M14x1.5)	45±5		
filter-feed pump (banjo M14x1.5)	45±5		

AUXILIARIES:

Starter motor:

Stud M16 metal and nut M16	60 120		
Terminal 30 (M10)		1382290, E:2 ✓	
Terminal 50 (M4)			
Terminal 31 (M10)			
Alternator:			
Pulley (nut M16x1.5)		1397038, E:6 ✓	
Steering pump:			
Gear (nut M14, 1122002)		1324961, C:6 ✓	

CONCERNS ONLY I/M-ENGINES:

Cooling system:

Protection anode-heat exchanger	20		

For other joints concerning the I/M-engines contact their division.

APÊNDICE 3

Processo de Produção - Seqüência de Montagem

Nome do Documento / Document Name
SEQÜÊNCIA DE MONTAGEM

Aprovado por / Approved by
IFDE Nestor Lopes Jr.
Elaborado por / Issued by
IFDE Carlson E. de Oliveira
IFDE Marco A. M. Infantozzi

Ramal/Phone
9428

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Para / To

Por Conhecimento / For information

MONTAGEM DO MOTOR D9 EM LB-IF

Posto	Descrição	Peças	Quant	Equipamento
01	Recebimento do Bloco	Mola	01	Apertadeira pneumática Chave ou soquete 19 mm
		Bujão	01	
		Junta de alumínio	02	
		Tampa	01	
		Anel	01	
		Parafuso M8x25	02	
		Bujão M10x1	01	
		Válvula	01	
02	Montagem da carcaça de distribuição	Carcaça distribuição	01	Martelo de borracha Martelo e localizador dos pinos Apertadeira pneumática
		Pino	02	
		Parafuso M10x35	06	
		Parafuso M8x20	03	
		Bujão	01	
03	Montagem da bomba injetora	Tubo de óleo	01	Apertadeira pneumática
		Parafuso vazado M10x33	01	
		Parafuso banjo	01	
		Junta	09	
		Bomba injetora	01	
		Parafuso M10x45	04	
		Arruela de aço	04	
		Tubo de lubrificação	01	
		Tubo de combustível	01	
		Parafuso M10x90	02	
		Suporte	01	
		Cone	01	
		Parafuso M12x40	01	
		Parafuso banjo M12	01	
		Parafuso banjo M14	01	
		Parafuso M12x30	05	
		Nípel cotovelo	01	
04				
05				

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06	Montagem da tampa de distribuição	PM – Tampa de distrb.	01	Dispositivo de aquecimento das engrenagens Martelo e localizador da engrenagem Apertadeira pneumática
		PM – Retentor	01	
		Parafuso flang. M12x100	02	
		Parafuso M10x60	03	
		Junta	01	
		Engrenagem	01	
		Parafuso M10x65	01	
		Arruela de bronze	02	
		Arruela de encosto	01	
		PM – Eixo da engrenagem	01	
		PM – Engrenagem	01	
		PM – Mancal	01	
		PM – Arruela	01	
		PM – Parafuso	04	
		Parafuso M10x80	04	
		Duto/suporte do defletor	01	
		Parafuso M10x60	01	
		Engrenagem	01	
		Porca M40x1,5	01	
		Eixo da engrenagem	01	
		Parafuso M10x65	04	
		Parafuso M10x100	01	
07	Montagem da carcaça do volante	Carcaça do volante	01	Apertadeira pneumática
		Parafuso M12x45	12	
		Parafuso M12x60	04	
		Arruela 13x28x4	16	
		Retentor	01	
		Suporte para chicote	01	
		Parafuso M8x16	02	
08	Montagem do defletor de óleo	Tampa	01	Torquímetro de estalo
		Junta	01	
		Suporte	01	
		Parafuso	09	
		Nípel reto	02	
		Tubo completo	01	
		Junta de cobre	02	
		Defletor de óleo	01	
		Cone de aço	01	
		Arruela	01	
		Cubo do amortecedor	01	
09	Montagem do acelerador	Acelerador	01	
		Parafuso flang. M6x16	02	
10	Montagem do volante	Volante	01	Localizador do volante na ponta do eixo Apertadeira elétrica com 2 fusos e monitoramento de torque Apertadeira pneumática
		Rolamento	01	
		Parafuso M14x35	08	
		Arruela	01	
		Bomba de óleo	01	
		Parafuso M10x65	02	
		Parafuso M10x80	02	
		Anel O	01	
		Tubo de sucção	01	
		Anel de vedação	01	
		Suporte completo	02	
		Parafuso M8x16	01	

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11	Montagem do cárter de óleo	Cárter Junta Parafuso M8x50 Bujão magnético	01 01 25 01	Braço de reação para apertadeira Apertadeira pneumática
12	Montagem da engrenagem da bomba injetora	Engrenagem da bomba inj Parafuso M12x30 Arruela	01 05 01	Apertadeira pneumática Soquete 18 mm
13	Montagem camara de ventilação	Camara de ventilação Parafuso M10x25 Parafuso M10x70 Parafuso flang. M10x110 Conexão completa Tubo flangeado Junta Parafuso M8x30 Suporte Tampa Parafuso M8x16 Suporte do anel defletor	01 01 01 02 01 01 01 01 01 01 02 01	
14				
15	Montagem do amortecedor de vibrações	Polia 2 canais Parafuso M12x35 Amortecedor Cubo	01 06 01 01	
16	Montagem do radiador de óleo	Radiador de óleo Junta Parafuso M10x40 Parafuso M10x90 Parafuso M10x80 Nípel latão Anel de vedação Suporte	01 01 03 01 03 01 01 01	
17	Montagem da torneira de latão	Torneira de latão Junta	01 01	
18	Montagem do sistema de injeção	Bico injetor Junta de cobre Parafuso banjo M14 Anel de vedação Nípel reto Juntas de vedação Presilha Tubo de combustível Cabecote filtro de comb. Parafuso banjo M10x30 Filtro de combustível Bujão M16x1,5 Capa de haste da válvula PM – Suporte do balancim PM – Braço do balancim PM – Parafuso de ajuste PM – Porca PM – Anel PM – Parafuso Vareta do tucho	06 06 02 04 01 02 04 02 01 02 01 01 12 06 12 12 12 12 6 12	

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19	Montagem diversas	Parafuso banjo M8x16 Anel de vedação Tubo de retorno Suporte Presilha de aço Parafuso flang. M6x16 Nipel reto Junta de vedação União banjo Parafuso banjo M14	06 14 01 01 01 02 01 01 01 01	Torquímetro de estaio Apertadeira pneumática
20	Montagem de mangueiras	Mangueira Abraçadeira Parafuso flang. M6x16	01 03 01	
21	Montagem das tampas de válvulas	PM-Tampa das válvulas PM-Junta PM-Anel de borracha PM-Arruela PM-Porca Tubo completo Parafuso banjo M14 Presilha Anel de vedação Placa de instrução Placa de emissão Coletor d'água Junta Parafuso Parafuso banjo M8x16 Mangueira Abraçadeira Tubo	06 06 06 06 06 01 01 01 02 01 01 01 06 12 01 01 02 01	
22	Montagem do coletor de escape	PM-Coletor de escape PM-Anel Junta Parafuso Prisioneiro M10x55 Espaçador Monitor de pressão Monitor de temperatura Arruela dentada Porca M4	03 04 08 12 02 10 01 01 01 01	Apertadeira pneumática Soquete 14 mm
23	Montagem do jogo de tubos de injeção	Jogo de tubos de injeção	01	

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24	Montagem do turbocompressor	Nipel reto	02	
		Junta de cobre	02	
		Tubo de lubrificação	01	
		Junta	02	
		Parafuso M8x20	02	
		Tubo de retorno de óleo	01	
		Mangueira	01	
		Abraçadeira de aço	02	
		Turbocompressor	01	
		Porca flangeada	02	
		Distanciador	02	
		Parafuso flang.	02	
		Pino de aço	01	
		Suporte	01	
		Presilha	01	
		Parafuso flang. M6x16	01	
		Parafuso M8x16	01	
25	Montagem do compressor de ar	PM-Compressor de ar	01	
		PM-Engrenagem	01	
		PM-Parafuso M12x33	01	
		PM-Arruela	01	
		PM-Válvula de segurança	01	
		PM-Junta	02	
		PM-Nipel cotovelo	02	
		PM-Nipel M22x1,5 k	01	
		PM-Nipel reto	02	
		PM-Anel de vedação	02	
		PM-Junta de vedação	01	
		PM-Mangueira	01	
		PM-Abraçadeira	02	
		PM-Cotovelo	01	
		Junta 22,2x26,9	01	
		Anel-O	01	
		Anel de vedação	03	
		Parafuso M10x100	01	
		PM-Suporte do filtro	01	
		PM-Bujão M14	01	
		PM-Junta	01	
		PM-Válvula de alívio	01	
		Junta	01	
		Parafuso M10x35	02	
		Parafuso M10x50	02	
		PM-Filtro centrífugo	01	
		PM-Nipel	01	
		PM-Anel	01	
		PM-Junta	01	
		PM-Suporte	01	
		PM-Parafuso	04	
		Elemento filtrante	01	
		Junta	01	
		Parafuso M10x40	03	
		Suporte	01	
		Mola	01	

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26	Montagem das tubulações	Placa do motor	01	
		Tubo de saída de ar do compressor	01	
		Tubo de arrefecimento do compressor	02	
		Abraçadeira	01	
		Mangueira	01	
		Tubo de retorno de água	01	
		Parafuso M8x16	01	
		Anel-O	01	
		Tubo de alívio do compressor	01	
		Nipel	01	
		Porca de aço M12	01	
		Suporte	01	
		Parafuso flang. M6x16	01	
		Presilha de aço	01	
		Tubo de entrada de óleo	01	
		Nipel	01	
		Junta de vedação	01	
27	Montagem do coletor de admissão	Coletor de admissão	01	
		Junta	06	
		Parafuso M8x70	12	
		Bujão M20	01	
		Junta de alumínio	01	
		Tubo limitador de fumaça	01	
		Nipel	01	
		Anel-O	01	
		Parafuso M6x20	01	
		Presilha	01	
		Parafuso Banjo M12	01	
		Anel de vedação	04	
		Parafuso M8x20	02	
		Serpentina	01	
		Nipel reto	02	
		Porca M24	01	
		Suporte	02	
		Capa	02	
		Parafuso M8x16	02	
		Duto do chicote	01	
28	Montagem do tubo de ar	Tubo de ar	01	
		Anel-O	02	
		Abraçadeira "V"	02	
		Suporte do tubo de ar	02	
		Parafuso M8x16	02	
		Parafuso M10x25	02	
		Parafuso M8x20	02	
		Parafuso M8x30	01	

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29	Montagem do freio motor	Freio motor	01	
		Abraçadeira "V"	01	
		Tubo do freio motor	01	
		Nipel	01	
		Porca M14	01	
		Prisioneiro	03	
		PM-Alternador	01	
		PM-Poli 2 canais	01	
		PM-Ventoinha	01	
		Parafuso M10x115	01	
		Parafuso esticador de correia	01	
		Parafuso M10x110	01	
		Luva distanciador	01	
		Porca M12	02	
		Parafuso M10x50	01	
		Porca flangeada autotravante M10	01	

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30	Montagens diversas	Correia	02	
		Anel do ventilador	01	
		Anel defletor	01	
		Parafuso M8x20	04	
		Arruela	04	
		Suporte do anel defletor	02	
		Parafuso M8x45	02	
		Porca M8	01	
		Motor de partida	01	
		Porca M10	01	
		Arruela trava	01	
		Porca flangeada M10	03	
		Distanciador	01	
		Porca M6	01	
		Arruela	01	
		Porca M5	03	
		Porca M4	02	
		Parafuso M8x16	14	
		Presilha	12	
		Bujão M20	01	
		Junta de cobre	01	
		Plug de vedação	01	
		Parafuso M6x10	01	
		Bucha de borracha	03	
		Presilha de alumínio	03	
		Grampo	02	
		Parafuso M8x30	01	
		Parafuso M8x16	01	
		Parafuso flang. M6x16	01	
		Parafuso M10x60	01	
		Suporte	01	
		Presilha de aço	01	
		Presilha de nylon	04	

APÊNDICE 4

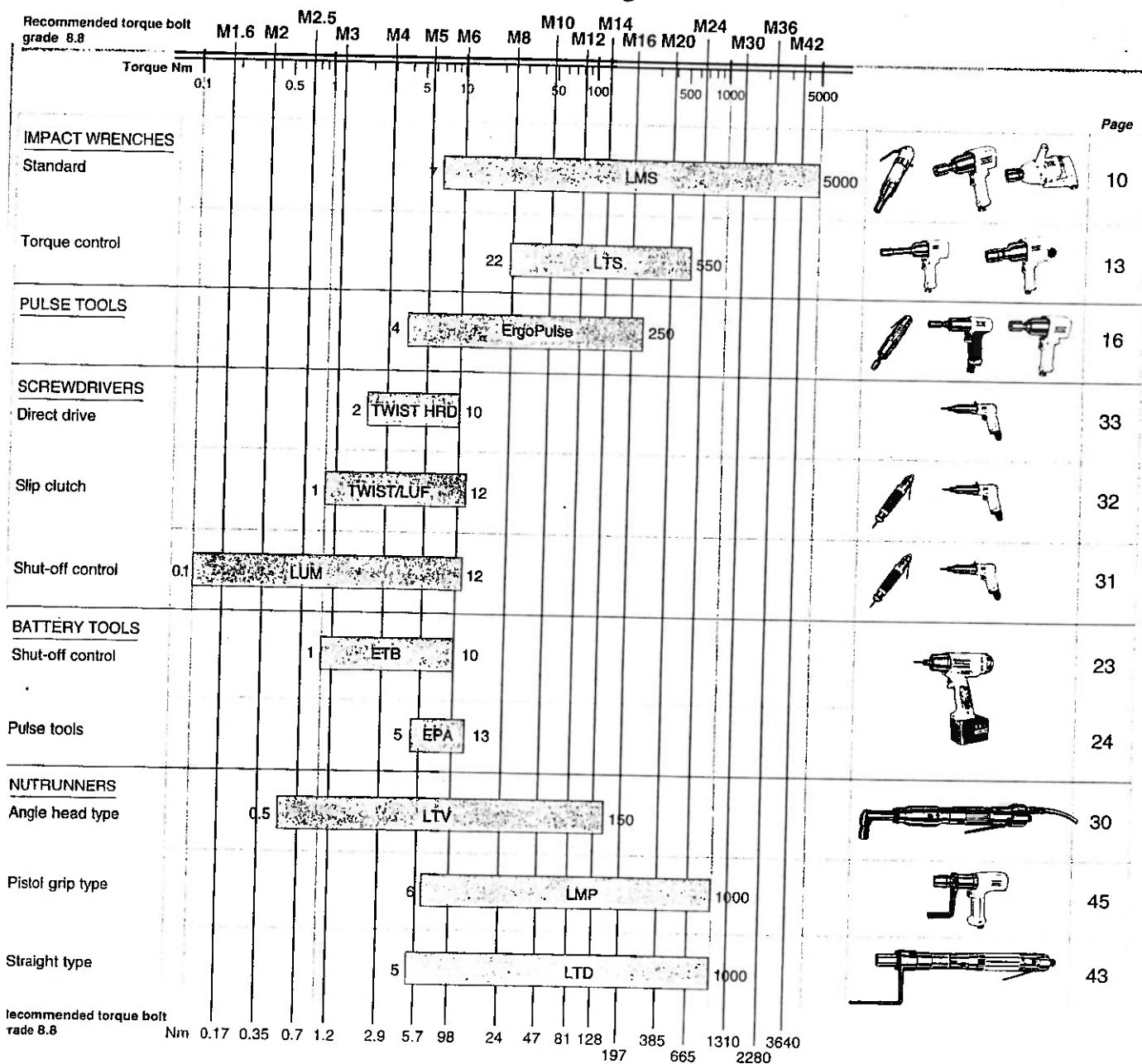
Arranjos Físicos

APÊNDICE 5

Equipamento de Produção - Ferramentas de Montagem

ASSEMBLY TOOLS

Selection guide



IMPACT WRENCHES (LMS, LTS)

Suitable for general assembly, repair jobs etc. when you require a powerful and lightweight tool, no reaction force and moderate accuracy. Best choice for loosening joints.

Select an impact wrench with torque control for the same kind of job when you have higher demands for accuracy. This type of tool is also suitable for serial production.

screws in plastic. Very high accuracy and lowest bit consumption.

Slip clutch (TWIST/ LUF)

Best for sheet metal screws, wood screws or self-tapping screws.

PULSE TOOLS (ErgoPulse)

Suitable both for general assembly and serial production. Same advantages as impact wrenches plus higher accuracy. In addition you will have a tool with good ergonomics which means lower sound level and less vibrations. Pulse tools also have a longer service life.

Factories all over the world are changing to ErgoPulse tools increase their productivity.

Direct drive (TWIST/LUF HRD)

The low cost alternative for wood and self-drilling screws.

SCREWDRIVERS

The biggest range on the market of extremely accurate screwdrivers with ergonomic design. All models are lubrication free. For all kinds of jobs involving smaller screw sizes, up to M6.

NUTRUNNERS

Angle type (LTV)

Suitable for high volume serial production.

Extremely good accuracy, small angle head, suitable for use where space is limited. Low sound and vibration levels.

Shut-off control (LUM, ETB)

Best practice in most cases, especially machine screws and

Pistol grip type (LMP, LTP)

An outstanding tool for fast and extremely accurate assembly. A low weight alternative with extremely high torque capacity and low sound level.

ASSEMBLY TOOLS

Selection guide

TORQUE RECOMMENDATIONS

The torque is important to ensure the required clamping force. These tables show the recommended torque for the most common types of screws and bolts.

SCREWS

Recommended max tightening torque (Nm) for untreated oil-smeared screws (friction coefficient = 0.125).

Metric coarse thread. The torque corresponds to approximately 62 % of tensile stress.

M-THREADED SCREWS/BOLTS

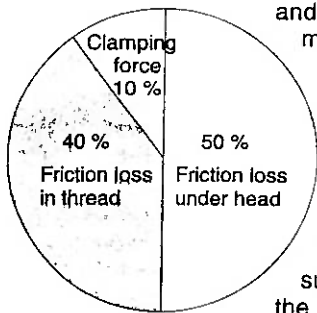
Tightening torque Nm, according to ISO 898/1

Thread	Bolt grade							Thread							
	3.6	4.6	4.8	5.8	8.8	10.9	12.9		4.6	4.8	5.8	8.8	10.9	12.9	
M1.6	0.05	0.065	0.086	0.11	0.17	0.24	0.29	M14	48	58	80	128	181	217	
M2	0.10	0.13	0.17	0.22	0.35	0.49	0.58	M16	74	88	123	197	277	333	
M2.2	0.13	0.17	0.23	0.29	0.46	0.64	0.77	M18	103	121	172	275	386	463	
M2.5	0.20	0.26	0.35	0.44	0.70	0.98	1.20	M20	144	170	240	385	541	649	
M3	0.35	0.46	0.61	0.77	1.20	1.70	2.10	M22	194	230	324	518	728	874	
M3.5	0.55	0.73	0.97	1.20	1.90	2.70	3.30	M24	249	295	416	665	935	1120	
M4	0.81	1.10	1.40	1.80	2.90	4.00	4.90	M27	360	435	600	961	1350	1620	
M5	0.60	2.20	2.95	3.60	5.70	8.10	9.70	M30	492	590	819	1310	1840	2210	
M6	2.80	3.70	4.90	6.10	9.80	14.0	17.0	M36	855	1030	1420	2280	3210	3850	
M8		8.90	10.50	15.0	24.0	33.0	40.0	M42	1360		2270	3640	5110	6140	
M10		17.0	21.0	29.0	47.0	65.0	79.0	M45	1690		2820	4510	6340	7610	
M12		30.0	36.0	51.0	81.0	114.0	136.0	M48	2040		3400	5450	7660	9190	

Basic tightening technique

The material

The material is decisive for the choice of which type of screw and fastening tools you should choose. The most common materials are steel, aluminium, plastic, wood and various types of construction material. Different materials withstand different clamping forces. The clamping force is the force that holds the joint together and assures its function. Clamping force is attained in practice by transmitting a specific torque. Out of the total torque applied in tightening, roughly 10% is consumed for clamping force, while the remaining 90% is used in overcoming the friction.



The friction

To assure the best possible results you should endeavour to achieve uniform quality and friction in the joint. This means that you must consider the dimensions of predrilled and punched holes, threads, washers etc. If there is too much variation in the dimensions, and thus in the friction, this could be very costly.

The screw/bolt

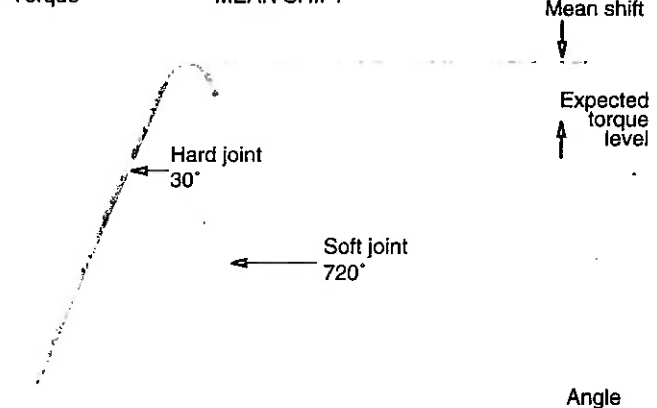
In most constructions the screw is the weakest link in the joint. If anything happens, it is usually cheapest to change screws. There are exceptions, however, such as when materials like sheet metal and plastic are involved, when the screw is the strongest link. Replacement of parts with defective threads can be expensive. For such applications, it is therefore very important to work with a tool with an accurate clutch.

Hard and soft joints

A joint is usually classified as either hard or soft. A hard joint is tightened to full torque through a tightening angle of roughly 30° after the screw has reached down to snug level. In a soft joint, the screw sometimes has to be tightened more than two complete turns before the full torque is attained. The same tools often give different torque values on hard and soft joints

Torque

MEAN SHIFT



respectively. This difference in torque values is generally known as "mean shift".

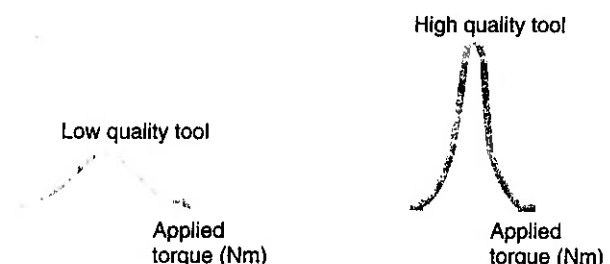
By measuring the torque from a series of tightening operations on the same joint, a measure is obtained of how accurately the tool can repeat a tightening. This is known as the scatter of the tool.

For more information about test procedure see ISO 5393.

The scatter is small for a high quality tool, and wide for a low quality tool

Number of tightenings

Number of tightenings



IMPACT WRENCHES

Selection guide

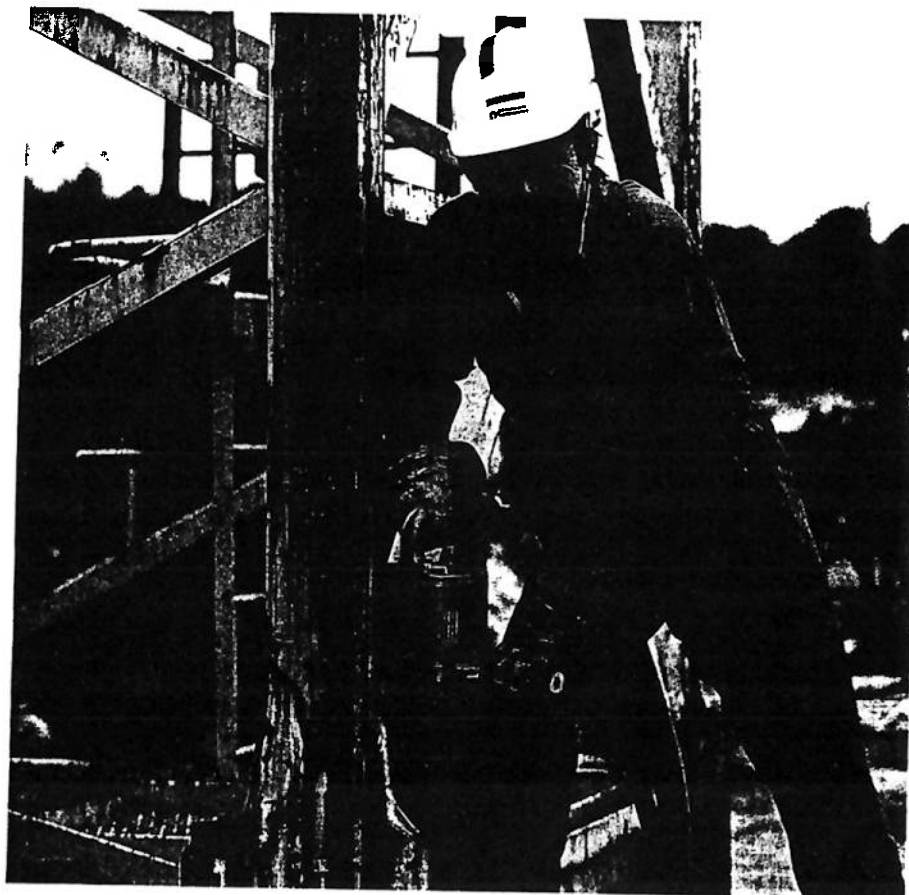
This guide will assist you in recommending an impact wrench for a specific application.

The torque figures are normal tightening torques for untreated, oil-smeared and rust-protected bolts and nuts in the most common strength grades. The torques correspond to approximately 62 % of tensile stress.

Impact wrenches build up torque in joints through a series of rotary impacts.

The torque obtained depends on air pressure and tightening time on the actual joint. These factors should be considered when choosing an impact wrench.

As a general rule, if a wrench impacts longer than 5 seconds on a fastener, a larger wrench should be used or a shorter life will result.



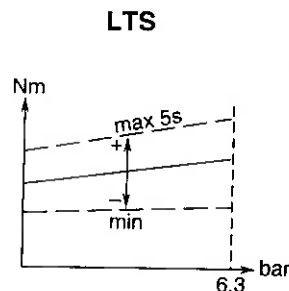
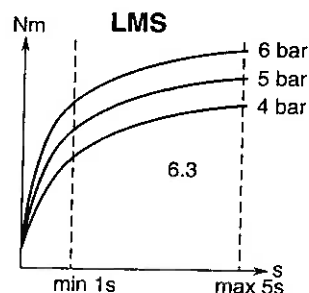
	M6	M8	M10	M12	M14	M16	M18	M20	M22	M24	M27	M30	M36	M42	M45	M48
Nm	9.8	24	47	81	128	197	275	385	516	665	961	1310	2280	3640	4510	5450
LMS	LMS06	LMS06	LMS16	LMS26	LMS36/37	LMS37/46	LMS46	LMS56	LMS56	LMS60	LMS60	LMS64	LMS86	LMS86	LMS86	LMS86
8.8		LMS16	LMS26	LMS36/37	LMS37/46	LMS46	LMS56	LMS56	LMS60	LMS64	LMS64	LMS64	LMS86	LMS86	LMS86	LMS86
LTS		LTS16	LTS16	LTS26	LTS26	LTS36	LTS56	LTS56	LTS56							
				LTS36	LTS36											

Nm	14	33	65	114	181	277	386	541	728	935	1350	1840	3210	5110	6340
LMS	LMS06	LMS16	LMS26	LMS26	LMS36/37	LMS37/46	LMS56	LMS56	LMS60	LMS60	LMS64	LMS86	LMS86	LMS86	LMS86
10.9	LMS16		LMS36/37	LMS36/37	LMS37/46	LMS56	LMS60	LMS60	LMS64	LMS64	LMS64	LMS86	LMS86	LMS86	LMS86
LTS		LTS16	LTS16	LTS26	LTS36	LTS56	LTS56	LTS56							
				LTS36											

Nm	17	40	75	136	217	333	463	649	874	1120	1620	2210	3850	6140
LMS	LMS06	LMS16	LMS26	LMS26	LMS36/37	LMS37/46	LMS56	LMS60	LMS60	LMS64	LMS86	LMS86	LMS86	LMS86
12.9	LMS16		LMS36/37	LMS36/37	LMS37/46	LMS56	LMS60	LMS60	LMS64	LMS64	LMS86	LMS86	LMS86	LMS86
LTS		LTS16	LTS16	LTS26	LTS36	LTS56	LTS56							
				LTS36										

HEAVY DUTY

EXTRA HEAVY DUTY

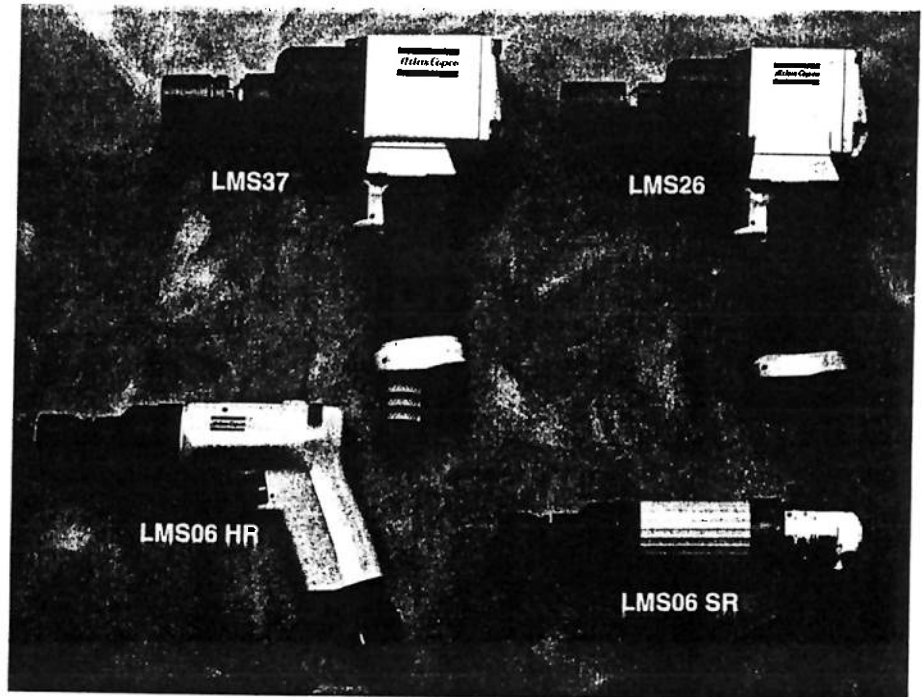


IMPACT WRENCHES

Reversible

M6-M16 bolt capacity

- ❑ **Fast tightening and disassembly** — with strong and fast air motor
- ❑ **Easy to work with** — negligible reaction torque and low weight
- ❑ **Highest availability** — designed for heavy industrial production work and highest availability
- ❑ **Flexible** — each tool has a wide torque range to suit many applications
- ❑ **Minimum operator fatigue** — well-balanced impact mechanism with lower vibration level for minimum operator fatigue
- ❑ **Lubrication-free** — LMS06-LMS26



Model	Bolt capacity mm	Square drive size in	Recommended torque range		Max. torque Nm	Impacts per min	Free speed r/min	Weight		Length excl anvil mm	Air consumption under load		Recommended hose size mm	Distance centre to side mm	Ordering No.
			Nm	Ft lb				kg	lb		l/s	cfm			
LMS06 SR-10	6-8	3/8	7- 30	5- 22	55	2100	12500	0.9	2.0	182	4	8	6.3	20	8434 1060 12
LMS06 HR-10	6-8	3/8	7- 30	5- 22	55	2100	13500	0.9	2.0	184	4	8	6.3	20	8434 1060 04*
LMS06 HR10-HD	6-8	3/8	7- 30	5- 22	55	2100	13500	0.9	2.0	184	4	8	6.3	20	8434 1060 08
LMS06 HR-42	6-8	1/4 ^a	7- 30	5- 22	55	2100	13500	0.9	2.0	184	4	8	6.3	20	8434 1060 20
LMS06 HR42-HD	6-8	1/4 ^a	7- 30	5- 22	55	2100	13500	0.9	2.0	184	4	8	6.3	20	8434 1060 16
LMS16A HR-10	10	3/8	10- 60	7- 45	100	1260	10000	1.7	3.8	141	6	13	8.0	24	8434 1160 60
LMS16A HR-13	10	1/2	10- 60	7- 45	100	1260	10000	1.7	3.8	141	6	13	10.0	24	8434 1160 29
LMS26 HR-13	12	1/2	30-160	22-120	200	1200	11500	2.1	4.6	142	8	17	10.0	29	8434 1260 02*
LMS26 HR-43	12	7/16 ^a	30-160	22-120	200	1200	11500	2.1	4.6	142	9	19	10.0	29	8434 1260 77
LMS36 HR-13	14	1/2	40-200	30-150	300	1100	8000	2.7	6.0	165	9	19	10.0	33	8434 1360 43*
LMS36 HR-16	14-16	5/8	40-280	30-210	400	1140	8800	2.7	6.0	165	10	21	10.0	33	8434 1360 01
LMS37 HR-13	14-16	1/2	40-340	30-250	480	1200	8800	2.7	6.0	165	13	27	10.0	33	8434 1360 41*

Air inlet thread INCH: 1/4"

HD = Suitable for soft joints

^a Female hex. quick change chuck

* Basic tools of the range, cover most needs

ACCESSORIES INCLUDED

Silenced air exhaust through handle
Hose fitting

OPTIONAL ACCESSORIES

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SELECTED SERVICE KITS TO ORDER

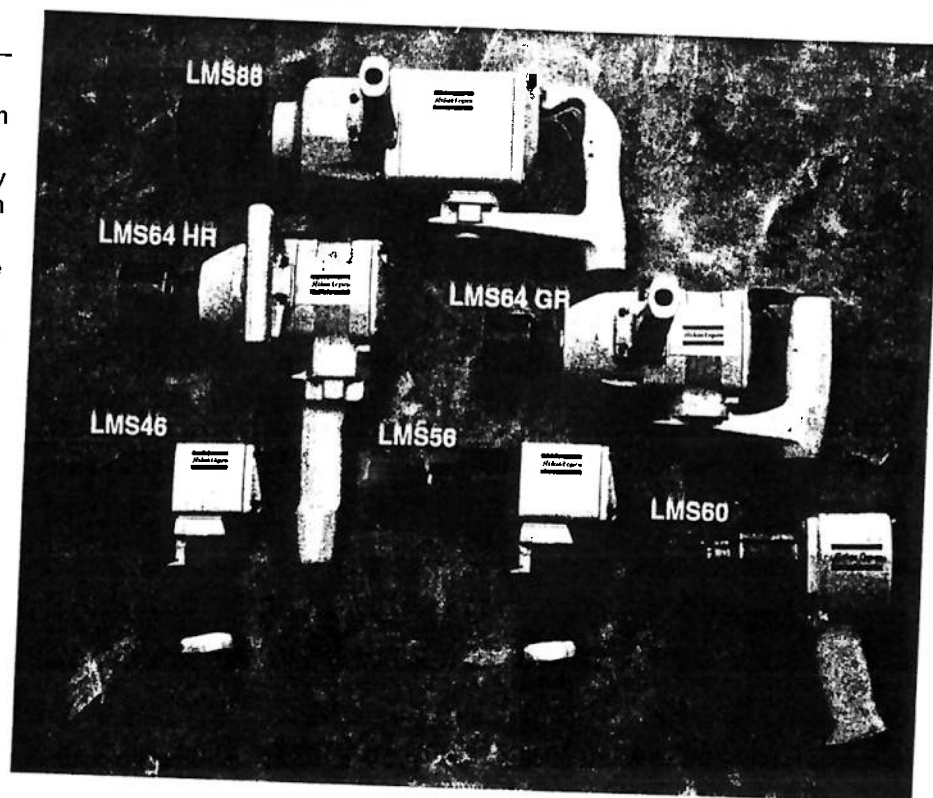
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IMPACT WRENCHES

Reversible

M16-M45 bolt capacity

- **Fast tightening and disassembly** — with strong air motor
- **Ergonomic** — negligible reaction torque and low weight
- **High availability** — designed for heavy industrial production work and high availability
- **Flexible** — each tool has a wide torque range to suit many applications
- **Minimum operator fatigue** — well-balanced impact mechanism with lower vibration level



Model	Bolt capacity mm	Square drive size in	Recommended torque range		Max. torque Nm	Impacts per min	Free speed r/min	Weight		Length excl anvil mm	Air consumption under load		Recommended hose size mm	Distance centre to side mm	Ordering No.
			Nm	Ft lb				kg	lb		l/s	cfm			
LMS46 HR20	16-19	3/4	70- 400	52- 295	500	900	6200	3.5	7.7	170	13	27	10.0	37	8434 1460 42
LMS56 HR20	18-20	3/4	100- 450	74- 332	800	960	4600	4.3	9.5	189	13	27	10.0	38	8434 1560 09*
LMS56 HR25	18-22	1	100- 550	74- 406	800	960	4600	4.3	9.5	189	13	27	10.0	38	8434 1560 41
LMS60 HR25*	20-22	1	200-1000	147- 737	1500	1200	5500	5.3	12.0	194	22	47	12.5	45	8434 1055 01
LMS64 HR25	24-32	1 ^b	400-1500	295-1106	2300	600	3750	9.0	20.0	195	21	44	12.5	57	8434 1640 03
LMS64 GR25	24-32	1 ^b	400-1500	295-1106	2300	600	3750	9.0	20.0	280	21	44	12.5	57	8434 1641 02*
LMS86 GOR38	32-45	1 1/2	1000-5000	737-3688	10000	450	3720	16.4	36.0	376	29	61	16.0	63	8434 1860 14
LMS86 GIR38	32-45	1 1/2	1000-5000	737-3688	10000	450	3720	16.4	36.0	376	29	61	16.0	63	8434 1860 22*

Air inlet thread INCH: LMS46 and LMS56 = 1/4", LMS60 = 3/8", LMS64 and LMS86 = 1/2"

GOR = Outside trigger GR/GIR = Inside trigger

* 3/4" square drive optional 4250 1498 03

^b 1 5/8" spline drive optional

* Basic tools of the range, cover most needs

ACCESSORIES INCLUDED

Filtered air exhaust through handle (MS46/56/60)

Hose fitting

OPTIONAL ACCESSORIES

Page 15



SELECTED SERVICE KITS TO ORDER

Page 15

IMPACT WRENCHES

With torque control — Reversible

M8-M22 bolt capacity

Torque control offers:

High productivity

- ☐ High power and torque shut-off contribute to short tightening time
- ☐ Designed for heavy industrial work and highest availability
- ☐ Stepless torque adjustment to suit all applications

No rejects in production

- ☐ Accurate tightening torque
- ☐ No over-torquing
- ☐ No loose bolts

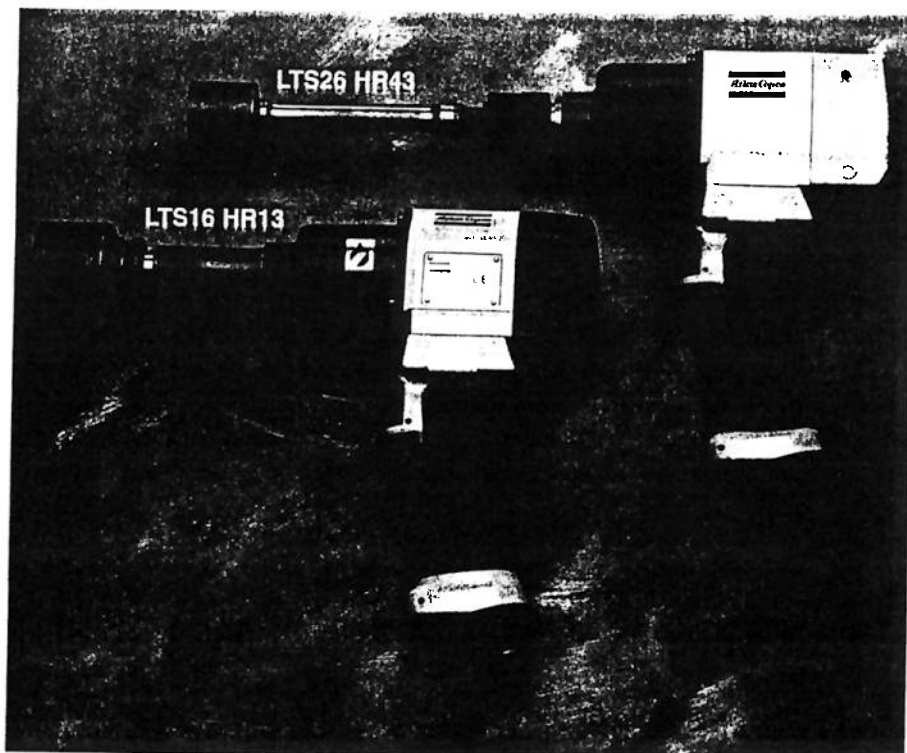
Independence of operator influence

- ☐ Automatic shut-off when desired torque is reached

Minimum operator fatigue

- ☐ The low weight in relation to the high output make LTS easy to work with
- ☐ Well-balanced impact mechanism with lower vibration level

- ☐ Lubrication-free — LTS16-LTS26



Model	Bolt capacity mm	Square drive size in	Recommended torque range		Impacts per min	Free speed r/min	Weight		Length excl anvil mm	Air consumption under load		Air inlet thread in	Recommended hose size mm	Distance centre to side mm	Ordering No.
			Nm	Ft lb			kg	lb		l/s	cfm				
LTS16 HR10	8-10	3/8	22 ^b - 40	16 - 29	960	10000	2.0	4.4	214	6	13	1/4	8	24	8434 1162 19
LTS16 HR13	8-10	1/2	34 ^b - 58	25 - 43	1100	10000	2.0	4.4	214	6	13	1/4	8	24	8434 1162 01*
LTS26 HR13-1	10-12	1/2	50 ^b - 90	37 - 66	960	9300	2.6	5.7	226	6	13	1/4	10	29	8434 1262 00
LTS26 HR13-2	12-14	1/2	70 ^b - 120	52 - 88	1100	9300	2.6	5.7	226	8	17	1/4	10	29	8434 1262 18
LTS26 HR43	10-14	7/16*	40 ^b - 150	29 - 111	1200	11500	2.5	5.5	164	8	17	1/4	10	29	8434 1262 59*

^a Female hex. quick change chuck — 1/2" square drive on torsion bar

^b Min torque at 3 bar air pressure and min setting of torque control mechanism

* Basic tools of the range, cover most needs

ACCESSORIES INCLUDED

Silenced air exhaust through handle

Hose fitting

LTS26 HR43

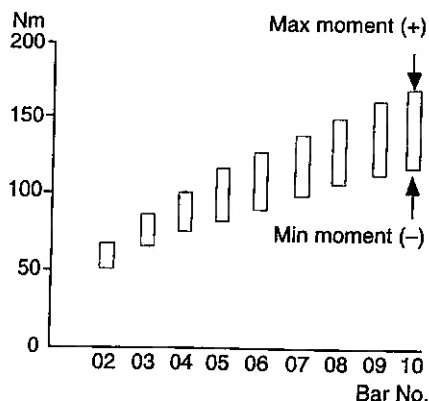
Torsion bar No.06

LTS16 and LTS26

Adjusting key

LTS16 and 26 torsion bar — bounce angle shut-off

The purpose of the torsion bar principle is to increase the bounce angle of the impact mechanism when the tightening torque is reached. The tool is shut off when torque is reached.



LTS26 HR 43

Female hexagon quick-change chuck for separate torsion bars with 1/2" square drive. The design is specially suitable for tightening of different bolt sizes at the same work place.

LTS16-26 HR 13 (10) built-in torsion bar

The anvil of the impact mechanism is extended with a built-in torsion bar to get high accuracy and low vibration level. These types are designed for serial production, i.e. frequent tightening of the same bolt size.

Torsion bar No.	Torque Nm	Ordering No.	NB
02	60	4250 1230 82	orange
03	75	4250 1230 83	yellow
04	90	4250 1230 84	green
05	100	4250 1230 82	blue
06	110	4250 1230 86	red (Standard)
07	120	4250 1230 87	orange
08	130	4250 1230 88	yellow
09	135	4250 1230 89	green
10	150	4250 1230 90	blue

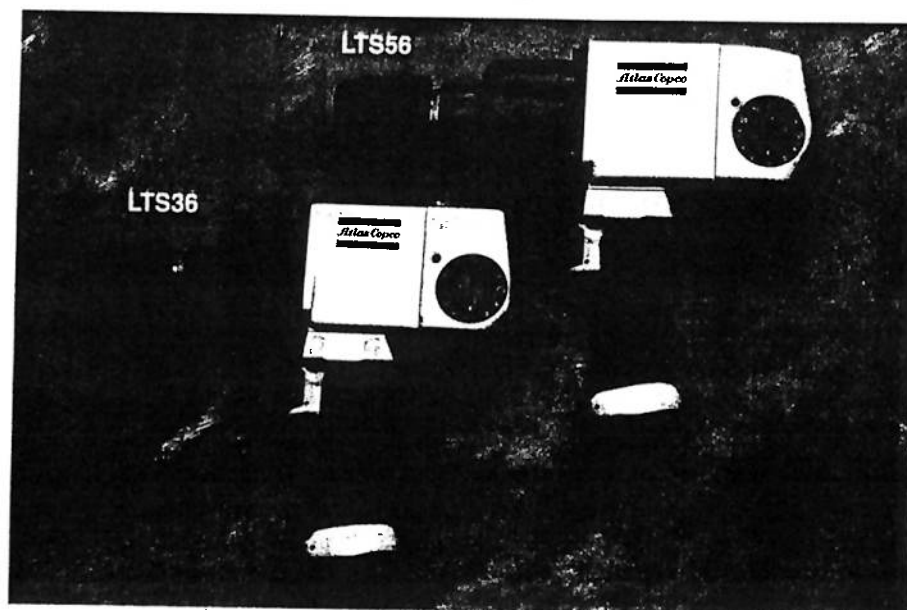
Valid at 6 bar air pressure

IMPACT WRENCHES

With torque control — Reversible

LTS36-56 — Added bounce energy principle

The energy content of each blow is added to the next and following blows until the pre set level is reached and the tool shuts off.



Model	Bolt capacity mm	Square drive size in	Recommended torque range		Impacts per min	Free speed r/min	Weight		Length excl anvil mm	Air consumption under load		Air inlet thread in	Recommended hose size mm	Distance centre to side mm	Ordering No.
			Nm	Ft lb			kg	lb		l/s	cfm				
LTS36 HR13	12-14	1/2	80 ^a -200	59-147	1140	8800	3.7	8.1	200	10	21	1/4	10	33	8434 1362 41*
LTS36 HR16	12-16	5/8	120 ^a -280	88-206	1140	8800	3.7	8.1	220	10	21	1/4	10	33	8434 1362 09
LTS56 HR20	18-20	3/4	200 ^a -450	147-332	960	4600	5.3	12.0	225	13	27	1/4	10	38	8434 1561 08
LTS56 HR25	18-22	1	200 ^a -550	147-406	960	4600	5.3	12.0	225	13	27	1/4	10	38	8434 1561 40*

Min torque at 4 bar air pressure and min setting of torque control mechanism

* Basic tools of the range, cover most needs

ACCESSORIES

EXTENDED ANVILS



Model	Dimensions		Ordering No.
	Drive size in	Extension mm	
Extended square drive anvil for			
.MS16	3/8	75	4250 1145 80 ^a
.MS16	1/2	75	4250 1147 80 ^b
.MS26	1/2	75	4250 1085 80 ^b
.MS26	1/2	150	4250 1086 80 ^b
.MS/LTS36	1/2	75	4250 1031 80 ^b
.MS/LTS36	1/2	150	4250 1032 80 ^b
.MS/LTS36	5/8	75	4250 1034 80 ^b
.MS/LTS36	5/8	150	4250 1035 80 ^b
.MS/LTS46	3/4	75	4250 1208 00
.MS/LTS46	3/4	150	4250 1209 00
.MS/LTS56	3/4	75	4250 1109 00
.MS/LTS56	3/4	150	4250 1110 00
.MS/LTS56	3/4	200	4250 1111 00
.MS/LTS56	1	75	4250 1113 00
.MS/LTS56	1	150	4250 1114 00
.MS64	1	80	4250 0774 00
.MS64	1	160	4250 0775 00

pline type anvil for			
VS64	1 5/8-14	—	4250 0967 80
eavy duty anvil (thru hole) for			
VS/LTS36	1/2	80	4250 1041 01

QUICK CHANGE CHUCK



Model	Dimensions		Ordering No.
	Drive size in	Extension mm	
Anvil with female hexagon quick change chuck for			
LMS06	1/4	—	4250 1513 80
LMS16	7/16	—	4250 1154 80
LMS26	7/16	—	4250 1088 80
LMS36	7/16	—	4250 1050 80 ^c

Ordering No.

^a Retainer pin — locking type 4250 0851 00

^b Retainer pin — quick change type 4250 1190 00

^c NOTE To be used together with reversing valve 4250 1345 01 (marked "1") only

SOCKET HOLDERS



Model	Drive	Length mm	Ordering No.
	size in		
Tool holder with square drive, for 7/16" quick change chuck, for			
LMS16,-26	3/8	75	4023 1210 03
	1/2	75	4023 1211 03

OPTIONAL ACCESSORIES

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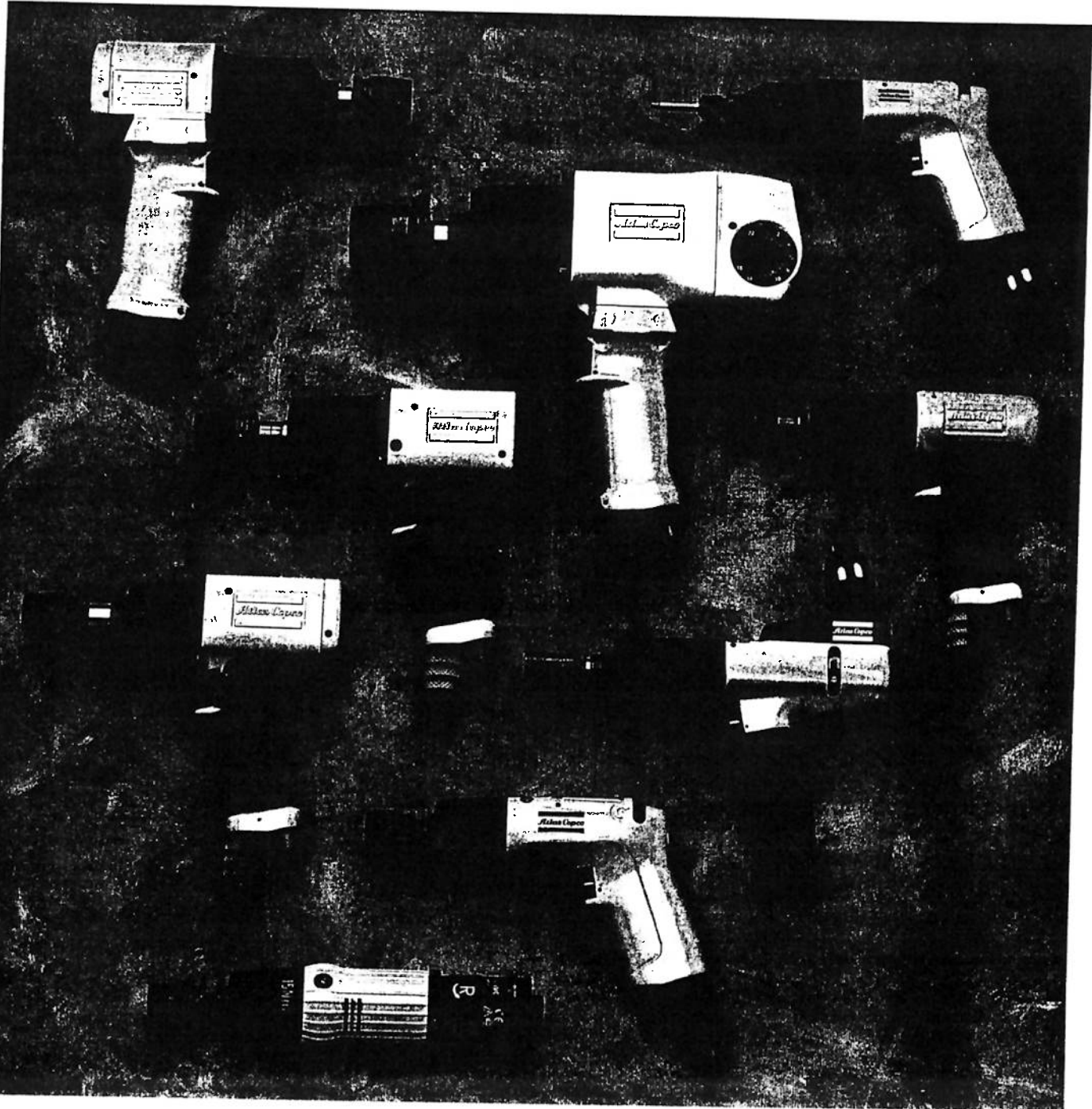


SELECTED SERVICE KITS TO ORDER

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ERGOPULSE

Hydraulic Impulse Nutrunners



The successful combination of high productivity and good working environment

Productivity booster

- ▣ Reaches the preset torque faster than conventional tightening tools
- ▣ A wide and easily adjusted torque range
- ▣ A service life up to 10 times that of conventional tools. Cuts expensive downtime
- ▣ Shut-off models give independence of operator influence

High accuracy

- ▣ The preset torque level remains constant
- ▣ Extremely good repeatability
- ▣ Final torque less independent of joint stiffness

Ergonomics

- ▣ Virtually no reaction forces
- ▣ Balanced handle
- ▣ Low noise and vibration levels
- ▣ Lubrication-free

ERGOPULSE

Selection guide

The ErgoPulse principle

ErgoPulse is based on the principle according to which the torque of the air motor is transmitted by pulses in a hydraulic system. The unique pulse unit increases the torque generated by the motor 50-100 times. The reaction forces are virtually eliminated. The hydraulic impulse system reduces noise and vibration levels considerably. Together with good balance and low weight the result is a tool that is extremely comfortable to operate.

The strong and fast motors used in the ErgoPulse tools shorten production time. Rundown is fast, and the preset torque is very rapidly reached. Shut-off models — PT and XT types give automatic shut-off when the preset torque is reached.

The reliability and accuracy of the ErgoPulse tools make them ideal for continuous and heavy production. Durability tests have shown no signs of wear after more than a million tightenings.

In short, ErgoPulse combines the best

from both conventional nutrunners and impact wrenches.

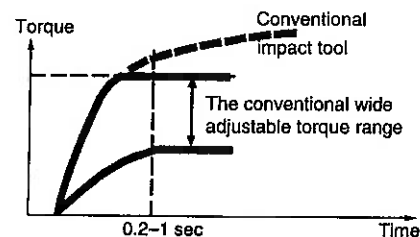
Torque characteristics

The unique ErgoPulse torque characteristic means a rapidly reached preset torque level that remains constant with extremely good repeatability.

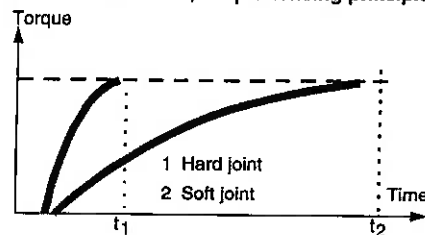
Ergonomics

These tools were definitely designed with a human hand in mind. Careful balance and low weight minimize wrist strain. The impulse mechanism suppresses all tendencies to counter rotation when tightening to give the ideal, one-hand tool.

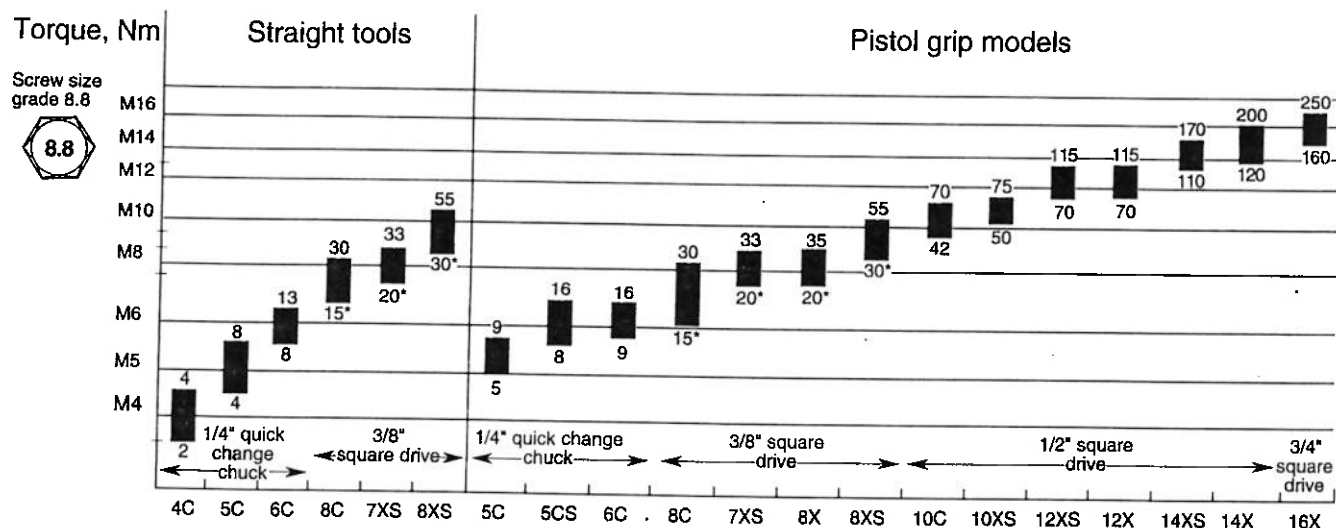
The action of the torque pulse in the impulse mechanism is cushioned in oil, reducing high-frequency noise in the joint and structure. The noise generated by the tool in operation on the shop floor is lower than the typical ambient noise level in such areas. The pulse mechanism reduces the level of vibration in the tool handle.



Automatic shut-off, torque sensing principle



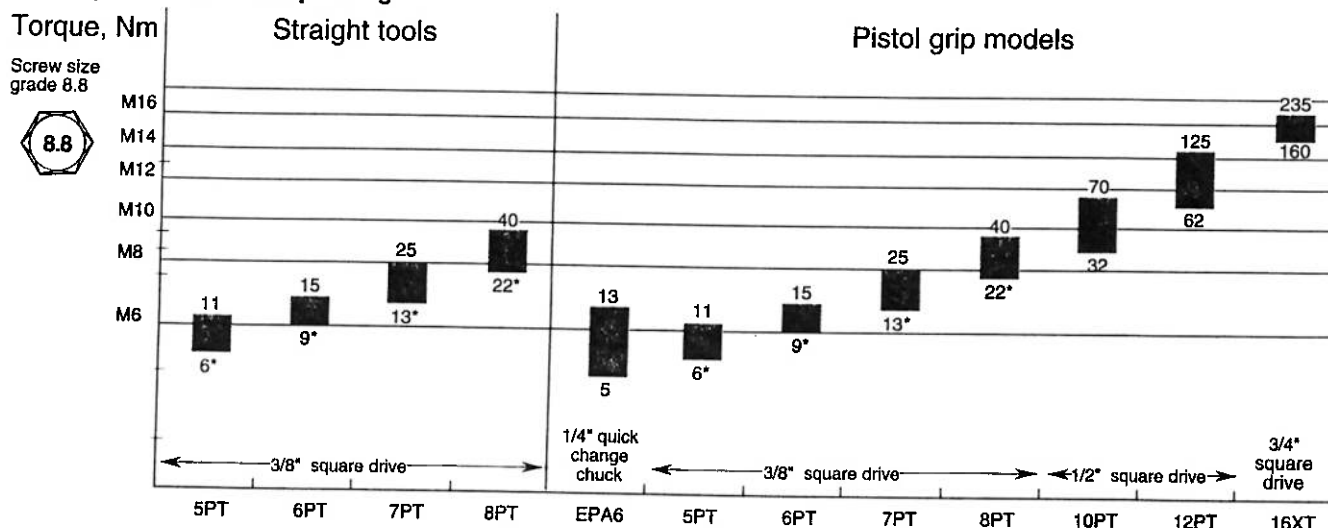
Non-shut-off pulse tools — torque range



* For tools with quick change chuck, see technical data

Available end 1997

Shut-off pulse tools — torque range



* For tools with quick change chuck, see technical data



ERGOPULSE

Screwdriver/Nutrunner type

Single blade pulse unit Screw size M4-M10

The small size tools for use in restricted spaces where small dimensions and low weight are important.

Pistol grip model

The well-known Atlas Copco pistol grip in combination with the ErgoPulse mechanism is ideally suited for applications where both high torque and axial forces are included. All pistol grip models have axial bearing for minimum feed force.

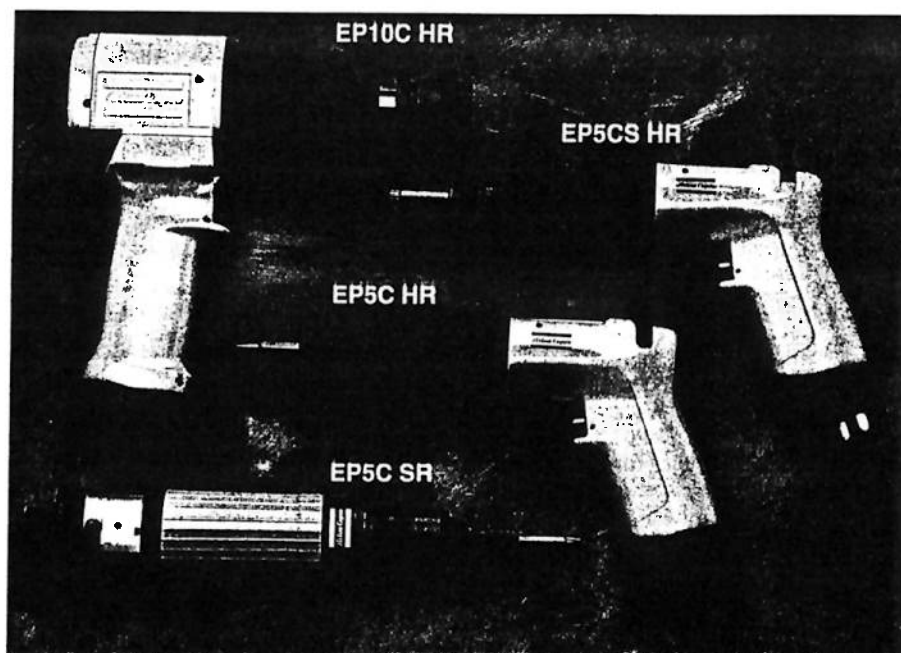
The 5CS HR model is a very powerful M5-M6 tool using the same single blade pulse unit technology as the battery pulse tool EPA6. Still same size and weight as the EP5C HR.

Straight model

The possibility of using both suspension in balancers and piped-away exhaust air makes it ideal for line assembly.

All models feature:

- ☐ Low vibration level
- ☐ Low noise level
- ☐ Fast accurate tightening
- ☐ No reaction force
- ☐ Comfortable working temperature
- ☐ Lubrication-free



Model	Bolt size mm	Square drive size in	Recommended torque range *		Free speed r/min	Weight		Length mm	Dis- tance centre to side mm	Air consumption under load		Recom- mended hose size mm	Air inlet thread in	Sound level ^b dB(A)	Ordering No.
			Nm	ft lb		kg	lb			l/s	cfm				
ErgoPulse 5-8. Straight models															
EP4C SR	M4	1/4 *	2- 4	1- 3	8200	0.81	1.8	255	19	2.5	5	6	1/4	70	8431 0350 02
EP5C SR	M5	1/4 *	4- 8	3- 6	10500	0.95	2.0	238	20	5	10	8	1/4	72	8431 0261 14*
EP6C SR	M6	1/4 *	8-13	6- 9	10500	1.0	2.2	263	20	5	10	8	1/4	72	8431 0261 22*
EP8C SR-Q6	M8	1/4 *	14-28	10-21	9000	1.2	2.6	246	24	5	10	8	1/4	73	8431 0261 48
EP8C SR	M8	3/8	15-30	11-22	9000	1.2	2.6	226	24	5	10	8	1/4	73	8431 0261 30*
Pistol grip models															
EP5C HR ^c	M5	1/4 *	5- 9	4- 7	4800	1.0	2.2	225	22	6	13	8	1/4	70	8431 0260 15*
EP5CS HR	M5-M6	1/4 *	8-16	6- 12	4800	1.0	2.2	225	22	6	13	8	1/4	70	8431 0260 17*
EP6C HR ^c	M6	1/4 *	9-16	7-12	4800	1.1	2.4	250	22	6	13	8	1/4	70	8431 0262 13
EP8C HR-P-Q6	M8	1/4 *	16-31	12-23	4800	1.3	2.9	255	24	6	13	8	1/4	70	8431 0360 71
EP8C HR-P	M8	3/8	18-34	13-25	4800	1.3	2.9	235	24	6	13	8	1/4	70	8431 0360 63*
ErgoPulse 8-10. Pistol grip type															
EP8C HR	M8	3/8	15-30	11-22	10000	1.6	3.5	158	26	5	11	8	1/4	73	8431 0360 22
EP10C HR ^d	M10	1/2	42-70	31-52	7500	2.0	4.4	163	27	7	15	8	1/4	79	8431 0365 01*

* To be used as a guide only, final torque depends on type of joint, accessories used and air pressure

^b When exhaust hose is used

^c Available as Air on Top (HRF) model, see page 34

^d Available with 75 mm extended anvil on request.

^e Female hexagon drive

* Basic tools of the range, cover most needs

ACCESSORIES INCLUDED

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OPTIONAL ACCESSORIES

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SELECTED SERVICE KITS TO ORDER

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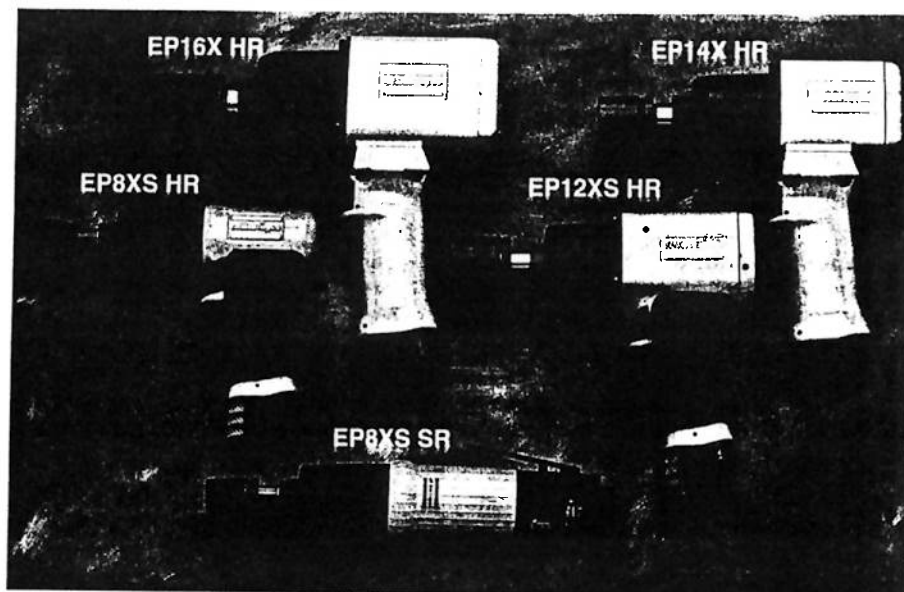
ERGOPULSE

Nutrunner type

Double and triple blade pulse unit Bolt capacity M8-M16

Nutrunners for fast and accurate tightening. These nutrunners are equipped with a double and triple blade impulse unit to minimize weight and maximize the power. They have all features and benefits of the other tools in the ErgoPulse series.

- ☐ Good accessibility
- ☐ Low noise level
- ☐ Fast accurate tightening
- ☐ No reaction force
- ☐ Comfortable working temperature
- ☐ Low weight and small dimensions
- ☐ High reliability due to cam guided impulse blades
- ☐ Twin chamber motor on XS tools. Ideal for pulse tools as this motor gives high torque at low speed



Model	Bolt size mm	Square drive size in	Recommended torque range ^a		Free speed r/min	Weight		Length mm	Distance centre to side mm	Air consumption under load		Recommended hose size mm	Air inlet thread in	Sound level ^b dB(A)	Ordering No.
			Nm	ft lb		kg	lb			l/s	cfm				
Straight models. ErgoPulse 7XS-8XS															
EP7 XS SR42	M8	1/4 ^d	17- 30	13- 22	10000	0.7	1.5	219	22	8	17	8	1/4	74	8431 0372 15
EP7 XS SR10	M8	3/8	20- 33	15- 24	10000	0.7	1.5	221	22	8	17	8	1/4	74	8431 0372 05
EP8 XS SR42	M8	1/4 ^d	22- 40	16- 29	8000	0.9	2.0	242	24	9	19	8	1/4	78	8431 0369 30
EP8 XS SR10	M8	3/8	30- 55	22- 40	8000	0.9	2.0	232	24	9	19	8	1/4	78	8431 0369 20
Pistol grip models. ErgoPulse 7XS-16X															
EP7 XS HR42	M8	1/4 ^d	17- 30	13- 22	9000	0.8	1.8	150	21	8	17	8	1/4	75	8431 0372 10
EP7 XS HR10	M8	3/8	20- 33	15- 24	9000	0.8	1.8	151	21	8	17	8	1/4	75	8431 0372 00
EP8X HR10 ^d	M8	3/8	20- 35	15- 26	9000	0.95	2.0	154	23	6	13	8	1/4	77	8431 0366 34 [*]
EP8X HR42 ^d	M8	1/4 ^d	18- 30	15- 26	9000	0.95	2.0	154	23	6	13	8	1/4	77	8431 0366 46
EP8XS HR42	M8	1/4 ^d	22- 40	16- 29	7000	1.0	2.0	172	23	9	19	10	1/4	80	8431 0369 12
EP8XS HR10	M8	3/8	30- 55	22- 40	7000	1.0	2.0	162	23	9	19	10	1/4	80	8431 0369 05 [*]
EP10XS HR13	M10	1/2	50- 75	37- 55	6000	1.3	2.9	168	26	11	23	10	1/4	78	8431 0369 40 [*]
EP12XS HR13	M12	1/2	70-115	52- 85	4500	1.6	3.5	178	29	12	25	10	1/4	79	8431 0371 00 [*]
EP12X HR13 ^c	M12	1/2	75-115	55- 85	6000	2.7	6.0	169	34	9	19	10	3/8	78	8431 0365 35
EP12X HR43	M12	7/16 ^d	70-100	55- 85	6000	2.7	6.0	164	34	9	19	10	3/8	78	8431 0365 43
EP14XS HR13 ^e	M14	1/2	110-170	81- 125	4000	2.3	5.0	188	34	14	19	10	3/8		8431 0371 50 [*]
EP14X HR13 ^c	M14	1/2	120-200	88-147	5500	3.3	7.2	175	38	11	23	10	3/8	81	8431 0365 68
EP16X HR20 ^c	M16	3/4	160-250	118-184	4000	4.3	9.4	212	41	12	25	10	3/8	80	8431 0365 76 [*]

^a To be used as a guide only, final torque depends on type of joint, accessories used and air pressure

^b When exhaust hose is used, except for XS-tools

^c Available with 75 mm extended anvil on request.

^d Female hexagon drive

^e Preliminary data. Available end 1997

* Basic tools of the range, cover most needs



SELECTED SERVICE KITS TO ORDER

The spare parts included in the service kits cover a normal overhaul of your tool. Have them always available for a fast and economical repair.

Main parts included:

- ☐ Vane kit
- ☐ Motor bearings
- ☐ Gaskets
- ☐ O-rings
- ☐ Circlips
- ☐ Pins etc.

Model	Service kit
EP5C/6C SR	4081 0110 90
EP5C/6C HR	4081 0111 90
EP8C SR	4081 0112 90
EP8C HR-P	4081 0113 90
EP10C HR	4081 0115 90
EP7XS HR	4081 0188 90
EP7XS SR	4081 0189 90
EP8X HR	4081 0114 90
EP8XS HR	4081 0119 90
EP8XS SR	4081 0190 90
EP10XS HR	4081 0191 90
EP12XS HR	4081 0192 90
EP12X HR	4081 0116 90
EP14X HR	4081 0117 90
EP16X HR	4081 0118 90
EP5/6PT HR	4081 0122 90
EP5/6PT SR	4081 0123 90
EP7/8PT HR	4081 0120 90
EP10PT HR	4081 0124 90
EP12PT HR	4081 0125 90

Oil filling kit (50 ml oil, syringe) 4081 0121 90

For complete information, see spare parts list.



ERGOPULSE PT-TRIM — NUTRUNNER TYPE

Torque sensing — Shut-off system

Twin piston pulse unit
Bolt capacity M6 — M12

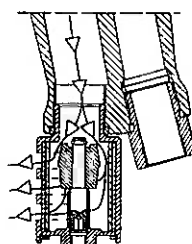
- ☐ Safer joints and fewer after-checks
- ☐ Fast and accurate tightening
- ☐ Minimum operator fatigue
- ☐ Independence of operator influence

A new reliable shut-off system

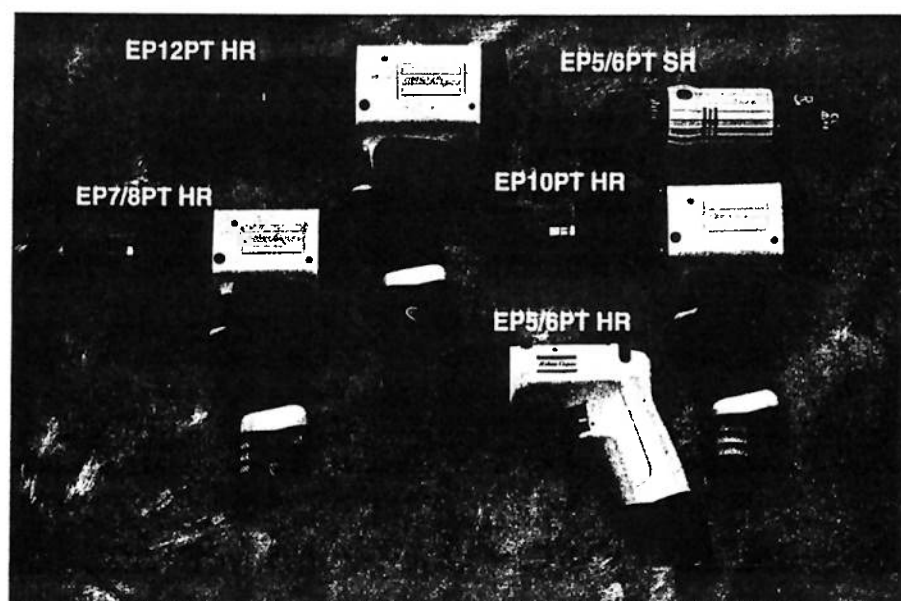
The ErgoPulse PT-TRIM nutrunners incorporate a shut-off system, based on retardation instead of timers or bypass valves. Torque is sensed by means of an inertial mass acting against an adjustable spring. When the force of the mass is sufficient to overcome the preset force in the spring, a lock pin releases a disc valve to shut off the air supply. The result is a reliable and easily adjustable shut-off system with improved performance, directly correlated to the tightening process.

TRIM-valve for enhanced performance on hard joints and at low torque levels

The new PT TRIM ErgoPulse shut-off tools incorporate an adjustable valve (patent pending) at the air outlet. This feature enhances the tool's performance on hard joints and at low torque levels.



The TRIM-valve gives an installed torque with high accuracy. You can tighten hard and soft joints with excellent results.



A pulse mechanism with pistons for minimum weight and long service life

The ErgoPulse PT pulse mechanism features a more efficient transfer of the impulse energy. The design is based on cam-guided pistons and rollers and the pulse cylinder is oil-filled. The moving parts are thus completely immersed in oil, which ensures a long service life.

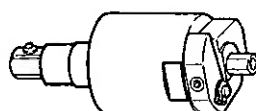
The unique piston principle makes the PT-TRIM tools extremely light.

The twin chamber motor

The ErgoPulse PT-TRIM nutrunners have a vane motor of double pressure chamber type.

It is designed for giving high torque at lower speed which gives the best characteristics for fast, reliable and accurate tightening.

PT shut-off system



Twin piston mechanism



Twin chamber motor



Model	Bolt size mm	Square drive size in	Recommended torque range*		Free speed r/min ^c	Weight		Length mm	Dis- tance centre to side mm	Air consumption under load		Recom- mended hose size mm	Air inlet thread in	Sound level dB(A)	Ordering No.
			Nm	ft lb		kg	lb			l/s	cfm				
Straight models. ErgoPulse 5-8 PT															
EP5PT SR42	M6	1/4 ^b	5- 10	4- 7	5000	0.9	1.9	212	21	6	13	8	1/4	74	8431 0368 02
EP5PT SR10	M6	3/8	6- 11	4- 8	5000	0.9	1.9	208	21	6	13	8	1/4	74	8431 0368 00
EP6PT SR42	M6	1/4 ^b	8- 14	6-10	6000	0.9	2.0	212	21	6	13	8	1/4	74	8431 0368 12
EP6PT SR10	M6	3/8	9- 15	7-11	6000	0.9	2.0	208	21	6	13	8	1/4	74	8431 0368 08*
EP7PT SR42	M8	1/4 ^b	12- 23	9-17	4500	1.2	2.5	240	25	7	15	8	1/4	78	8431 0368 37
EP7PT SR10	M8	3/8	13- 25	10-18	4500	1.2	2.5	236	25	7	15	8	1/4	78	8431 0368 31
EP8PT SR42	M8	1/4 ^b	20- 35	15-26	6000	1.2	2.6	240	25	8	17	8	1/4	78	8431 0367 90
EP8PT SR10	M8	3/8	22- 40	16-29	6000	1.2	2.6	236	25	8	17	8	1/4	78	8431 0367 80
Pistol grip models. ErgoPulse 5-12 PT															
EP5PT HR42	M6	1/4 ^b	5- 10	4- 7	5500	0.95	2.1	205	21	6	13	8	1/4	74	8431 0368 05
EP5PT HR10	M6	3/8	6- 11	4- 8	5500	0.95	2.1	200	21	6	13	8	1/4	74	8431 0368 04
EP6PT HR42	M6	1/4 ^b	8- 14	6-10	6000	1.0	2.2	205	21	6	13	8	1/4	74	8431 0368 23*
EP6PT HR10	M6	3/8	9- 15	7-11	6000	1.0	2.2	200	21	6	13	8	1/4	74	8431 0368 16*
EP7PT HR42	M8	1/4 ^b	12- 23	9-17	4500	1.3	2.9	175	26	7	15	8	1/4	77	8431 0368 36
EP7PT HR10	M8	3/8	13- 25	10-18	4500	1.3	2.9	177	26	7	15	8	1/4	77	8431 0368 30
EP8PT HR42	M8	1/4 ^b	20- 35	15-26	6000	1.4	3.0	175	26	8	17	8	1/4	77	8431 0367 94
EP8PT HR10	M8	3/8	22- 40	16-29	6000	1.4	3.0	177	26	8	17	8	1/4	77	8431 0367 85*
EP10PT HR13	M10	1/2	32- 70	24-51	4000	1.8	4.0	192	29	10	21	10	1/4	81	8431 0367 66*
EP12PT HR13	M12	1/2	62-125	46-92	3500	2.4	5.3	201	34	12	25	10	1/4	81	8431 0368 40*

To be used as a guide only, final torque depends on type of joint, accessories used and air pressure

* Basic tools of the range, cover most needs

Female hexagon drive

With TRIM valve fully open

ACCESSORIES INCLUDED

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OPTIONAL ACCESSORIES

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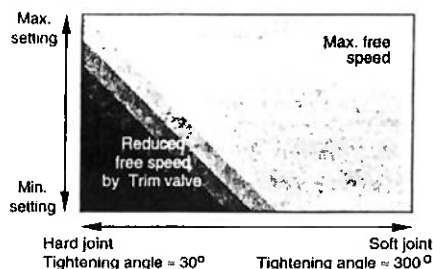


ERGOPULSE PT-TRIM — NUTRUNNER TYPE

Recommended operating area

Max. recommended tightening time is 3 seconds. Longer time indicates that the joint is too soft for the tool used. If so it is recommended to choose a bigger size of tool or another type of nutrunner.

Min. recommended number of pulses per tightening is 3-5. Fewer pulses will result in increased scatter. By reducing the free speed with the TRIM-valve there will be more pulses per tightening and improved accuracy.



Reporting, RE-versions

ErgoPulse PT TRIM tools are also available in reporting versions for process control. The RE-tools supply an air signal

that can be connected to a controller to count the number of tightenings and to detect premature shut-off and rehits.

ErgoPulse PT RE-versions (technical data same as standard versions)

EP5PT SR42RE	8431 0370 02	EP7PT SR10RE	8431 0368 33
EP5PT SR10RE	8431 0370 00	EP7PT HR42RE	8431 0368 38
EP5PT HR42RE	8431 0370 05	EP7PT HR10RE	8431 0368 32
EP5PT HR10RE	8431 0370 04	EP8PT SR42RE	8431 0367 92
EP6PT SR42RE	8431 0368 14	EP8PT SR10RE	8431 0367 82
EP6PT SR10RE	8431 0368 06	EP8PT HR42RE	8431 0367 96
EP6PT HR42RE	8431 0368 26	EP8PT HR10RE	8431 0367 99
EP6PT HR10RE	8431 0368 19	EP10PT HR13RE	8431 0367 78
EP7PT SR42RE	8431 0368 39	EP12PT HR13RE	8431 0368 42

OPTIONAL ACCESSORIES — RE-versions

Trim valve adjustment key, HR-versions 4250 2040 00

Signal tube protector, 7/8/10/12 HR-versions 4250 2131 80



ERGOPULSE XT — NUTRUNNER TYPE

Added bounce energy — Shut-off system

Bolt capacity M12 — M16

- ☐ Low reaction force and fast, accurate tightening
- ☐ Double-bladed impulse unit with unique cam guided design for optimum power and long service life
- ☐ Low noise level and low vibration level minimize operator fatigue
- ☐ Lubrication-free
- ☐ Well-balanced handle



EP16XT HR

Model	Bolt size mm	Square drive size in	Recommended torque range ^a		Free speed r/min	Weight		Length mm	Distance centre to side mm	Air consumption under load		Recommended hose size mm	Air inlet thread in	Sound level dB(A)	Ordering No.
			Nm	ft lb		kg	lb			l/s	cfm				
ErgoPulse 12XT and 16XT															
EP12XT HR13 ^b	M12	1/2	75-115	55- 85	6000	3.5	7.7	208	34	9	19	10	1/4	78	8431 0366 59
EP16XT HR20 ^b	M14-16	3/4	160-235	118-173	4000	5.0	11.0	230	41	12	25	10	1/4	80	8431 0366 75

^a To be used as a guide only, final torque depends on type of joint, accessories used and air pressure

^b Available with 75 mm extended anvil on request.

* Basic tools of the range, cover most needs

ACCESSORIES INCLUDED

Page 22

OPTIONAL ACCESSORIES

Page 22

SCREWDRIVERS

Ergonomic tools improve productivity

All Atlas Copco screwdrivers are designed with ergonomics in mind. Our philosophy is simple: each job shall be performed with a minimum of effort and a minimum amount of wear and tear on the operator. By reducing the physical load, noise and oil mist the operator will be less tired and this improves productivity.

The main benefits are:

- **High torque accuracy**
- **Lower sound level reduces fatigue**
- **Optimum grip and fast clutch give minimum reaction force**
- **Ergonomic handle shape to reduce gripping and trigger force needed**

Lubrication-free

With a technical breakthrough in new materials Atlas Copco screwdrivers are lubrication-free. Oil-free screwdrivers offer the following benefits

- **Pollution-free** exhaust air contributes to better operator comfort
- **No oil contamination in air** close to sensitive areas
- **No air line lubrication saves installation costs** and reduces air line inspection and maintenance

A complete range

Our screwdrivers are called LUM, LUF, Twist, Eliza and ErgoPulse. If you choose one or more of these screwdrivers you can be quite sure that you have what you need.

For highest accuracy the LUM screwdriver has a fast and accurate shut-off clutch. It is ideal for joints with high torque demands.

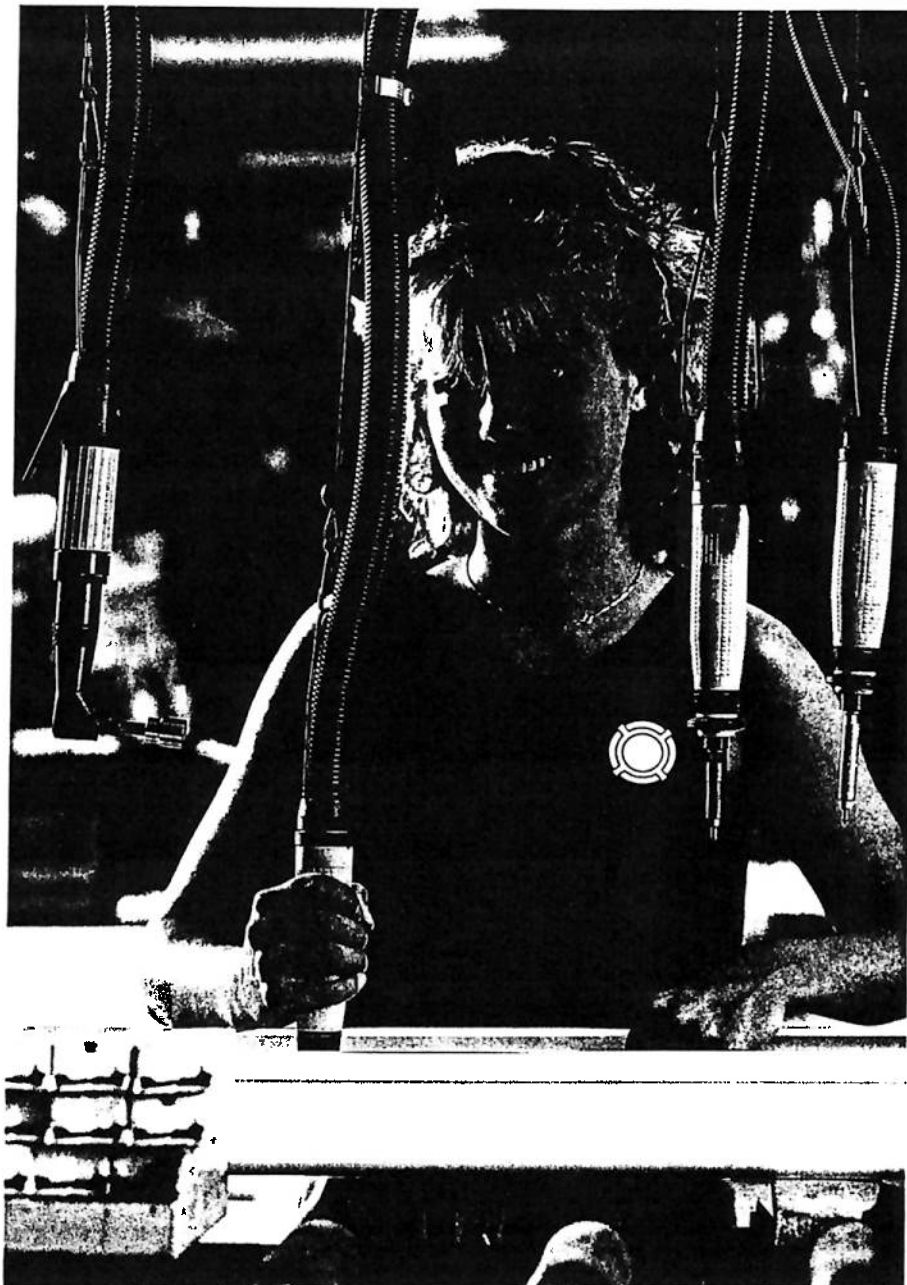
The LUF/TWIST screwdrivers have a slip clutch, implying that the clutch starts to "judder" when the torque level is reached. These tools are suitable for soft joints or when the torque level may temporarily rise during the homing phase, for instance when using sheet metal screws, wood screws or self-tapping screws.

Twist HRD/VRD is a direct drive screwdriver which stalls when final torque is reached. The torque level is adjusted by regulating the air pressure. Twist HRD/VRD is the best screwdriver for self drilling and wood screws.

Atlas Copco's pneumatic screwdrivers are available in straight, pistol and for cramped spaces, angle head versions.

ELIZA is the name given to our electric screwdrivers. These are available in three basic models covering needs for tight joints in the range from 0.05 to 3.5 Nm.

ErgoPulse is based on the principle according to which the torque of the air motor is transmitted by pulses in a hydraulic system. This ensures fast tightening and accurate torque, as well as low sound and vibration levels. Moreover the reaction force is virtually eliminated.



Air on Top and interchangeable handles — HRF

The Air on Top range is a good example of how Atlas Copco has adapted the tools to the operator instead of the other way round. Read more about Air on Top on page 34.

- **Air on Top** — Means air supply inlet is on top and hose connection is from above. No exhaust air via the handle and no "hose hook" disturbing the operator

- **Interchangeable handles** — All HRF tools have different handles for different sizes of hands. The HRF tools have a nice warm grip and the ergonomic design reduces the effort needed in gripping the handle and pulling the trigger

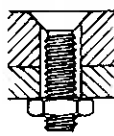
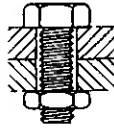
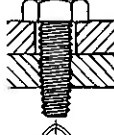
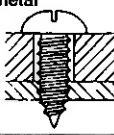
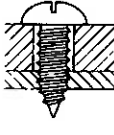
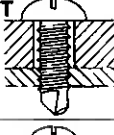
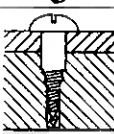
- **Wide range** — Includes screwdrivers with air shut-off and with slip-clutch, ErgoPulse tools up to size M8 as well as drills and tappers

SCREWDRIVERS

Selection guide

SCREW TYPE

SCREWDRIVER

Screw type		Screw size										
Machine screw 4.8 Property class 4.8 normal for cross recessed and slotted screws 	Ø Screw size	M1.6	M2	M2.5	M3	M3.5	M4	M5	M6			
	Torque Nm	0.086	0.17	0.35	0.61	0.97	1.4	2.9	4.9			
	Recommended tool						ETB					
		ELIZA										
		LUM05		LUM10			LUM21		LUM-24B/-25 ERGOPULSE			
Machine screw 8.8 Property class 8.8 normal for hexagon, Allen head and Torx ®. Locking nut with plastic insert, increase torque 10%, mechanical-lock nut, increase torque 20% 	Ø Screw size	M1.6	M2	M2.5	M3	M3.5	M4	M4.5	M5	M6		
	Torque Nm	0.17	0.35	0.7	1.2	1.9	2.9	4.3	5.7	9.8		
	Recommended tool						ETB					
		ELIZA										
		LUM05		LUM10			LUM-24B/-25 ERGOPULSE					
Thread rolling screw-M Property class between 8.8 and 10.9 due to case hardening. Taptite ® and Swageform are examples 	Ø Screw size	M2		M3		M4		M5	M6			
	Torque Nm	0.5		1.4		3.2		6.5	11.0			
	Recommended tool						ETB					
		ELIZA										
		LUM05		LUM10			LUM-24B/-25 ERGOPULSE					
Thread forming screw-ST (sheet metal screw) for metal 	Ø Screw size	ST2.2		ST2.9		ST3.5		ST4.2		ST4.8	ST5.5	ST6.3
	Torque Nm	0.30		1.0		1.8		2.9		4.2	6.7	9.1
	Recommended tool	LUF10				LUF20		TWIST				
						LUF34		ERGOPULSE				
						LUM-24B/-25						
Thread forming screw-ST for plastic 	Ø Screw size	ST2.2		ST2.9		ST3.5		ST4.2		ST4.8	ST5.5	ST6.3
	Torque Nm	0.30		1.0		1.8		2.9		4.2	6.7	9.1
	Recommended tool	ELIZA										
		LUM05		LUM10			LUM21		LUM-24B/-25			
Self drilling screw-ST 	Ø Screw size	ST2.2		ST2.9		ST3.5		ST4.2		ST4.8	ST5.5	ST6.3
	Torque Nm	0.30		1.0		1.8		2.9		4.2	6.7	9.1
	Recommended tool					LUF20HR		LUF34		TWIST HR16		
Wood screw 	Ø Screw size	1.5		3		5		7.5		12		
	Torque Nm											
	Recommended tool	TWIST HR08				TWIST HR05		LUF34 HRD				

☐ Shut-off clutch
 ☐ ErgoPulse
 ☐ Slip clutch
 ☒ Direct drive

* With optional coupling-ring. Ordering No. 4210 2316 01

⚙ With optional spring. 4210 1831 00

START OPTIONS



Push start

Normally selected for straight tools. The tools starts when you push the bit to the screw. Minimizes tightening time. On a pistol grip tool with push-start you have the option of both fast assembly as well as best positioning.



Trigger start

Best option if precise bit engagement is needed before the tool starts. Normally selected on pistol grip tools.



Reverse options

Straight screwdrivers are normally equipped with a ring for reverse operation. All push start models are equipped with push button for frequent and fast reversing.

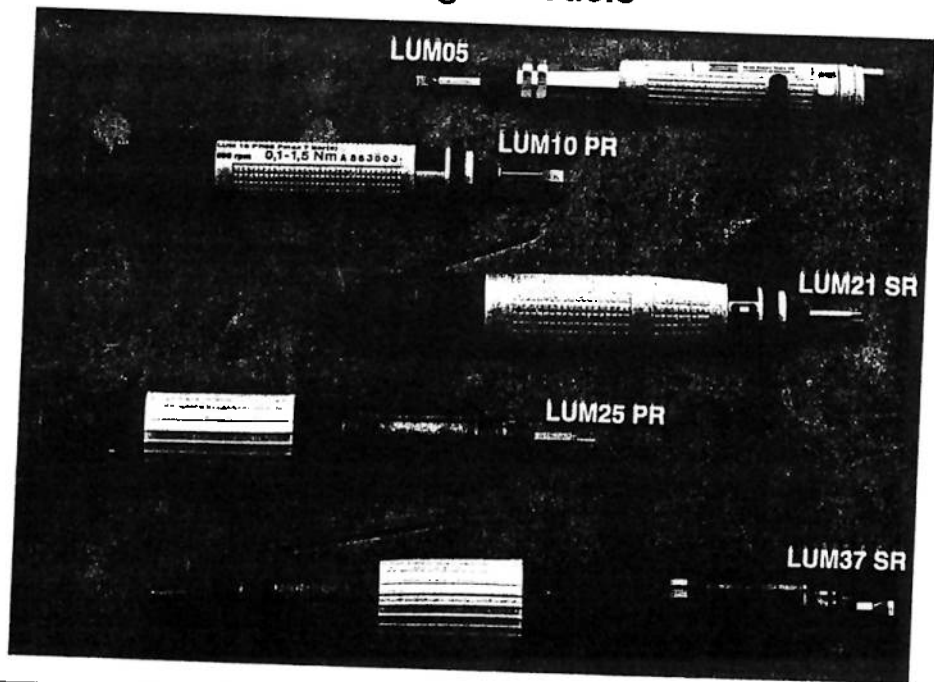


SCREWDRIVERS

With air shut-off control — Straight models

Screw size M1.6-M6
Torque range 0.1-11 Nm

- **Safer joints** — The LUM shut-off mechanism means accurate tightening, time after time, independent of variations in joint stiffness
- **Rapid clutch** with air shut-off reduces the reaction force on the wrist
- **Low sound levels** — Thanks to non resonating plastics on LUM10/21, patented silencer and exhaust hose
- **Operator comfort** — Correct grip diameter means minimum reaction force and less operator fatigue. Optimal grip for women is 34 mm and for men 38 mm. Atlas Copco offers grip diameter between 30 and 40 mm
- **Lubrication-free** — Means clean environment, no units to refill or maintain and quicker set-up



Model	Screw Ø mm	Torque range Soft joint		Free speed r/min	Air con- sumption at free speed		Sound level dB(A)	Weight		Length mm	Air inlet thread In	Distance centre to side mm	Ordering No.
		Nm	In lb		l/s	cfm		kg	lb				
Straight models with push start and push button reverse													
LUM05 PR04 ^a	M1.6-M3	0.1- 0.8	0.8- 7	400	2	5	64	0.2	0.5	178	1/8	12	8431 0124 01
LUM05 PR07 ^a	M1.6-M3	0.1- 0.8	0.8- 7	700	2	5	64	0.2	0.5	178	1/8	12	8431 0124 03
LUM05 PR13 ^a	M1.6-M2.5	0.1- 0.6	0.8- 5	1100	2	5	64	0.2	0.5	178	1/8	12	8431 0124 05
LUM10 PR05	M1.6-M4	0.1- 1.5	0.8-13	500	3	6	66	0.4	0.8	206	1/8	15	8431 0136 09*
LUM10 PR12	M1.6-M3	0.1- 1.1	0.8-10	1200	3	6	66	0.4	0.8	196	1/8	15	8431 0136 17*
LUM10 PR21	M1.6-M2.5	0.1- 0.7	0.8- 6	2100	3	6	67	0.4	0.8	196	1/8	15	8431 0136 25
LUM21 PR04-P	M2.5-M5	0.5- 4.5	4.4-40	370	4	8	70	0.7	1.5	239	1/8	18	8431 0267 02
LUM21 PR07-P	M2.5-M5	0.5- 4.5	4.4-40	700	4	8	70	0.7	1.5	239	1/8	18	8431 0267 00*
LUM21 PR10-P	M2.5-M5	0.5- 3.2	4.4-30	1000	4	8	71	0.7	1.5	239	1/8	18	8431 0267 08*
LUM21 PR14-P	M2.5-M4	0.5- 2.4	4.4-21	1400	4	8	71	0.7	1.5	239	1/8	18	8431 0267 14*
LUM21 PR23-P	M2.5-M4	0.5- 1.5	4.4-13	2300	4	8	69	0.7	1.5	239	1/8	18	8431 0267 20
LUM25 PR05-P	M4-M6	3.5-11.0 ^b	30.1-97	500	6	13	70	1.0	2.2	242	1/4	19	8431 0265 41*
LUM25 PR07-P	M4-M5	3.5- 7.0 ^b	30.1-62	700	6	13	70	1.0	2.2	242	1/4	19	8431 0265 43*
LUM25 PR10-P	M4	3.5- 5.5 ^b	30.1-49	1000	6	13	71	1.0	2.2	242	1/4	19	8431 0265 46
LUM25 PR14-P	M2.5-M4	0.6- 3.5	5.3-31	1400	6	13	71	1.0	2.2	205	1/4	19	8431 0265 49*
LUM25 PR18-P	M2.5-M4	0.6- 3.2	5.3-28	1800	6	13	71	1.0	2.2	205	1/4	19	8431 0265 52
Straight models with lever start and without push start													
LUM21 SR04-U	M2.5-M5	0.5- 4.5	4.4-40	400	4	8	70	0.7	1.5	240	1/8	18	8431 0267 22
LUM21 SR07-U	M2.5-M5	0.5- 4.5	4.4-40	700	4	8	70	0.7	1.5	240	1/8	18	8431 0267 24*
LUM21 SR10-U	M2.5-M5	0.5- 3.2	4.4-30	1000	4	8	71	0.7	1.5	240	1/8	18	8431 0267 28*
LUM21 SR14-U	M2.5-M4	0.5- 2.4	4.4-21	1400	4	8	71	0.7	1.5	240	1/8	18	8431 0267 30
LUM21 SR23-U	M2.5-M4	0.5- 1.5	4.4-13	2300	4	8	71	0.7	1.5	240	1/8	18	8431 0267 34
LUM25 SR05-U	M4-M6	3.5-11.0 ^b	24.8-97 ^b	450	6	13	71	1.1	2.4	266	1/4	19	8431 0264 29*
LUM25 SR07-U	M4-M5	3.5- 7.0 ^b	24.8-62 ^b	700	6	13	71	1.1	2.4	266	1/4	19	8431 0264 37*
LUM25 SR10-U	M4	3.5- 5.5 ^b	24.8-49 ^b	1000	6	13	71	1.1	2.2	266	1/4	19	8431 0264 39
LUM25 SR14-U	M2.5-M4	0.6- 3.5	5.3-31	1400	6	13	71	1.0	2.2	229	1/4	19	8431 0264 41
LUM25 SR18-U	M2.5-M4	0.6- 3.2	5.3-28	1800	6	13	71	1.0	2.2	229	1/4	19	8431 0264 43
LUM37 SR36-U	M3-M5	1.5- 4.5	13.3-40	3600	16	34	80	1.5	3.3	317	1/4	20	8431 0266 20
LUM37 SR25-U	M4-M6	4.0- 8.5	35.4-75	2500	16	34	80	1.6	3.5	338	1/4	20	8431 0266 15

All models Are reversible — Have quick change chuck except LUM05

SR-models have ring reverse control

PR-models have push button reverse

* Require some lubrication due to the high speed of the motor

^b 1.4-4 Nm with spring Ordering No. 4210 1831 00

* Basic tools of the range, cover most needs

ACCESSORIES INCLUDED

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OPTIONAL ACCESSORIES

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SELECTED SERVICE KITS TO ORDER

Page 35



SCREWDRIVERS

With air shut-off control — Pistol grip models

Screw size M2.5-M6
Torque range 0.5-12.5 Nm

- **Safer joints** — The LUM shut-off mechanism means accurate tightening, time after time, independent of variations in joint stiffness
- **Low reaction force** — Rapid clutch with air shut-off reduce the reaction force on the wrist
- **Low sound levels** — The housing and patented silencer give a low sound level
- **Operator comfort** — Thanks to the ergonomic designed pistol grip. High grip when high feeding force is needed, i.e., cross recess screws. Use low grip for minimum reaction force
- **Lubrication-free**



Model	Screw Ø mm	Torque range Soft joint		Free speed r/min	Air consump- tion at free speed		Sound level dB(A)	Weight		Length mm	Air inlet thread in	Female hexagon drive for bits in	Dis- tance centre to side mm	Ordering No.
		Nm	in lb		l/s	cfm		kg	lb					
Pistol grip models with trigger and push start														
LUM21 HR05	M2.5-M5	0.5 - 4.5	4.4- 40	500	7	15	78	0.9	2.0	222	1/8	1/4	23	8431 0267 38*
LUM21 HR08	M2.5-M5	0.5 - 4.5	4.4- 40	800	7	15	75	0.9	2.0	222	1/8	1/4	23	8431 0267 40*
LUM21 HR12	M2.5-M4	0.5 - 3.5	4.4- 31	1200	4-6	8	76	0.8	1.8	212	1/8	1/4	23	8431 0267 44*
LUM21 HR15	M2.5-M4	0.5 - 3.5	4.4- 31	1500	7	15	76	0.8	1.8	212	1/8	1/4	23	8431 0267 48
LUM21 HR23	M2.5-M4	0.5 - 2.5	4.4- 22	2300	7	15	76	0.8	1.8	212	1/8	1/4	23	8431 0267 50
LUM24B HR03	M4-M6	3.5 ^c -12.5 ^d	24.8-111	350	7	15	78	1.1	2.4	250	1/4	1/4	23	8431 0249 33
LUM24B HR05	M4-M6	3.5 ^c -12.0 ^d	24.8-111	500	7	15	78	1.1	2.4	250	1/4	1/4	23	8431 0249 44*
LUM24B HR08	M4-M6	3.5 ^c - 7.5 ^d	24.8- 66	800	7	15	75	1.1	2.4	250	1/4	1/4	23	8431 0249 55*
LUM24B HR11	M4-M5	3.5 ^c - 5.5	24.8- 49	1100	6	13	75	1.1	2.6	226	1/4	1/4	23	8431 0249 56
Pistol grip models with trigger start														
LUM21 HR05-U	M2.5-M5 ^a	0.5 - 4.5	4.4- 40	500	7	15	78	0.9	2.0	219	1/8	1/4	23	8431 0267 58
LUM21 HR08-U	M2.5-M5 ^a	0.5 - 4.5	4.4- 40	800	7	15	75	0.9	2.0	219	1/8	1/4	23	8431 0267 60*
LUM21 HR12-U	M2.5-M4	0.5 - 3.5	4.4- 31	1200	4-6	8	76	0.8	1.8	209	1/8	1/4	23	8431 0267 64*
LUM21 HR15-U	M2.5-M4 ^a	0.5 - 3.5	4.4- 31	1500	7	15	76	0.8	1.8	209	1/8	1/4	23	8431 0267 68
LUM21 HR23-U	M2.5-M4 ^a	0.5 - 3.5	4.4- 22	2300	7	15	76	0.8	1.8	209	1/8	1/4	23	8431 0267 70
LUM24B HR01-U	M4-M6 ^b	3.5 ^c -12.5 ^d	24.8-111 ^c	100	7	15	78	1.1	2.4	260	1/4	1/4	23	8431 0264 50
LUM24B HR03-U	M4-M6	3.5 ^c -12.5 ^d	24.8-111 ^c	350	7	15	78	1.1	2.4	250	1/4	1/4	23	8431 0264 45
LUM24B HR05-U	M2.5-M6 ^a	3.5 ^c -12.0 ^d	24.8-111 ^c	500	7	15	78	1.1	2.4	250	1/4	1/4	23	8431 0264 03*
LUM24B HR08-U	M2.5-M6 ^a	3.5 ^c - 7.5 ^d	24.8-111 ^c	800	7	15	75	1.1	2.4	250	1/4	1/4	23	8431 0264 11*
LUM24B HR11-U	M4-M5	3.5 ^c - 5.5	24.8- 49	1100	6	13	75	1.1	2.6	226	1/4	1/4	23	8431 0264 16
All models Are reversible — Have quick change chuck														

All models Are reversible — Have quick change chuck

^a Available as Air on Top model, see page 26

^b Support handle included

^c 1.4-4 Nm with spring Ordering No. 4210 1831 00

^d For operator comfort support handle recommended for higher torque than 4 Nm, see OPTIONAL ACCESSORIES

* Basic tools of the range, cover most needs

ACCESSORIES INCLUDED

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OPTIONAL ACCESSORIES

Pages 35-36



SELECTED SERVICE KITS TO ORDER

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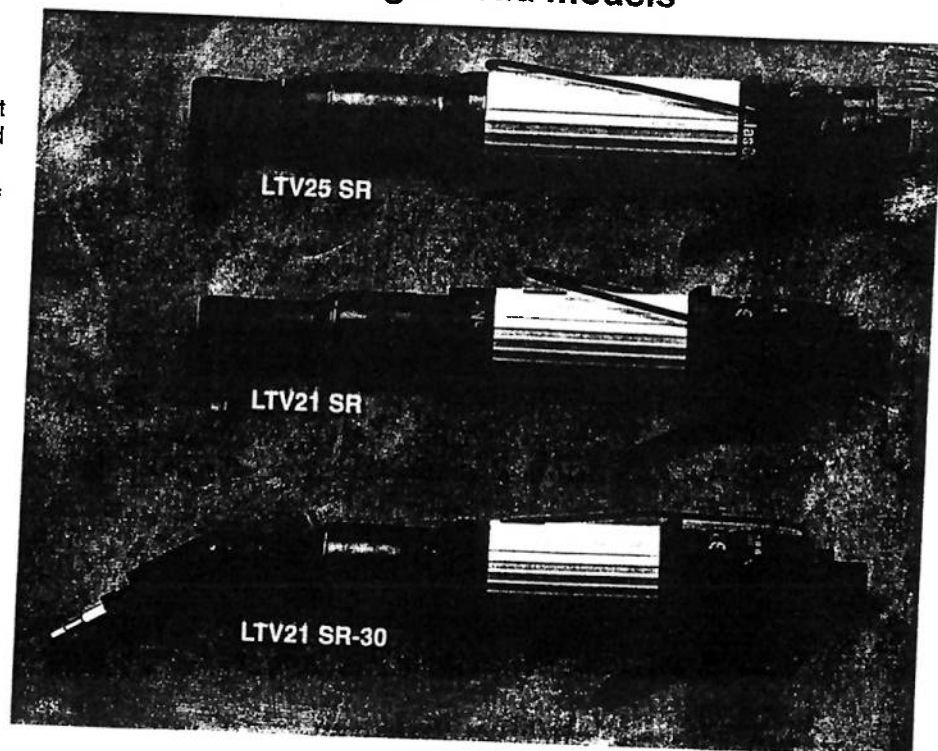
SCREWDRIVERS

With air shut-off control — Angle head models

Screw size M2.5-M5

Torque range 0.5-7 Nm

- **Good accessibility** — Excellent screwdrivers for access in limited spaces and awkward positions
- **Safer joints** — The rapid shut-off mechanism means accurate tightening, time after time, independent of variations in joint stiffness
- **Lubrication-free**



Model	Screw Ø mm	Torque range Soft joint		Free speed r/min	Air consump- tion at free speed		Sound level dB(A)	Weight		Length mm	Air inlet thread in	Angle head centre to side mm	Angle head height mm	Ordering No.
		Nm	in lb		l/s	cfm		kg	lb					
1/4" female hexagon drive														
LTV21 SR07-I6	M2.5-M4	0.5-4.5	4.4-40	700	4	8	69	0.8	1.7	272	1/8	10	28	8431 0267 74*
LTV21 SR10-I6	M2.5-M4	0.5-3.0	4.4-27	1000	4	8	69	0.8	1.7	272	1/8	10	28	8431 0267 84*
LTV21 SR10-MG	M2.5-M4	0.5-3.0	4.4-27	1000	4	8	69	0.8	1.7	272	1/8	10	28	8431 0267 86
LTV25 SR03-I6	M4-M5	3.5-7.0 ^a	24.8-62	300	6	13	71	1.2	2.6	300	1/4	10	28	8431 0258 55
LTV25 SR05-I6	M4-M5	3.5-7.0 ^a	24.8-62	500	6	13	71	1.2	2.6	300	1/4	10	28	8431 0258 58
LTV25 SR07-I6	M4-M5	3.5-7.0 ^a	24.8-62	700	6	13	71	1.2	2.6	300	1/4	10	28	8431 0258 61*
LTV25 SR10-I6	M4	3.5-5.5 ^a	24.8-62	1000	6	13	71	1.2	2.6	300	1/4	10	28	8431 0258 63
LTV27 SR009-I6	M5	3.0-7.0		900	8	17	76	1.6	3.5	368	1/4	10	28	8431 0531 73
1/4" square drive														
LTV21 SR07-6	M2.5-M4	0.5-4.5	4.4-40	700	4	8	69	0.8	1.7	272	1/8	10	29	8431 0267 78*
LTV21 SR10-6	M2.5-M4	0.5-3.0	4.4-27	1000	4	8	69	0.8	1.7	272	1/8	10	29	8431 0267 88*
LTV25 SR05-6	M4-M5	3.5-7.0 ^a	30.1-62	500	6	13	71	1.2	2.6	300	1/4	10	29	8431 0258 57
LTV25 SR07-6	M4-M5	3.5-7.0 ^a	30.1-62	700	6	13	71	1.2	2.6	300	1/4	10	29	8431 0258 72*
LTV27 SR009-6	M5	3.0-7.0	26.5-62	1100	8	17	76	1.6	2.6	368	1/4	10	29	8431 0531 65*
Quick change chuck (conversion kit for other models, see page 37)														
LTV21 SR10-Q	M2.5-M4	0.5-3.0	4.4-27	1000	4	8	69	0.8	1.8	272	1/8	10	28	8431 0267 85
LTV21 SR23-Q	M2.5-M4	0.5-1.5	4.4-13	2300	4	8	69	0.8	1.8	272	1/8	10	28	8431 0267 89
LTV25 SR05-Q	M4-M5	3.5-7.0 ^a	31.0-62	500	6	13	71	1.2	2.6	300	1/4	10	28	8431 0258 59
LTV25 SR07-Q	M4-M5	3.5-7.0 ^a	30.1-62	700	6	13	71	1.2	2.6	300	1/4	10	28	8431 0258 60
30° angle head with 1/4" hex drive														
LTV21 SR10-30-I6	M2.5-M4	0.5-3.0	4.4-27	1000	4	8	69	0.8	1.8	305	1/8	10	40	8431 0267 90
LTV25 SR07-30-I6	M4-M5	3.5-5.5	24.8-49	700	6	13	71	1.2	2.6	333	1/4	10	40	8431 0258 62
All models	Are reversible													

All models Are reversible

-I6 = 1/4" female hexagon drive for bits

-6 = 1/4" square drive for sockets

-MG means magnetic bit holder

-30-I6 means 30 (degrees) angle head

* 1.4-4 Nm with spring Ordering No. 4210 1831 00

* Basic tools of the range, cover most needs

ACCESSORIES INCLUDED

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OPTIONAL ACCESSORIES

Pages 35-36



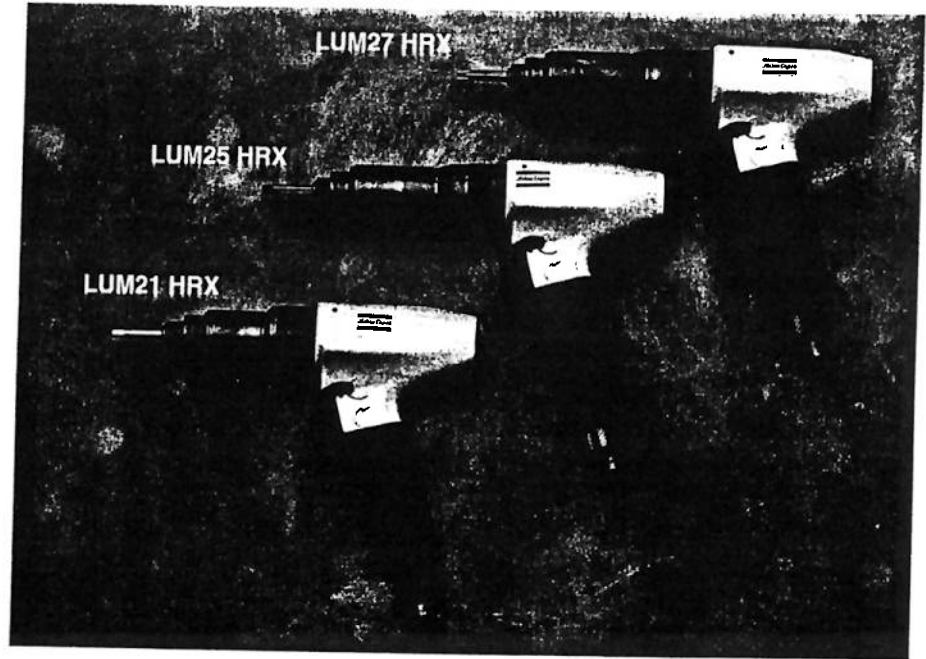
SELECTED SERVICE KITS TO ORDER

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SCREWDRIVERS

HRX type — Pistol grip models

- **A true one hand tool** — Easy to reverse with one hand
- **Operator comfort** — A well balanced handle fitted with a warm composite grip for improved comfort and ease of use
- **Low reaction force** — Rapid clutch with air shut-off and an extra fast motor on LUM27 HRX reduce the reaction force on the wrist
- **Safer joints** — The LUM shut-off mechanism means accurate tightening, time after time, independent of joint stiffness
- **Lubrication-free**
- **Available with integrated air signal ports.** See page 35



Model	Screw Ø mm	Torque range Soft joint		Free speed r/min	Air con- sumption at free speed		Sound level dB(A)	Weight		Length mm	Air inlet thread in	Dis- tance centre to side mm	Ordering No.
		Nm	in lb		l/s	cfm		kg	lb				
Shut-off clutch with trigger start													
LUM21 HRX08-U	M2.5-M5	0.5- 4.5	4.4- 40	800	7	15	75	0.9	2.0	180	1/8	20	8431 0263 54
LUM21 HRX15-U	M2.5-M4	0.5- 3.5	4.4- 31	1500	7	15	76	0.8	1.8	170	1/8	20	8431 0263 56
LUM25 HRX03-U	M4-M6	3.5-12.5 ^a	31.0-116	350	7	15	77	1.1	2.4	209	1/4	20	8431 0263 79
LUM25 HRX05-U	M4-M6	3.5-12.0 ^a	31.0-111	500	7	15	77	1.1	2.4	209	1/4	20	8431 0263 70*
LUM25 HRX08-U	M4-M6	3.5- 7.5 ^a	31.0- 66	800	7	15	75	1.1	2.4	209	1/4	20	8431 0263 72*
Shut-off clutch with extra powerful motor and trigger start													
LUM27 HRX08-U	M6	3.5-11.0	31.0-111	800	9	19	79	1.2	2.7	217	1/4	20	8431 0263 83*
LUM27 HRX11-U	M4-M6	3.5- 8.0	31.0- 68	1100	9	19	79	1.2	2.7	217	1/4	20	8431 0263 85*
Slip clutch with trigger start and push start													
TWIST HRX08	M4-M5	1.5- 7.5	13.2- 68	800	7	15	75	1.1	2.4	196	1/4	20	8431 0263 26
TWIST HRX16	M4-M5	2.2- 6.5	19.5- 58	1600	7	15	76	1.1	2.4	196	1/4	20	8431 0263 28*
Slip clutch with trigger start and adapted for double ended bits D14													
TWIST HRX16U D14	M4-M5	2.2- 6.5	19.5- 58	1600	7	15	76	1.1	2.4	192	1/4	20	8431 0263 30

All models: Are reversible

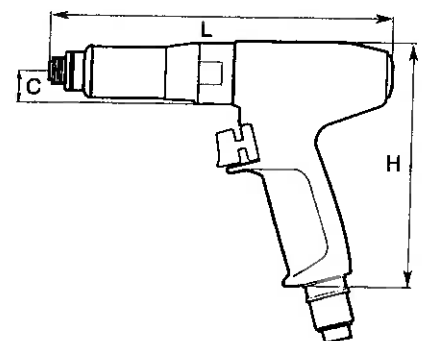
Have 1/4" female hexagon drive for bits

Have quick change chuck

All data at an air pressure of 6.3 bar

* Basic tools of the range, cover most needs

^a 1.4- 4 Nm with spring Ordering No. 4210 1831 00



Model	L	C	H
LUM21 HRX08-U	180	19	129.5
LUM21 HRX15-U	170	19	129.5
LUM25 HRX03-U	209	19	129.5
LUM25 HRX05-U	209	19	129.5
LUM25 HRX08-U	209	19	129.5
LUM27 HRX08-U	217	19	129.5
LUM27 HRX11-U	217	19	129.5
TWIST HRX08	196	19	129.5
TWIST HRX16	196	19	129.5
TWIST HRX16-U D14	192	19	129.5

SCREWDRIVERS

With slip-clutch

Screw size M1.6-M6
Torque range 0.1-18 Nm

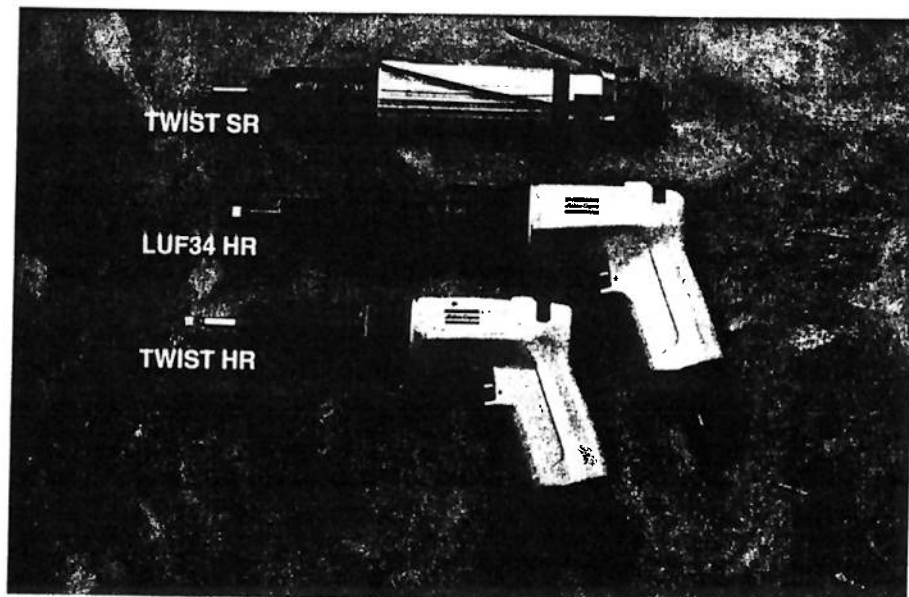
The slip clutch is the most suitable alternative for sheet metal screws.

□ **Flexible** — All models are reversible and designed for both left and right hand operations

□ **Fast tightening** — Fast rundown and tightening by the high speed/high torque combination

□ **Operator comfort** — Thanks to the ergonomic design of the pistol grip. High grip when high feeding force is needed, i.e., cross recess screws. Use low grip for minimum twisting force

□ **Lubrication-free**



Model	Screw Ø mm	Torque range Soft joint		Free speed r/min	Air con- sumption at free speed		Sound level dB(A)	Weight		Length mm	Air Inlet thread in	Dis- tance centre to side mm	Angle centre to side mm	Angle head height mm	Ordering No.
		Nm	in lb		l/s	cfm		kg	lb						
Straight models with push start															
LUF10 PR12	M1.6-M3.5	0.1- 1.0	0.9- 9	1200	3	6	66	0.4	0.8	196	1/8	15	—	—	8431 0136 33
LUF10 PR21	M1.6-M3.5	0.1- 1.2	0.9- 11	2100	3	6	67	0.4	0.8	196	1/8	15	—	—	8431 0136 41
LUF14 PR07	M2.5-M4	0.5- 3.2	4.4- 28	700	3	6	62	0.6	1.4	238	1/8	16	—	—	8431 0106 05*
LUF14 PR11	M2.5-M3	0.5- 2.4	4.4- 21	1100	3	6	64	0.6	1.4	238	1/8	16	—	—	8431 0106 13
LUF14 PR18	M2.5-M3	0.5- 1.8	4.4- 16	1900	3	6	64	0.6	1.3	229	1/8	16	—	—	8431 0106 21
LUF20 PR14	M2.5-M4	1.0- 2.0	8.8- 18	1400	4	8	64	0.5	1.2	213	1/8	18	—	—	8431 0258 84
LUF20 PR23	M2.5-M4	1.0- 2.0	8.8- 18	2300	4	8	71	0.5	1.2	213	1/8	18	—	—	8431 0258 92
Straight models with lever start															
LUF20 SR14	M2.5-M4	1.0- 2.0	8.8- 18	1400	4	8	71	0.7	1.5	240	1/8	18	—	—	8431 0258 43
LUF20 SR23	M2.5-M4	1.0- 2.0	8.8- 18	2300	4	8	69	0.7	1.5	240	1/8	18	—	—	8431 0258 50
TWIST SR07	M4-M5	1.3- 7.0	11.5- 62	700	4	8	76	0.9	2.0	260	1/4	19	—	—	8431 0252 15*
TWIST SR13	M4-M5	2.0- 6.0	17.7- 53	1300	4	8	72	0.9	2.0	260	1/4	19	—	—	8431 0252 23*
TWIST SR20	M4	2.2- 4.5	19.5- 40	2000	7	15	70	0.9	1.9	250	1/4	19	—	—	8431 0252 31*
Pistol grip models with trigger and push start															
LUF14 HR08	M2.5-M4	0.5- 3.2	4.4- 28	750	3	6	68	0.8	1.8	217	1/4	20	—	—	8431 0106 62
LUF14 HR12	M2.5-M3	0.5- 2.4	4.4- 21	1100	3	6	70	0.8	1.8	217	1/4	20	—	—	8431 0106 70
TWIST HR05*	M5-M6	5.0-12.0	44.2-106	500	7	15	78	1.1	2.3	245	1/4	20	—	—	8431 0252 56*
TWIST HR08*	M4-M5	1.5- 7.5	13.2- 66	800	7	15	75	1.1	2.3	245	1/4	20	—	—	8431 0252 64*
TWIST HR11	M4-M5	1.5- 7.5	13.2- 66	1100	7	15	75	1.0	2.3	245	1/4	20	—	—	8431 0252 60*
TWIST HR16*	M4-M5	2.2- 6.5	19.5- 58	1600	7	15	76	1.0	2.3	245	1/4	20	—	—	8431 0252 72*
TWIST HR23	M4-(M5)	2.4- 5.0	21.1- 44	2300	7	15	76	1.0	2.2	235	1/4	20	—	—	8431 0252 80*
LUF34 HR04	M4-M6	3.0-17.0	26.5-150	400	9.5	19	79	1.4	3.1	265	1/4	21	—	—	8431 0311 05
LUF34 HR08	M4-M6	2.0-15.0	17.7-133	800	9.5	19	79	1.4	3.1	265	1/4	21	—	—	8431 0311 09*
LUF34 HR16	M4-M6	3.0-12.0	26.5-107	1600	9.5	19	79	1.4	3.1	265	1/4	21	—	—	8431 0311 17
Pistol grip models with trigger and without push start															
LUF20 HR16-U	M2.5-M4	0.5- 1.9	4.4- 17	1600	3.4	7	76	0.8	1.8	212	1/8	23	10	29	8431 0259 59
LUF20 HR23-U	M3-M4	0.6- 2.5	5.3- 22	2300	6.4	14	76	0.8	1.8	212	1/8	23	10	29	8431 0259 42
LUF20 HR36-U	M3.5-M4	0.8- 2.5	7.1- 22	3600	6.4	14	76	0.8	1.8	212	1/8	23	10	29	8431 0259 26
Angle head models with 1/4" square drive															
TWIST VR07-6	M4-M5	1.3- 7.0	11.5- 62	700	4	8	72	1.0	2.2	280	1/4	—	10	29	8431 0256 11*
TWIST VR13-6	M4-M5	2.0- 6.0	17.7- 53	1300	4	8	72	1.0	2.2	280	1/4	—	10	29	8431 0256 37
TWIST VR20-6	M4	2.2- 4.5	19.5- 40	2000	7	15	74	1.0	2.2	270	1/4	—	10	29	8431 0256 52
Angle head models with 1/4" female hexagon drive															
TWIST VR07-I6	M4-M5	1.3- 7.0	11.5- 62	700	4	8	72	1.0	2.2	280	1/4	—	10	29	8431 0256 03*
TWIST VR13-I6	M4-M5	2.0- 6.0	17.7- 53	1300	4	8	72	1.0	2.2	280	1/4	—	10	29	8431 0256 29
TWIST VR20-I6	M4	2.2- 4.5	19.5- 40	2000	7	15	74	1.0	2.2	270	1/4	—	10	29	8431 0256 45

All models Are reversible
Female hexagon drive for bits: 1/4" except -6 models 1/4" square drive for sockets

All tools have quick change chuck except LUF14 and the angle head models

Non push start washer for TWIST SR/HR 4210 2760 03

* Available as Air on Top model (HRF), see page 34

* Basic tools of the range, cover most needs

ACCESSORIES INCLUDED

Page 35

OPTIONAL ACCESSORIES

Pages 35-36



SELECTED SERVICE KITS TO ORDER

Page 35

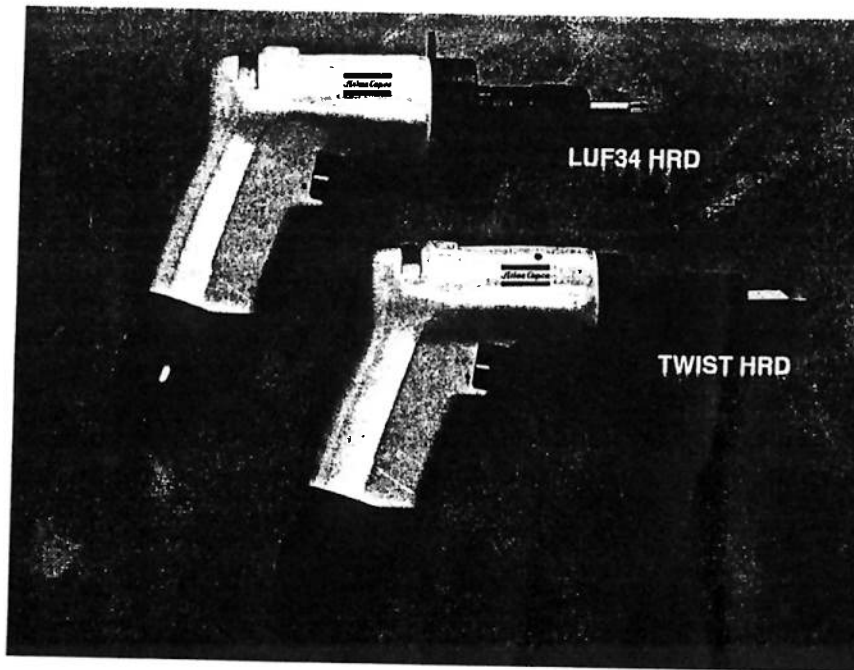
SCREWDRIVERS

Direct drive

Screw size M4-M8

Torque range for 1.6-18 Nm

- ☐ **Suitable** for sheet metal, self tapping and wood screws
- ☐ **Flexible** — All models are reversible and designed for both left and right hand operations
- ☐ **Combination tools** — Choose the Combi models including drill chuck, suitable for screwdriving, drilling and tapping
- ☐ **Good accessibility** — The short length on the pistol models gives very good accessibility. The angle types for access in limited space and awkward positions
- ☐ **Lubrication-free**



Model	Screw Ø mm	Torque range Soft joint		Free speed r/min	Air con- sumption at free speed		Sound level dB(A)	Weight		Length mm	Air inlet thread In	Dis- tance centre to side mm	Angle head centre to side mm	Angle head height mm	Ordering
		Nm	in lb		l/s	cfm		kg	lb						
Pistol grip models with trigger start															
TWIST HRD08	M6	5.0-10.0	44.2- 89	800	7	15	75	1.0	2.2	225	1/4	20	—	—	8431 0255
TWIST HRD16	M4-M5	2.7- 5.7	23.9- 50	1600	7	15	76	0.8	1.7	195	1/4	20	—	—	8431 0255
TWIST HRD36	M3.5	2.0- 2.7	17.7- 24	3600	7	15	76	0.8	1.7	195	1/4	20	—	—	8431 0255
Pistol grip models with trigger start. Direct drive															
LUF34 HRD04	M6-M8	8.0-18.0	70.6-160	400	9	19	79	1.2	2.6	212	1/4	20	—	—	8431 0311
LUF34 HRD08	M6	8.0-11.0	70.6- 97	800	9	19	79	1.2	2.6	212	1/4	20	—	—	8431 0311
LUF34 HRD16	M5-M6	4.0- 8.0	35.4- 71	1600	9	19	79	0.9	2.0	179	1/4	20	—	—	8431 0311
LUF34 HRD21	M4-M6	2.2- 4.5	19.5- 40	2100	9	19	79	0.9	2.0	179	1/4	20	—	—	8431 0311
Reversible drill, tapper and screwdriver															
COMBI24 HR08	M6	5.0-10.0	44.2- 89	800	7	15	75	1.1	2.4	240	1/4	20	—	—	8431 0255
COMBI24 HR16	M4-M5	2.7- 5.7	23.9- 50	1600	7	15	75	0.9	2.0	205	1/4	20	—	—	8431 0255
COMBI24 HR36	M3.5	2.0- 2.7	17.7- 24	3600	7	15	75	0.9	2.0	205	1/4	20	—	—	8431 0255
COMBI34 HR04	M6-M8	8.0-18.0	70.6-159	400	9	19	79	1.5	3.3	228	1/4	20	—	—	8431 0311
COMBI34 HR08	M6	8.0-11.0	70.6- 97	800	9	19	79	1.3	2.9	218	1/4	20	—	—	8431 0311
COMBI34 HR16	M5-M6	4.0- 8.0	35.4- 71	1600	9	19	79	1.0	2.2	179	1/4	20	—	—	8431 0311
Angle head models with 1/4" square drive															
TWIST VRD07-6	M4-M5	1.6- 6.0	14.2- 53	700	4	9	72	1.0	2.2	280	1/4	—	10	29	8431 0256
TWIST VRD13-6	M4-M5	2.5- 5.0	22.1- 44	1300	4	9	72	1.0	2.2	280	1/4	—	10	29	8431 0256
TWIST VRD20-6	M4-M5	2.7- 4.0	23.9- 35	2000	7	15	74	1.0	2.2	270	1/4	—	10	29	8431 0257
Angle head models with 1/4" female hexagon drive															
TWIST VRD07-16	M4-M5	1.6- 6.0	14.2- 53	700	4	9	72	1.0	2.2	280	1/4	—	10	29	8431 0256
TWIST VRD13-16	M4-M5	2.5- 5.0	22.1- 44	1300	4	9	72	1.0	2.2	280	1/4	—	10	29	8431 0256
TWIST VRD20-16	M4-M5	2.7- 4.0	23.9- 35	2000	7	15	74	1.0	2.2	270	1/4	—	10	29	8431 0257

All models Are reversible

Female hexagon drive for bits: 1/4" on pistol grip models

Combi-tools are delivered with drill chuck and 1/4" female hex drive for bits

Torque at min 3 bar and max 6 bar

* Basic tools of the range, cover most needs

ACCESSORIES INCLUDED

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OPTIONAL ACCESSORIES

Pages 35-36



SELECTED SERVICE KITS TO ORDER

Page 35

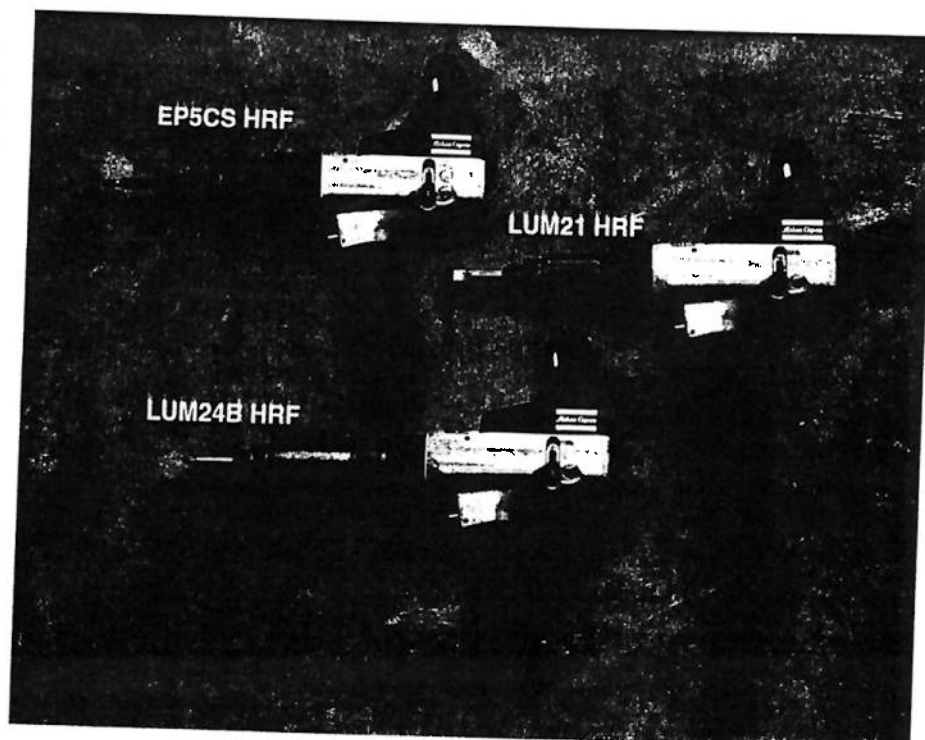


AIR ON TOP AND INTERCHANGEABLE HANDLES

□ **Air on Top** — Means air supply inlet is on top and hose connection is from above. No exhaust air via the handle and no hose hook disturbing the operator. As Air on Top tools are easier to manoeuvre than traditional suspended tools, they are ideal for work stations

□ **Interchangeable handles** — The HRF tools have different handles for different sizes of hands. All HRF tools have a nice warm grip and the ergonomic design reduces the effort needed in gripping the handle and pulling the trigger

□ **Wide range** — Includes screwdrivers with air shut-off and with slip clutch ErgoPulse tools up to size M8, drills and tappers



Model	Screw Ø mm	Torque range Soft joint		Free speed r/min	Air con- sumption at free speed		Sound level dB(A)	Weight		Length mm	Air inlet thread In	Distance centre to side mm	Ordering No.
		Nm	In lb		l/s	cfm		kg	lb				
Screwdrivers with air shut-off control													
LUM21 HRF05-U	M2.5-M5	0.5- 4.5	4.4- 40	500	7	15	71	1.1	2.4	197	1/4	25	8431 0267 92
LUM21 HRF08-U	M2.5-M5	0.5- 4.5	4.4- 40	800	7	15	71	1.1	2.4	197	1/4	25	8431 0267 94*
LUM21 HRF15-U	M2.5-M4	0.5- 3.5	4.4- 31	1500	7	15	71	1.1	2.4	187	1/4	25	8431 0267 96*
LUM21 HRF23-U	M2.5-M4	0.5- 2.5	4.4- 22	2300	7	15	71	1.1	2.4	187	1/4	25	8431 0267 98
LUM25 HRF05-U	M4-M6	3.5-12.0*	31.0-106	500	6	13	73	1.2	2.6	226	1/4	26	8431 0249 05*
LUM25 HRF08-U	M4-M5	3.5- 7.5*	31.0- 66	800	6	13	73	1.2	2.6	226	1/4	26	8431 0249 07*
LUM25 HRF11-U	M4-M5	3.5- 5.5*	31.0- 49	1100	6	13	73	1.2	2.6	226	1/4	26	8431 0249 09
Screwdrivers with slip clutch													
TWIST HRF05	M5-M6	5.0-12.0	44.2-106	500	7	15	74	1.2	2.6	212	1/4	25	8431 0252 40
TWIST HRF08	M4-M5	1.5- 7.5	13.2- 66	800	7	15	74	1.2	2.6	212	1/4	25	8431 0252 42
TWIST HRF16	M4-M5	2.2- 6.5	19.5- 58	1600	7	15	74	1.2	2.6	212	1/4	25	8431 0252 44*
Hydraulic impulse nutrunners													
EP5 HRF	M5	5- 9	44.2- 79.6	4800	6	13	72	1.1	2.4	201	1/4	25	8431 0260 23
EP6 HRF	M6	9-16	79.6-141.6	4800	6	13	74	1.2	2.6	226	1/4	25	8431 0260 30
EP8X HRF-10	M6	20-35	177.0-309.8	9000	6	13	70	1.2	2.6	184	1/4	25	8431 0360 89
EP8X HRF-42	M6	20-35	177.0-309.8	9000	6	13	70	1.2	2.6	184	1/4	25	8431 0360 97
Drills and tappers													
LB24 HF045	6.5	—	—	4500	6	13	73	1.0	2.2	165	1/4	25	8421 0212 30
LB24 HF020	6.5	—	—	2000	6	13	72	1.0	2.2	165	1/4	25	8421 0212 31
LB24 HF007	M6	—	—	700	6	13	70	1.2	2.4	235	1/4	25	8421 0210 80
LB24 HF007Q	M6	—	—	700	6	13	70	1.2	2.6	235	1/4	25	8421 0210 82

All models Are reversible

Female hexagon drive for bits: 1/4" except VRD types

Have quick change chuck and female hexagon drive for bits except drills and tappers and ErgoPulse8x HRF-10

-10 = 3/8" square drive for sockets

* 1.4-4 Nm with spring Ordering No. 4210 1831 00

* Basic tools of the range, cover most needs

ACCESSORIES INCLUDED

Exhaust hose
Suspension yoke
Handle standard size

OPTIONAL ACCESSORIES

Swivel, hose dia 8 mm 4210 3134 80
Handle small size 4210 3139 00
Support handle 4110 1355 86
Hose nipple, hose dia 8 mm 9090 1715 00
Hose Reel Balancer, HRIL4 8202 0600 29

ANGLE AND STRAIGHT NUTRUNNERS

Torque control and stall type

M2.5 — M14 bolt capacity

The heart in all Atlas Copco angle nutrunners with torque control is the high accuracy mechanical shut-off clutch. Together with the ergonomic and compact design and the reliability of the tools this gives you a number of benefits:

- **Accuracy** — click! and the clutch shuts off at the same torque, tightening after tightening
- **Independent of joint variation** — the tool gives the same torque on both hard and soft joints
- **Torque results** — unaffected by variations in air pressure and lubrication
- **Less operator fatigue** — low reaction forces to the operator's arm due to the fast clutch
- **Fast** — helps the operator do the job quickly and properly
- **Good durability** — sturdy and well proven design. Unique quality angle and planetary gears give long service life
- **Air signals for job verification** — for remote indication of clutch release function, all LTV tools can be equipped with air signal outlet — RE

Advanced tightening technique — page 58

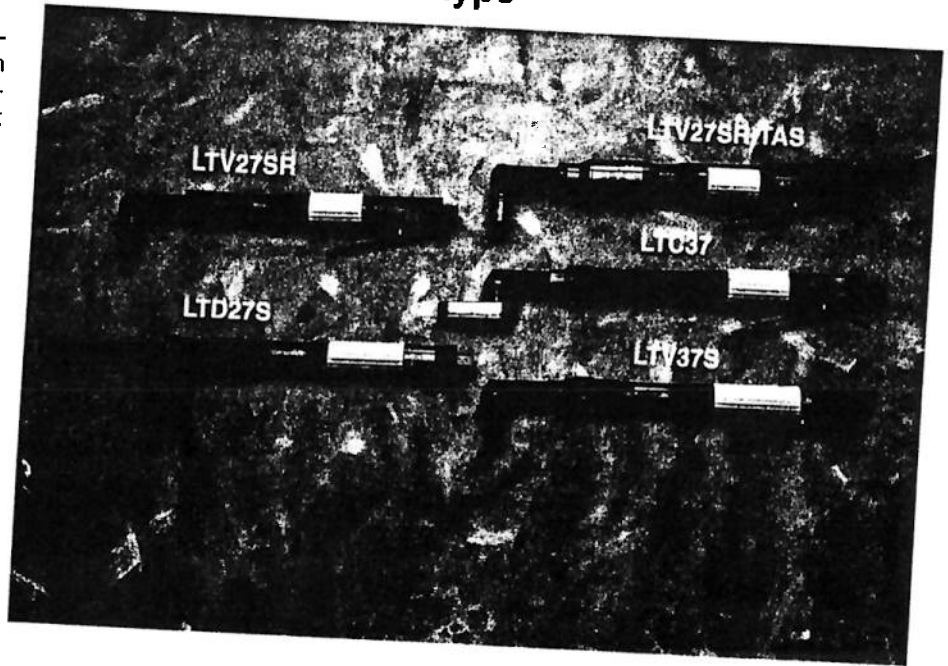
- **Electronic monitoring and control options** — most tools in the range can be equipped with integrated electronics for monitoring and control applications

equipped with integrated electronics for torque monitoring. Built-in options include:

Sophisticated monitoring and control

For joints classified as critical, most nutrunners in the LTV range can also be

- **Torque transducer and tool mounted signal lights** — TS
- **Torque transducer, angle encoder and tool mounted signal lights** — TAS



System LTV

The options available are :

Crowfoots LTC
see page 47

Integrated sockets LTV-FS
see page 48

Hold-and-drive
LTV-HAD
see page 49

Straight tools LTD
see page 43



Selection guide — standard LTV nutrunners

Torque Nm	Screw size grade 8.8	LTV27							LTV37			
		LTV21	LTV25	SR009	SR006	SR009	SR005	SR004	SR003	SR001	S004	SR007
30	M8											
20	M8											
10	M6											
5	M5											
	M4											
	M3.5											
1	M3											
0.5	M2.5											
		0.5	2.8	2.5	11.5	7	15	18	20	28	28	32
							10	11	12	14	13	18

Torque Nm	Screw size grade 8.8	LTV37						LTV46				
		SR005	S006	SR004	SR005	SR004A	SR003	SR002	S005	S004	S003	S002
200	M14											
100	M12											
50	M10											
	M8											
		42	45	50	55	60	70	90				
		20	22	25	30	30	34	40				

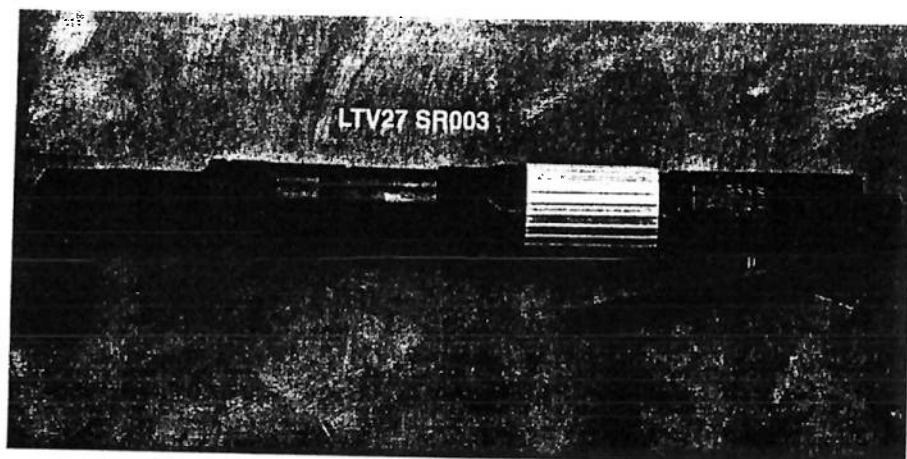


ANGLE NUTRUNNERS

With torque control

M2.5 — M14 bolt capacity

- **Accuracy** — click! and the clutch shuts off at the same torque, tightening after tightening
- **Independent of joint variation** — the tool gives the same torque on both hard and soft joints
- **Torque results** — unaffected by variations in air pressure and lubrication



Model	Suitable for bolt size mm	Square* drive size in	Torque range Soft joint		Free speed r/min	Weight		Length mm	Distance centre to side angle head mm	Angle head height mm	Recom- mended hose size mm	Air consump- tion at free speed		Ordering No.
			Nm	Ft lb		kg	lb					l/s	cfm	
Torque control LTV. Reversible models														
LTV21 SR07-16	M2.5-M4	1/4 ^b	0.5- 4.5	0.4- 3.3	700	0.8	1.7	272	10	29	6.3	4	8	8431 0267 74*
LTV21 SR10-16	M2.5-M4	1/4 ^b	0.5- 3	0.4- 2.2	1000	0.8	1.7	272	10	29	6.3	4	8	8431 0267 84*
LTV21 SR07-6	M2.5-M4	1/4	0.5- 4.5	0.4- 3.3	700	0.8	1.7	272	10	29	6.3	4	8	8431 0267 78*
LTV21 SR10-6	M2.5-M4	1/4	0.5- 3	0.4- 2.2	1000	0.8	1.7	272	10	29	6.3	4	8	8431 0267 88*
LTV25 SR03-16	M4-M5	1/4 ^b	2.8- 7	2 - 5	300	1.2	2.6	300	10	28	8	6	13	8431 0258 55
LTV25 SR05-16	M4-M5	1/4 ^b	2.8- 7	2 - 5	500	1.2	2.6	300	10	28	8	6	13	8431 0258 58
LTV25 SR07-16	M4-M5	1/4 ^b	2.8- 7	2 - 5	700	1.2	2.6	300	10	28	8	6	13	8431 0258 61
LTV25 SR07-6	M4-M5	1/4	2.8- 7	2 - 5	700	1.2	2.6	300	10	28	8	6	13	8431 0258 72
LTV27 SR009-6	M5	1/4	2.5- 7	2 - 5	1100	1.2	2.6	348	10	29	8	7	15	8431 0531 65
LTV27 SR009-16	M5	1/4 ^b	2.5- 7	2 - 5	1100	1.2	2.6	348	10	29	8	7	15	8431 0531 73
LTV27 SR006-10	M6	3/8	6 -12	4 - 8	800	1.3	2.9	365	14	34	10	8	17	8431 0531 57
LTV27 SR005-10	M6	3/8	10 -20	7 -14	515	1.4	3.1	390	13.5	35	10	8	17	8431 0531 50
LTV27 SR004-10	M8	3/8	11 -24	8 -17	400	1.4	3.1	385	14	34	10	8	17	8431 0531 48
LTV27 SR003-10	M8	3/8	14 -28	10 -21	330	1.4	3.1	385	14	34	10	8	17	8431 0531 40*
LTV27 SR003-16	M8	3/8	9 -20	6 -14	330	1.4	3.1	385	14	34	10	8	17	8431 0531 41
LTV27 SR001-10	M8	3/8	14 -28	10 -21	80	1.4	3.1	385	14	34	10	8	17	8431 0531 33
LTV27 SR001-16	M8	3/8	9 -20	6 -14	80	1.4	3.1	385	14	34	10	8	17	8431 0531 34
LTV37 SR007-10	M8	3/8	13 -27	9 -20	670	2.0	4.4	465	13.5	35	10	16	34	8431 0533 45
LTV37 SR006-10	M8	3/8	18 -32	13 -24	560	2.0	4.4	465	13.5	35	10	16	34	8431 0533 50
LTV37 SR005-10	M8	3/8	20 -42	15 -31	430	2.2	4.8	470	18	38	10	16	34	8431 0533 55
LTV37 SR005-13	M8	1/2	20 -42	15 -31	430	2.4	5.3	487	20	45	10	16	34	8431 0533 69*
LTV37 SR004-10	M10	3/8	25 -50	18 -37	360	2.2	4.8	485	18	38	10	16	34	8431 0533 63
LTV37 SR004-13	M10	1/2	25 -50	18 -37	360	2.4	5.3	487	20	45	10	16	34	8431 0533 71
LTV37 SR004A-13	M10	1/2	30 -60	22 -44	305	2.4	5.3	487	20	45	10	16	34	8431 0533 51
LTV37 SR003-13	M10-12	1/2	34 -70	25 -52	250	2.6	5.7	542	20	45	10	16	34	8431 0533 46
LTV37 SR002-L13	M12	1/2	40 -90	29 -66	210	3.0	6.6	569	25	52	10	16	34	8431 0533 38

ANGLE NUTRUNNERS

With torque control

Model	Suitable for bolt size mm	Square* drive size in	Torque range Soft joint		Free speed r/min	Weight		Length mm	Distance centre to side angle head mm	Angle head height mm	Recommended hose size mm	Air consumption at free speed		Ordering No.	
			Nm	Ft lb		kg	lb					l/s	cfm		
Non-reversible models															
LTV27 S015-10	M5/M6	3/8	4- 9	3- 7	1500	1.2	2.6	321	13	35	10	11	23	8431 0530 88	
LTV27 S009-10	M6	3/8	7- 15	5- 11	950	1.2	2.6	321	13	34	10	11	23	8431 0530 99*	
LTV27 S006-10	M6	3/8	11- 22	8- 16	600	1.3	2.9	341	13	34	10	11	23	8431 0530 87	
LTV27 S004-10	M8	3/8	14- 28	10- 21	400	1.3	2.9	341	13	34	10	11	23	8431 0530 81*	
LTV37 S007-10	M8	3/8	18- 32	13- 23	660	2.0	4.4	417	13	35	10	20	42	8431 0532 05	
LTV37 S008-10	M8	3/8	18- 31	13- 22	800	2.0	4.4	417	13	35	10	20	42	8431 0532 04	
LTV37 S006-10	M8-M10	3/8	22- 45	16- 33	520	2.0	4.4	427	18	38	10	20	42	8431 0532 06*	
LTV37 S005-10	M10	3/8	30- 55	22- 41	440	2.0	4.4	427	18	38	10	20	42	8431 0532 14	
LTV37 S005-13	M10	1/2	30- 55	22- 41	440	2.2	4.8	444	20	45	10	20	42	8431 0532 22*	
LTV37 S004A-13	M10	3/8	30- 68	22- 49	370	2.2	4.8	444	20	45	10	20	42	8431 0532 48	
LTV37 S003-13	M10	1/2	40- 85	29- 62	300	2.4	4.8	500	20	45	10	20	42	8431 0532 52	
LTV37 S002-L13	M12	1/2	50-100	37- 74	250	2.8	6.1	527	25	52	10	20	42	8431 0532 59	
LTV46 S005-13	M10	1/2	20- 55	15- 40	500	2.9	6.3	495	20	45	12.5	27	57	8431 0460 70	
LTV46 S004-13	M10-M12	1/2	25- 70	18- 51	400	2.9	6.3	495	20	45	12.5	27	57	8431 0460 05*	
LTV46 S003-L13	M12	1/2	35- 90	26- 66	280	3.3	7.2	515	25	52	12.5	27	57	8431 0460 47	
LTV46 S002-L13	M12-M14	1/2	50-115	37- 84	220	3.3	7.2	515	25	52	12.5	27	57	8431 0460 13	
LTV46 S001-L13	M14	1/2	60-150	44-111	180	3.3	7.2	515	25	52	12.5	27	57	8431 0460 62*	

Torque range is achieved at min 5 bar on LTV46

Air inlet thread in: LTV27/37 = 1/4 and LTV46 = 1/2

Sound level dB(A): LTV21 = 69, LTV25 = 71, LTV27 SR009 = 76, LTV27 = 76, LTV37 = 80, LTV46 = 81, LTV27 SR = 76, LTV37 SR = 80

* Double square drive is available as optional for LTV37/46

* Female hex drive, quick chuck

* Basic tools of the range, cover most needs

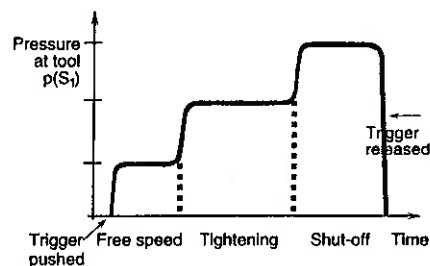
Reporting, RE-versions

The LTV angle nutrunners are also available in reporting versions for process control. The RE-tools supply an air signal that can be connected to a controller to count the number of tightenings and to detect premature shut-off and rehits.

LTV RE-versions (technical data same as standard versions)

LTV27 SR009-6-RE	8431 0574 22	LTV27 S015-10-RE	8431 0574 61
LTV27 SR009-16-RE	8431 0574 28	LTV27 S009-10-RE	8431 0574 50
LTV27 SR006-10-RE	8431 0574 49	LTV27 S006-10-RE	8431 0574 52
LTV27 SR005-10-RE	8431 0574 45	LTV27 S004-10-RE	8431 0574 55
LTV27 SR004-10-RE	8431 0574 48	LTV37 S007-10-RE	8431 0575 58
LTV27 SR003-10-RE	8431 0574 40	LTV37 S008-10-RE	8431 0575 62
LTV27 SR001-10-RE	8431 0574 43	LTV37 S006-10-RE	8431 0575 65
LTV37 SR007-10-RE	8431 0575 21	LTV37 S005-10-RE	8431 0575 70
LTV37 SR006-10-RE	8431 0575 25	LTV37 S005-13-RE	8431 0575 73
LTV37 SR005-10-RE	8431 0575 55	LTV37 S004A-13-RE	8431 0575 75
LTV37 SR005-13-RE	8431 0575 57	LTV37 S003-13-RE	8431 0575 77
LTV37 SR004-10-RE	8431 0575 32	LTV37 S002-L13-RE	8431 0575 79
LTV37 SR004-13-RE	8431 0575 37	LTV46 S005-13-RE	8431 0460 73
LTV37 SR004A-13-RE	8431 0575 60	LTV46 S004-13-RE	8431 0460 08
LTV37 SR003-13-RE	8431 0575 46	LTV46 S003-L13-RE	8431 0460 50
LTV37 SR002-L13-RE	8431 0575 42	LTV46 S002-L13-RE	8431 0460 16
		LTV46 S001-L13-RE	8431 0460 65

LTV RE signal outlets pressure levels



Pressure levels at signal outlets

LTV27/37 S $p(S_1)=2$ bar $p(S_2)=2$ bar

LTV27/37 SR $p(S_1)=2$ bar $p(S_2)=0.2$ bar

Outlet S_1 takes the air signal between trigger and shut-off valve. S_2 takes the air signal after shut-off valve.

ACCESSORIES INCLUDED

Hose fitting

Clutch adjustment key

OPTIONAL ACCESSORIES

Page 45



SELECTED SERVICE KITS TO ORDER

Page 46



STRAIGHT NUTRUNNERS

With torque control

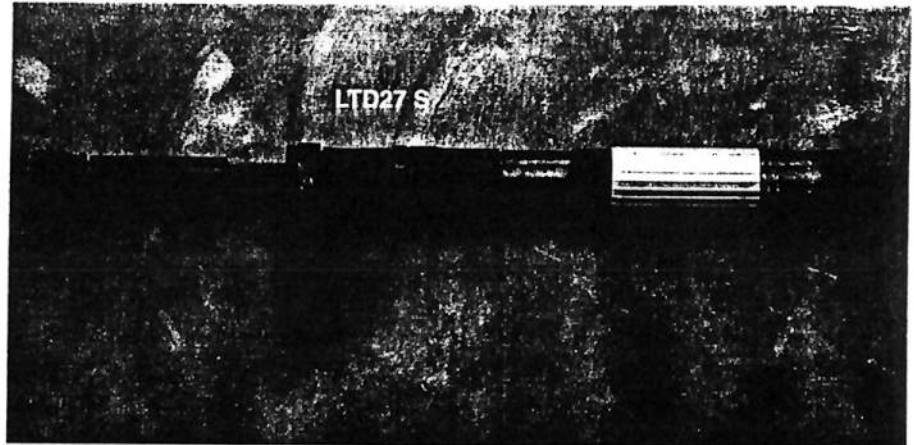
M5 — M12 bolt capacity

The LTD27, -37 and -46 range of straight nutrunners are based on the LTV range of angle nutrunners and offers the same tightening characteristics. They have the same motor, clutch and gear parts as the LTV range.

LTD straight nutrunners are available either with fixed square drive or a 25 mm (1") floating square drive (-F). The nutrunners can preferably be used for the following applications:

- ☐ Fixed to telescopic or articulated arms
- ☐ Customer designed, built-in applications
- ☐ Hand held with reaction bar

For indication of clutch release function, all LTD27, -37 and -46 nutrunners are equipped with pneumatic, air signal outlets-RE. A full range of reaction bars and mounting brackets are available for LTD nutrunners, as optional accessories.



ACCESSORIES INCLUDED

Hose fitting
Clutch adjustment key

Model	Suitable for bolt size mm	Square drive size in	Torque range		Free speed r/min	Weight without reaction bar/bracket		Length mm	Distance centre to side max width mm	Recom- mended hose size mm	Air Inlet thread in	Sound level dB (A)	Air consump- tion at free speed		Ordering No.
			Soft joint			kg	lb						l/s	cfm	
			Nm	Ft lb											
Models with fixed square drive															
LTD27 S012-RE	M5-M6	3/8	5- 9	4- 6	1400	1.1	2.4	333	20	10	1/4	76	9	19	8431 0534 05
LTD27 S007-RE	M6	3/8	8-18	6-13	780	1.2	2.6	353	20	10	1/4	76	9	19	8431 0534 08
LTD27 S006-RE	M6	3/8	10-21	7-15	570	1.2	2.6	353	20	10	1/4	76	9	19	8431 0534 13
LTD27 S001-RE	M6	3/8	10-22	7-16	140	1.2	2.6	353	20	10	1/4	76	9	19	8431 0534 18
LTD37 S008-RE	M8	1/2	14-30	10-21	820	2.0	4.4	411	22	10	1/4	80	16	34	8431 0535 04
LTD37 S006-RE	M8	1/2	20-38	15-27	680	2.2	4.8	411	22	10	1/4	80	16	34	8431 0535 12
LTD37 S005-RE	M8-M10	1/2	18-44	13-32	580	2.2	4.8	411	22	10	1/4	80	20	42	8431 0535 17
LTD37 S003-RE	M10	1/2	27-55	20-40	470	2.2	4.8	484	22	10	1/4	80	16	34	8431 0535 20
LTD46 S004-RE	M10	1/2	30-68	22-50	410	3.0	6.6	485	27	12.5	1/2	81	27	57	8431 0447 03
LTD46 S003-RE	M12	1/2	40-84	29-62	340	3.0	6.6	485	27	12.5	1/2	81	27	57	8431 0447 11
Models with 25 mm (1") floating square drive															
LTD27 S012F-RE	M5-M6	3/8	5- 9	4- 6	1400	1.5	3.3	441	20	6.3	1/4	76	9	19	8431 0534 21
LTD27 S007F-RE	M6	3/8	8-18	6-13	780	1.6	3.5	461	20	10	1/4	76	9	19	8431 0534 19
LTD27 S006F-RE	M6	3/8	10-21	7-15	570	1.6	3.5	461	20	6.3	1/4	76	9	19	8431 0534 39
LTD27 S001F-RE	M6	3/8	10-22	7-16	140	1.6	3.5	461	20	10	1/4	76	9	19	8431 0534 43
LTD37 S008F-RE	M8	1/2	14-30	10-21	820	2.3	5.0	519	22	10	1/4	80	20	42	8431 0535 38
LTD37 S006F-RE	M8	1/2	20-38	15-27	680	2.5	5.5	519	22	10	1/4	80	20	42	8431 0535 46
LTD37 S005F-RE	M8-M10	1/2	18-44	13-32	580	2.6	5.7	519	22	10	1/4	80	20	42	8431 0535 31
LTD37 S003F-RE	M10	1/2	27-55	20-40	470	2.5	5.5	596	22	10	1/4	80	20	42	8431 0535 53
LTD46 S004F-RE	M10	1/2	30-68	22-50	410	3.3	7.3	597	27	12.5	1/2	81	27	57	8431 0447 29
LTD46 S003F-RE	M12	1/2	40-84	29-62	340	3.3	7.3	597	27	12.5	1/2	81	27	57	8431 0447 37
Reversible models with fixed square drive															
LTD27 SR011-RE	M5-M6	3/8	3- 8	2- 6	1100	1.2	2.6	358	20	10	1/4	76	8	17	8431 0534 61
LTD27 SR006-RE	M6	3/8	7-16	6-12	610	1.3	2.9	378	20	10	1/4	76	8	17	8431 0534 65
LTD27 SR005-RE	M6-M8	3/8	10-20	7-15	520	1.3	2.9	378	20	10	1/4	76	8	17	8431 0534 51
LTD27 SR001-RE	M6-M8	3/8	10-22	7-16	125	1.3	2.9	378	20	10	1/4	76	8	17	8431 0534 54
LTD37 SR007-RE	M8	1/2	13-27	10-20	670	2.1	4.6	436	22	10	1/4	80	16	34	8431 0534 53
LTD37 SR006-RE	M8	1/2	18-32	13-24	560	2.3	5.1	436	22	10	1/4	80	16	34	8431 0534 52
LTD37 SR005-RE	M8-M10	1/2	19-38	14-28	480	2.3	5.1	436	22	10	1/4	80	16	34	8431 0535 78
LTD37 SR003-RE	M8-M10	1/2	22-47	16-35	380	2.3	5.1	509	22	10	1/4	80	16	34	8431 0535 83
Reversible models with 25 mm (1") floating square drive															
LTD27 SR011F-RE	M5-M6	3/8	3- 8	2- 6	1100	1.6	3.5	466	20	10	1/4	76	8	17	8431 0534 78
LTD27 SR006F-RE	M6	3/8	7-16	6-12	620	1.7	3.7	486	20	10	1/4	76	8	17	8431 0534 85
LTD27 SR005F-RE	M6-M8	3/8	10-20	7-15	570	1.7	3.7	486	20	10	1/4	76	8	17	8431 0534 37
LTD27 SR001F-RE	M6-M8	3/8	10-22	7-16	125	1.7	3.7	486	20	10	1/4	76	8	17	8431 0534 89
LTD37 SR007F-RE	M8	1/2	13-27	10-20	670	2.5	5.5	544	22	10	1/4	80	16	34	8431 0535 65
LTD37 SR006-REF	M8	1/2	18-32	13-24	560	2.7	5.9	544	22	10	1/4	80	16	34	8431 0535 91
LTD37 SR005F-RE	M8-M10	1/2	19-38	14-28	480	2.7	5.9	544	22	10	1/4	80	16	34	8431 0535 95
LTD37 SR003F-RE	M8-M10	1/2	22-47	16-35	380	2.7	5.9	617	22	10	1/4	80	16	34	8431 0535 99



STRAIGHT NUTRUNNERS

Torque control and stall type

M12-M24 bolt capacity

The LTD/LMD51 range of straight nutrunners are based on the LTP/LMP51 range of pistol grip nutrunners and offers the same tightening characteristics.

They have the same twin motor system and are available as shut off tools — LTD or stall type- LMD.

LTD/LMD51 straight nutrunners are supplied with a fixed square drive as standard. As optional accessory a front part with floating square drive can be mounted on the tool.

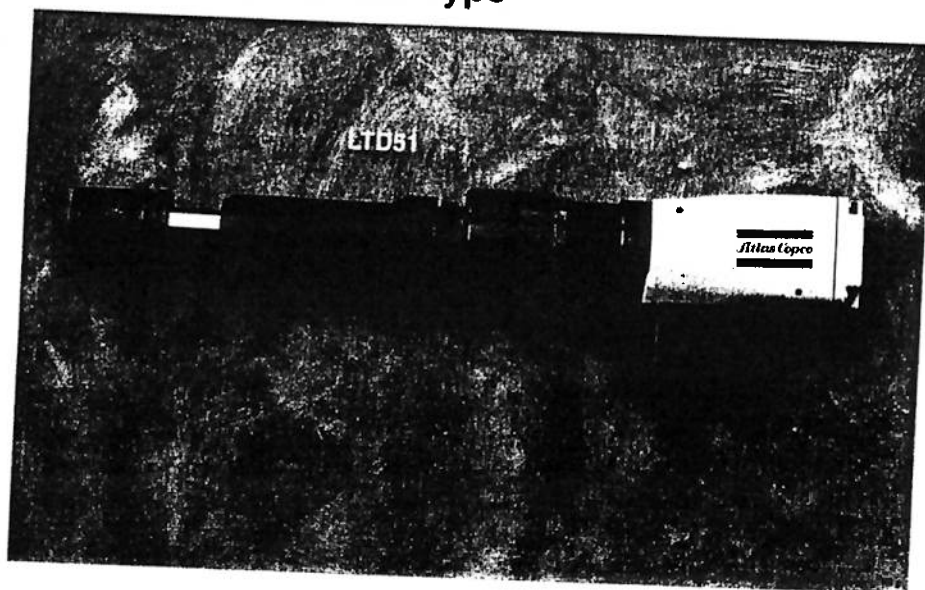
The nutrunners can preferably be used for the following applications:

- ☐ Fixed to telescopic or articulated arms
- ☐ Customer designed built in applications

The range of straight LTD/LMD51 tools can be equipped with a torque transducer (PRT) and also supplied in versions with angle encoders, LED's on special request.

See page 58 and following.

All LTD51 tools are equipped with signal outlets -RE.



Model	Suitable for bolt size	Square drive size	Torque range at 5 bar				Min torque at 3 bar		Max torque at 6.3 bar		Free speed r/min	Weight		Length mm	Air consump- tion at free speed		Ordering No.	
															Distance centre to side mm	l/s		cfm
			Nm	ft lb	Nm	ft lb	Nm	ft lb	Nm	ft lb		kg	lb					
Torque control models with fixed square drive																		
LTD51 012-13-RE	M12	1/2	85	65	60	45	45	35	100	75	1000	2.6	5.7	223	29	19	40	8431 0525 07
LTD51 008-13-RE	M14	1/2	150	110	85	60	70	50	175	130	600	2.6	5.7	223	29	19	40	8431 0525 15
LTD51 006-19-RE	M16	3/4	185	135	120	85	85	60	225	165	450	2.6	5.7	223	29	19	40	8431 0525 23
LTD51 004-20-RE	M18	3/4	270	200	200	145	145	105	320	235	300	3.3	7.3	260	31	19	40	8431 0525 31
LTD51 002-20-RE	M20	3/4	380	280	265	195	220	160	460	335	200	3.3	7.3	260	31	19	40	8431 0525 49
LTD51 001-25-RE	M24	1	700	510	450	330	300	220	900	660	52	3.6	7.9	282	32	19	40	8431 0525 21
Stall type models with fixed square drive																		
LMD51 012-13	M12	1/2	-	-	-	-	110	80	60	45	1100	2.6	5.7	223	29	19	40	8431 0526 05
LMD51 008-13	M14	1/2	-	-	-	-	190	140	95	70	680	2.6	5.7	223	29	19	40	8431 0526 13
LMD51 006-19	M16	3/4	-	-	-	-	250	185	132	95	520	2.6	5.7	223	29	19	40	8431 0526 69
LMD51 004-20	M18	3/4	-	-	-	-	380	275	195	140	305	3.3	7.3	260	31	19	40	8431 0526 39
LMD51 002-20	M20	3/4	-	-	-	-	550	400	260	190	210	3.3	7.3	260	31	19	40	8431 0526 47
LMD51 001-25	M24	1	-	-	-	-	950	695	470	345	125	3.7	8.2	282	32	19	40	8431 0526 37
TD51 / LMD51: Change over torque is around 7% of maximum torque																		

LTD51 / LMD51: Change over torque is around 7% of maximum torque on a given air pressure.
Telescopic front parts for LTD / LMD51 see page 46

OPTIONAL ACCESSORIES

Page 57



SELECTED SERVICE KITS TO ORDER

Page 57



ANGLE NUTRUNNERS

With crowfoot and torque control

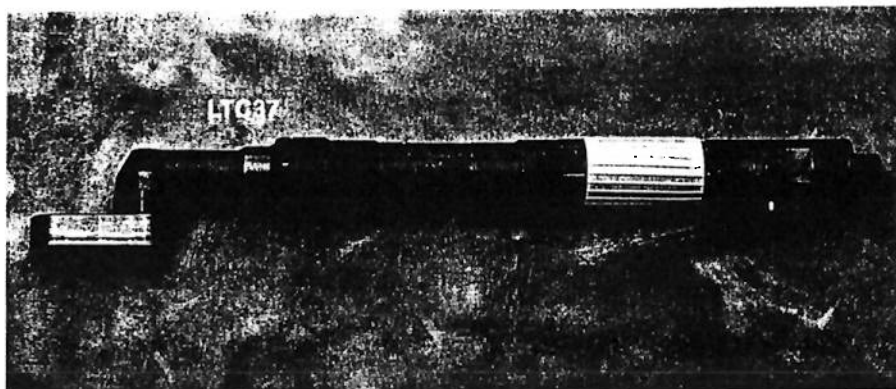
M8-M12 bolt capacity

LTC Crowfoot tools

A good solution in many cases of inaccessibility is the crowfoot, which has the smallest height and side to centre dimensions.

The LTC range of nutrunners are based on the LTV range of angle nutrunners and offers the same tightening characteristics. They have the same motor, clutch and gear parts as the LTV range.

The crowfoot is attached to a standard angle nutrunner LTV/LMV and can easily be adjusted $\pm 90^\circ$ of centre line.



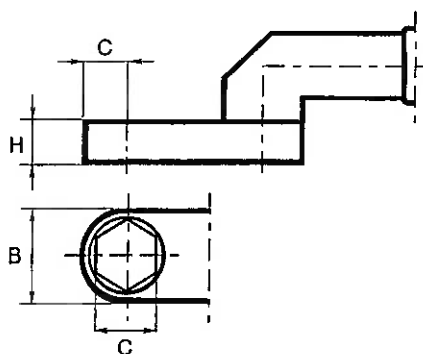
Model	Suitable for bolt size mm	Female hex drive size in	Torque range Soft joint		Free speed r/min	Weight kg lb		Length mm	Crowfoot dimensions			Recommended hose size mm	Air consumption at free speed		Air inlet thread in	Sound level dB (A)	Ordering No.
									H mm	B mm	C mm		l/s	cfm			
			Nm	Ft lb		H	B		C	l/s	cfm						
Non-reversible																	
LTC37 S006-8	M8	13	18- 41	13-30	520	2.4	5.3	479	19	32	16	10	20	42	1/4	80	8431 0536 01
LTC37 S005-10	M10	17	24- 48	17-35	440	2.8	6.1	511	19	39	20	10	20	42	1/4	80	8431 0536 09
LTC46 S005-10	M10	17	16- 46	12-34	500	3.5	7.7	561	19	39	20	12.5	27	57	1/2	81	8431 0468 07
LTC46 S004-10	M10	17	20- 55	15-40	400	3.5	7.7	561	19	39	20	12.5	27	57	1/2	81	8431 0469 06
LTC46 S003-12	M12	19	28- 78	21-57	280	4.1	9.0	577	25	39	20	12.5	27	57	1/2	81	8431 0470 03
LTC46 S002-12	M12	19	40- 93	29-69	220	4.1	9.0	577	25	39	20	12.5	27	57	1/2	81	8431 0471 02
LTC46 S001-12	M12	19	48-120	35-88	180	4.1	9.0	577	25	39	20	12.5	27	57	1/2	81	8431 0472 01
Reversible																	
LTC37 SR005-8	M8	13	16- 33	12-24	430	2.6	5.7	508	19	32	16	10	18	38	1/4	80	8431 0536 00
LTC37 SR004-10	M10	13	23- 40	17-29	360	3.0	6.6	540	19	39	20	10	18	38	1/4	80	8431 0536 08

NOTE: Suitable sockets have to be ordered separately

FEMALE HEX SOCKETS FOR LTC CROWFOOT NUTRUNNERS

Width across flat mm	In	Crowfoot size	Ordering No.
	7/16	LTC37-8	4210 2625 03
12		LTC37-8	4210 2625 04
	1/2	LTC37-8	4210 2625 01
13		LTC37-8	4210 2625 00
14		LTC37-8	4210 2625 02
13		LTC37/46-10	4210 2626 06
14		LTC37/46-10	4210 2626 04
15		LTC37/46-10	4210 2626 03
	1/2	LTC37/46-10	4210 2625 05
	5/8	LTC37/46-10	4210 2626 02
16		LTC37/46-10	4210 2626 00
17		LTC37/46-10	4210 2626 01
13		LTC46-12	4210 2624 06
14		LTC46-12	4210 2624 05
15		LTC46-12	4210 2624 04
16		LTC46-12	4210 2624 03
17		LTC46-12	4210 2624 02
18		LTC46-12	4210 2624 01
19	3/4	LTC46-12	4210 2624 00

Crowfoot dimensions



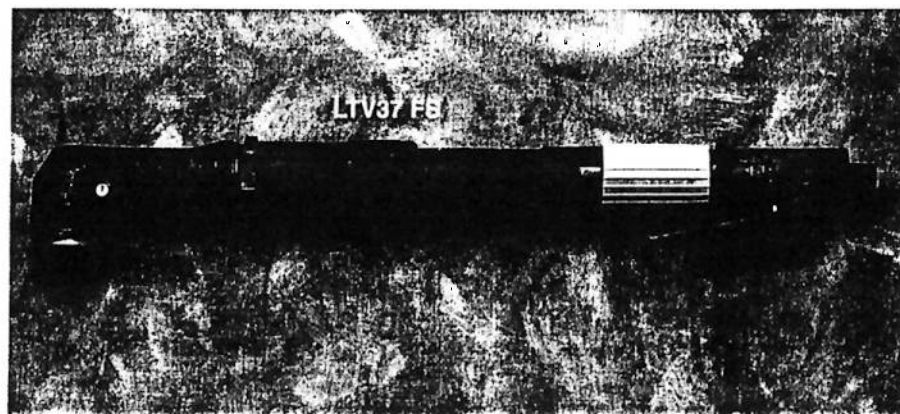
ANGLE NUTRUNNERS

With integrated socket and torque control

LTV FS Flush Socket tools

A good solution for access problems where minimum angle head size and high torque accuracy is required is the LTV FS. The flush socket tools have integrated sockets to achieve a reduced angle head height.

The LTV46 FS nutrunners are based upon the LTV range of angle nutrunners and offer the same tightening characteristics. They have the same motor, clutch and gear parts as the LTV range.



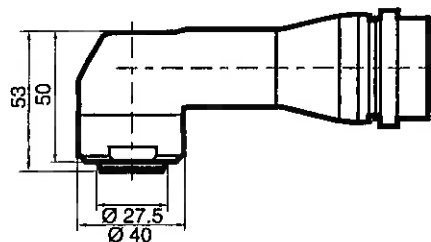
Model	Suitable for bolt size mm	Torque range		Free speed r/min	Weight		Length mm	Angle head height incl socket mm	Distance centre to side angle head mm	Re-com-mended hose size mm	Air consumption at free speed		Air inlet thread In	Sound level dB (A)	Ordering No.	
		Soft joint			kg	lb					l/s	cfm				
		Nm	Ft lb													
Flush socket angle nutrunners LTV FS. Reversible models																
LTV37 SR004 FS	M10	25- 50	18- 37	360	2.2	4.8	454	53	20	10	18	38	1/4	80	8431 0537 85	
LTV37 SR003 FS	M12	34- 70	25- 52	280	2.6	5.7	515	53	20	10	18	38	1/4	80	8431 0463 87	
Non-reversible models																
LTV37 S005 FS	M10	30- 55	22- 40	440	2.0	4.4	441	53	20	10	20	42	1/4	80	8431 0537 93	
LTV46 S005 FS	M10	20- 55	15- 40	500	2.9	6.3	495	53	20	12.5	27	57	1/2	81	8431 0463 77	
LTV46 S004 FS	M10-M12	25- 70	18- 51	400	2.9	6.3	495	53	20	12.5	27	57	1/2	81	8431 0463 69	
LTV46 S003 FS	M12	35- 90	26- 66	280	3.3	7.2	515	70	25	12.5	27	57	1/2	81	8431 0463 51	
LTV46 S002 FS	M12	50-115	37- 84	220	3.3	7.2	515	70	25	12.5	27	57	1/2	81	8431 0463 44	
LTV46 S001 FS	M12-M14	60-150	44-111	180	3.3	7.2	515	70	25	12.5	27	57	1/2	81	8431 0463 36	

Torque range is achieved at min 5 bar on LTV46

NOTE: Suitable sockets have to be ordered separately

SOCKETS ANGLE HEAD size "A"

for LTV37 SR004 FS
LTV37 S005 FS
LTV46 S005 FS
LTV46 S004 FS



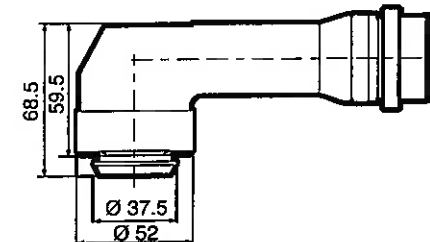
Integrated sockets for angle head "A"

Width across flats mm	Width across flats in	Ordering No.
12		4210 2749 03
13		4210 2749 01
14		4210 2749 04
15		4210 2749 02
16		4210 2882 01
17		4210 2882 02
18		4210 2882 03
	7/16	4210 2949 06
	9/16	4210 2749 05

Other dimensions on request

SOCKETS ANGLE HEAD size "B"

for LTV46 S003 FS
LTV46 S002 FS
LTV46 S001 FS



Integrated sockets for angle head "B"

Width across flats mm	Width across flats in	Ordering No.
15		4210 3534 15
16		4210 3534 16
17		4210 3534 17
18		4210 3534 18
19		4210 3534 19
21		4210 3534 21
22		4210 3534 22

Other dimensions on request

ACCESSORIES INCLUDED

Hose fitting
Clutch adjustment key



NUTRUNNERS FOR HOLD AND DRIVE BOLTS

Tools for hold and drive bolts.

M10-M14 bolt capacity

What used to be a two-man operation has now become a one-man task. No reaction arms.

The distinguishing feature of a hold and drive bolt is that one part is held and the other is tightened from the same side.

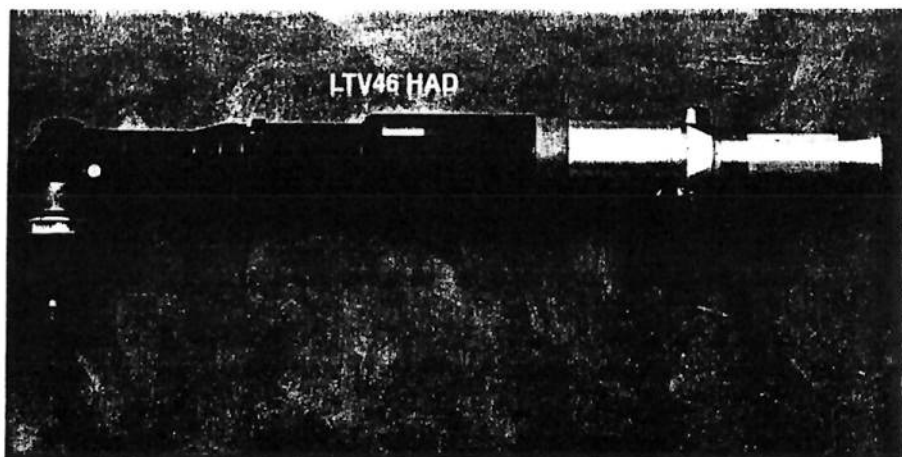
Hold and drive bolts are being used increasingly by, for example, truck manufacturers on the frame assembly line. The LTV46 HAD is especially suitable for shock absorber assembly.

Atlas Copco has developed special tools for use on hold and drive bolts based on the standard LTV46. The reaction torque is absorbed while the bolt is gripped during assembly.

The LTV46 sockets are available in three different lengths, special sockets are available upon request.

Also suitable for break away bolts, Hi Lok/Hi Shear.

NOTE The screw must be strong enough to carry the final torque.



Model	Bolt size	Torque range ^a		Weight		Free speed r/min	Ordering No.
		Nm	ft lb	kg	lb		
LTV46 S003 HAD	M10-12	35- 95	26- 70	3.3	7.3	280	8431 0463 28
LTV46 S002 HAD	M12-14	50-120	37- 89	3.3	7.3	220	8431 0463 10
LTV46 S001 HAD	M14	60-150	44-111	3.3	7.3	180	8431 0463 02
LTV37 SR002 HAD	M10-12	40- 90	30- 67	3.0	7.3	210	8431 0533 40
LTV37 SR002 HAD-LT ^b	M8-10	15- 40	11- 30	3.0	7.3	210	8431 0533 41

^a At min 5 bar

^b For low torque applications

NOTE Sockets and holders have to be ordered separately see page 50

ACCESSORIES INCLUDED

Hose fitting

Clutch adjustment key

OPTIONAL ACCESSORIES

Page 42



SELECTED SERVICE KITS TO ORDER

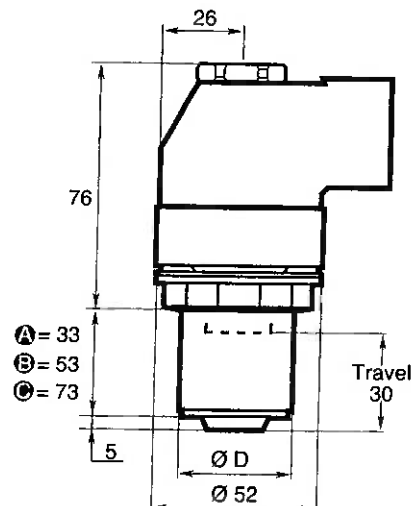
Page 46

ACCESSORIES

Nut socket – For all types of joints

Measurements in mm

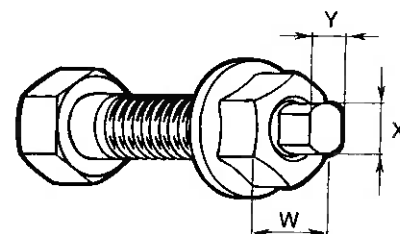
Width across flats W mm	Socket Ø D mm	Ordering No.		
		A	B	C
15	30	4210 3513 15	4210 3513 35	4210 3513 55
16	30	4210 3513 16	4210 3513 36	4210 3513 56
17	30	4210 3513 17	4210 3513 37	4210 3513 57
18	31	4210 3513 18	4210 3513 38	4210 3513 58
19	32	4210 3513 19	4210 3513 39	4210 3513 59
21	35	4210 3513 21	4210 3513 41	4210 3513 61
22	35	4210 3513 22	4210 3513 42	4210 3513 62
24	35	4210 3513 24	4210 3513 44	4210 3513 64



Screw holder – Two flats

Dimension X x Y mm	Suitable socket size mm	Ordering No.		
		A	B	C
8 x 6	15-24	4210 2694 05	4210 2694 10	4210 2694 15
9.55 x 7.6	18-24	4210 2694 01	4210 2694 06	4210 2694 11
11.20 x 8.9	19-24	4210 2694 02	4210 2694 07	4210 2694 12
13 x 9.8	19-24	4210 2694 03	4210 2694 08	4210 2694 13
13.20 x 10.5	19-24	4210 2694 04	4210 2694 09	4210 2694 14

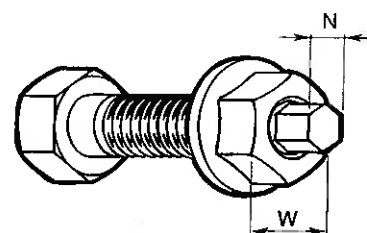
Two Flats



Screw holder – Male hexagon

Dimension N mm	Suitable socket size mm	Ordering No.		
		A	B	C
8	15-24	4210 2825 01	4210 2825 05	4210 2825 09
9	15-24	4210 2825 02	4210 2825 06	4210 2825 10
10	18-24	4210 2825 03	4210 2825 07	4210 2825 11
11	19-24	4210 2825 04	4210 2825 08	4210 2825 12

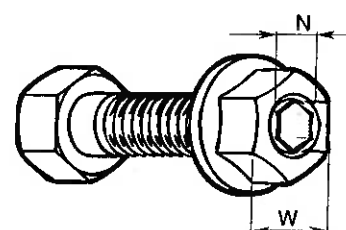
Male hexagon



Screw holder – Female hexagon

Bit holder			5/16" Bits	
A	B	C	Width N, mm	Ordering No.
4210 2991 01	4210 2991 02	4210 2991 03	5	4023 1215 00
			6	4023 1216 00
			7	4023 1219 00
			8	4023 1217 00
			10	4023 1218 00

Female hexagon



NUTRUNNERS

Angle, stall type — ratchet wrenches — worm drive

Angle nutrunners

M6-M12 bolt capacity

- **Independence of joint variation** — low inertia design gives accurate torque independent of joint stiffness, in other words low mean shift
- **Easy torque setting** — by adjusting the inlet air pressure
- **Reliable** — well-proven design
- **Good accessibility** — due to small dimensioned angle head

Ratchet wrenches

M6-M10

- **Unique accessibility** — The ratchet wrench is a superior tool, for limited space applications
- **To loosen** — turn the tool upside down

Worm-drive nutrunners

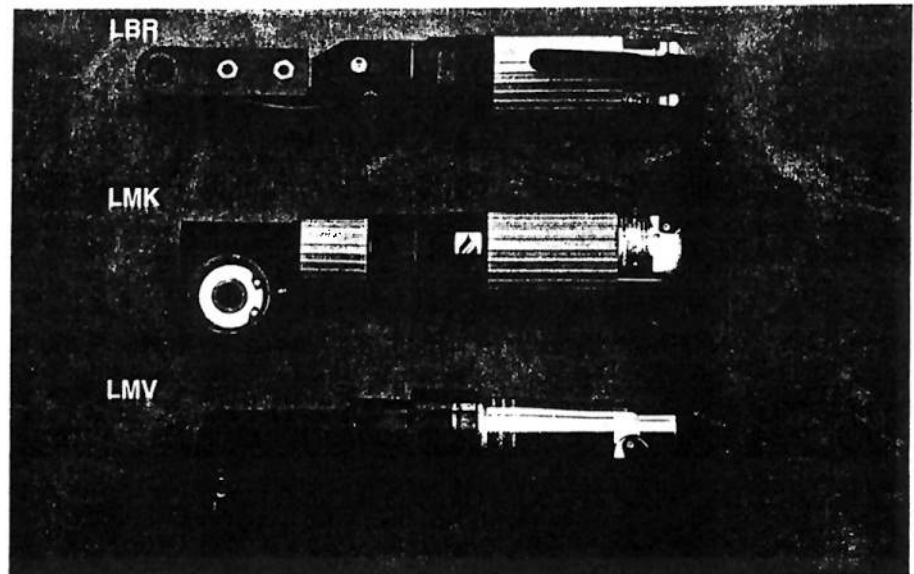
M6-M12 bolt capacity

□ Teasing throttle characteristics

Give you a significantly reduced free speed. The worm-drive nutrunners can therefore be used for:

- Nutrunning – Light reaming
- Tapping – Tube-rolling

Can also be used for incorporation in rigs as air motors for intermittent operation



Model	Suitable for bolt size mm	Square drive* size in	Torque at 6 bar Nm Ft lb	Free speed r/min	Weight kg lb	Length mm	Distance centre to side angle head mm	Angle head height mm	Air consumption at free speed l/s cfm	Recommended hose size mm	Air inlet thread in	Sound level dB(A)	Ordering No.
Angle, nutrunners stall type													
LMV22 S0080-10	M6	3/8	13 10	800	0.9 2.1	247	14	34	11 23	6	1/4	79	8431 0244 24
LMV22 S0070-10	M6	3/8	16 12	670	0.9 2.1	247	14	34	11 23	6	1/4	79	8431 0244 16
Ratchet wrenches													
LBR33 S26/114-13	M8	13	22 16	185	1.4 3.1	290	13	15	9.5 20	10	1/4	90	8431 0345 71
LBR33 S26/118-16	M8-M10	16	30 22	135	1.4 3.1	300	18	15	9.5 20	10	1/4	91	8431 0346 70
LBR33 S26/118-17	M8-M10	17	30 22	135	1.4 3.1	300	18	15	9.5 20	10	1/4	91	8431 0346 62
Worm drive nutrunners													
LMK22 S004	M8	7/16	19 14	450	1.0 2.2	240	31	30	6 13	6	1/4	90	8431 0242 26
LMK22 S002	M10	7/16	23 17	200	1.0 2.2	240	31	30	6 13	6	1/4	90	8431 0242 18
LMK33 S005	M10	7/16	29 21	480	1.7 3.7	263	41	39	9.5 20	10	1/4	90	8431 0343 24
LMK33 S002	M10-M127/16	32 24	235	1.9 4.2	291	41	39	39	9.5 20	10	1/4	90	8431 0343 16
LMK33 S001	M10-M127/16	55 41	130	2.2 4.9	385	41	39	39	9.5 20	10	1/4	90	8431 0343 08

* Female hex drive

OPTIONAL ACCESSORIES. Socket adapters for LBR

Dimensions	Ordering No. LBR33 S26/114	Ordering No. LBR33 S26/118
1/2" hex 3/8" square drive	4090 0163 00	4090 0163 00
1/2" hex 1/2" square drive	4090 0164 00	4090 0164 00

Female hex sockets for LBR

Dimensions in	Ordering No. LBR33 S26/114	Ordering No. LBR33 S26/118	Dimensions mm	Ordering No. LBR33 S26/114	Ordering No. LBR33 S26/118
1/4	4210 0360 05	—	10	4210 0414 10	—
5/16	4210 0360 02	—	12	4210 0414 12	4210 0418 12
3/8	4210 0360 03	4210 0389 02	13	4210 0414 13	4210 0418 13
7/16	4210 0360 04	4210 0389 03	14	4210 0414 14	4210 0418 14
1/2	4210 0360 01	4210 0389 04	15	4210 0414 15	4210 0418 15
9/16	—	4210 0389 06	16	—	4210 0418 16
5/8	—	4210 0389 01	17	—	4210 0418 17
3/4	—	4210 0389 05	18	—	4210 0418 18

NOTE That 1/2" female hex sockets must be used together with socket adapters
See accessories for Nutrunners page 37

ACCESSORIES INCLUDED

Hose fitting

Socket adaptor 3/8" square drive, LMK22 1/2" square drive, LMK33



SELECTED SERVICE KITS TO ORDER

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OPEN END NUTRUNNERS

Stall type

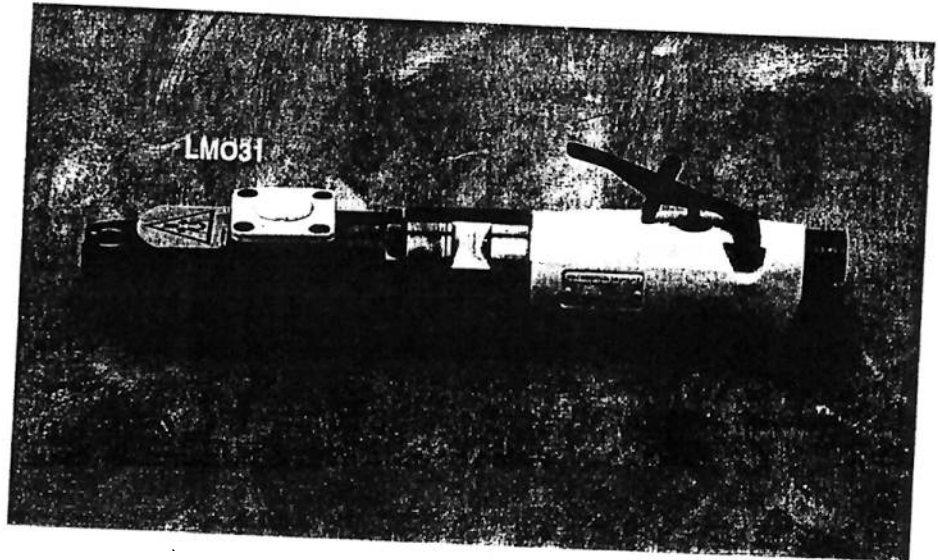
LMO31 models of open-end nutrunners are designed for tube nut tightening.

Applications are mainly to be found within the motor vehicle industry, where assembly of hydraulic and pneumatic brake pipes and other hose and cable connections are very common.

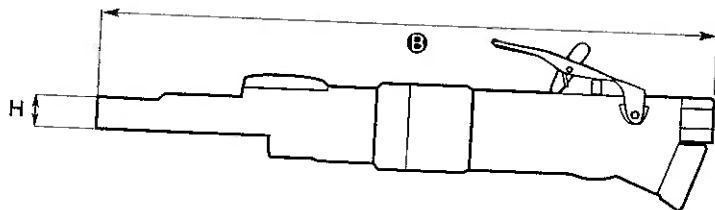
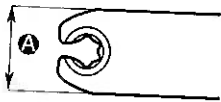
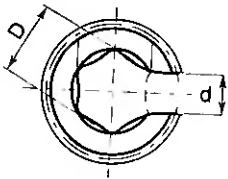
The power from the air motor is transferred to the nut through a gear drive mechanism without impacting or ratcheting, offering a low noise operation and a long service life between overhauls.

The one-hand two step mechanism simplifies the socket release back to open position.

As on all stall type tools the torque is controlled by regulating the air pressure.



Model	Female hex drive in	Torque at 6 bar soft joint		Free speed r/min	Air inlet thread in	A Width of head mm	B Length mm	Weight		Air consumption at free speed		Recommended hose size mm	Ordering No.
		Nm	Ft lb					kg	lb	l/s	cfm		
LMO31 004-10	10	13	10	400	1/4	37	295	1.4	3.1	9	19	10	8431 0344 31
LMO31 003-14	14	18	13	300	1/4	40	301	1.5	3.3	9	19	10	8431 0344 23
LMO31 002-22	22	24	18	240	1/4	56	326	1.7	3.7	9	19	10	8431 0344 15
LMO31 001-30	30	32	24	165	1/4	63	347	2.2	4.9	9	19	10	8431 0344 07



OPTIONAL GEAR SOCKETS

Model	H mm	D mm	D in	d mm	Ordering No.	Model	H mm	D mm	D in	d mm	Ordering No.	
LMO31 004	14	8	1/4 3/8	5	4112 0497 00	LMO31 001	16	18	9/16 5/8 11/16	13	4112 0515 00	
		9		6	4112 0498 00			19		15	4112 0516 00	
		10*		6	4112 0499 00			21		15	4112 0517 00	
		11		6	4112 0500 00			22*		15	4112 0518 00	
				4.8	4112 0501 00					13	4112 0519 00	
				6	4112 0502 00					13	4112 0520 00	
LMO31 003	14	10	1/2 7/16 9/16	6	4112 0503 00			23	18	4112 0522 00		
		11		6	4112 0504 00			24	18	4112 0523 00		
		12		8	4112 0505 00			27	21	4112 0524 00		
		13		9	4112 0506 00			28	21	4112 0525 00		
		14*		9	4112 0507 00			29	22	4112 0526 00		
		15		9	4112 0508 00			30*	23	4112 0527 00		
		17		11	4112 0509 00				5/8	13	4112 0528 00	
				8	4112 0510 00				7/8	15	4112 0529 00	
				8	4112 0511 00				1 3/16	15	4112 0530 00	
				9	4112 0512 00				1	18	4112 0531 00	
LMO31 002	14 17		13	4112 0513 00	22				1 1/8			
			13	4112 0514 00								
Standard socket											4112 0532 00	

* Standard socket

PISTOL GRIP NUTRUNNERS

The pistol grip nutrunners are extremely accurate tools, designed for one-hand operation.

- **Extremely fast** — Due to the twin motor concept of LTP/LMP51
- **Good torque accuracy** — even on soft joints
- **No reaction forces due to the reaction bar**
- **Low sound level** — exhaust through handle
- **Single handed operation** — The low weight and the perfectly balanced pistol grip design make the single hand operated LMP24 and -51 and LTP51 nutrunners safer and comfortable to use
- **Reversible for maximum flexibility** — Being able to loosen fasteners without changing tools improves productivity and is a major operator benefit in terms of time and effort

Electronic monitoring and control

In order to obtain the highest possible production quality all tools can be equipped for electronic monitoring and control. See page 58

- **Torque transducer** — The LMP24 can be used together with the accurate and easy to use PRT add on transducers, for torque monitoring
- **Torque transducer and angle encoder** — The LMP/LTP51 series can be used with the accurate and easy to use PRT add on transducers. For total control of the tightening process, the tool can be equipped with a PRT transducer and built-in angle encoder. For torque and angle monitoring

- **Signal lights** — The LMP/LTP51 series can also be equipped with integrated signal lights when used together with electrical control equipment

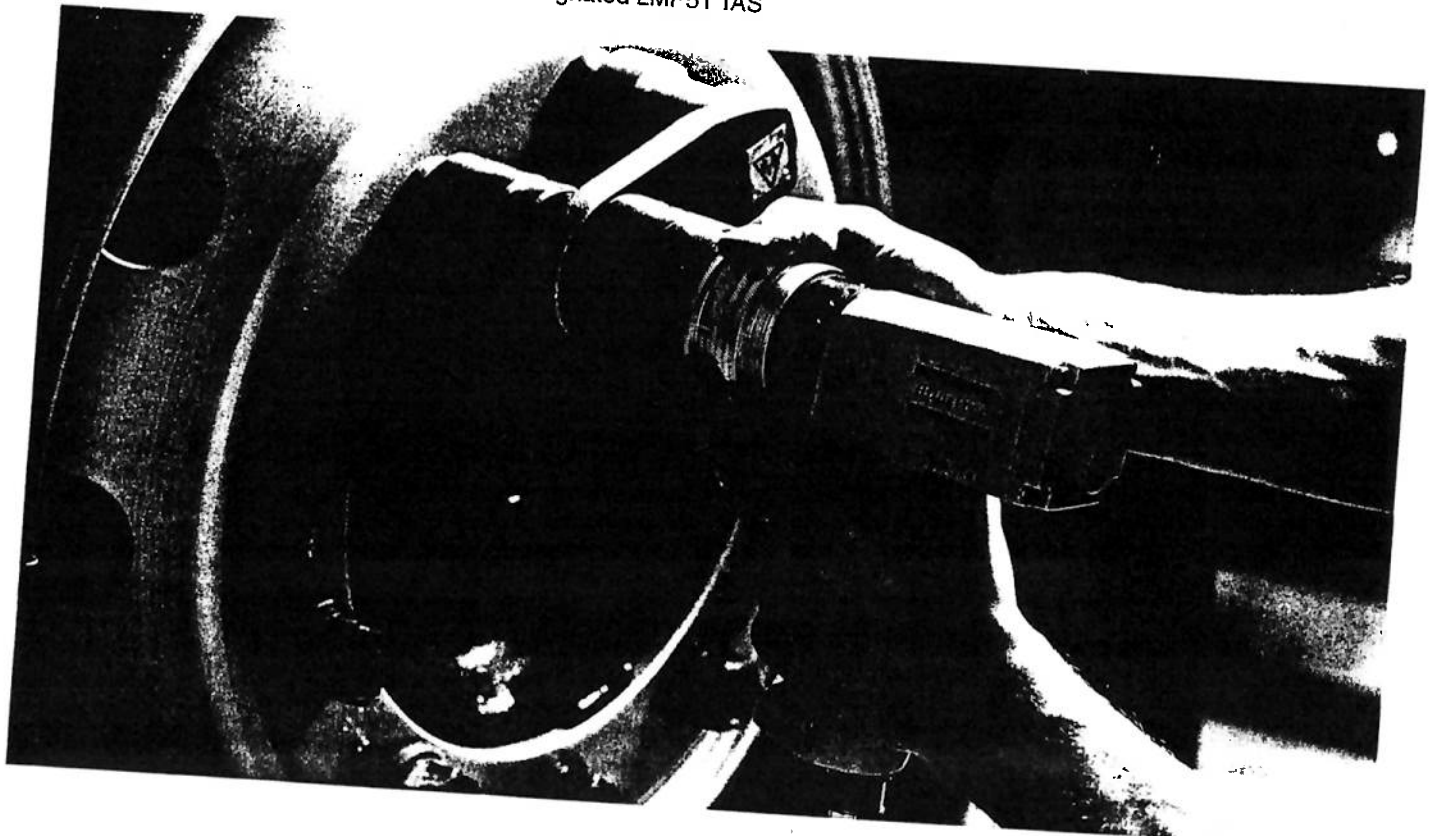
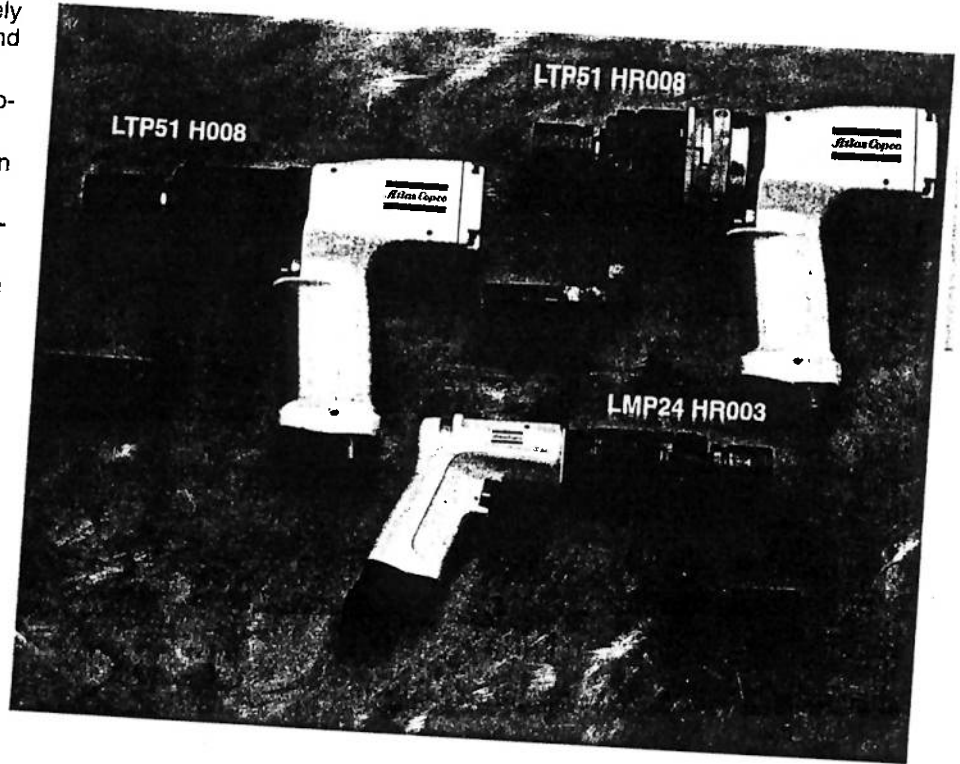
- **Designations** — LMP51 with PRT transducer is designated LMP51T (PRT=T). The signal lights are called "S" and the Angle encoder "A". Thus an LMP51 with PRT transducer built-in signal lights and angle encoder is designated LMP51 TAS

Parameter Control Unit

Seven different torque levels with one single tool.

The LMP24 and LMP51 are suitable for use with the Parameter Control Unit or PCU.

The parameter control unit gives the operator the possibility to easily obtain up to seven different torque levels.





PISTOL GRIP NUTRUNNERS

Stall type — Non reversible

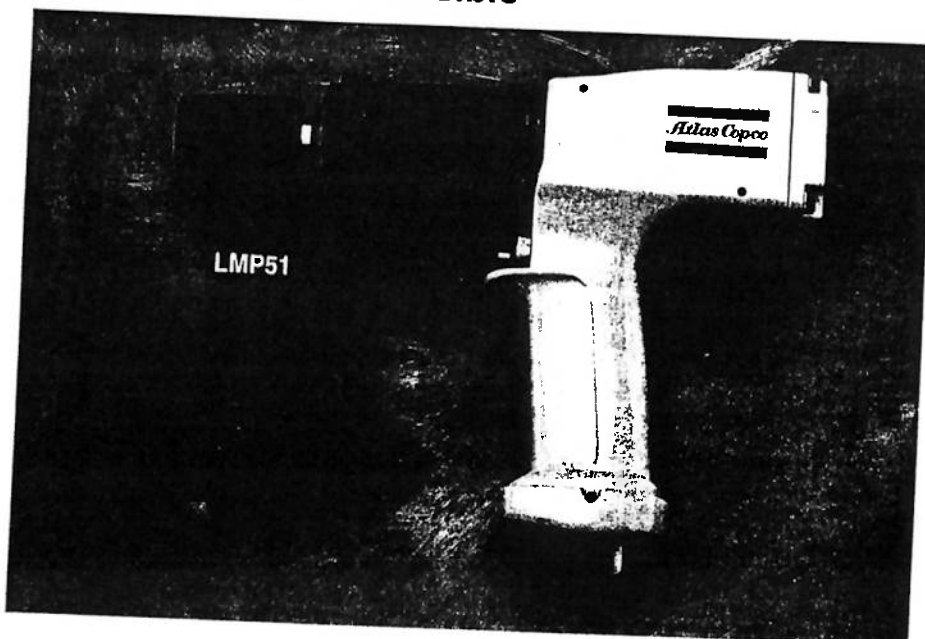
LMP24. M6-M10 bolt capacity

- ☐ High torque accuracy, regardless of joint stiffness
- ☐ Swivelling function as option
- ☐ High torque capacity, in relation to weight
- ☐ Low vibration level

LMP51 H. M12-M27 bolt capacity

Patented standard twin motor gives faster production and an increased accuracy with a minimum of air consumption.

- ☐ Very high torque accuracy
- ☐ The swivelling function facilitates tool positioning
- ☐ Fast rundown motor for time saving
- ☐ Extremely good weight to torque output ratio compared to single motor pistol grip nutrunners
- ☐ Special model for fast tightening of prevailing applications, LMP51 PH



Model	Suitable for bolt size	Square drive size	Torque range Soft joint				Free speed r/min	Weight *		Length mm	Distance centre to side mm	Air inlet thread in	Air consumption at free speed		Recommen- ded hose size mm	Sound level dB(A)	Ordering No.
			at 6.3 bar		at 3 bar			kg	lb				l/s	cfm			
			Nm	ft lb	Nm	ft lb											
Pistol grip nutrunners																	
LMP24 H011-10	M6	3/8	13	10	6	4	1550	1.0	2.2	210	18	1/4	11	23	10	78	8431 0245 56
LMP24 H005-10	M8	3/8	30	22	14	10	500	1.0	2.2	210	18	1/4	11	23	10	78	8431 0245 49*
LMP24 H003-13	M8	1/2	40	30	14	10	330	1.2	2.6	210	18	1/4	11	23	10	78	8431 0245 64
LMP24 H002-13	M10	1/2	58	43	27	20	240	1.3	2.9	230	21	1/4	11	23	10	78	8431 0245 31*
LMP51 H012-13	M12	1/2	110	80	60	45	1100	2.6	5.7	223	29	3/8	19	40	10	79	8431 0510 05
LMP51 H008-13	M14	1/2	190	140	95	70	680	2.6	5.7	223	29	3/8	19	40	10	79	8431 0510 13*
LMP51 H006-19	M16	3/4	250	185	132	95	520	2.6	5.7	223	29	3/8	19	40	10	79	8431 0513 69
LMP51 H004-20	M18	3/4	380	275	195	140	305	3.3	7.3	260	31	3/8	19	40	10	79	8431 0510 39*
LMP51 H002-20	M20	3/4	550	400	260	190	210	3.3	7.3	260	31	3/8	19	40	10	79	8431 0510 47*
LMP51 H001-25	M24	1	950	695	470	345	125	3.7	8.2	282	32	3/8	19	40	10	79	8431 0512 37*
LMP51 H: Charge pump																	

LMP51 H: Change over torque is around 7% of maximum torque on a given air pressure

* Basic tools of the range, cover most needs

LMP51 PH

For prevailing applications

The LMP51 PH and LTP51 PH are specially designed to handle prevailing applications, such as locking nuts. A special gear gives a higher change over torque. This allows the fast rundown motor to handle most of the rundown before the slower but stronger tightening motor is used.

Model	Suitable for bolt size	Square drive size	Torque range Soft joint				Free speed r/min	Weight*		Length mm	Distance centre to side mm	Air consumption at free speed l/s	cfm	Recommended hose size mm	Sound level dB(A)	Ordering No.
			at 6.3 bar Nm	ft lb	at 3 bar Nm	ft lb		kg	lb							
LMP51 PH005-13	M12	1/2	125	90	65	45	470	2.6	5.7	223	29	19	40	10	79	8431 0510 96
LMP51 PH004-13	M12	1/2	200	145	105	75	300	2.6	5.7	223	29	19	40	10	79	8431 0510 88
LMP51 PH003-19	M16	3/4	280	205	140	100	220	2.6	5.7	223	29	19	40	10	79	8431 0513 85
LMP51 PH002-20	M18	3/4	420	305	210	155	135	3.3	7.3	260	31	19	40	10	79	8431 0510 62
LMP51 PH001-20	M20	3/4	590	430	290	215	90	3.3	7.3	260	31	19	40	10	79	8431 0510 54
LMP51 PH0005-25	M27	1	950	695	470	345	55	3.7	8.2	282	32	19	40	10	79	8431 0512 45

LMP51 PH: Change over torque is around 15% of maximum torque on a given air pressure

* Without reaction bar

ACCESSORIES INCLUDED

- LMP24: Suspension yoke, reaction bar
- LMP51: Swivel type reaction bar

OPTIONAL ACCESSORIES

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SELECTED SERVICE KITS TO ORDER

Page 57



PISTOL GRIP NUTRUNNERS

Torque control type — Non reversible

LTP51 H. M12-M27 bolt capacity

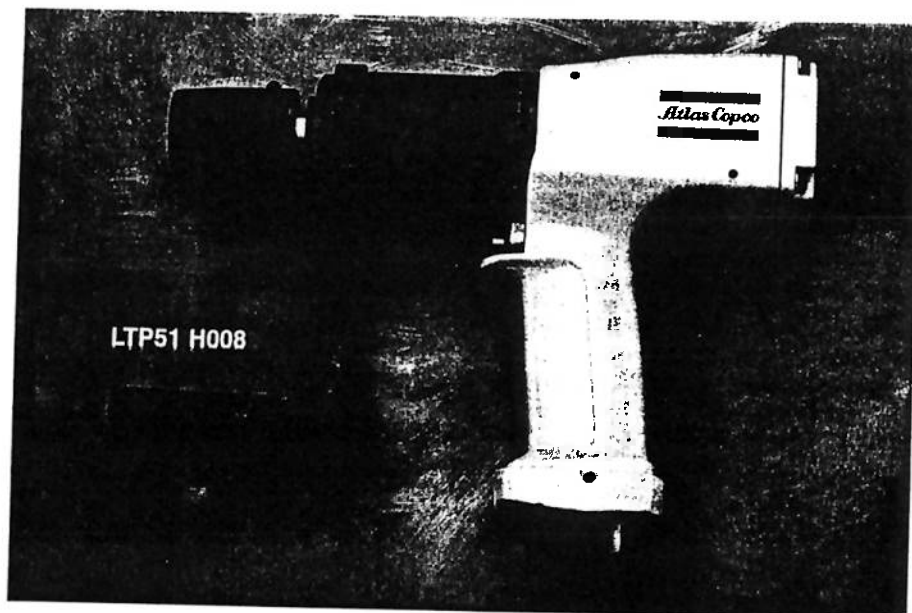
Torque control type

- The LTP51 has all the features of the LMP51 plus an easy to use shut-off valve.
- Automatic shut-off at preset level
- Gives fast and reliable tightening

LTP51 H. M12-M27 bolt capacity

Patented standard twin motor gives faster production and an increased accuracy with a minimum of air consumption.

- Very high torque accuracy
- The swivelling function facilitates tool positioning
- Fast rundown motor for time saving
- Extremely good weight to torque output ratio compared to single motor pistol grip nutrunners
- Special model for fast tightening of prevailing applications, LTP51 PH



Model	Suitable for bolt size	Square drive size	Torque range at 5 bar				Min torque at 3 bar		Max torque at 6.3 bar		Free speed r/min	Weight *		Length mm	Distance to side centre		Air consumption at free speed		Ordering No.		
			Nm		ft lb		Nm		ft lb			Nm			ft lb		mm	mm		l/s	cfm
Pistol grip nutrunners — Torque control type																					
LTP51 H012-13	M12	1/2	85	65	60	45	45	35	100	75	1000	2.6	5.7	223	29	19	40	8431 0500 07*			
LTP51 H008-13	M14	1/2	150	110	85	60	70	50	175	130	600	2.6	5.7	223	29	19	40	8431 0500 15*			
LTP51 H006-19	M16	3/4	185	135	120	85	85	60	225	165	450	2.6	5.7	223	29	19	40	8431 0513 77*			
LTP51 H004-20	M18	3/4	270	200	200	145	145	105	320	235	300	3.3	7.3	260	31	19	40	8431 0500 31*			
LTP51 H002-20	M20	3/4	380	280	265	195	220	160	460	335	200	3.3	7.3	260	31	19	40	8431 0500 49*			
LTP51 H001-25	M24	1	700	510	450	330	300	220	900	660	52	3.6	7.9	282	32	19	40	8431 0502 21*			

LTP51 H: Change over torque is around 7% of maximum torque on a given air pressure

* Basic tools of the range, cover most needs

LTP51 PH

For prevailing applications

The LMP51 PH and LTP51 PH are specially designed to handle prevailing applications, such as locking nuts. A special gear gives a higher change over torque. This allows the fast rundown motor to handle most of the rundown before the slower but stronger tightening motor is used.

Model	Suitable for bolt size	Square drive size	Torque range at 5 bar				Min torque at 3 bar		Max torque at 6.3 bar		Free speed r/min	Weight *		Length mm	Distance to side mm	Air consump- tion at free speed		Ordering No.
			Nm	ft lb	Nm	ft lb	Nm	ft lb	Nm	ft lb		kg	lb			l/s	cfm	
LTP51 PH005-13	M12	1/2	90	65	65	45	50	35	110	80	425	2.6	5.7	223	29	19	40	8431 0500 98
LTP51 PH004-13	M14	1/2	155	115	100	75	80	60	190	140	255	2.6	5.7	223	29	19	40	8431 0500 80
LTP51 PH003-19	M16	3/4	205	150	150	110	95	70	260	190	190	2.6	5.7	223	29	19	40	8431 0513 93
LTP51 PH002-20	M18	3/4	300	220	220	160	160	115	390	285	130	3.3	7.3	260	31	19	40	8431 0500 64
LTP51 PH001-20	M20	3/4	415	305	305	220	220	160	520	380	85	3.3	7.3	260	31	19	40	8431 0500 56
LTP51 PH0005-25	M27	1	805	590	595	435	450	330	950	695	52	3.7	8.2	282	32	19	40	8431 0502 39
LTP51 H: Change over torque in 100% steps																		

LTP51 H: Change over torque is around 15% of maximum torque on a given air pressure

* Without reaction bar

Air inlet thread	in	3/8
Recommended hose size	mm	10
Sound level	dB(A)	79

ACCESSORIES INCLUDED

LTP51: Swivel type reaction bar

OPTIONAL ACCESSORIES

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SELECTED SERVICE KITS TO ORDER

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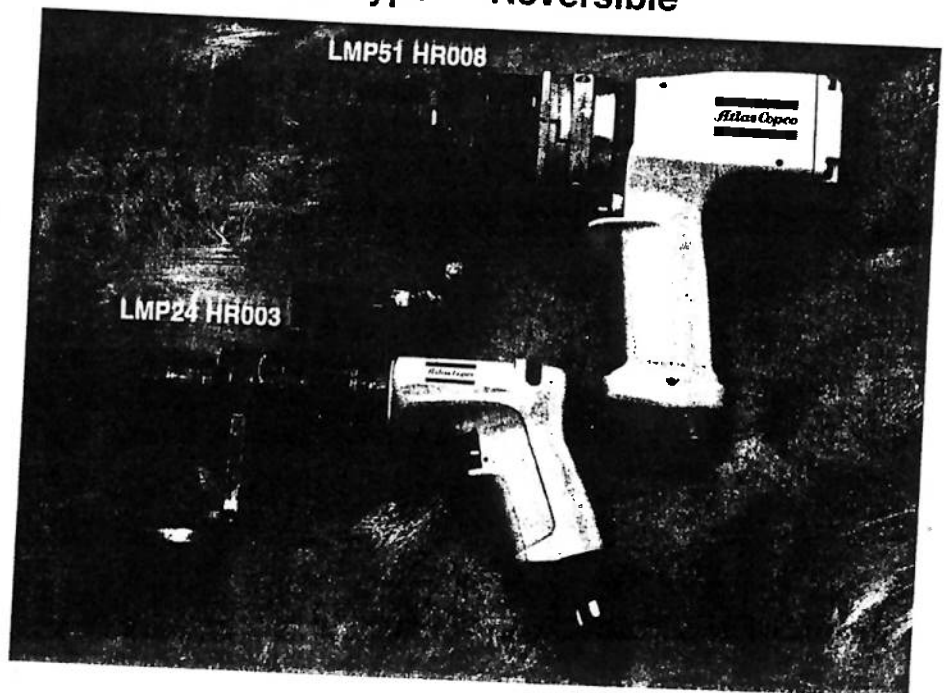
PISTOL GRIP NUTRUNNERS

Stall type and torque control type — Reversible

LMP24HR, LMP51HR, PHR —
LTP51HR, PHR
M6-M27 bolt capacity

LMP51HR. M12-M27 bolt capacity

- Patented standard twin motor gives faster production and an increased accuracy with a minimum of air consumption
- Very high torque accuracy
- Fast rundown motor for time saving
- Extremely good weight to torque output compared to single motor pistol grip nutrunners
- The swivelling function facilitates tool positioning
- **Reversible for maximum flexibility** — Being able to loosen fasteners without changing tools improves productivity and is a major operator benefit in terms of time and effort



Model	Suitable for bolt size	Square drive size	Torque range Soft joint				Free speed r/min	Weight ^a		Length mm	Distance centre to side mm	Air inlet thread in	Air consumption at free speed		Recommended hose size mm	Sound level dB(A)	Ordering No.
			at 6.3 bar Nm	at 3 bar ft lb	at 3 bar Nm	at 3 bar ft lb		kg	lb				l/s	cfm			
LMP24 HR011-10	M6	3/8	10	7	5	4	860	1.0	2.2	210	18	1/4	7	15	10	79	8431 0245 85
LMP24 HR005-10	M8	3/8	22	16	10	7	380	1.0	2.2	210	18	1/4	7	15	10	79	8431 0245 77
LMP24 HR003-13	M8	1/2	30	22	14	10	250	1.2	2.6	210	18	1/4	7	15	10	79	8431 0245 91
LMP24 HR002-13	M10	1/2	40	33	20	15	180	1.3	2.9	230	21	1/4	7	15	10	79	8431 0245 70
LMP51 HR008-13	M14	1/2	190	140	95	70	680	2.6	6.6	238	30	3/8	19	40	10	79	8431 0528 13
LMP51 HR004-20	M18	3/4	380	275	195	140	305	3.9	8.6	275	34	3/8	19	40	10	79	8431 0528 39
LMP51 HR002-20	M20	3/4	550	400	260	190	210	3.9	8.6	275	34	3/8	19	40	10	79	8431 0528 47
LMP51 HR001-25	M24	1	950	695	470	345	125	4.3	9.5	305	34	3/8	19	40	10	79	8431 0528 37
LMP51 HR0005-25	M27	1	950	695	470	345	55	4.3	9.5	305	34	3/8	19	40	10	79	8431 0528 45

Model	Suitable for bolt size	Square drive size	Torque range at 5 bar				Min torque at 3 bar		Max torque at 6.3 bar		Free speed r/min	Weight ^a		Distance centre to side mm	Air consumption at free speed		Ordering No.
			Nm	ft lb	Nm	ft lb	Nm	ft lb	Nm	ft lb		kg	lb		l/s	cfm	
LTP51 HR008-13	M14	1/2	150	110	85	60	70	50	175	130	600	3.0	6.6	238	30	19	40
LTP51 HR004-20	M18	3/4	270	200	200	145	145	105	320	235	300	3.9	8.6	275	34	19	40
LTP51 HR002-20	M20	3/4	380	280	265	195	220	160	460	235	200	3.9	8.6	275	34	19	40
LTP51 HR001-25	M24	1	700	510	450	330	300	220	900	660	100	4.3	9.5	305	34	19	40
LTP51 PHR0005-25	M27	1	805	590	595	435	450	330	950	695	52	4.3	9.5	305	34	19	40

^a Without reaction bar

LMP51/LTP51 H/HR:

Change over torque is around 7% of maximum torque on a given air pressure

LMP51/LTP51 PH/PHR:

Change over torque is around 15% of maximum torque on a given air pressure

Air inlet thread LMP24 in 1/4"
LMP/LTP51 in 3/8"
Recommended hose size 10 mm
Sound level 79 dB(A)

ACCESSORIES INCLUDED

• LMP24: Suspension yoke, reaction bar
• LMP51/LTP51: Swivel type reaction bar

OPTIONAL ACCESSORIES

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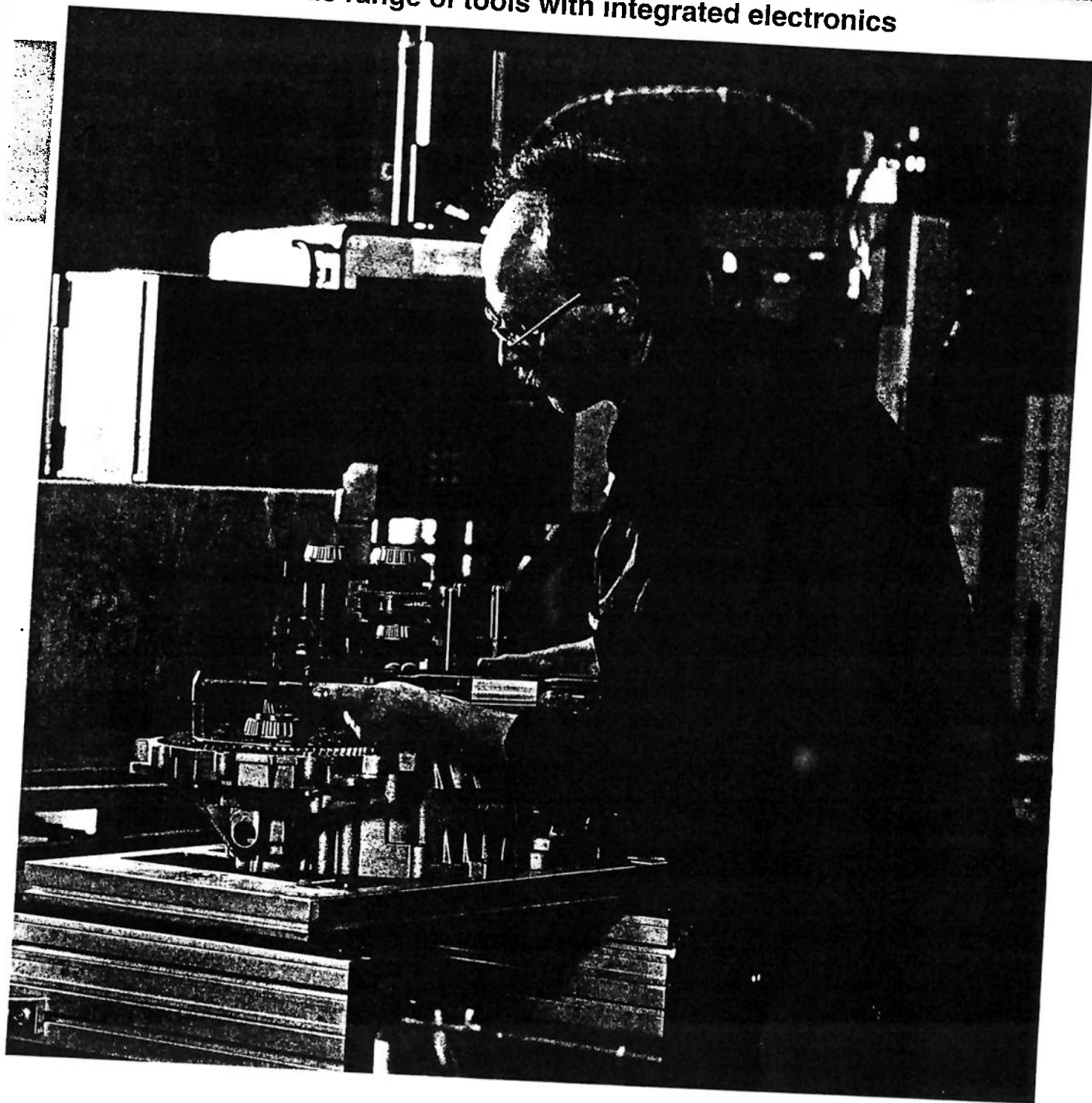


SELECTED SERVICE KITS TO ORDER

Page 57

ADVANCED TIGHTENING TECHNIQUE

Wide range of tools with integrated electronics



HIGHER QUALITY

Today's rapidly increasing quality demands encompass the whole manufacturing process from the use of high quality materials to the use of accurate assembly tools. Statistical Process Control (SPC) has become an important way to guarantee a high quality manufacturing process, according to international quality standards such as the ISO 9000.

To meet these demands Atlas Copco offers a number of tools with integrated electronics (torque transducers and angle encoders) to monitor or control the tightening process.

Atlas Copco can also offer a full range of control equipment: From the

portable and easy to use ACTA 2000. To the FOCUS that can be used to collect statistical data, both torque and angle data, and to control the tool by means of a solenoid valve.

There are two basic ways to handle the assembly of important joints:

Monitored tightening: to use a high quality shut off tool such as the LTP51 or a tool from the LTV range and to monitor the torque or the angle.

Tightening results can be monitored and recorded continuously.

Controlled tightening: to use an electrical control system to shut off the tool when a preset torque or angle is

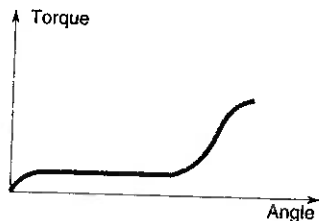
reached. The electrical control system can be controlled centrally. The system makes it possible to use one tool for several different torque levels. The tool can also be used for two-step tightening.

For more information about monitored/controlled tightening with the LMP/LTP51 and the LMP24 see pages 64 and 66.

For the LTV series of tools see page 59.

APPLICATIONS

❑ **Monitored tightening, torque only:** This is the most common method. For most applications the accuracy that is achieved with a high quality shut-off tool meets the process demands. The torque level is monitored to make sure that the correct torque level was reached. Statistics can be collected in order to document that the joint was correctly tightened



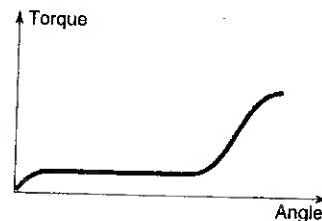
❑ **The number of tightenings in one cycle can also be counted to help the operator**

❑ **Signal lights can be mounted on the tool or on the wall in order to simplify the monitoring**

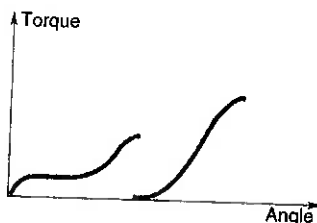
❑ **Two independent systems — for maximum reliability**
One system — the clutch shuts off the tool.

The other system — the transducer monitors the torque level

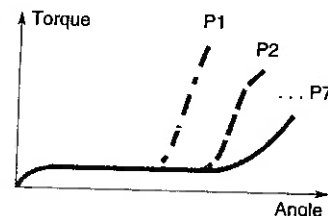
❑ **Monitored tightening, torque and angle:** Same as monitored tightening torque only, plus the possibility to detect faulty joints. It is also possible to monitor the whole tightening process in order to detect joint and friction variation and assembly errors such as clamped hoses, missing parts or damaged threads



❑ **Controlled tightening, torque only:** A solenoid valve that is shut off by the FOCUS is the ideal way to achieve the correct torque on difficult applications. The joint can be tightened in two steps. One tool can be used for several different torque levels

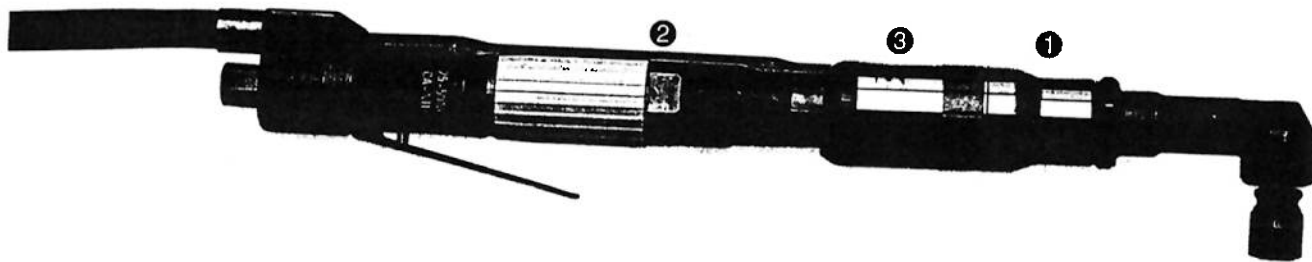


❑ **Controlled tightening, torque and angle:** By means of controlling the tightening angle the requested clamping force can be achieved even with variable friction and stiffness. For the most difficult assembly problems, such as relaxation or extremely high accuracy demands, two stage tightening is recommended. This means that the tool is first shut off at a pre set torque then started to turn the joint to the final target angle.



MONITORED/CONTROLLED TIGHTENING

With LTV series nutrunners



① Torque transducers, "TS" tools

Most tools in the LTV series can be equipped with built-in torque transducers, see page 60. The LTD range of tools can either be equipped with the accurate and easy to use PRT add on transducers or with built-in transducer, see page 62.

② Angle encoder tools, "TAS"

All tools that can be equipped with a transducer can also be with an angle encoder. The torque transducer provides the angle encoder with a start signal.

③ Signal lamps "S"

All transducerized LTV nutrunners are equipped with signal lights. Two sets of green, red and yellow lamps provide the operator with information about the tightening.

Green = OK

Red = High torque (angle)

Yellow = Low torque (angle)

③ Tool memory

The flex card holding signal lights also includes a memory chip. Connected with the FOCUS 2000 instrument calibration will be performed automatically. The chip also contains information about tool identity and number of tightenings etc.



ANGLE NUTRUNNERS

For monitored tightening

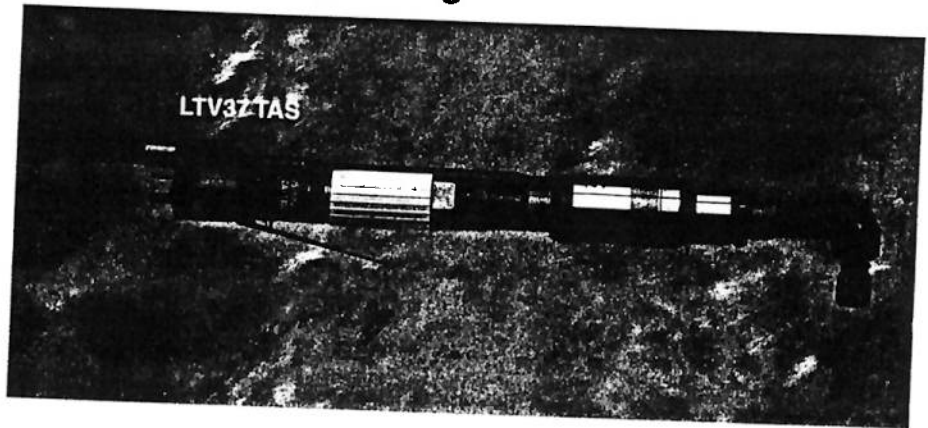
Built-in torque transducer, signal lights, angle encoder

Atlas Copco LTV -TS and TAS nutrunners feature built-in electronics and integrated wiring to a cable whip.

The transducer is actuated by the torque from the last gear step before the angle head, which ensures maximum measuring accuracy.

The LTV -TS and TAS nutrunner is easily connected to the process measuring instrument, type FOCUS or similar.

Both models are equipped with signal lights (red, green and yellow LED's) for indication of tightening status.



Model	Suitable for bolt size mm	Square drive size in	Torque range Soft joint		Free speed r/min	Weight*		Length mm	Dis- tance centre to side angle head mm	Air con- sumption at free speed		Air inlet thread in	Sound level dB(A)	Ordering No.
			Nm	Ft lb		kg	lb			l/s	cfm			
Angle nutrunners with built-in torque transducer and signal lights — LTV-TS. Reversible models														
LTV27 SR006-10-TS	M6	3/8	6-12	4- 9	690	2.6	5.7	423	13.5	11	23	1/4	76	8431 0543 10
LTV27 SR003-10-T6S	M6	3/8	7-14	5-10	350	2.6	5.7	398	13.5	11	23	1/4	76	8431 0543 80
LTV27 SR005-10-TS	M6	3/8	10-18	7-13	550	2.6	5.7	423	13.5	11	23	1/4	76	8431 0543 01
LTV27 SR004-10-TS	M8	3/8	11-24	8-18	440	2.6	5.7	398	13.5	11	23	1/4	76	8431 0543 75
LTV27 SR003-10-T8S	M8	3/8	15-28	11-21	350	2.6	5.7	398	13.5	11	23	1/4	76	8431 0543 98
LTV27 SR001-10-TS	M8	3/8	15-28	11-21	80	2.6	5.7	398	13.5	11	23	1/4	76	8431 0543 03
LTV37 SR007-10-TS	M8	3/8	13-27	10-20	670	3.1	6.8	480	13.5	20	42	1/4	80	8431 0544 02
LTV37 SR006-10-TS	M8	3/8	18-32	13-24	560	3.1	6.8	480	13.5	20	42	1/4	80	8431 0544 03
LTV37 SR005-10-TS	M8	3/8	20-42	15-31	430	3.2	7.0	490	17.5	20	42	1/4	80	8431 0544 70
LTV37 SR005-13-TS	M8	1/2	20-42	15-31	430	3.3	7.3	486	20.0	20	42	1/4	80	8431 0544 73
LTV37 SR004-10-TS	M10	3/8	28-50	21-37	360	3.2	7.0	490	17.5	20	42	1/4	80	8431 0544 88
LTV37 SR004-13-TS	M10	1/2	28-50	21-37	360	3.3	7.3	486	20.0	20	42	1/4	80	8431 0544 96
LTV37 SR004A-13-TS	M10	1/2	30-60	22-44	305	3.3	7.3	486	20.0	20	42	1/4	80	8431 0544 97
LTV37 SR003-13-TS	M10-M12	1/2	34-70	25-52	250	3.5	7.7	524	20.0	20	42	1/4	80	8431 0544 99
LTV37 SR002-L13-TS	M12	1/2	40-90	30-66	210	3.9	8.6	547	25.0	20	42	1/4	80	8431 0544 04
Non-reversible models														
LTV27 S006-10-TS	M6	3/8	10- 22	7- 16	620	2.5	5.5	398	13.5	11	23	1/4	76	8431 0543 12
LTV27 S004-10-T6S	M6	3/8	7- 15	5- 11	400	2.5	5.5	373	13.5	11	23	1/4	76	8431 0543 64
LTV27 S004-10-T8S	M8	3/8	15- 28	11- 21	400	2.5	5.5	373	13.5	11	23	1/4	76	8431 0543 72
LTV37 S008-10-TS	M8	3/8	18- 32	13- 24	800	3.0	6.6	454	13.5	20	42	1/4	80	8431 0544 43
LTV37 S007-10-TS	M8	3/8	18- 32	13- 23	660	3.1	6.8	454	13.5	20	42	1/4	80	8431 0544 44
LTV37 S006-10-TS	M8-M10	3/8	22- 45	16- 33	520	3.1	6.8	464	17.5	20	42	1/4	80	8431 0544 47
LTV37 S005-10-TS	M10	3/8	30- 55	22- 41	440	3.1	6.8	464	17.5	20	42	1/4	80	8431 0544 54
LTV37 S005-13-TS	M10	1/2	30- 55	22- 41	440	3.2	7.0	460	20.0	20	42	1/4	80	8431 0544 62
LTV37 S004A-13-TS	M10	1/2	30- 68	22- 50	370	3.2	7.0	460	20.0	20	42	1/4	80	8431 0544 65
LTV46 S005-13-TS	M10	1/2	20- 57	15- 42	500	3.9	8.6	610	20.0	27	57	1/2	81	8431 0541 17
LTV46 S004-13-TS	M12	1/2	25- 73	18- 54	400	3.9	8.6	610	20.0	27	57	1/2	81	8431 0541 18
LTV46 S003-L13-TS	M12	1/2	35- 90	26- 66	280	4.3	9.5	634	25.0	27	57	1/2	81	8431 0541 19
LTV46 S002-L13-TS	M14	1/2	50-116	37- 86	220	4.3	9.5	634	25.0	27	57	1/2	81	8431 0541 20
LTV46 S001-L13-TS	M14	1/2	60-150	44-111	180	4.4	9.7	634	25.0	27	57	1/2	81	8431 0541 21

Recommended hose size mm

LTV27/37 = 10, LTV46 = 13

Signal connectors

TS-tools 19 pole male connector

* Weight including 0.4 kg (0.9 lb) cable connection

All tools are individually calibrated and the value is engraved on the cover

All tools above for monitoring instrument with 12 V I/O signals

ACCESSORIES INCLUDED

Clutch adjustment wrench

OPTIONAL ACCESSORIES

Transducer cables, see page 66

Other accessories, see page 45



ANGLE NUTRUNNERS

For monitored tightening

Model	Suitable for bolt size mm	Square drive size in	Torque range Soft joint		Free speed r/min	Weight ^a		Length mm	Distance centre to side angle head mm	Angle encoder resolution in pulses /rev	Air inlet tread in	Sound level dB(A)	Recommended hose size mm	Ordering No.
			Nm	Ft lb		kg	lb							
Angle nutrunners with built-in torque transducer, angle encoder and signal lights LTV-TAS. Reversible models														
LTV27 SR006-10-TAS M6	3/8	3/8	6-12	4- 9	690	2.7	6.0	438	13.5	90	1/4	76	10	8431 0560 60
LTV27 SR003-10-T6AS M6	3/8	3/8	7-14	5-10	350	2.7	6.0	413	13.5	220	1/4	76	10	8431 0560 01
LTV27 SR005-10-TAS M6	3/8	3/8	10-18	7-13	550	2.7	6.0	438	13.5	141	1/4	76	10	8431 0560 02
LTV27 SR004-10-TAS M8	3/8	3/8	11-24	8-18	440	2.7	6.0	413	13.5	176	1/4	76	10	8431 0560 70
LTV27 SR003-10-T8AS M8	3/8	3/8	15-28	11-21	350	2.7	6.0	413	13.5	220	1/4	76	10	8431 0560 03
LTV27 SR001-10-TAS M8	3/8	3/8	15-28	11-21	80	2.7	6.0	413	13.5	982	1/4	76	10	8431 0560 04
LTV37 SR007-10-TAS M8	3/8	3/8	13-27	10-20	670	3.2	7.1	495	13.5	98	1/4	80	10	8431 0560 05
LTV37 SR006-10-TAS M8	3/8	3/8	18-32	13-24	560	3.2	7.1	495	13.5	117	1/4	80	10	8431 0560 06
LTV37 SR005-10-TAS M8	3/8	3/8	20-42	15-31	430	3.3	7.3	505	17.5	152	1/4	80	10	8431 0560 07
LTV37 SR005-10-TAS M8	1/2	1/2	20-42	15-31	430	3.4	7.5	501	20.0	152	1/4	80	10	8431 0560 72
LTV37 SR004-10-TAS M10	3/8	3/8	28-50	21-37	360	3.3	7.3	505	17.5	183	1/4	80	10	8431 0560 08
LTV37 SR004-10-TAS M10	1/2	1/2	28-50	21-37	360	3.4	7.5	501	20.0	183	1/4	80	10	8431 0560 09
LTV37 SR004A-13-TAS M10	1/2	1/2	30-60	22-44	305	3.4	7.5	501	20.0	214	1/4	80	10	8431 0560 74
LTV37 SR003-13-TAS M10-M12	1/2	1/2	34-70	25-52	250	3.6	7.9	539	20.0	266	1/4	80	10	8431 0560 10
LTV37 SR002L-13-TAS M12	1/2	1/2	40-90	30-66	210	4.0	8.8	562	25.0	318	1/4	80	10	8431 0560 11
Non-reversible models														
LTV27 S006-10-TAS M6	3/8	3/8	10- 22	7- 16	620	2.6	5.7	413	13.5	141	1/4	76	10	8431 0560 62
LTV27 S004-10-T6AS M6	3/8	3/8	7- 15	5- 11	400	2.6	5.7	388	13.5	220	1/4	76	10	8431 0560 12
LTV27 S004-10-T8AS M8	3/8	3/8	15- 28	11- 21	400	2.6	5.7	388	13.5	220	1/4	76	10	8431 0560 13
LTV37 S008-10-TAS M8	3/8	3/8	18- 32	13- 24	800	3.1	6.8	469	13.5	98	1/4	80	10	8431 0560 76
LTV37 S007-10-TAS M8	3/8	3/8	18- 32	13- 23	660	3.2	7.1	480	13.5	242	1/4	80	10	8431 0560 77
LTV37 S006-10-TAS M8-M10	3/8	3/8	22- 45	16- 33	520	3.2	7.1	479	17.5	152	1/4	80	10	8431 0560 14
LTV37 S005-10-TAS M10	3/8	3/8	30- 55	22- 41	440	3.2	7.1	479	17.5	183	1/4	80	10	8431 0560 15
LTV37 S005-13-TAS M10	1/2	1/2	30- 55	22- 41	440	3.3	7.3	475	20.0	183	1/4	80	10	8431 0560 16
LTV37 S004A-13-TAS M10	1/2	1/2	30- 68	22- 50	370	3.3	7.3	475	20.0	214	1/4	80	10	8431 0560 78
LTV46 S005-13-TAS M10	1/2	1/2	20- 57	15- 42	500	4.0	8.8	620	20.0	255	1/2	82	13	8431 0560 17
LTV46 S004-13-TAS M12	1/2	1/2	25- 73	18- 54	400	4.0	8.8	620	20.0	314	1/2	81	13	8431 0560 18
LTV46 S003-L13-TAS M12	1/2	1/2	35- 90	26- 66	280	4.4	9.7	644	25.0	442	1/2	81	13	8431 0560 19
LTV46 S002-L13-TAS M14	1/2	1/2	50-116	37- 86	220	4.4	9.7	644	25.0	563	1/2	81	13	8431 0560 20
LTV46 S001-L13-TAS M14	1/2	1/2	60-150	44-111	180	4.4	9.7	644	25.0	696	1/2	81	13	8431 0560 21

Air consumption at free speed l/s LTV27 = 11, LTV37 = 20, LTV46 = 27
cfm LTV27 = 23, LTV37 = 42, LTV46 = 57

Signal connectors

TAS-tools 19 pole male connector

All tools are individually calibrated and the value is engraved on the cover

All tools above for monitoring instrument with 12 V I/O signals

^a Weight including 0.4 kg (0.9 lb) cable connection

Versions for monitoring instrument with 24 Volt I/O signals and 0 Volt common
19-pole connector with bayonette ring (technical data same as standard version)

Reversible models

Non-reversible models

	Ordering No.		Ordering No.
LTV27 SR006-10-TS/24V	8451 0553 78	LTV27 S006-10-TS/24V	8451 0555 06
LTV27 SR003-10-T6S/24V	8451 0553 83	LTV27 S004-10-T6S/24V	8451 0553 87
LTV27 SR005-10-TS/24V	8451 0553 81	LTV27 S004-10-T8S/24V	8451 0553 72
LTV27 SR004-10-TS/24V	8451 0553 88	LTV37 S008-10-TS/24V	8451 0555 07
LTV27 SR003-10-T8S/24V	8451 0553 89	LTV37 S007-10-TS/24V	8451 0555 08
LTV27 SR001-10-TS/24V	8451 0553 90	LTV37 S006-10-TS/24V	8451 0553 74
LTV37 SR007-10-TS/24V	8451 0555 00	LTV37 S005-10-TS/24V	8451 0555 09
LTV37 SR006-10-TS/24V	8451 0555 01	LTV37 S005-13-TS/24V	8451 0555 10
LTV37 SR005-10-TS/24V	8451 0553 79	LTV37 S004A-10-TS/24V	8451 0553 71
LTV37 SR005-13-TS/24V	8451 0555 02	LTV37 S004A-13-TS/24V	8451 0553 76
LTV37 SR004-10-TS/24V	8451 0555 03	LTV46 S005-13-TS/24V	8451 0555 11
LTV37 SR004-13-TS/24V	8451 0555 04	LTV46 S004-13-TS/24V	8451 0555 12
LTV37 SR004A-13-TS/24V	8451 0553 80	LTV46 S003-L13-TS/24V	8451 0555 13
LTV37 SR003-13-TS/24V	8451 0555 05	LTV46 S002-L13-TS/24V	8451 0553 85
LTV37 SR002-L13-TS/24V	8451 0553 82	LTV46 S001-L13-TS/24V	8451 0553 75

ACCESSORIES INCLUDED

Clutch adjustment wrench

OPTIONAL ACCESSORIES

Transducer cables, see page 66

Other accessories, see page 45

INTEGRATED ELECTRONICS

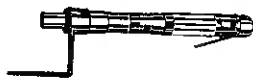
Straight, Crowfoot, Flush head, Hold and drive

Model	Suitable for bolt size mm	Square drive size in	Torque range soft joint		Free speed r/min	Weight T,-TS (-TAS+0.1 kg/0.2 lb)		Length -T-TS (-TAS+15 mm) mm	Ordering No.		
			Nm	Ft lb		kg	lb		Torque transducer -T6/T8/T	+ signal lights -T6S/T8S/TS	+ angle encoder -T6AS/T8AS/TAS

STRAIGHT NUTRUNNERS — LTD

Non-reversible models with fixed square drive

LTD27 S006-T6	M5	3/8	5-10	4- 7	570	2.4	5.3	379	8431 0553 01	+	+
LTD27 S007-T8	M5-M6	3/8	8-18	6-13	780	2.4	5.3	379	8431 0553 20	+	+
LTD27 S006-T8	M6	3/8	10-21	7-15	570	2.4	5.3	379	8431 0553 02	+	+
LTD37 S008-T	M8	1/2	14-30	10-21	820	3.0	6.6	438	8432 0553 03	+	+
LTD37 S006-T	M8	1/2	20-38	12-27	680	3.0	6.6	438	8433 0553 04	+	+
LTD37 S003-T	M10	1/2	27-55	15-40	470	3.1	6.8	473	8434 0553 05	+	+
LTD46 S004-T	M10	1/2	30-68	22-50	410	3.9	8.6	585	8435 0553 06	+	+
LTD46 S003-T	M12	1/2	40-80	29-59	340	3.9	8.6	585	8436 0553 07	+	+



Non-reversible models with 25 mm floating square drive

LTD27 S006F-T6	M5	3/8	5-10	4- 7	570	2.7	5.9	482	8431 0553 08	+	+
LTD27 S007F-T8	M5-M6	3/8	8-18	6-13	780	2.7	5.9	482	8431 0553 21	+	+
LTD27 S006F-T8	M6	3/8	10-21	7-15	570	2.7	5.9	482	8431 0553 09	+	+
LTD37 S008F-T	M8	1/2	14-30	10-21	820	3.3	7.3	547	8432 0553 10	+	+
LTD37 S006F-T	M8	1/2	20-38	12-27	680	3.3	7.3	547	8433 0553 11	+	+
LTD37 S003F-T	M10	1/2	27-55	15-40	470	3.6	7.9	584	8434 0553 12	+	+
LTD46 S004F-T	M10	1/2	30-68	22-50	410	4.4	9.7	697	8435 0553 13	+	+
LTD46 S003F-T	M12	1/2	40-80	29-59	340	4.4	9.7	697	8436 0553 14	+	+

Reversible models with fixed square drive

LTD27 SR005-T6	M5	3/8	5- 9	4- 6.5	520	2.5	5.5	404	8431 0553 22	+	+
LTD27 SR006-T8	M5-M6	3/8	7-16	5-12	620	2.5	5.5	404	8431 0553 23	+	+
LTD27 SR005-T8	M6	3/8	10-20	7-13	520	2.5	5.5	404	8431 0553 24	+	+
LTD37 SR007-T	M8	1/2	13-27	10-20	670	3.1	6.8	463	8431 0553 50	+	+
LTD37 SR006-T	M8	1/2	18-32	13-24	560	3.1	6.8	463	8431 0553 25	+	+
LTD37 SR003-T	M10	1/2	22-47	15-35	380	3.2	7.0	498	8431 0553 26	+	+

Reversible models with 25 mm floating square drive

LTD27 SR005F-T6	M5	3/8	5- 9	4- 6.5	520	2.8	6.2	507	8431 0553 27	+	+
LTD27 SR006F-T8	M5-M6	3/8	7-16	5-12	620	2.8	6.2	507	8431 0553 28	+	+
LTD27 SR005F-T8	M6	3/8	10-20	7-13	520	2.8	6.2	507	8431 0553 29	+	+
LTD37 SR007F-T	M8	1/2	13-27	10-20	670	3.4	7.5	572	8431 0553 30	+	+
LTD37 SR006F-T	M8	1/2	18-32	13-24	560	3.4	7.5	572	8431 0553 31	+	+
LTD37 SR003F-T	M10	1/2	22-47	15-35	380	3.7	8.1	609	8431 0553 32	+	+

Air consumption at free speed l/s: LTD27=11, LTD37=20, LTD46=27
cfm: LTD27=23, LTD37=42, LTD46=57

+ = Available on request

* Weight including 0.4 kg (0.9 lb) cable connection

Signal connectors: T-tools 6-pin male connector

TS- and TAS-tools 19-pin male connector

All tools are individually calibrated and the value is engraved on the tool

All tools above for monitoring instrument with 12 V I/O signals

Transducerized LTC, LTV-FS and LTV-HAD are available on request

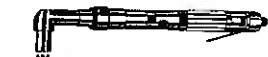
CROWFOOT NUTRUNNERS — LTC



NUTRUNNERS WITH FLUSH SOCKET — LTV-FS



NUTRUNNERS WITH HOLD AND DRIVE SOCKET — LTV-HAD





ANGLE NUTRUNNERS

For controlled tightening. Built-in torque-transducer, signal lights and solenoid valve

Controlled tightening M8-M14

□ **Parameter tool** — One tool can be used for up to fifteen different torque levels

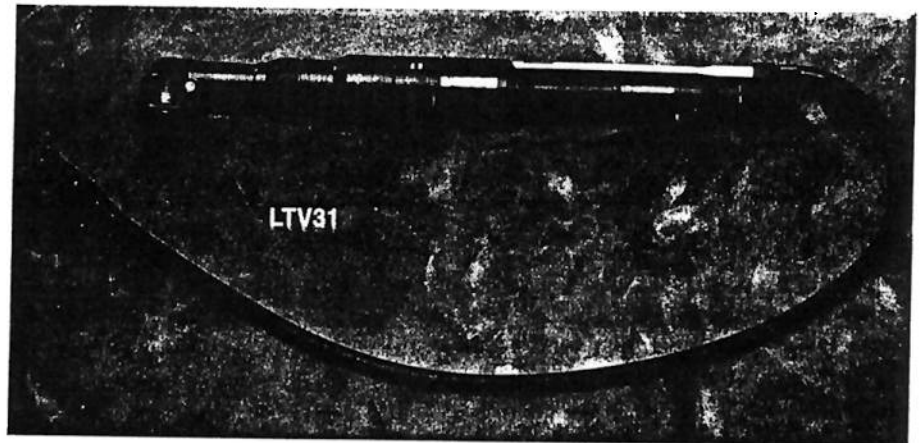
□ **Ideal for difficult joints** — Handles joints with variable stiffness, friction or relaxation problems

The LTV31 and -40 are the ideal angle nutrunners for controlled tightening. They feature a built-in torque transducer, signal lights and an integrated solenoid valve. The IA versions are also equipped with a built-in angle encoder.

The fast built-in solenoid valve shuts off the tool when a pre set torque level is reached ensuring maximum accuracy in tightening important joints such as safety joints.

Maximum accuracy — The transducer is actuated by the torque from the last gear step before the angle head which gives highest possible measuring accuracy.

Parameter tool — The LTV31/-40/IA can also be used as a parameter tool to tighten several joints with different torque levels with one single tool.



Angle encoder — The LTV31 and 40IA versions of the LTV31-40I are equipped with an angle encoder, for applications when an even higher level of control of the clamping force is needed or when joint friction is highly variable.

The angle encoder can also be used to detect different assembly errors such as forgotten washers, clamped hoses or damaged threads.

Reliable well proven design — The built-in solenoid, the well proven gears and transducer together with the sturdy cable whip ensure good accuracy and high productivity for a long tool life. The suspension yoke is integrated in the tool.

For suitable control equipment see page 67.

Model	Bolt size mm	Square drive in	Torque range				Free speed rpm	Weight*		Length mm	Air consumption		Sound level at free speed dB (A)	Angle encoder resolution in pulses/rev	Dis-tance centre side to mm	Ordering No.
			max 6.3 bar		min 3.0 bar			kg	lb		l/s	cfm				
			Nm	Ft lb	Nm	Ft lb										
Angle nutrunners with built-in torque transducer LTV31I and 40I																
LTV31 SR005-10-I	M8	3/8	30	22	15	11	500	2.5	5.5	480	16	34	79	—	14	8431 0461 68
LTV31 SR003-13-I	M10	1/2	55	41	20	15	300	3.3	7.3	530	16	34	79	—	20	8431 0461 64
LTV31 SR002-L13-I	M12	1/2	90	66	25	18	180	3.7	8.2	570	16	34	79	—	25	8431 0461 72
LTV40 S003-13-I	M10	1/2	70	52	30	22	290	3.8	8.4	540	19	40	77	—	20	8431 0461 59
LTV40 S001-L13-I	M12-14	1/2	130	96	40	30	150	4.3	9.5	570	19	40	77	—	25	8431 0461 51
Tools with integrated angle encoder																
LTV31 SR005-10-IA	M8	3/8	30	22	15	11	500	2.5	5.5	480	16	34	79	132	14	8431 0461 70
LTV31 SR003-13-IA	M10	1/2	55	41	20	15	300	3.3	7.3	530	16	34	79	215	20	8431 0461 66
LTV31 SR002-L13-IA	M12	1/2	90	66	25	18	180	3.5	7.7	570	16	34	79	367	25	8431 0461 74
LTV40 S003-13-IA	M10	1/2	70	52	30	22	290	3.8	8.4	540	19	40	77	428	20	8431 0461 62
LTV40 S001-L13-IA	M12-14	1/2	130	96	40	30	150	4.3	9.5	570	19	40	77	789	25	8431 0461 53
FOCUS 2101V with solenoid drive card and connections																
Connection cable for FOCUS 2101V																
5 m																
8092 1126 03																
4145 0952 05																

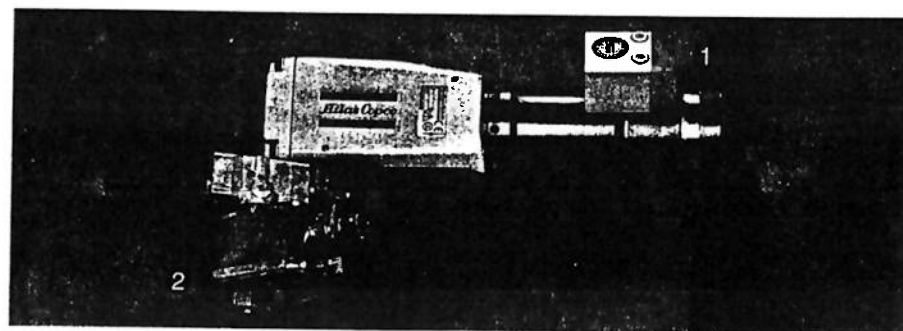
Retainer pin quick change type included for 1/2" square drive

*Weight including 0.4 kg (0.9 lb) cable connection length 1 m

PISTOL AND STRAIGHT NUTRUNNERS

For monitored/controlled tightening

The reaction bar supported pistol grip and straight nutrunners are ideally suitable for electronic monitored or controlled tightening. The equipment is adapted for signal processing by the portable torque monitoring instrument type ACTA 2000 for sample checking or the advanced torque analyser type FOCUS 2000 for continuous monitoring and control.



1 Torque transducers PRT

The reaction bar torque transducers PRT are mounted externally on the front of the tool replacing the standard reaction bar. Consequently, they are equally suitable for spot checks and continuous signal processing. The PRT transducers have no rotating parts and are therefore most accurate and reliable. The reaction bar swivel function is maintained on tools with this feature.

2 Solenoid valves

The Atlas Copco in-line solenoid valves are rugged and fast acting for maximum reliability and accuracy. However, for new installations in the torque range above 50 Nm we recommend the tools with built-in solenoid valve presented below. (The straight nutrunners LMD51 and LTD51 must always have a separate throttle valve for their operation).

ADD-ON ELECTRONICS

Standard nutrunners can be adapted for electronic monitoring and even control of the tightening torque. The simplest way to achieve electronic monitoring of the torque is to equip the standard stall type or shut-off type, straight or pistol nutrunners with an add-on reaction bar torque transducer.

The signal can also be used for tightening control by adding a solenoid valve in the supply air line to the tool for shut-off.

Technical data and ordering numbers are found on page 65.

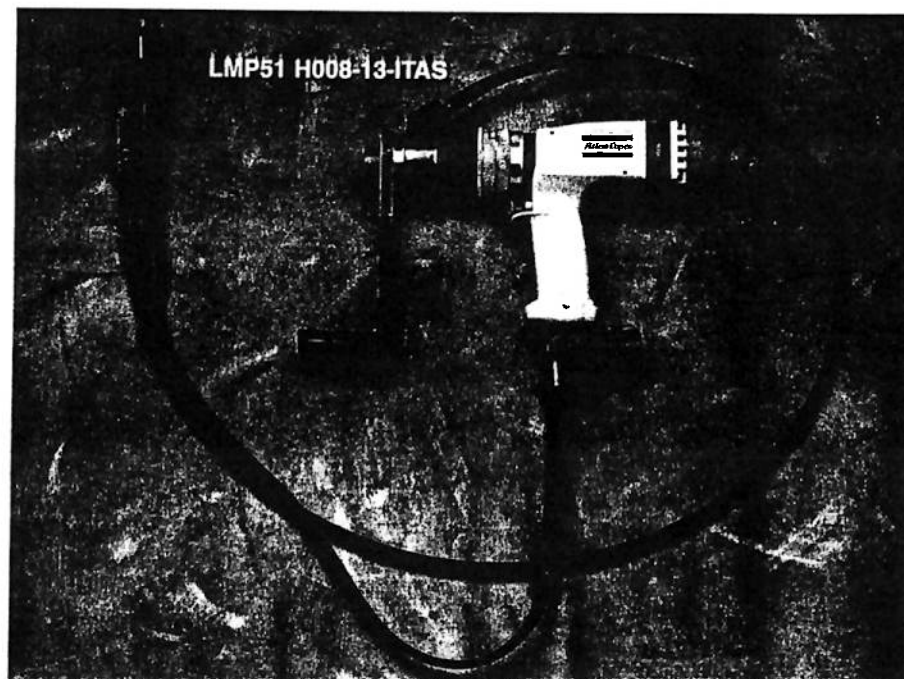
With integrated electronics

The high torque, pistol grip nutrunners LMP/LTP51 are also supplied as factory made units equipped with the PRT transducers and built-in angle encoders for torque rate and tightening angle monitoring. The stall type LMP51 can be supplied with integrated solenoid valve for advanced electronic control of the tightening process.

All models with integrated electronics have a signal light display on the tool giving a confirmation to the operator of the status of the operation. The coloured lamps have the following codes:

- Green = OK
- Red = High torque or angle
- Yellow = Low torque or angle

The chart below shows the complete range of variants manufactured to order. The most common models, i.e. the non-reversible electronically controlled nutrunners, are listed with ordering numbers in the data table on the following page.



Torque control	Rotation	Nut/screw run-down	Basic model		Suffix*			
			Designation	See page	-TS	-TAS	-ITS	-ITAS
Stall type LMP	Non-reversible	Free	LMP51 H	54	Optional	Optional	Standard	Standard
		Prevailing	LMP51 PH	54	Optional	Optional	Standard	Standard
	Reversible	Free	LMP51 HR	56	Optional	Optional	Optional	Optional
		Prevailing	LMP51 PHR	56	Optional	Optional	Optional	Optional
Shut-off type LTP	Non-reversible	Free	LTP51 H	55	Optional	Optional	Not supplied	
		Prevailing	LTP51 PH	55	Optional	Optional		
	Reversible	Free	LTP51 HR	56	Optional	Optional	Not supplied	
		Prevailing	LTP51 PHR	56	Optional	Optional		



PISTOL GRIP NUTRUNNERS

With integrated electronics

MONITORED TIGHTENING

□ Nutrunners with torque transducer and signal lights (-TS)

The -TS variants of the pistol grip nutrunners LMP51 and LTP51 are intended for continuous monitoring of the tightening torque with a feed-back to the operator of the completed assembly operation within specified tolerances.

□ Nutrunners with angle encoder, torque transducer and signal lights (-TAS)

For detection of faulty joints, e.g. damaged and incomplete threads or missing members of the joint, the transducerized nutrunners LMP51 and LTP51 can be supplied with built-in angle encoder designated by suffix -TAS. The signal lights on the tool can be programmed for either torque, angle or combined fault detection.

CONTROLLED TIGHTENING

□ Controlled nutrunners with torque transducer and signal lights (-ITS)

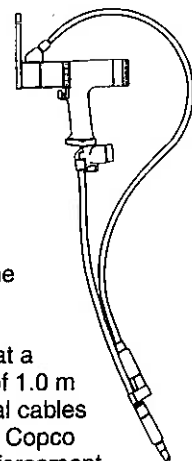
The LMP51 -ITS models have a fast built-in solenoid valve activated by the trigger via the FOCUS controller. The tools can be used for up to fifteen different parameter sets.

□ Controlled nutrunners with angle encoder, torque transducer and signal lights (-ITAS)

An even higher level of clamping force control is offered by the electronically controlled versions of LMP51 with a built-in angle encoder. Apart from being used to detect assembly errors, the turning angle can also be selected as shut-off target, alone or in combination with torque to cope with all specific tightening demands. Specially useful when joint friction varies.

Signal cables

All models of LMP/LTP with integrated electronics and signal lights are supplied with one pigtail cable for the signal lights, angle encoder and solenoid valve combined and one separate pigtail to the swivelling PRT torque transducer connected at a junction at a distance of 1.0 m from the tool. The signal cables are of the special Atlas Copco design with Kevlar reinforcement for maximum flexibility and service life. The common cable from the junction to the FOCUS monitoring/control instrument must be ordered separately to the desired length (see Signal cables, page 66).



Model	Suitable for bolt size mm	Square drive size in	Torque range				Free speed rpm	Weight*		Length mm	Air consumption		Air inlet thread in	Rec. hose size mm	Distance centre to side mm	Ordering No.
			max		min			kg	lb		l/s	cfm				
			6.3 bar Nm	ft lb	3.0 bar Nm	ft lb										
LMP51-ITS — Pistol grip nutrunners with built-in solenoid valve and signal lights																
LMP51 H012-13-ITS	M12	1/2	110	81	30	22	1100	4.2	9.2	226	19	40	3/8	10	31	8431 0520 05
LMP51 H008-13-ITS	M14	1/2	180	133	50	37	680	4.2	9.2	226	19	40	3/8	10	31	8431 0520 13
LMP51 H006-19-ITS	M16	3/4	240	177	70	52	520	4.2	9.2	226	19	40	3/8	10	31	8431 0520 69
LMP51 H004-20-ITS	M18	3/4	340	251	90	66	305	5.1	11.2	263	19	40	3/8	10	38	8431 0520 39
LMP51 H002-20-ITS	M20	3/4	520	384	140	103	210	5.1	11.2	263	19	40	3/8	10	38	8431 0520 47
LMP51 H001-25-ITS	M24	1	900	664	250	184	125	6.1	13.4	285	19	40	3/8	10	48	8431 0520 37
LMP51-ITAS — Pistol grip nutrunners with built-in solenoid valve, angle encoder and signal lights																
LMP51 H012-13-ITAS	M12	1/2	110	81	30	22	1100	4.3	9.5	245	19	40	3/8	10	31	8431 0521 05
LMP51 H008-13-ITAS	M14	1/2	180	133	50	37	680	4.3	9.5	245	19	40	3/8	10	31	8431 0521 13
LMP51 H006-19-ITAS	M16	3/4	240	177	70	52	520	4.3	9.5	245	19	40	3/8	10	31	8431 0521 69
LMP51 H004-20-ITAS	M18	3/4	340	251	90	66	305	5.2	11.4	279	19	40	3/8	10	38	8431 0521 39
LMP51 H002-20-ITAS	M20	3/4	520	384	140	103	210	5.2	11.4	279	19	40	3/8	10	38	8431 0521 47
LMP51 H001-25-ITAS	M24	1	900	664	250	184	125	6.2	13.6	301	19	40	3/8	10	48	8431 0521 37
LMP51PH-ITS — Pistol grip nutrunners for prevailing applications with built-in solenoid valve and signal lights																
LMP51 PH005-13-ITS	M12	1/2	110	81	30	22	470	4.2	9.2	226	19	40	3/8	10	31	8431 0520 96
LMP51 PH004-13-ITS	M14	1/2	180	133	50	37	300	4.2	9.2	226	19	40	3/8	10	31	8431 0520 88
LMP51 PH003-19-ITS	M16	3/4	240	177	70	52	220	4.2	9.2	226	19	40	3/8	10	31	8431 0520 85
LMP51 PH002-20-ITS	M18	3/4	400	295	95	66	135	5.1	11.2	263	19	40	3/8	10	38	8431 0520 62
LMP51 PH001-20-ITS	M20	3/4	550	406	150	103	90	5.1	11.2	263	19	40	3/8	10	38	8431 0520 54
LMP51 PH0005-25-ITS	M24	1	930	686	260	184	55	6.1	13.4	285	19	40	3/8	10	48	8431 0520 45
LMP51PH-ITAS — Pistol grip nutrunners for prevailing applications with built-in solenoid valve, angle encoder and signal lights																
LMP51 PH005-13-ITAS	M12	1/2	110	81	30	22	470	4.3	9.5	245	19	40	3/8	10	31	8431 0521 96
LMP51 PH004-13-ITAS	M14	1/2	180	133	50	37	300	4.3	9.5	245	19	40	3/8	10	31	8431 0521 88
LMP51 PH003-19-ITAS	M16	3/4	240	177	70	52	220	4.3	9.5	245	19	40	3/8	10	31	8431 0521 85
LMP51 PH002-20-ITAS	M18	3/4	400	295	95	66	135	5.2	11.4	279	19	40	3/8	10	38	8431 0521 62
LMP51 PH001-20-ITAS	M20	3/4	550	406	150	103	90	5.2	11.4	279	19	40	3/8	10	38	8431 0521 54
LMP51 PH0005-25-ITAS	M24	1	930	686	260	184	55	6.2	13.6	301	19	40	3/8	10	48	8431 0521 45

LMP51 H: Change over torque is around 7% of maximum torque on a given air pressure

LMP51 PH: Change over torque is around 15% of maximum torque on a given air pressure

NOTE PRT torque transducer is included.

* Without torque transducer and reaction bar.

Including 0.8 kg (1.8 lb) cable connection

ELECTRONIC ACCESSORIES

High quality cables for industrial use

Atlas Copco has developed a special Kevlar reinforced cable to meet the demands for flexibility and wearing properties in portable tool applications. This cable design is standard in all factory mounted pigtail signal cables for torque, angle, lights and the built-in solenoid valve as well as in all the connection cables for the FOCUS 2000 instrument. The cables intended for continuous or semi-continuous monitoring of torque with the ACTA 2000 instrument are of conventional heavy-duty design, whereas the cable for spot checking with the ACTA 2000, the IRTT in-line torque transducer cables and control cable for the solenoid valve are standard laboratory quality.



Signal cable type	For Instrument	Length m	Number of pins Tool - Instrument	Ordering No.
Tool cables for continuous monitoring/control				
Torque only	FOCUS 2000	5	6-19	4145 0953 05
		10	6-19	4145 0953 10
		15	6-19	4145 0953 15
Torque/Angle/Signal light/ Solenoid combinations	FOCUS 2000	5	19-19	4145 0952 05
		10	19-19	4145 0952 10
		15	19-19	4145 0952 15
All 19 pin tool cables – extension	FOCUS 2000	10	19-19	4145 0951 10
Torque only	ACTA 2000	5	6- 6	4145 0900 05
		10	6- 6	4145 0900 10
		15	6- 6	4145 0900 15
Torque only extension	ACTA 2000	10	6- 6	4145 0903 10
Tool cables for spot checking				
Torque only	ACTA 2000	10	6- 6	4145 0776 10
IRTT in-line transducer cables				
Torque only	ACTA 2000	3	19- 6	4145 0948 03
		10	19- 6	4145 0948 10
Torque/Angle	FOCUS 2000	3	19-19	4145 0949 03
		10	19-19	4145 0949 03
Solenoid valve cable				
Control cable	FOCUS 2000	10	4-19	4210 2989 80

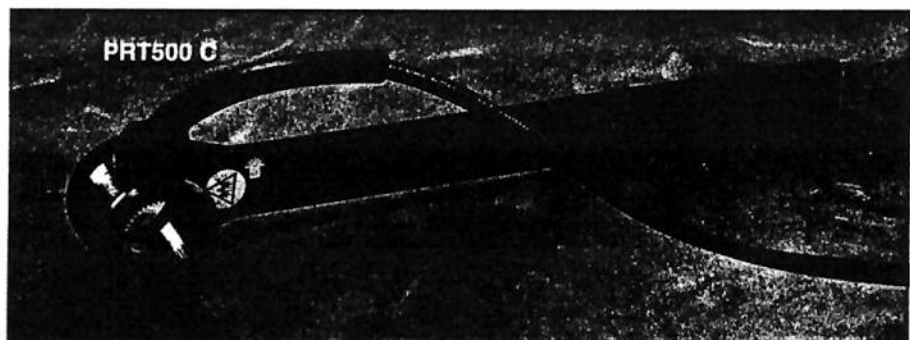
NOTE Check number of connector pins on both instrument end and tool end to make sure the correct cable is ordered.

Add-on electronics

PRT torque transducers

The PRT torque transducers are intended for the reaction bar supported pistol and straight nutrunners type LMP, LTP and LTD. Two models are available; The PRT -A model with a connector fixed to the transducer housing and the PRT -C model with a 1.5 m pigtail connector cable.

The -A model is suitable for the LTD straight nutrunners and for spot checking of the LMP/LTP pistol grip versions. For continuous monitoring the -C model is recommended due to the ability to stand rough treatment.



PRT torque transducers

Model	Tool	Calibration torque		Ordering No.
		0.59 mV/V Nm	0.8 mV/V Ft lb	
PRT50A	LMP24 (except LMP24 H002-13), LTD27	50	37	8092 1110 15
PRT60A	LMP24 H002-13, LTD37	60	44	8092 1110 23
PRT200A	LMD/LTD51-13, -19, LTD37 S003, LTD46	200	148	8092 1110 64
PRT500A	LMD/LTD51-20	500	369	8092 1110 72
PRT1000A	LMD/LTD51-25	1000	738	8092 1110 80
PRT200C	LMP/LTP51-13, -19, LTD37 S003, LTD46	200	148	8092 1121 00
PRT500C	LMP/LTP51-20, LTD46	500	369	8092 1122 00
PRT1000C	LMP/LTP51-25	1000	738	8092 1123 00

Solenoid valves

Description	Dimension	For	Ordering No.
Solenoid valve	1/4"	LMP24	8092 1110 07
	3/8"	LMD/LMP51	8092 1111 06

Solenoid valves

The solenoid valves for tools air supply are primarily intended for general remote control of the straight nutrunners LMD51 and LTD51 and for electronic tightening control of the small pistol nutrunners LMP24. They can also be used for upgrading of existing nutrunners with mechanical torque control only. For best torque accuracy the valve should be installed close to the tool.

INSTRUMENT FOR TORQUE/ANGLE CONTROL

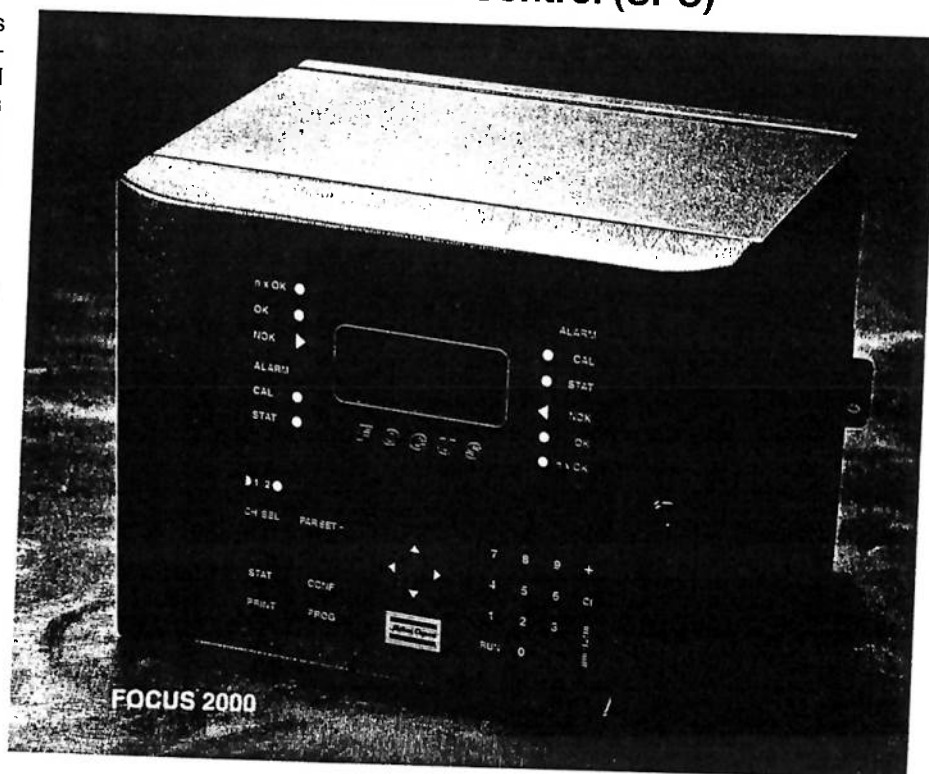
FOCUS 2000 — For Statistic Process Control (SPC)

The FOCUS 2000 series, Atlas Copco's latest, purpose-built control and monitoring system, is ideal for virtually all tightening applications. The system is specifically designed to support the zero fault philosophy and includes a wide range of tightening functions — from torque monitoring to prevailing torque control.

To ensure maximum flexibility, it can be used for both air tool monitoring and air tool control. An advanced level of operator-friendliness saves time and reduces down-time.

The FOCUS 2000's modular construction enables you to tailor an entire system to your own specific needs. FOCUS 2000 can also be expanded cost-effectively to meet future requirements, including unforeseen ones.

For further information see separate brochure 9833 9037 01.



- ☐ A new dimension in user-friendliness
- ☐ Modular concept
- ☐ One or two channels
- ☐ Sophisticated quality assurance functions
- ☐ Advanced operator information and documentation
- ☐ Quick-programming option
- ☐ Automatic calibration
- ☐ Time monitoring
- ☐ Adaptive learning function
- ☐ Advanced diagnostic functions
- ☐ Prevailing torque functions
- ☐ Multistage function

Designation	Ordering No.	Designation	Ordering No.
FOCUS 2101	8092 1126 01	FOCUS 2102	8092 1126 11
FOCUS 2101-R	8092 1126 02	FOCUS 2102-R	8092 1126 12
FOCUS 2101-V	8092 1126 03	FOCUS 2102-V	8092 1126 13
FOCUS 2101-VR	8092 1126 04	FOCUS 2102-VR	8092 1126 14

2101 = Instrument for one tool

2102 = Instrument for two tools

R — with built in Relay board

V — with built in Valve board for Air tool control

OPTIONAL ACCESSORIES

Pages 66 and 68

FOCUS

Accessories — Parameter selector

SOCKET TRAY

Choose the required torque level or parameter set by picking a socket.

Up to six different sockets/tray.

Well protected design with proximity sensors and replaceable socket holders.

Fool proof — only one socket at a time.

Designation	Type	Ordering No.
Master tray	Selector 15	8433 0601 13
Slave tray	Selector 15-SL	8433 0603 65
Length of cable:		
	Selector 15	5 meters
	Selector 15-SL	1 meters
5 m extension cable		4222 0222 05
Printer cable 5 m		4145 0890 05

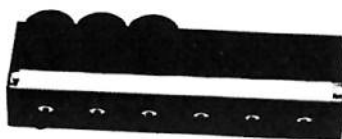
If more than six different sockets are in use, one or more slave trays can be connected to the master allowing up to 15 torque levels to be selected. Both the socket tray and the selector can be used with the Parameter Control Unit, PCU or the FOCUS.



TURN SELECTOR

With six positions for six or fifteen torque levels or parameter sets. Can be attached to the tool, cable/hose.

Turn Selector-R	8431 0417 90
Turn Selector 15R	8433 0606 41



RE-ALARM

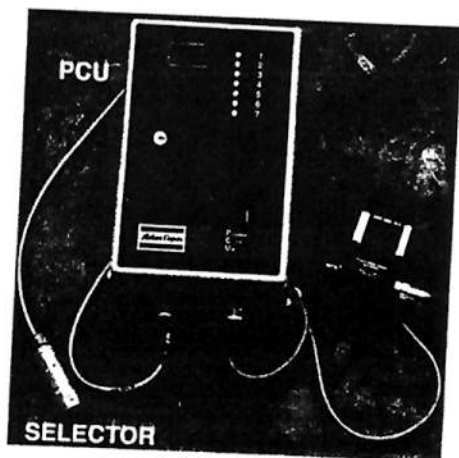
The RE-ALARM is a remote signal light panel with a sound alarm.

The RE-ALARM is available in two versions for connection to FOCUS 2000, either to repeat the yellow, green and red lights on FOCUS and give an acoustic alarm (RE-ALARM 02F), or in a version that also provides — "n OK" signal when a preset number of tightenings is achieved (RE-ALARM 01F).

RE-Alarm 01F	8431 0455 36
RE-Alarm 02F	8431 0455 44
5 meter cable included	

PARAMETER CONTROL UNIT

- ☐ Seven torque levels with one tool
- ☐ Increased productivity
- ☐ Improved working environment
- ☐ Customer cost effective



A large number of tasks can be performed with one tool. This means higher flexibility and productivity. The work area can be used with utmost efficiency.

The different torque levels are achieved by altering the air pressure either with a turn selector or with a socket tray. The socket tray can accommodate up to six different sockets depending on socket size parameter.

The PCU and a stall type tool, for example LMP51, is the ideal combination giving a low cost parameter solution.

The PCU is also suitable for use together with ErgoPulse tools.

The control unit or PCU sets the pressure on an electrically controlled valve to a level corresponding to the chosen torque.

The parameter control unit is used together with a remote controlled valve and a turn selector or a socket tray.

Designation	Ordering No.
PCU	8092 1108 31
Remote controlled valve	9093 0010 21
Turn selector	8431 0417 90
Socket tray	8433 0601 13



TENSOR S

Electric nutrunners range

Tensor S dominates as the electric power tool alternative in motor vehicle production by virtue of unsurpassed productivity (power), accuracy, ergonomics and dependability. Traceable calibration is another important aspect when fastening safety critical joints.

The range is comprehensive enough to allow the set up of a modern car or truck plant with electric tools only.

Outside high speed line production another way of applying Tensor S gains popularity:

A way to reduce cost and assembly time, at the same time improve on quality and ergonomics is to apply Tensor S with parameter selection devices like a socket tray, thus using one Tensor S tool to replace several conventional tools.

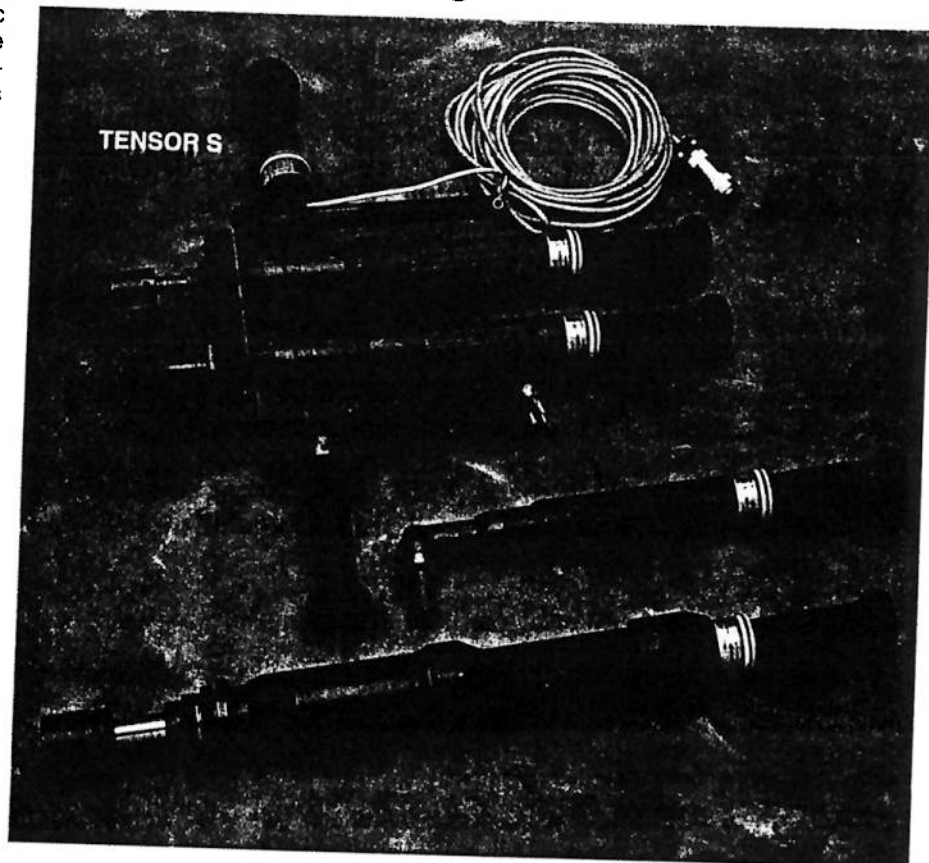
Tensor S is controllable from 100% to 15% of rated torque.

Speeds are unequalled e.g.

M8 — 1300 rpm

M12 — 950 rpm

M20 — 120 rpm



Power Focus

- ☐ Easy to understand logic programming structure
- ☐ Quick programming feature for easy set up
- ☐ One or two channels
- ☐ Communication possibilities with external systems

Tensor S Tool

- ☐ Light weight / high speed
- ☐ Operator feed back through signal lights on the tool
- ☐ Extremely wide torque range
- ☐ Ergonomic design
- ☐ Minimal maintenance through design

TENSOR S — the complete range

Config	Tool	Controller	Cables	Accessories	Network
Angle	S4	1 Channel 2 Channel Synchro Tork	5/ 10/ 15 m	Crowfoots Selector RE-Alarm Flush socket head Suspension yokes HAD Telescopic spindle ... etc	TN 3.0
Pistol	S7				
	S9				
Inline	Twin-spin				

1—1000 Nm

For further information contact Atlas Copco Tools. Please note that the Tensor S range is not marketed in all countries.



TENSOR S

Model	Square Drive	Torque		Speed r/min	Weight		Length mm	CS dist mm	Ordering No.
		Nm	ft/lb		kg	lb			
M5									
ETP S4-04-106CTADS	1/4 (1)	1- 5	0.7- 3.6	1460	1.2	2.6	195	21	8433 0234 75
ETD S4-04-106CTADS	1/4 (1)	1- 5	0.7- 3.6	1460	1.4	3.1	375	15	8433 0237 47
M6									
ETV S4-10-10CTADS	3/8	3- 15	2.2- 11	680	1.5	3.3	380	14	8433 0236 51
ETP S4-10-106CTADS	1/4 (1)	3- 12	2.2- 8.8	750	1.2	2.6	195	21	8433 0235 01
ETD S4-10-10CTADS	3/8	3- 14	2.2- 10.3	700	1.4	3.1	370	15	8433 0238 18
ETD S4-10-10CTADST	3/8	3- 14	2.2- 10.3	700	1.5	3.3	423	15	8433 0238 79
M8									
ETV S7-28-10CTADS	3/8	5- 29	3.6- 21	1300	1.6	3.5	415	13.5	8433 0245 20
ETV S7-30-10CTADS	3/8	6- 35	4.4- 25	910	1.6	3.5	415	14.5	8433 0247 33
ETD S7-20-10CTADST	3/8	5- 20	3.6- 15	1370	2.4	5.5	453	15	8433 0294 81
ETD S7-30-10CTADST	3/8	6- 35	4.4- 25	850	2.5	5.6	453	15	8433 0295 21
M10									
ETV S7-40-10CTADS	3/8	8- 40	6.0- 29	910	1.7	3.8	435	18	8433 0250 00
ETV S7-50-10CTADS	3/8	10- 55	7.3- 40	545	1.8	4.0	435	18	8433 0252 87
ETP S7-50-13CTADS	1/2	10- 55	7.3- 40	610	2.2	4.9	306	23	8433 0314 91
ETD S7-50-13CTADST	1/2	10- 55	7.3- 40	610	2.7	6.0	486	17	8433 0197 83
M12									
ETV S7-70-13CTADS	1/2	14- 80	11 - 58	390	2.2	4.9	460	20	8433 0273 09
ETV S7-100-13CTADS	1/2	20- 110	15 - 80	300	2.5	5.5	480	20	8433 0280 00
ETV S9-80-13CTADS	1/2	30- 80	22 - 58	950	4.3	9.4	590	20	8433 0350 03
ETV S9-100-13CTADS	1/2	40- 100	30 - 73	800	4.4	9.7	595	25	8433 0350 22
ETD S7-70-13CTADST	1/2	15- 80	11 - 58	385	2.9	6.4	507	17	8433 0298 34
ETD S7-90-13CTADST	1/2	20- 95	15 - 69	340	2.9	6.4	507	17	8433 0299 41
ETD S9-100-13CTADST	1/2	30- 100	22 - 73	780	4.1	9.0	575	32	8433 0362 08
M14									
ETV S7-150-13CTADS	1/2	30- 150	22 -110	185	2.9	6.4	520	25	8433 0288 67
ETV S9-180-13CTADS	1/2	45- 180	33 -132	450	4.5	9.9	595	25	8433 0350 85
ETD S7-120-13CTADST	1/2	25- 125	18 - 91	280	2.9	6.4	507	23	8433 0299 85
M16									
ETV S7-200-13CTADS	1/2	40- 200	30 -146	160	3.0	6.6	520	25	8433 0291 17
ETV S9-270-20CTADS	3/4	65- 270	47 -198	250	7.4	16.3	665	34	8433 0252 39
ETD S9-200-13CTADST	1/2	50- 200	36 -146	370	4.3	9.5	575	32	8433 0362 55
ETD S9-270-20CTADST	3/4	65- 270	47 -198	250	6.4	14.1	660	36	8433 0364 12
M18									
ETV S9-370-20CTADS	3/4	90- 370	66 -270	160	7.5	16.5	665	34	8433 0252 74
ETD S9-450-20CTADST	3/4	110- 450	80 -330	150	8.0	17.6	695	36	8433 0364 61
M20									
ETD S9-600-20CTADST	3/4	150- 600	110 -440	120	8.0	17.6	695	36	8433 0364 96
M27									
ETD S9-1000-25CTADST	1	250-1000	180 -730	80	13.0	29.0	826	52	8433 0365 14

ETD S7 models are also available in pistol grip version, ETP.

1) Female 1/4" hex chuck

ACCESSORIES

Power Focus	Ordering No.	Power Focus Synchro Tork	Ordering No.	Cables	
PF 2101-S4-115R	8433 0530 20	PF 2102-S4-115RST	8433 0531 10	5 M	4220 0982 05
PF 2101-S4-230R	8433 0530 60	PF 2102-S4-230RST	8433 0531 30	10 M	4220 0982 10
PF 2101-S7-115R	8433 0535 20	PF 2102-S7-115RST	8433 0536 10	15 M	4220 0982 15
PF 2101-S7-230R	8433 0535 60	PF 2102-S7-230RST	8433 0536 30		
PF 2101-S9-115R	8433 0540 20	PF 2102-S9-115RST	8433 0541 10		
PF 2101-S9-230R	8433 0540 60	PF 2102-S9-230RST	8433 0541 30		

For further information about accessories and tool configurations please refer to Tensor S leaflets or contact your Atlas Copco Tools representative

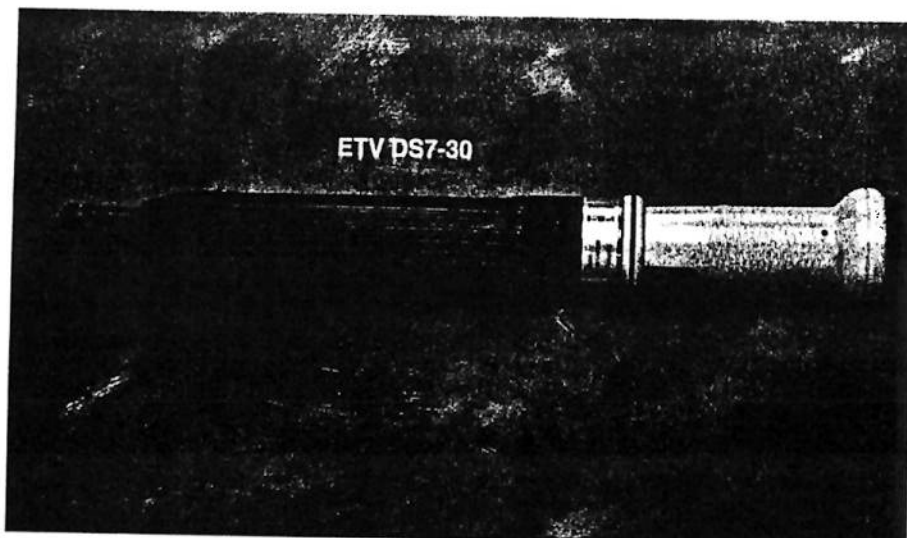


TENSOR DS

The new generation electrically controlled nutrunners

Tensor DS is a new generation of nutrunners which are controlled by an intelligent drive unit. The tool is easily installed and programmed through a laptop computer. The user friendly software package which is included with the drive allows easy programming. You simply enter the target torque and the software programs all other parameters.

The tools are signified by their extremely low weight in comparison to speed and torque capacity, an example: 1.5 kg / 40 Nm / 820 r/min!



DS Drive

- ☐ Easily installed
- ☐ Small and compact
- ☐ Windows 95 @ graphic user interface via a normal PC
- ☐ Line control functions with electronic Poka Yoke signals
- ☐ Multi torque capability through socket tray

DS Tool

- ☐ Light weight
- ☐ Operator feed back through signal lights on tool
- ☐ High speed
- ☐ Ergonomic design
- ☐ Clean design for easy service
- ☐ Wide torque range

Model	Square drive in	Torque		Speed r/min	Weight		Length mm	CS dist mm	Ordering No.
		Nm	in		kg	lb			
M5									
ETP DS4-05-106S	1/4 (1)	2- 5	1.5- 3.6	1310	1.1	2.4	195	21	8433 0708 61
ETD DS4-05-106S	1/4 (1)	2- 5	1.5- 3.6	1310	1.2	2.6	375	15	8433 0710 26
M6									
ETV DS4-10-10S	3/8	6- 15	4.4- 11	610	1.3	2.9	365	14	8433 0706 14
ETP DS4-10-10S	3/8	5- 12	3.6- 8.8	675	1.1	2.4	190	21	8433 0708 83
ETD DS4-10-10S	3/8	6- 14	4.4- 10	630	1.2	2.6	370	15	8433 0710 52
ETD DS4-10-10ST	3/8	6- 14	4.4- 10	630	1.4	3.1	420	15	8433 0710 79
M8									
ETV DS7-30-10S	3/8	14- 35	10- 25	820	1.4	3.1	400	14	8433 0721 42
ETP DS7-30-10S	3/8	14- 35	10- 25	760	1.7	3.7	262	18	8433 0726 53
ETD DS7-30-10S	3/8	14- 35	10- 25	760	1.4	3.1	438	15	8433 0730 88
ETD DS7-30-10ST	3/8	14- 35	10- 25	760	1.5	3.3	488	15	8433 0731 05
M10									
ETV DS7-40-10S	3/8	16- 40	12- 29	820	1.5	3.3	420	18	8433 0721 94
ETV DS7-50-10S	3/8	22- 55	16- 40	490	1.5	3.7	420	18	8433 0722 58
ETP DS7-50-13S	1/2	22- 55	16- 40	550	2.1	4.6	306	23	8433 0726 87
ETD DS7-50-13S	1/2	22- 55	16- 40	550	1.8	4.0	447	17	8433 0731 24
ETD DS7-50-13ST	1/2	22- 55	16- 40	550	2.0	4.4	486	17	8433 0731 37
M12									
ETV DS7-70-13S	1/2	32- 80	23- 58	350	1.7	4.6	445	20	8433 0723 16
ETV DS7-100-13S	1/2	44-110	32- 80	270	2.4	5.3	465	20	8433 0723 70
ETP DS7-90-13S	1/2	38- 95	28- 69	300	2.4	5.3	327	23	8433 0727 19
ETD DS7-90-13S	1/2	38- 95	28- 69	300	2.4	5.3	468	17	8433 0731 52
ETD DS7-90-13ST	1/2	38- 95	28- 69	300	2.6	5.7	507	17	8433 0731 74
M14									
ETV DS7-150-13S	1/2	55-150	40- 110	165	2.8	6.2	508	25	8433 0723 98
ETP DS7-120-13S	1/2	50-125	39- 91	250	2.6	5.7	327	23	8433 0727 47
ETD DS7-120-13S	1/2	50-125	39- 91	250	2.7	6.0	468	17	8433 0731 96
ETD DS7-120-13ST	1/2	50-125	39- 91	250	2.9	6.4	507	17	8433 0732 18

(1) Female 1/4" hex chuck

NOTE: Available spring 1998

ACCESSORIES

DS drives

DS4-115-Drive	8433 0810 21
DS4-230-Drive	8433 0810 42
DS7-115-Drive	8433 0812 21
DS7-230-Drive	8433 0812 42

Cables

5 M	4220 1616 05
10 M	4220 1616 10
15 M	4220 1616 15

Suspension yoke

ETV and ETD S4/S7	4220 0987 85
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Socket trays

Selector 15	8433 0601 13
Selector 15S	8433 0603 65
Rotary Selector 15	8433 0606 41

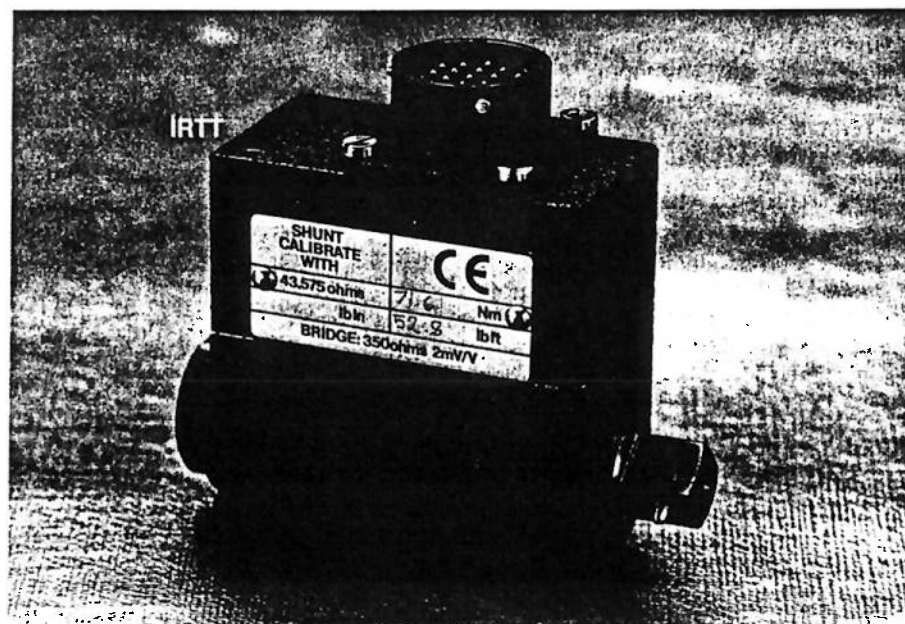
Annunciator box

RE-Alarm 01F	8431 0455 36
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IRTT TORQUE TRANSDUCERS

New IRTT in-line rotary transducers available in Torque and Torque/Angle version. The built-in memory allows automatic calibration when used with FOCUS 2000.

- ☐ New design brushes for minimal wear.
- ☐ For use with non-impacting nutrunners.
- ☐ High torque read out accuracy
- ☐ For use on test joints or on production joints



Drive		Rated capacity		Ordering No.
Hex In	Square In	Nm	Ft lb	
Model				
Torque models				
IRTT 5-106	1/4	5	4	8092 1129 05
IRTT 20-106	1/4	20	15	8092 1129 10
IRTT 20-06	1/4	20	15	8092 1129 15
IRTT 25-10	3/8	25	18	8092 1129 20
IRTT 75-10	3/8	75	55	8092 1129 25
IRTT 180-13	1/2	180	133	8092 1129 30
IRTT 500-20	3/4	500	369	8092 1129 35
IRTT 750-25	1	750	553	8092 1129 40
IRTT 1400-25	1	1400	1033	8092 1129 45

Drive		Rated capacity		Ordering No.
Hex In	Square In	Nm	Ft lb	
Model				
Torque/angle models				
IRTT 5A-106	1/4	5	4	8092 1130 06
IRTT 20A-106	1/4	20	15	8092 1130 11
IRTT 20A-06	1/4	20	15	8092 1130 16
IRTT 25A-10	3/8	25	18	8092 1130 21
IRTT 75A-10	3/8	75	55	8092 1130 26
IRTT 180A-13	1/2	180	133	8092 1130 31
IRTT 500A-20	3/4	500	369	8092 1130 36
IRTT 750A-25	1	750	553	8092 1130 41
IRTT 1400A-25	1	1400	1033	8092 1130 46

NOTE New IRTT are equipped with 19-pin connector.

TORQUE TESTERS TT12 AND TT30

The Atlas Copco TT 12 and TT 30 consist of an electronic strain gauge read-out instrument with an integrated torque transducer built into an aluminium alloy housing. The instrument is powered by a built-in rechargeable battery.

TT 12/30 is

- ☐ Suitable for clutch and impulse tools
- ☐ Protected from overload by a mechanical stop
- ☐ Displayed torque values in either Nm/in. lb

Test joints included.

NOTE Not suitable for impact tools.



Model	Measure range Nm	Accuracy % of full scale	Size mm	Weight		Ordering No.
				kg	lb	
TT12	2-12	±0.5	162x240x112	3.5	7.7	8092 1101 73
TT30	6-30	±0.5	162x240x112	3.5	7.7	8092 1101 81

INSTRUMENT FOR TORQUE MONITORING

A torque testing read-out instrument for use with separate in-line, in-between or built-in torque transducer on power tools.

Available in two versions:

ACTA 2000 with LCD read-out and
ACTA 2000P with LCD read-out
plus an integrated printer.

The ACTA 2000 and 2000P are equipped with built-in rechargeable batteries for flexible usage.

Torque setting of nutrunners:

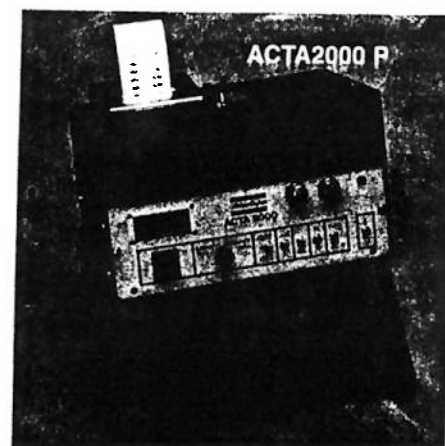
Checking correct torque setting of tools on the production lines.

Checking of tool performances in combination with service work.

ACTA 2000 8092 1102 15

ACTA 2000P 8092 1102 23

Cable 6-19 pin 4145 0948 03



TORQUE TESTERS

The torque testers of TT1 and TT10 type are ideal for calibrating screwdrivers. Test joint is included.

They are also suitable for testing screwdrivers after service and for calibration of torque wrenches.

The torque testers of HT type are for testing the torque of installed screws. A buzzer can be set to alarm at reached preset torque level.

Connected to the DP-1 HS printer (optional) individual torque data and a

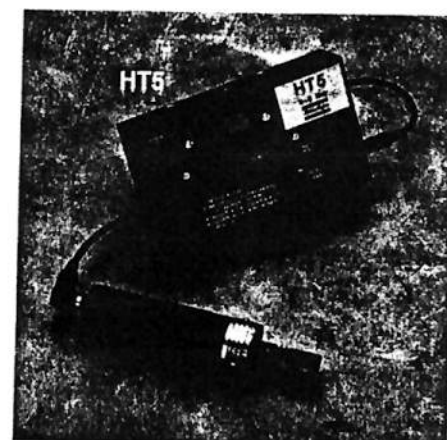
number of statistical calculations and charts can be made.

The analogue output can be used together with a pen recorder, oscilloscope or voltmeter for joint analysis.

The testers are powered by rechargeable NiCd cells. Charger is optional.

They are supplied in a cushioned instrument box.

NOTE Not suitable for impact or impulse tools.



Model	Measuring range Nm	Accuracy % of full scale	Size mm	Weight		Ordering No.
				kg	lb	
TT1	0- 1.0	±0.5	230x125x55	2.2	4.9	8092 1113 04
TT10	0-10.0	±0.5	230x125x55	2.2	4.9	8092 1113 12
HT0.5	0- 0.5	±0.5	160x95x60	1.2	2.6	8092 1113 20
HT5	0- 5.0	±0.5	160x95x60	1.2	2.6	8092 1113 38

OPTIONAL ACCESSORIES

Designation	Ordering No.
Battery charger 220-240 VAC	4222 0162 00
Battery charger 110-120 VAC	4222 0162 01
Printer DP-1 HS	8092 1117 00
Printer cable 1 m	4222 0171 00



FOCUS

Accessories — Parameter selector

SOCKET TRAY

Set the required torque level or parameter set by picking a socket. Available in six different sockets/tray. All protected design with proximity sensors and replaceable socket holders. All proof — only one socket at a



Designation	Type	Ordering No.
Socket tray	Selector 15	8433 0601 13
Socket tray	Selector 15-SL	8433 0603 65
Cable of cable:		
	Selector 15	5 meters
	Selector 15-SL	1 meters
Extension cable		4222 0222 05
Cable 5 m		4145 0890 05

More than six different sockets are required, one or more slave trays can be connected to the master allowing up to 15 torque levels to be selected. Both the socket tray and the selector can be used with a Parameter Control Unit, PCU or FOCUS.

TURN SELECTOR

With six positions for six or fifteen torque levels or parameter sets. Can be attached to the tool, cable/hose.

Turn Selector-R	8431 0417 90
Turn Selector 15R	8433 0606 41



RE-ALARM

The RE-ALARM is a remote signal light panel with a sound alarm.

The RE-ALARM is available in two versions for connection to FOCUS 2000, either to repeat the yellow, green and red lights on FOCUS and give an acoustic alarm (RE-ALARM 02F), or in a version that also provides — "n OK" signal when a preset number of tightenings is achieved (RE-ALARM 01F).

RE-Alarm 01F	8431 0455 36
RE-Alarm 02F	8431 0455 44
5 meter cable included	

PARAMETER CONTROL UNIT

Set torque levels with one tool. Increased productivity. Improved working environment. Lower cost effective.

A large number of tasks can be performed with one tool. This means higher flexibility and productivity. The work area can be used with utmost efficiency.

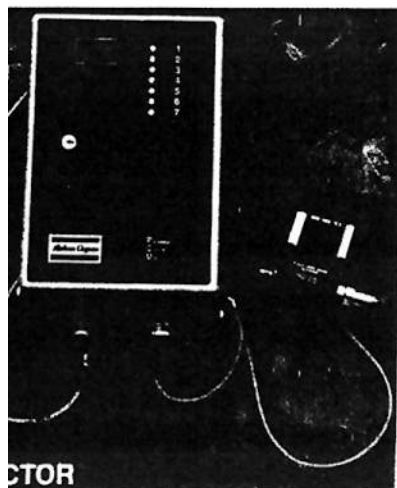
The different torque levels are achieved by altering the air pressure either with a turn selector or with a socket tray. The socket tray can accommodate up to six different sockets depending on socket size parameter.

The PCU and a stall type tool, for example LMP51, is the ideal combination giving a low cost parameter solution.

The PCU is also suitable for use together with ErgoPulse tools.

The control unit or PCU sets the pressure on an electrically controlled valve to a level corresponding to the chosen torque.

The parameter control unit is used together with a remote controlled valve and a turn selector or a socket tray.



Designation	Ordering No.
PCU	8092 1108 31
Remote controlled valve	9093 0010 21
Turn selector	8431 0417 90
Socket tray	8433 0601 13

APÊNDICE 6

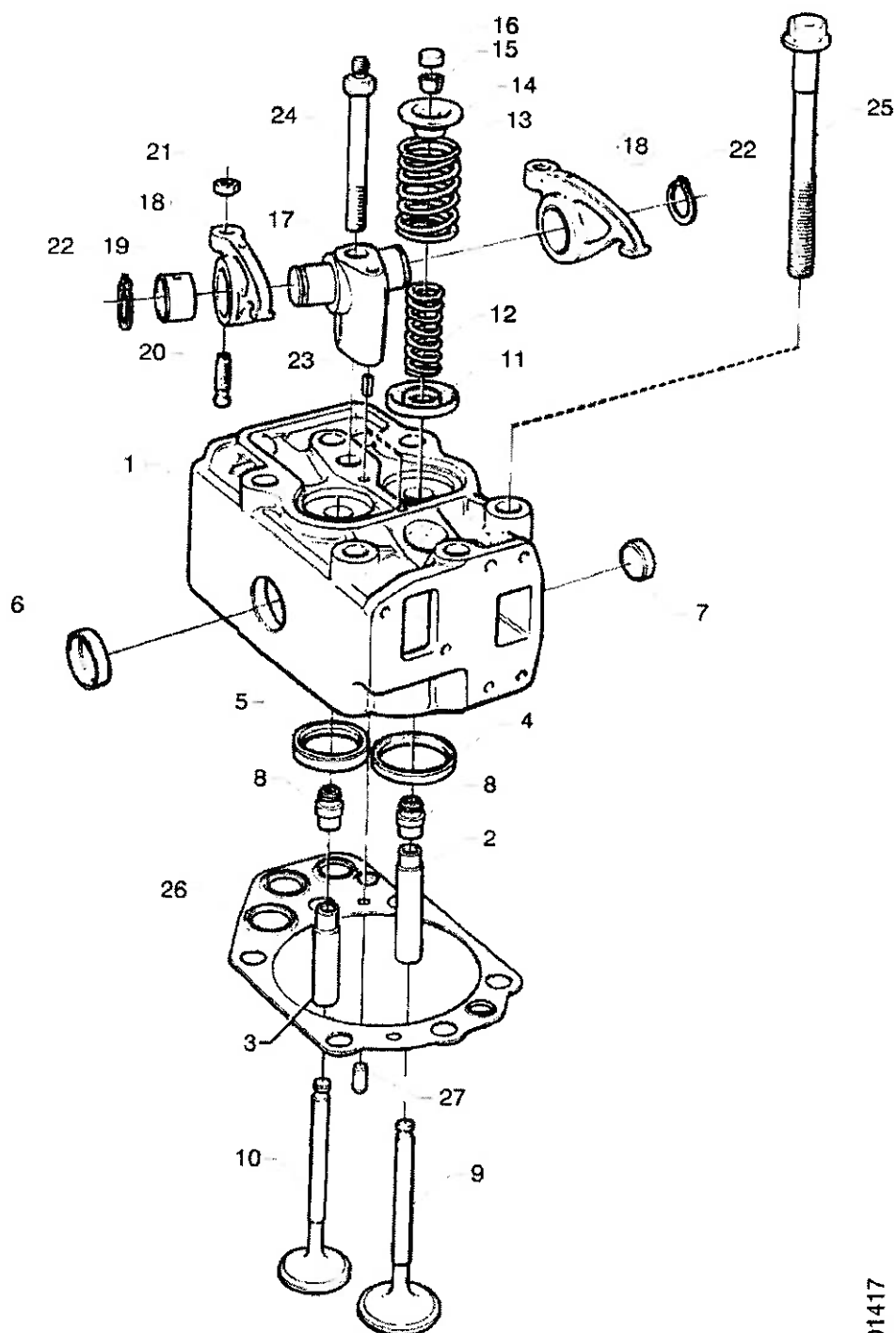
Desenhos de Montagem / Listas de Peças

Motor
Cabeçote
DSC9

Desenho
101417

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101417

Motor

Cabeçote

DSC9

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101417

1-01

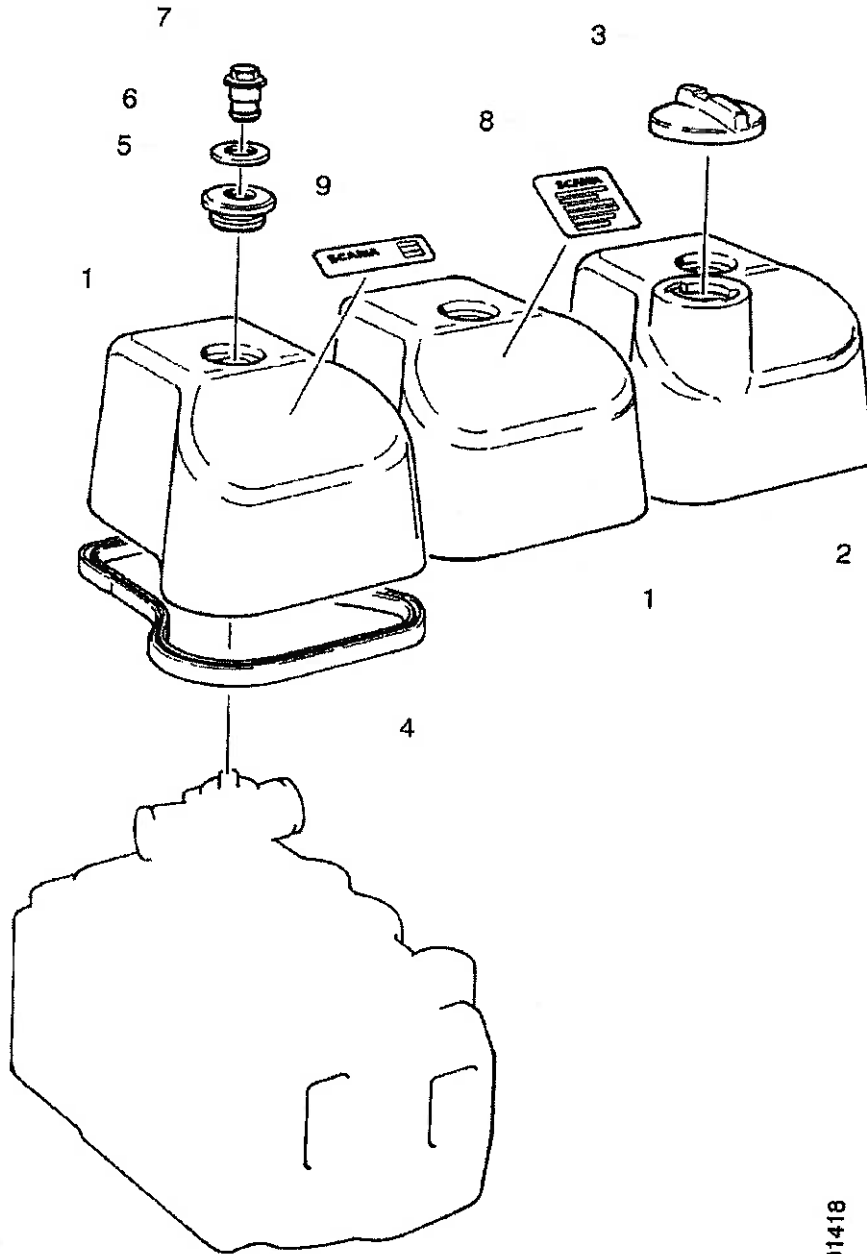
1

Fig.	Peça N°.	Notas	Qtde.				Descrição
			A	B	C	D	
1	1344352	Assy					
2	1398624	(393264)Intake	6				Cabeçote
3	1398624	(393264)Exhaust	6				Guia de válvula
4		Nss, intake	6				Guia de válvula
5	351352	STD, exhaust	6				Sede de válvula
	388756	Osz 0.2 mm, exhaust	6				Sede de válvula
6	1345683	Ø36 mm	6				Sede de válvula
7	1345682	Ø25 mm	6				Bujão do núcleo
			6				Bujão do núcleo
8	1304293	K					
9	1319081		12				Vedação
10	1360833		6				Válvula de admissão
11	170084	Lo	6				Válvula de escape
12	170043	Intake, in	12				Guia de mola
	367891	Exhaust, in	6				Mola da válvula
13	170042	Intake, ou	6				Mola da válvula
	367890	Exhaust, ou	6				Mola da válvula
14	275473	Intake, up	6				Mola da válvula
	1312940	Exhaust, up	6				Guia de mola
15	17113		6				Guia de mola
16	246638		24				Chaveta cônica
17	387778		12				Capa de válvula
18	1333871		6				Suporte do balancim
19	1100677		12				Balancim
20	1408646	(275036*)	12				Bucha
21	394640	M10	12				Parafuso de ajuste
22	804781	30	12				Porca sextavada
23	811777	6x18	12				Anel-trava
	804939	4x10	6				Pino elástico
24	1369499		6				Pino
25	346318	M16x169	6				Parafuso
26	387503	K	36				Parafuso flangeado
	1357283	K 735)	6				Junta do cabeçote
27	803466	8x20	6				Junta
			12				Pino
	550270	veja : 1-99	6				Jogo de juntas
	551524	735) veja : 1-99	6				Cabeçote
	551526	veja : 1-99	1				Jogo de juntas
							Cabeçote
							Jogo recondicionamento geral

735. Guarnição da cabeça do cilindro marcada com R para renovação. Tem anéis de vedação mais espessos (4,65 mm) para o

Motor
Tampa das válvulas
DSC9

Desenho	Gr.	Pág.
101418	1-01	1



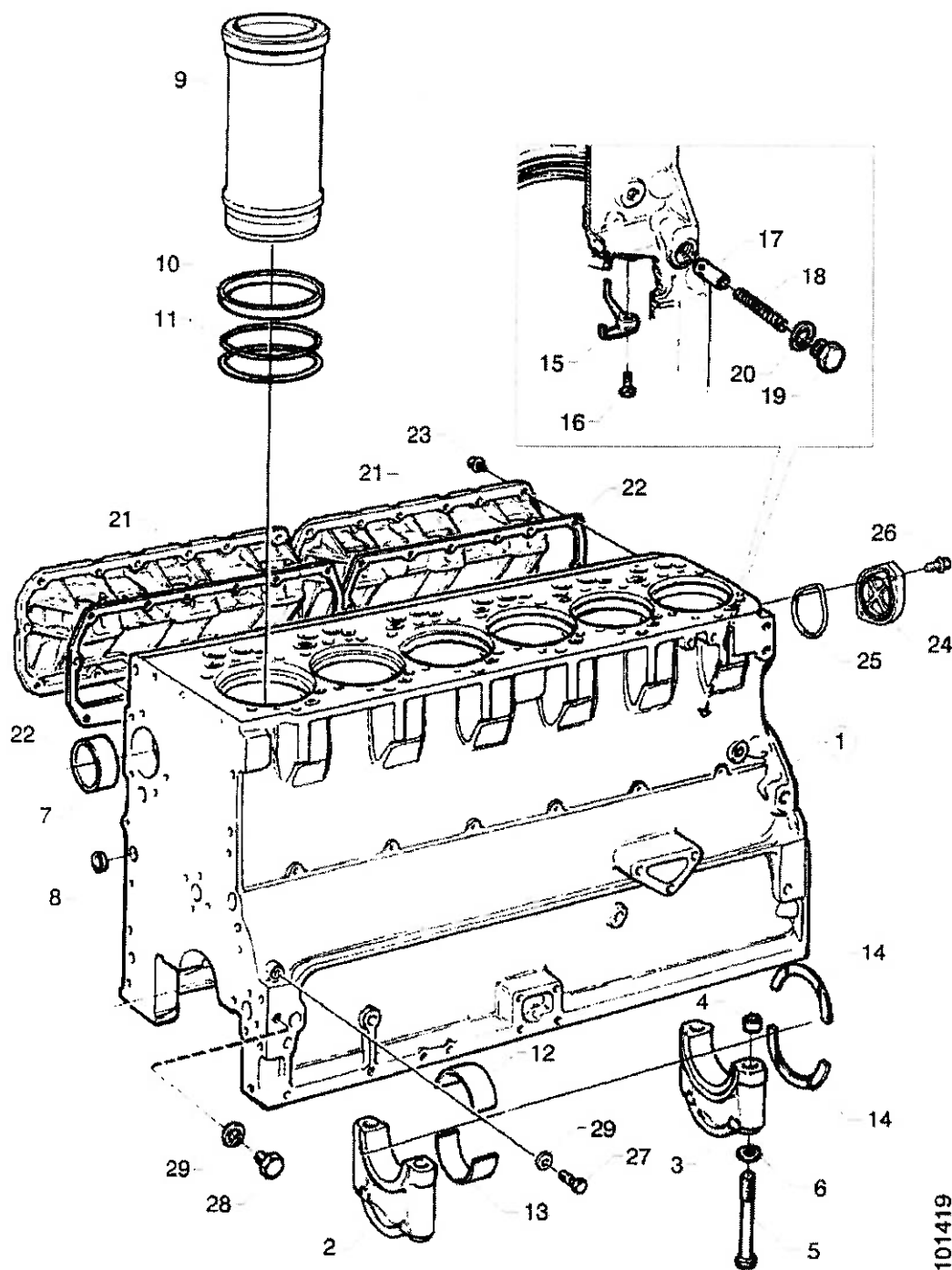
101418

Motor								Desenho	Gr.	Pág.
Tampa das válvulas										
DSC9										
								101418	1-01	1
Fig.	Peça Nº.		Notas				Qtde.		Descrição	
							A	B		

1	1369500			5				Tampa das válvulas
2	1373257			1				Tampa das válvulas
3	931106			1				Tampa de enchimento
4	1369501	K		6				Junta da tampa das válvulas
5	292811	K		6				Retentor
6	261561			6				Arruela
7	310735			6				Porca de capa
8	1349058	DSC9 11/12		1				Etiqueta de instruções
	355546	DSC9 13/15		1				Etiqueta de instruções
9	1379901	DSC9 11		1				Rótulo
	1379461	DSC9 12		1				Rótulo
	1378546	DSC9 13		1				Rótulo
	1386673	DSC9 15		1				Rótulo
	550270	veja : 1-99		6				Jogo de juntas
								Cabeçote
	551524	veja : 1-99		6				Jogo de juntas
								Cabeçote
	551526	veja : 1-99		1				Jogo recondicionamento geral

Motor
Bloco do motor
DSC9

Desenho	Gr.	Pág.
101419	1-05	1



101419

Motor					Desenho	Gr.	Pág.
Bloco do motor							
DSC9							
					101419	1-05	2
Fig.	Peça N°.		Notas	Qtde.		Descrição	
				A	B	C	D

550266	DSC9 12			6				Jogo de reparação	
	veja : 1-99							Pistão e camisa	
550267	DSC9 13/15			6				Jogo de reparação	
	veja : 1-99							Pistão e camisa	
550263	DSC9 11/12			6				Jogo de reparação	
	veja : 1-99							Segmentos e camisa	
550264	DSC9 13/15			6				Jogo de reparação	
	veja : 1-99							Segmentos e camisa	
551526	veja : 1-99			1				Jogo recondicionamento geral	

Motor

Tampa da distribuição, sem tomada de força

DSC9

Desenho

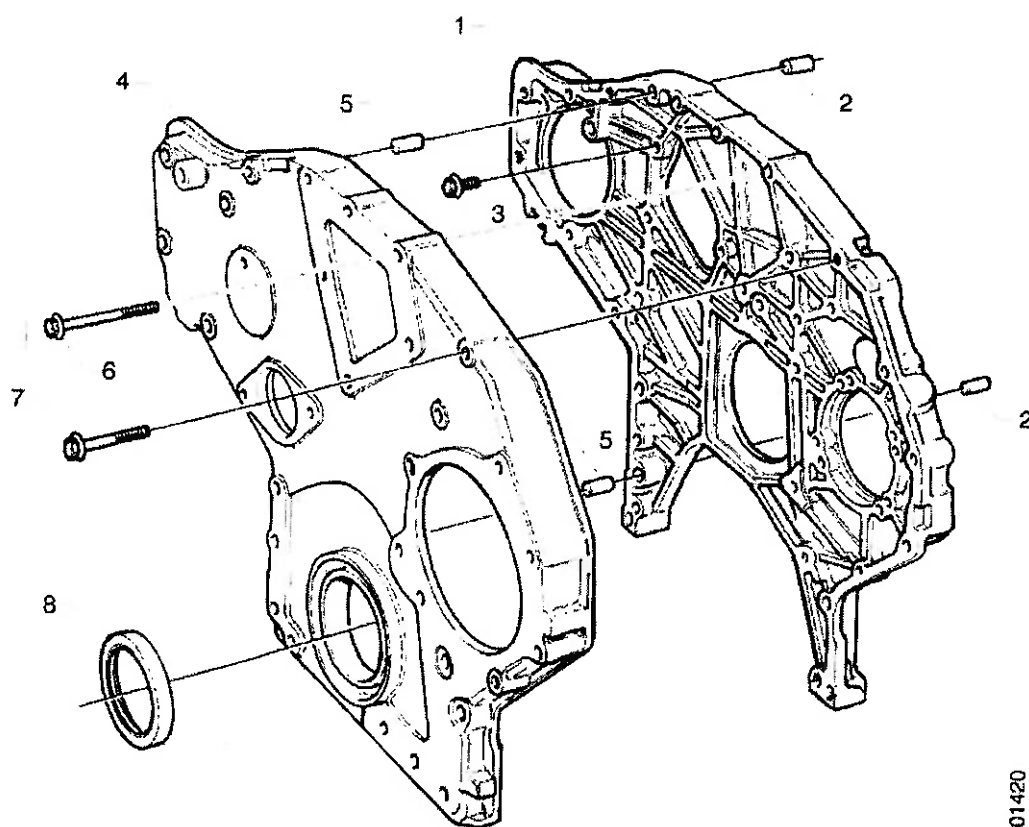
Gr.

Pág.

101420

1-05

1



101420

Motor
Carcaça do volante
DSC9

Desenho

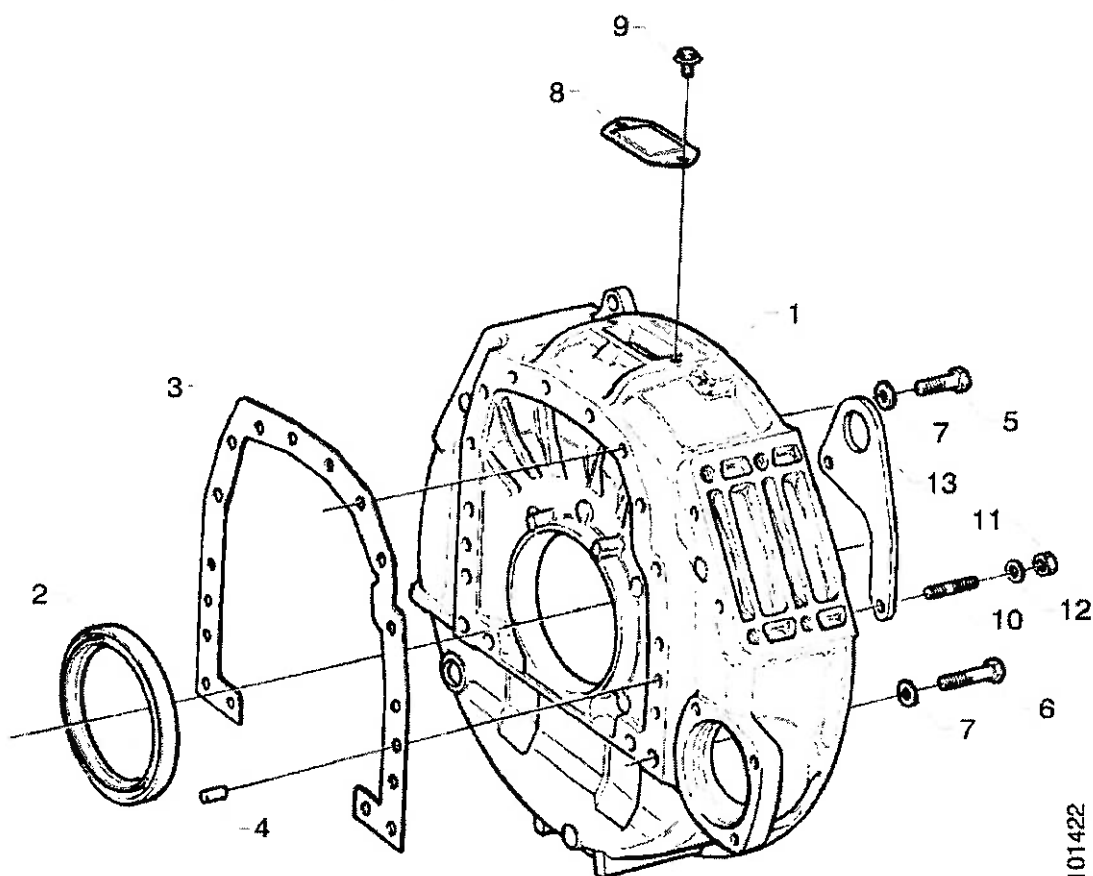
Gr.

Pág.

101422

1-05

1



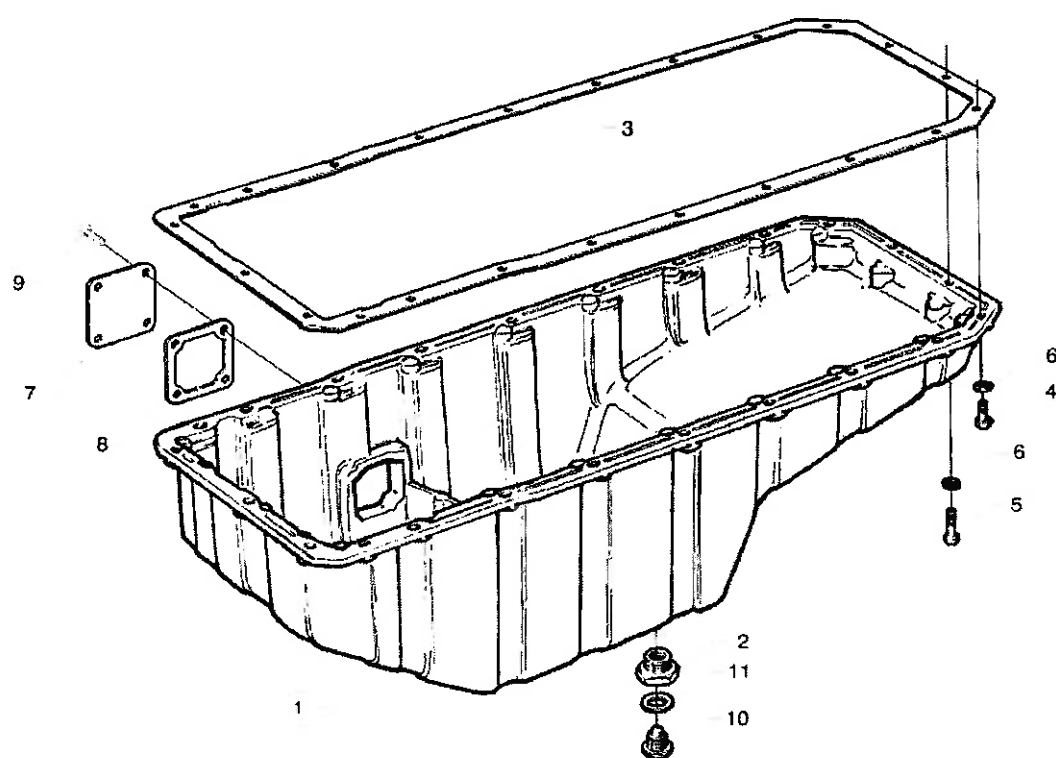
101422

Motor				Desenho	Gr.	Pág.
Carcaça do volante						
DSC9				101422	1-05	1

Fig.	Peça N°.	Notas	Qtde.				Descrição
			A	B	C	D	
1	1369269	(1374729)	1				Carcaça do volante
	348380		8				Inserto roscado
2	369478	K (366303)	1				Retentor
3	1403120	K (366546)	1				Junta
4	803515	12x30	2				Pino
5	814843	M12x45	12				Parafuso sextavado
6	814893	M12x60	4				Parafuso sextavado
7	132248	13x28	16				Arruela
8	16022		2				Tampa
9	812997	M8x16	4				Parafuso auto-roscante
10	800610	M10x50	10				Prisioneiro
	800617	M10x70	2				Prisioneiro
11	815147	M10	12				Porca autotravante
12	807310	10.5x22	12				Arruela
13	1360442		2				Olhal
	551526	veja : 1-99	1				Jogo recondicionamento geral

Motor
Cárter de óleo
DSC9

Desenho	Gr.	Pág.
106323	1-05	1

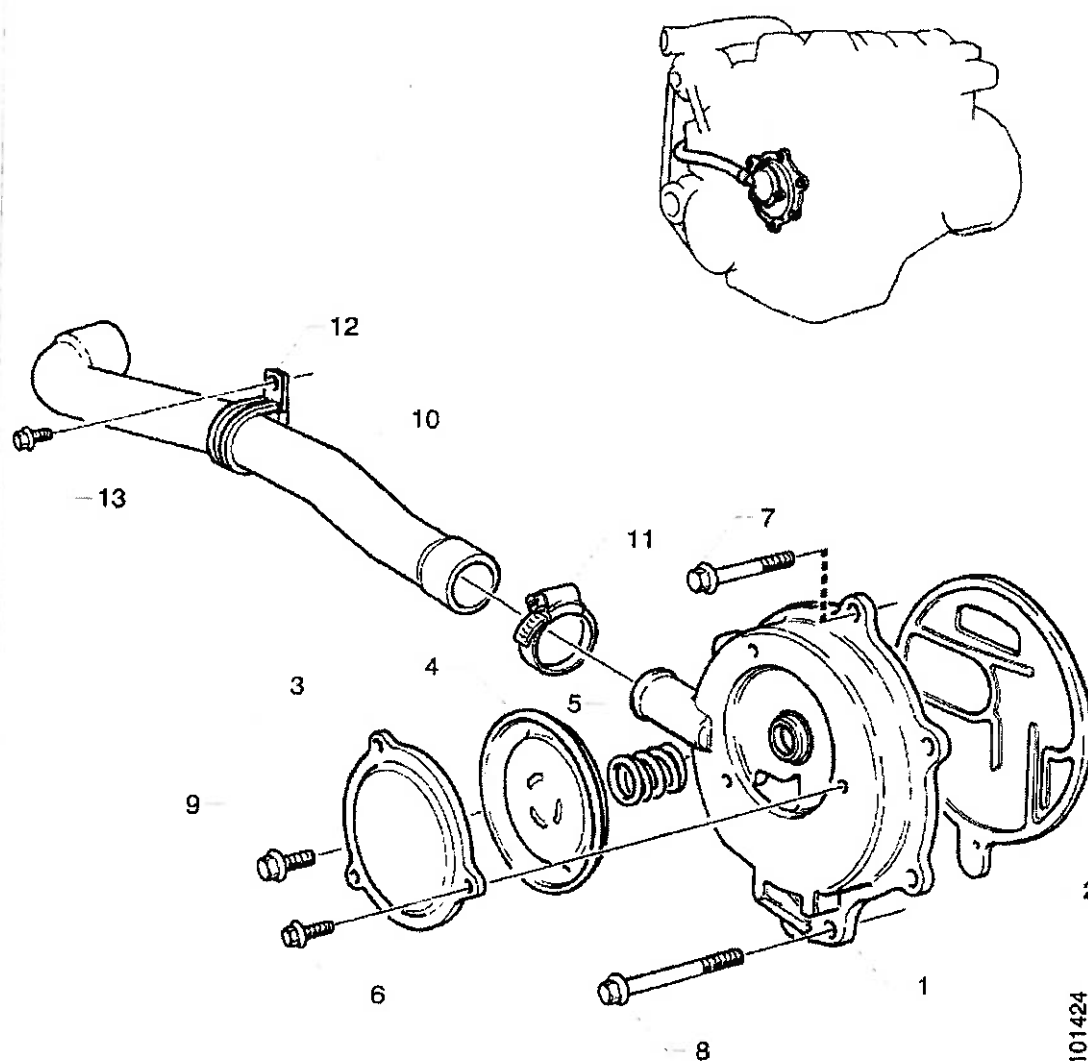


106323

[illegible]

Motor
Ventilação do cárter, fechado
DSC9

Desenho	Gr.	Pág.
101424	1-05	1



101424

Motor					Desenho	Gr.	Pág.
Ventilação do cárter, fechado							
DSC9					101424	1-05	1
Fig.	Peça Nº.	Notas	Qtde.				Descrição
			A	B	C	D	

	1352664	Assy	1				Carcaça
1		Nss	1				Carcaça
2		Nss	1				Junta
3	1383840		1				Tampa
4	1354468		1				Diafragma
5		Nss	1				Mola
6	812990	M6x20	3				Parafuso auto-roscante
7	812545	M10x70	1				Parafuso flangeado
8	812545	141) M10x70	2				Parafuso flangeado
	1360987	159) M10x110	2				Parafuso flangeado
9	812536	M10x25	1				Parafuso flangeado
10	1356651		1				Mangueira moldada
11	796357		2				Braçadeira
12	804591		1				Braçadeira
13	812989	M6x16	1				Parafuso auto-roscante

141. Veículos sem tomada de força.

159. Veículos com tomada de força.

Motor

Mecanismo árvore manivelas

DSC9

Desenho

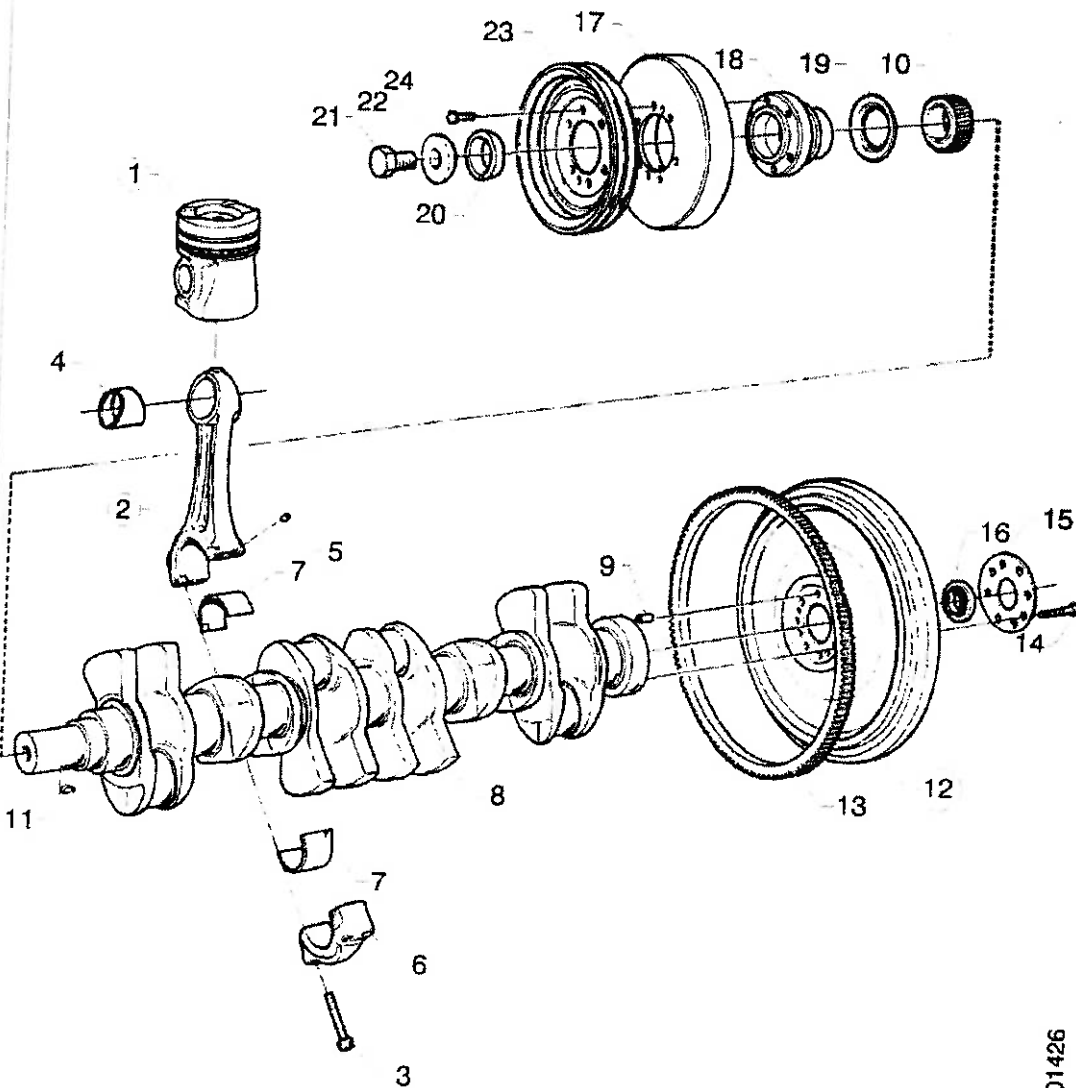
Gr.

Pág.

101426

1-10

1



Motor

Mecanismo árvore manivelas

DSC9

Desenho

Gr.

Pág.

101426

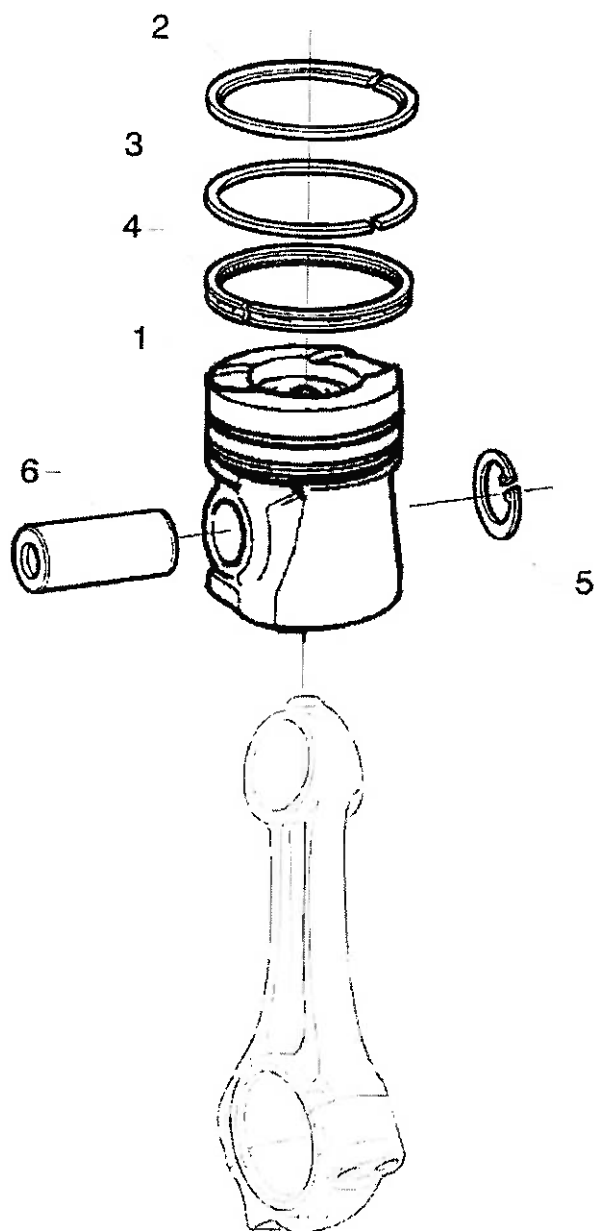
1-10

1

Fig.	Peça Nº.	Notas	Qtde.				Descrição
			A	B	C	D	

1		veja : 1-10					
2	1397335	(338253)Assy	6				Pistão
3	1100867	M12x72	6				Biela
4	1320973		24				Parafuso flangeado
5	131058		6				Bucha
6		Nss	12				Pino
7	346879	STD 80.00 mm	6				Capa de rolamento
	346880	Usz1: 79.75 mm	12				Mancal da biela
	346881	Usz2: 79.50 mm	12				Mancal da biela
	346882	Usz3: 79.25 mm	12				Mancal da biela
	346883	Usz4: 79.00 mm	12				Mancal da biela
	346884	Usz5: 78.75 mm	12				Mancal da biela
	346885	Usz6: 78.50 mm	12				Mancal da biela
8	1338810	☒					
	570880	Exchange unit	1				Árvore de manivelas
9	1394506	(131041)	1				Árvore de manivelas
10	358462		3				Pino
11	353893	8x10.5	1				Engrenagem árvore manivelas
12	393151	EN-5 122 028 SSS, assy	1				Chaveta
		EN-4 024 842 SNL	1				Volante
	324640	EN 5 122 029- SSS, assy	1				Volante
		EN 4 024 843- SNL					
13	139625		1				Cremalheira
14	394591	M14x35	8				Parafuso sextavado
15	371990	Ø56 mm	1				Arruela
16	1313606		1				Rolamento de esferas
17	1373127		1				Amortecedor de vibrações
18	1341594		1				Cubo
19	348551		1				Defletor de óleo
20	329636		1				Cone
21	361623		1				Parafuso
22	348632		1				Arruela
23	1380166	Ø260 mm	1				Polia
24	394588	M12x35	6				De 2 vias
							Parafuso sextavado

Motor Pistão DSC9	Desenho 101416	Gr. 1-10	Pág. 1
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Motor					Desenho	Gr.	Pág.	
Pistão								
DSC9								
					101416	1-10	1	
Fig.	Peça N°.		Notas		Qtde.		Descrição	
					A	B		C

	1393166	K	DSC9 11, assy		6				Pistão	
1		K	Nss		6				Pistão	
2	371993	K	Up		6				Anel de compressão	
3	229995	K	Lo		6				Anel de compressão	
4	1337374	K			6				Anel raspador	
5	804830	K	Ø50 mm		12				Anel-trava	
6	340327	K			6				Pino do pistão	
	1393167	K	DSC9 12, assy		6				Pistão	
1		K	Nss		6				Pistão	
2	371993	K	Up		6				Anel de compressão	
3	229995	K	Lo		6				Anel de compressão	
4	1337374	K			6				Anel raspador	
5	804830	K	Ø50 mm		6				Anel-trava	
6	340327	K			6				Pino do pistão	
	1393168	K	DSC9 13/15, assy		6				Pistão	
1		K	Nss		6				Pistão	
2	1372886	K	Up		6				Anel de compressão	
3	229995	K	Lo		6				Anel de compressão	
4	1337374	K			6				Anel raspador	
5	804830	K	Ø50 mm		6				Anel-trava	
6	340327	K			6				Pino do pistão	
	550265		DSC9 11		6				Jogo de reparação	
			veja : 1-99						Pistão e camisa	
	550266		DSC9 12		6				Jogo de reparação	
			veja : 1-99						Pistão e camisa	
	550267		DSC9 13/15		6				Jogo de reparação	
			veja : 1-99						Pistão e camisa	
	550263		DSC9 11/12		6				Jogo de reparação	
			veja : 1-99						Segmentos e camisa	
	550264		DSC9 13/15		6				Jogo de reparação	
			veja : 1-99						Segmentos e camisa	
	550261		DSC9 11/12 veja : 1-99		6				Jogo de aneis segm.do pistão	
	550258		DSC9 13/15 veja : 1-99		6				Jogo de aneis segm.do pistão	

Motor
Distribuição
DSC9

Desenho

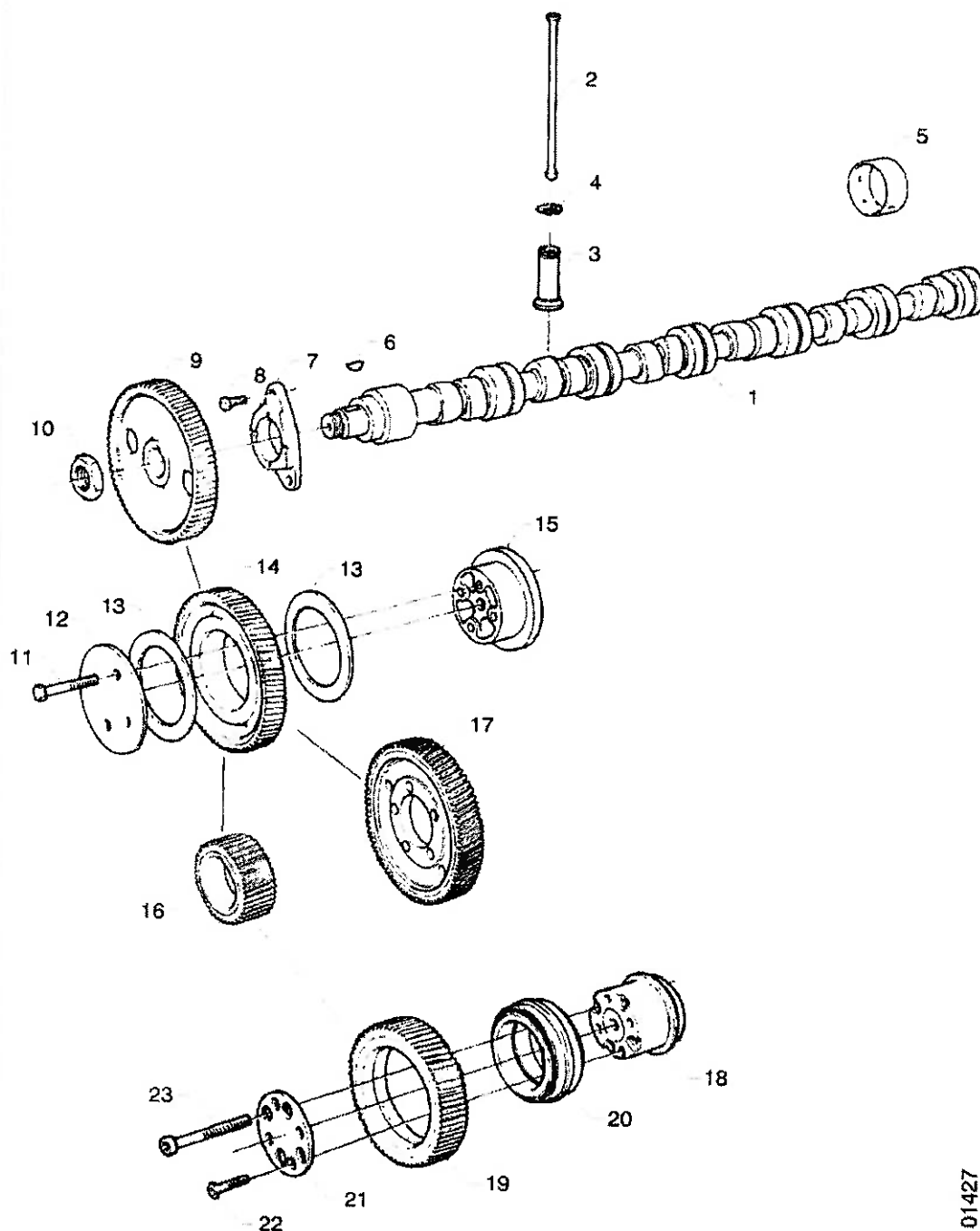
Gr.

Pág.

101427

1-15

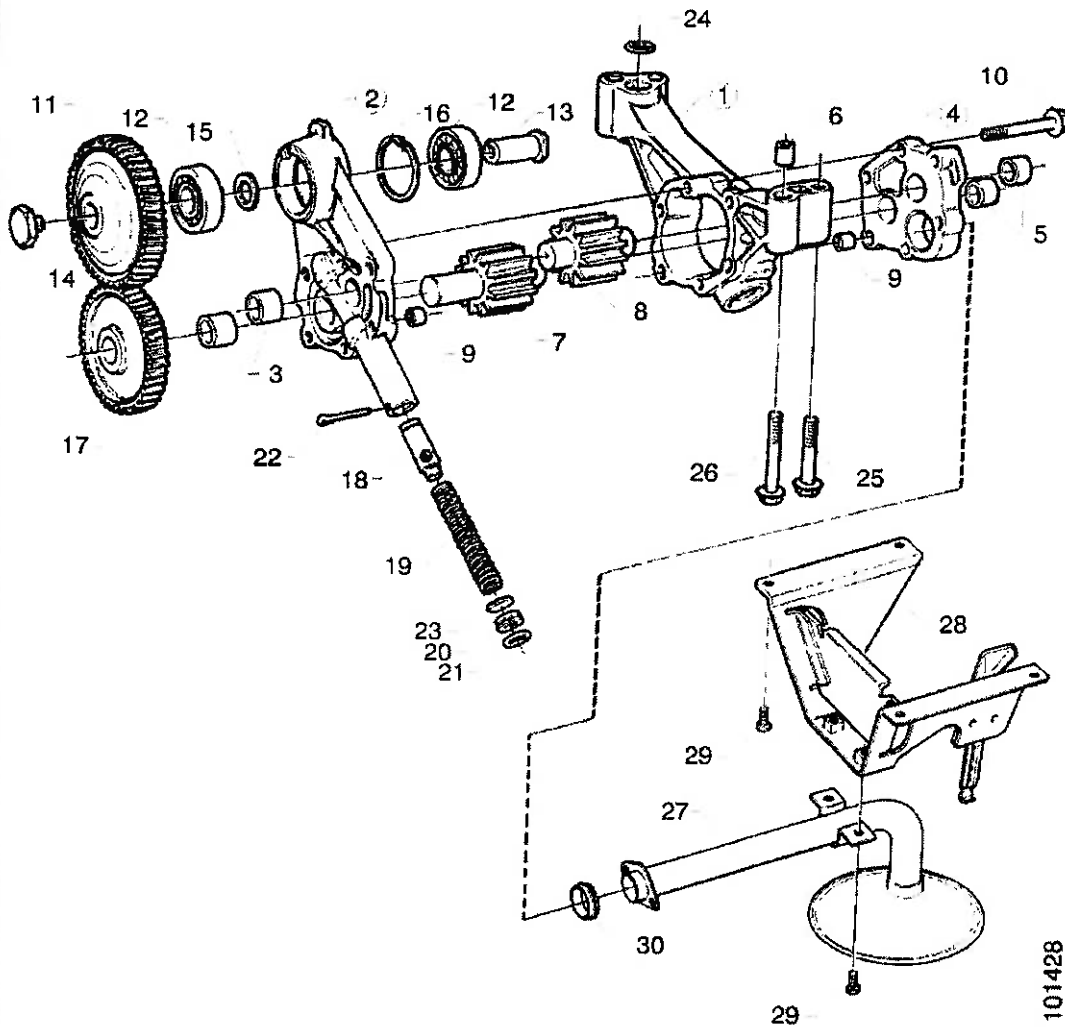
1



101427

Motor
Bomba de óleo
DSC9

Desenho	Gr.	Pág.
101428	1-20	1



Motor				Desenho	Gr.	Pág.	
Bomba de óleo							
DSC9							
				101428	1-20	1	
Fig.	Peça N°.		Notas	Qtde.		Descrição	
				A	B		C

	1402400	(1341496)Assy	1				Bomba de óleo
1		Nss	1				Carcaça da bomba de óleo
2		Nss	1				Tampa da bomba de óleo
3	139110		2				Bucha
4		Nss	1				Tampa da bomba de óleo
5	139110		2				Bucha
6	300292		2				Luva-guia
7	1313863		1				Engrenagem motriz
8	1318055		1				Engrenagem acionada
9	328681		4				Luva-guia
10	812529	M8x80	6				Parafuso flangeado
11	380934		1				Engrenagem da bomba
12	288767		2				Rolamento de esferas
13	154622		1				Eixo
14	154623		1				Parafuso
15	154624		1				Anel espaçador
16	804831	52	1				Anel-trava
17	1313880		1				Engrenagem da bomba
18	300271		1				Pistão
19	1327064	Marked with white colour	1				Mola
20	300273		1				Bujão
21	804882	15.1x1.6	1				Anel de vedação-O
22	805443	3.2x28	1				Cupilha
23	372032		rq				Arruela de ajuste
24	392653	K 22.1x1.6	1				Anel de vedação-O
25	812544	M10x65	2				Parafuso flangeado
26	812547	M10x80	2				Parafuso flangeado
27	1302911		1				Tubo de sucção
28	1383107		1				Suporte
29	812515	M8x16	6				Parafuso flangeado
30	381235	K	1				Retentor
	551526	veja : 1-99	1				Jogo recondicionamento geral

Motor
Filtro de óleo
DSC9

Desenho

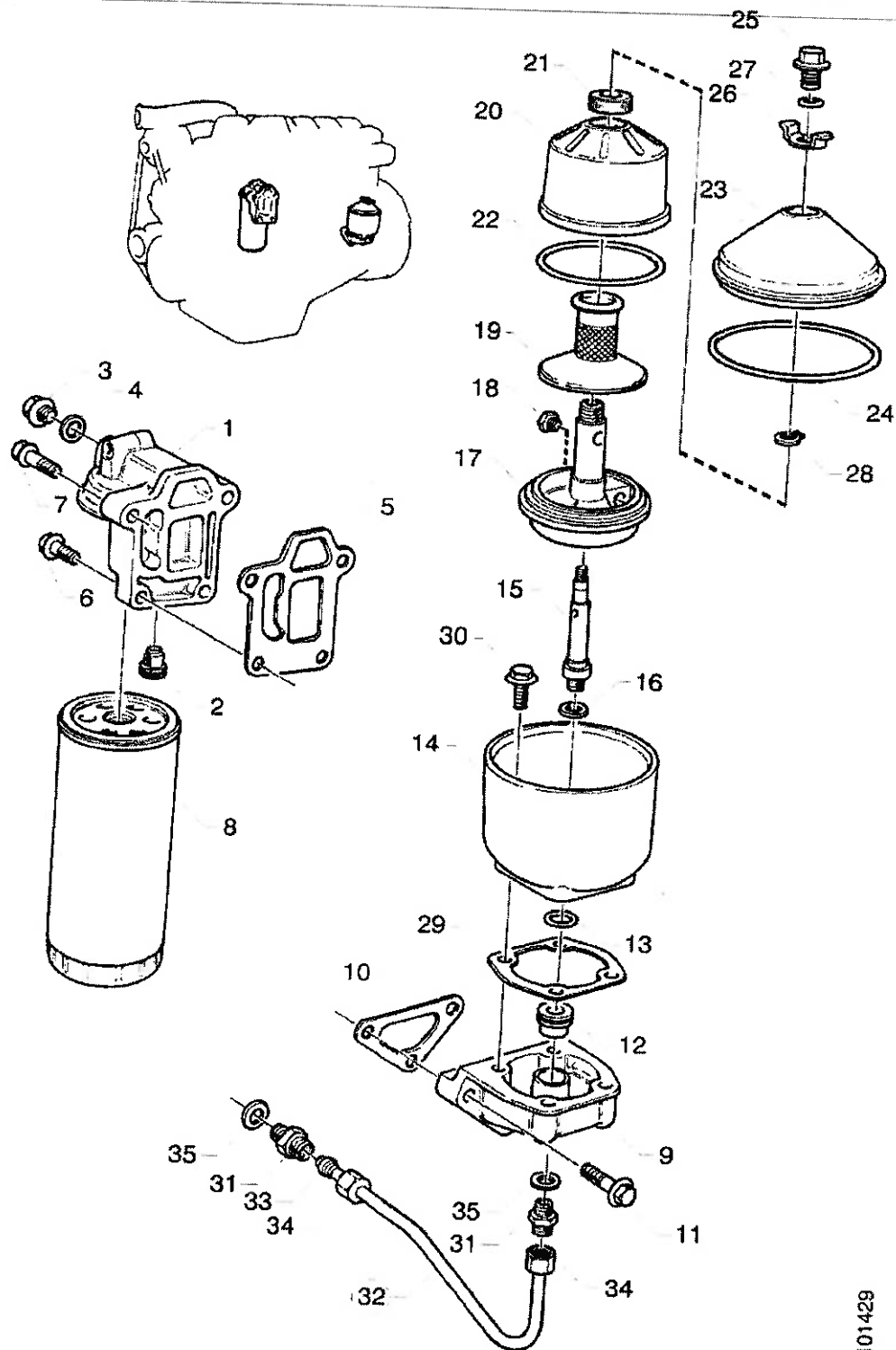
Gr.

Pág.

101429

1-20

1



101429

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Motor					Desenho	Gr.	Pág.
Filtro de óleo							
DSC9							
Fig.	Peça N°.		Notas	Qtde.		Descrição	
				A	B	C	D
1	1000010						

1	1363642				1				Cabeçote do filtro
2	1326437				1				Válvula de alívio
3	812372	M14x1.5x9			1				Bujão
4	303098	K			1				Junta
5	1326291	K			1				Junta
6	812538	M10x35			2				Parafuso flangeado
7	812541	M10x50			2				Parafuso flangeado
8	1117285				1				Filtro de óleo
9	1332088				1				Suporte
10	1332089	K			1				Junta
11	812539	M10x40			3				Parafuso flangeado
12	309116				1				União
13	197800	K 26.2x3			1				Anel de vedação-O
	383864	Assy			1				Filtro de óleo
14	384370				1				Carcaça do rotor
15	362257				1				Eixo
16	211808				1				Arruela
	384371				1				Conjunto do rotor
17	384372				1				Rotor
18	290535				1				Bico
19	290531				1				Filtro
20	290532				1				Tampa do rotor
21	310976				1				Porca
22	372984	K			1				Anel de vedação-O
23	372980				1				Tampa
24	372985	K			1				Anel de vedação-O
25	372981				1				Porca autotravante
26	372982				1				Arruela
27	372983	K			1				Anel de vedação-O
28	804772	K Ø16			1				Anel-trava
29	1392196	K (1320290*)			1				Junta
30	812538	M10x35			4				Parafuso flangeado
31	813198				2				União reta
32	1372501				1				Tubo de óleo lubrificante
33	813223	Ø 12			2				Anel de penetração
34	814555	Ø 12			2				Porca de união
35	812415	K 16.5x19.9			2				Junta
	551491	veja : 1-99			1				Jogo de juntas
	551526	veja : 1-99			1				Filtro de óleo
									Jogo recondiçãoamento geral

Motor
Radiador de óleo
DSC9

Desenho

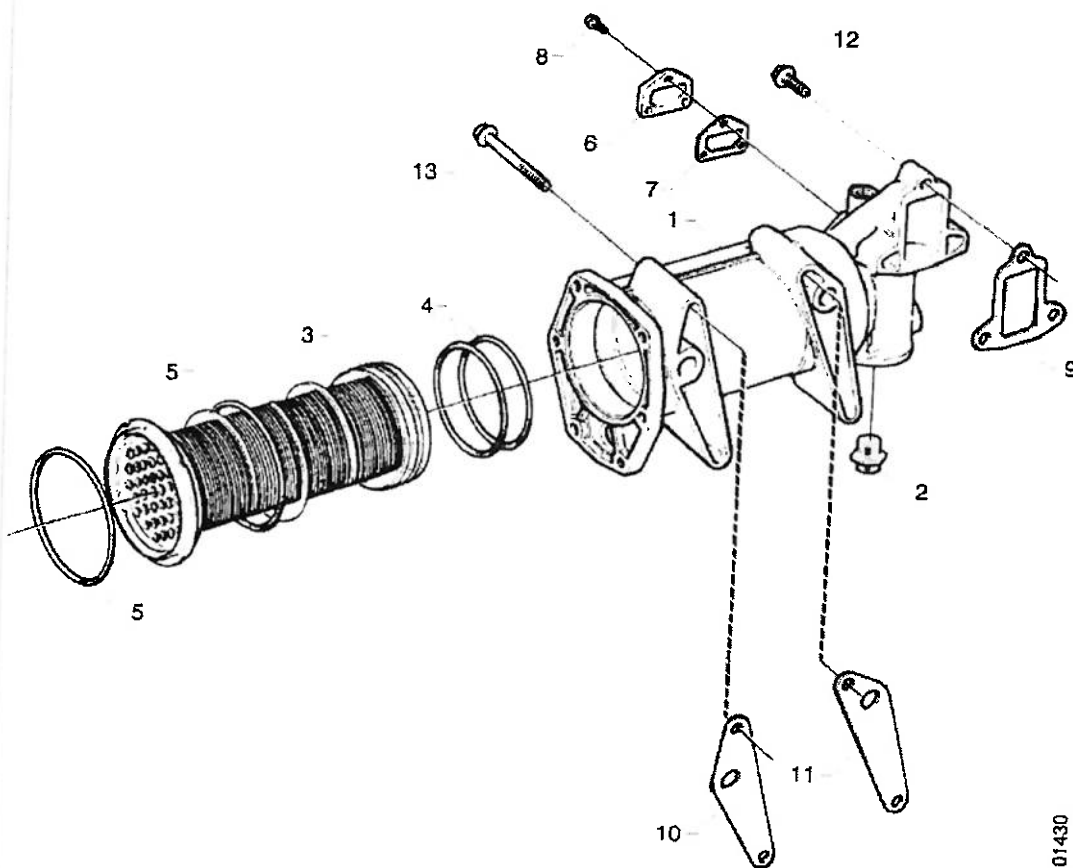
Gr.

Pág.

101430

1-20

1



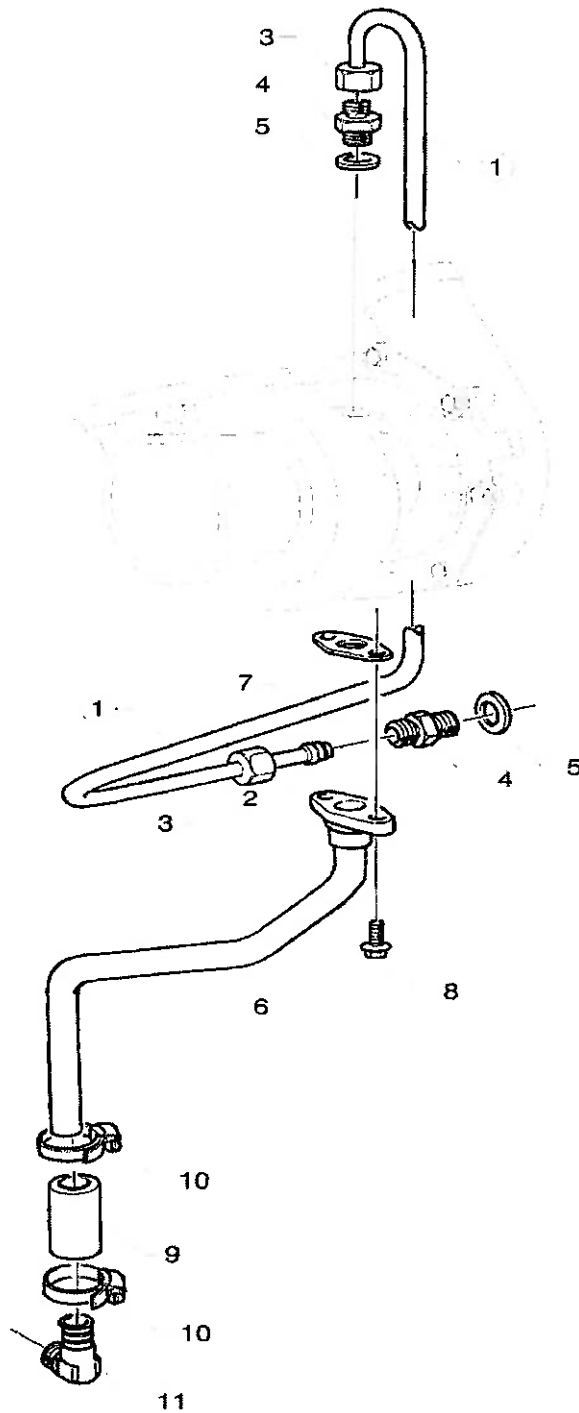
101430

Motor					Desenho	Gr.	Pág.	
Radiador de óleo								
DSC9								
					101430	1-20	1	
Fig.	Peça N°.		Notas		Qtde.		Descrição	
					A	B		C

1	372636				1				Carcaça
2	373073				1				União
3	365068				1				Núcleo do radiador
4	321991	K	99.5x3		2				Anel de vedação-O
5	321992	K	106.2x3		2				Anel de vedação-O
6	372098				1				Tampa
7	1391726	K	(366550*)		1				Junta
8	812502		M6x16		3				Parafuso flangeado
9	1350378	K			1				Junta
10	1350379	K			1				Junta
11	1350380	K			1				Junta
12	812539		M10x40		3				Parafuso flangeado
13	812547		M10x80		3				Parafuso flangeado
	812548		M10x90		1				Parafuso flangeado
	551451		veja : 1-99		1				Jogo de juntas
									Radiador de óleo
	551526		veja : 1-99		1				Jogo recondiçnamento geral

Motor
Lubrificação, turbocompressor
DSC9

Desenho	Gr.	Pág.
101431	1-20	1



101431

Motor					Desenho	Gr.	Pág.
Lubrificação, turbocompressor					101431	1-20	1
DSC9							
Fig.	Peça N°.	Notas	Qtde.				Descrição
			A	B	C	D	

1	1377089	DSC9 11/13/15	1				Tubo de óleo lubrificante
	1377089	DSC9 12: EN-5 121 433 SSS	1				Tubo de óleo lubrificante
		EN-4 024 110 SNL					
	1380368	DSC9 12:	1				Tubo de óleo lubrificante
		EN 5 121 434- SSS					
		EN 4 024 111- SNL					
		Turbo: 1 382 085					
2	813223	Ø 12	2				Anel de penetração
3	814555	Ø 12	2				Porca de união
4	813192		2				União reta
5	812415 K	16.5x19.9	2				Junta
6	1383195		1				Tubo de retorno do óleo
7	1375992 K		1				Junta
8	812516	M8x20	2				Parafuso flangeado
9	397999	L=60 mm	1				Mangueira
10	796354	Ø 30	2				Braçadeira
11	367171		1				Cotovelo de união
	551526	veja : 1-99	1				Jogo recondicionamento geral

Motor

Bocal para óleo, vareta de nível

DSC9

Desenho

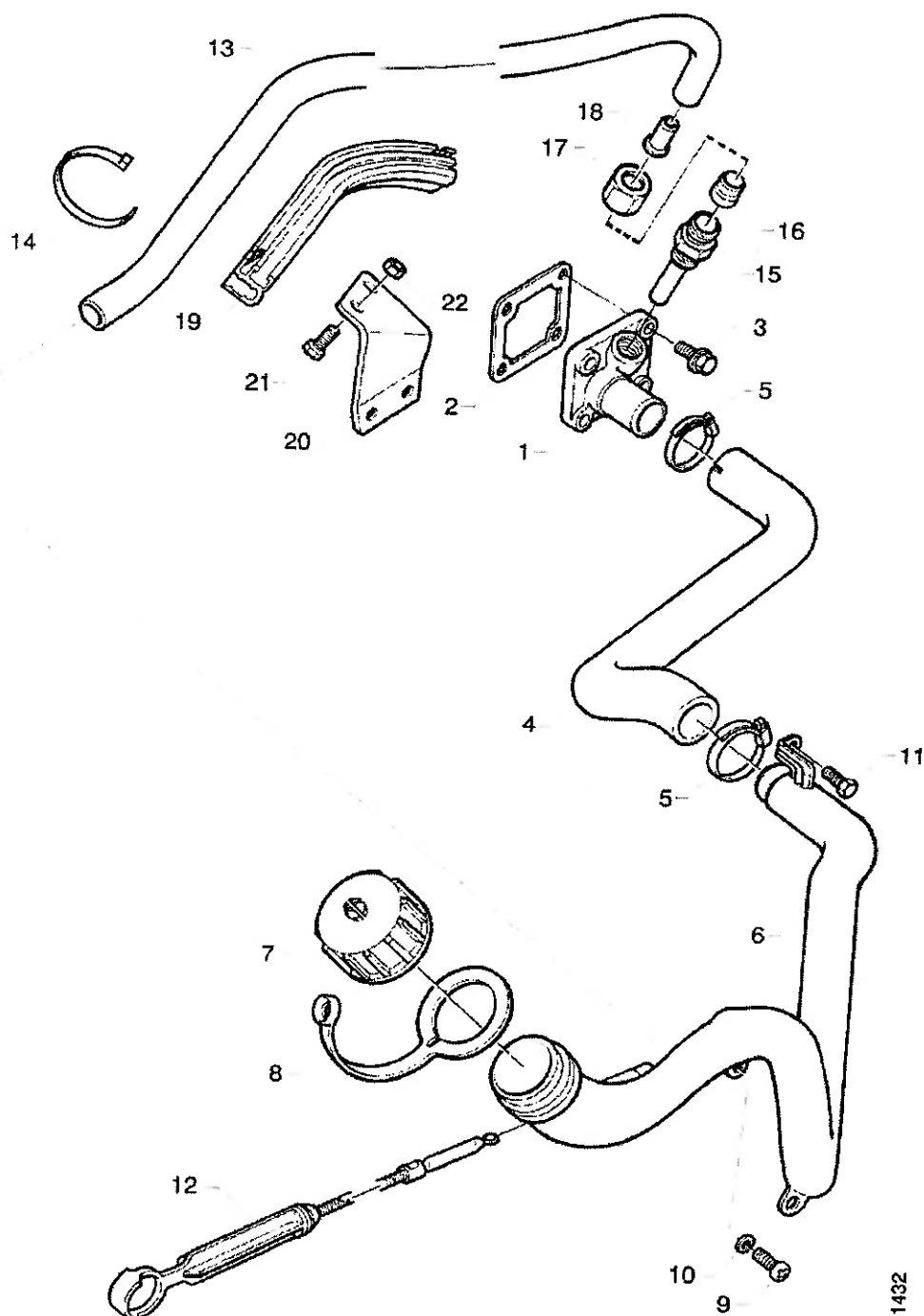
Gr.

Pág.

101432

1-20

1



101432

Motor					Desenho	Gr.	Pág.
Bocal para óleo, vareta de nível							
DSC9							
					101432	1-20	1
Fig.	Peça N°.		Notas	Qtde.		Descrição	
				A	B	C	D

1	1373216			1				Tubo flangeado
2	1374330	K		1				Junta
3	812519	M8x30		4				Parafuso flangeado
4	1400420	(1344223)		1				Mangueira moldada
5	796356	Ø 42		2				Braçadeira
		Assy, nsp		1				Tubo de abastecimento de óleo
6	1356216			1				Tubo
7	1385367			1				Tampa de enchimento
8	1356218			1				Presilha
9	815472	M8x20		2				Parafuso
10	802998	8.4x16		2				Arruela
11	813005	M10x20		1				Parafuso auto-roscante
12	1394974	(1369060)		1				Vareta de nível
13	813869	Req 1310 mm, Ø12x1.5		m				Tubo de plástico
14	815361	L=185x4,6		2				Presilha
15	1381884	Assy		1				União reta
16	813223	Ø 12		1				Anel de penetração
17	814555	Ø 12		1				Porca de união
18	812913	Ø 12		1				Inserto
19	1363111			1				Guia para chicotes
20	1363112			1				Suporte
21	808294	M8x20		4				Parafuso sextavado
22	815123	M8		4				Porca sextavada
	551526	veja : 1-99		1				Jogo recondiçãoamento geral

Motor

Sensor da pressão do óleo

DSC9

Desenho

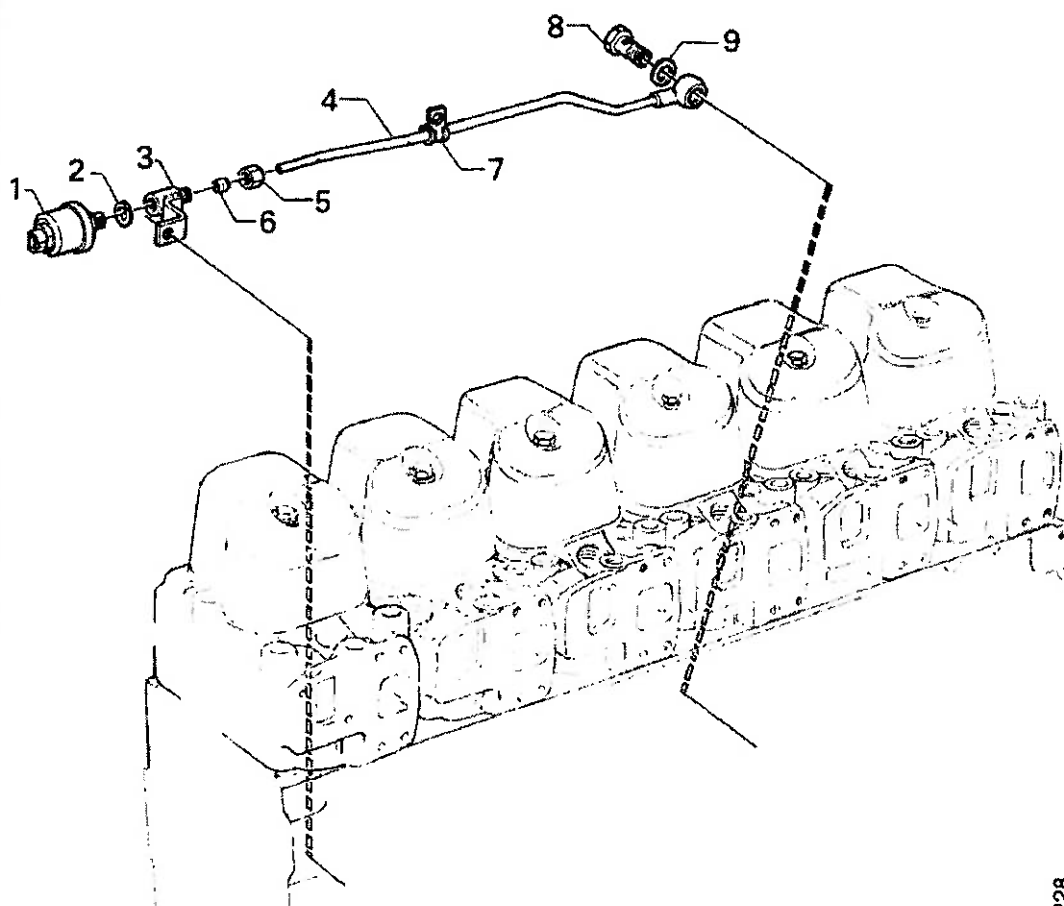
Gr.

Pág.

019228

1-20

1

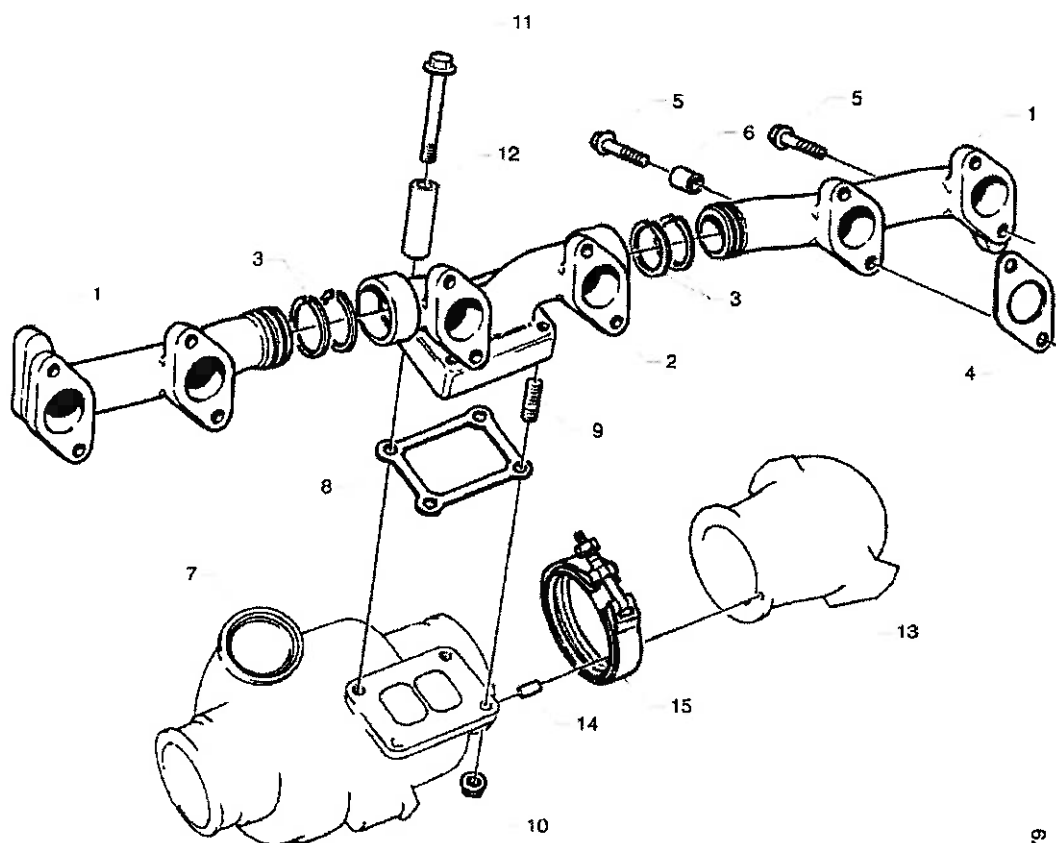


19228

Motor				Desenho	Gr.	Pág.	
Sensor da pressão do óleo							
DSC9							
				019228	1-20	1	
Fig.	Peça N°.		Notas	Qtde.		Descrição	
				A	B		C

1	374338	0.7+-0.15 bar	1				Sensor da pressão do óleo
2	1373792 K		1				Vedação
3	1108579		1				União
	1118454	Assy	1				Tubo
4	811311	Req 455 mm, 6x1	m				Tubo
5	814552	Ø 6	1				Porca de união
6	813220	Ø 6	1				Anel de penetração
7	293100	Ø 6	1				Braçadeira
8	812390	M14x1.5	1				Parafuso banjo
9	1374845 K		2				Vedação
	551526	veja : 1-99	1				Jogo recondicionamento geral

Motor	Desenho	Gr.	Pág.
Coletor de escape			
DSC9	106379	1-25	1



106379

Motor					Desenho	Gr.	Pág.
Coletor de escape							
DSC9					106379	1-25	1
Fig.	Peça N°.	Notas	Qtde.				Descrição
			A	B	C	D	

1	1388318	Front and rear	2				Coletor de escape
2	1374233	EN-5 122 831 SSS, ctr, repl	1				Coletor de escape
		EN-4 025 612 SNL	1				
	1400365	EN 5 122 832- SSS, ctr	1				Coletor de escape
		EN 4 025 613- SNL					
3	1336398	K	4				Anel de vedação
4	1336138	K	6				Junta
5	303713	M10x55	12				Parafuso flangeado
6	1378280	L=24 mm	10				Luva espaçadora
7		veja : 1-30	1				Turbocompressor
8	1393937	K (1375794)	1				Junta
9	191892	EN-5 122 831 SSS, M10x40	4				Prisioneiro
		EN-4 025 612 SNL					
	1387005	EN 5 122 832- SSS, M10x55	2				Prisioneiro
		EN 4 025 613- SNL					
10	1355746	EN-5 122 831 SSS, M10	4				Porca flangeada
		EN-4 025 612 SNL					
	1387007	EN 5 122 832- SSS, M10	2				Porca flangeada
		EN 4 025 613- SNL					
11	1387006	EN 5 122 832- SSS, § M10x90	2				Parafuso flangeado
		EN 4 025 613- SNL					
12	1400658	EN 5 122 832- SSS, L=56 mm	2				Luva espaçadora
		EN 4 025 613- SNL					
13		veja : 10-45	1				Tubo de escape do turbo
14	132650	4x8	1				Pino
15	1392945	(1371086)	1				Braçadeira
	550270	veja : 1-99	6				Jogo de juntas
							Cabeçote
	551524	735) veja : 1-99	6				Jogo de juntas
							Cabeçote
	551526	veja : 1-99	1				Jogo recondiçionamento geral

735. Guarnição da cabeça do cilindro marcada com R para renovação. Tem anéis de vedação mais espessos (4,65 mm) para c

Motor
Turbocompressor
DSC9

Desenho

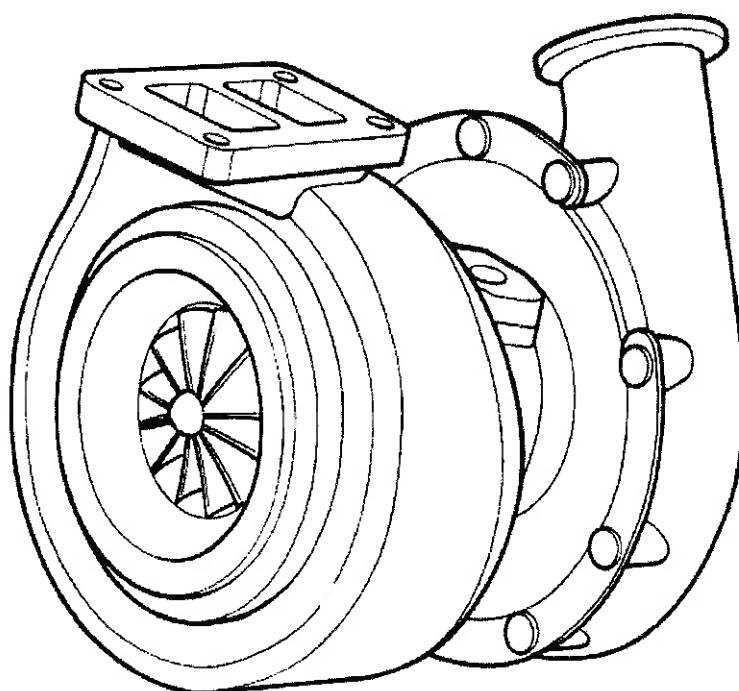
Gr.

Pág.

025949

1-30

1



25949

Motor					Desenho	Gr.	Pág.
Turbocompressor							
DSC9							
Fig.	Peça N°.		Notas	Qtde.		Descrição	
				A	B	C	D

1386402 DSC9 11, repl, assy, AlliedSignal 1 Turbocompressor

EN-5 122 831 SSS

EN-4 025 612 SNL

1400414 ☐ DSC9 11, assy, AlliedSignal 1 Turbocompressor

EN 5 122 832- SSS

EN 4 025 613- SNL

571488 Assy, Exchange unit 1 Turbocompressor

1380097 DSC9 12, repl, assy, AlliedSignal 1 Turbocompressor

EN-5 121 433 SSS

EN-4 024 110 SNL

1382085 DSC9 12, repl, assy, Holset, repl 1 Turbocompressor

EN 5 121 434- SSS

EN-5 122 831 SSS

EN 4 024 111- SNL

EN-4 025 612 SNL

1400413 ☒ DSC9 12, assy, Holset 1 Turbocompressor

EN 5 122 832- SSS

EN 4 025 613- SNL

571489 Assy, Exchange unit 1 Turbocompressor

1372846 DSC9 13/15, repl, assy, AlliedSignal 1 Turbocompressor

EN-5 122 831 SSS

EN-4 025 612 SNL

1400412 ☒ DSC9 13/15, assy, AlliedSignal 1 Turbocompressor

EN 5 122 832- SSS

EN 4 025 613- SNL

571491 Assy, Exchange unit 1 Turbocompressor

Motor
Coletor de admissão
DSC9

Desenho

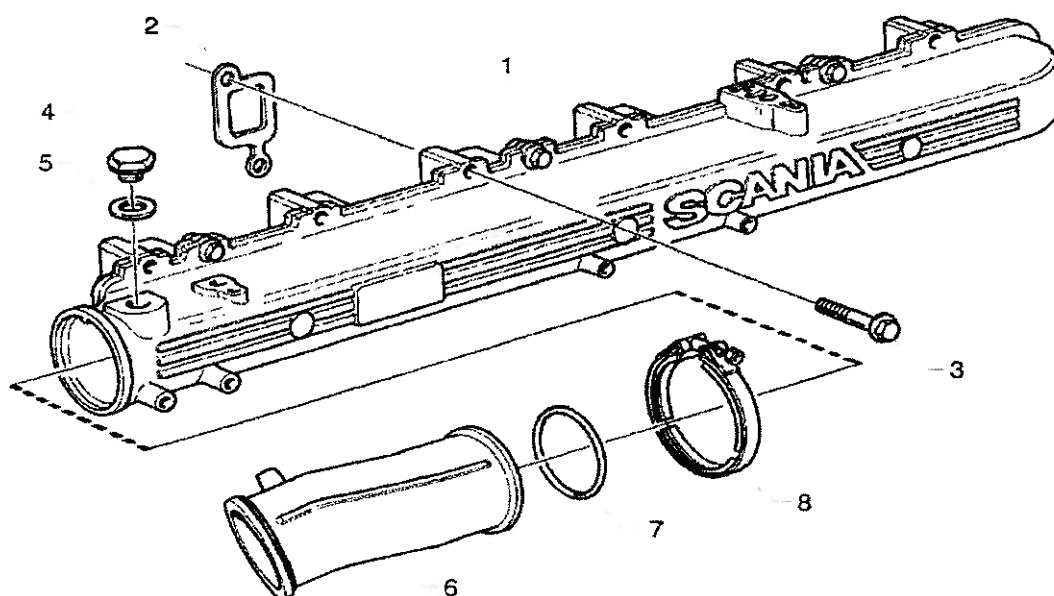
Gr.

Pág.

101434

1-40

1



101434

94

Motor					Desenho	Gr.	Pág.	
Coletor de admissão								
DSC9								
					101434	1-40	1	
Fig.	Peça N°.		Notas	Qtde.				Descrição
				A	B	C	D	
1	1382522							

1	1383533		Assy	1				Coletor de admissão
2	1349714	K		6				Junta
3	812527		M8x70	12				Parafuso flangeado
4	812375		M20x1.5x9	1				Bujão
5	239457	K		1				Junta
6	1383556		P94	1				Tubo flangeado
	1383555		R94	1				Tubo flangeado
7	368030	K	79,5X3	1				Anel de vedação-O
8	1392943		(1363764)Assy	1				Braçadeira
	550270		veja : 1-99	6				Jogo de juntas
	551524		735) veja : 1-99	6				Cabeçote
	551526		veja : 1-99	1				Jogo de juntas
								Cabeçote
								Jogo recondicionamento geral

735. Guarnição da cabeça do cilindro marcada com R para renovação. Tem anéis de vedação mais espessos (4,65 mm) para o

Motor

Tomada de ar

CP

Desenho

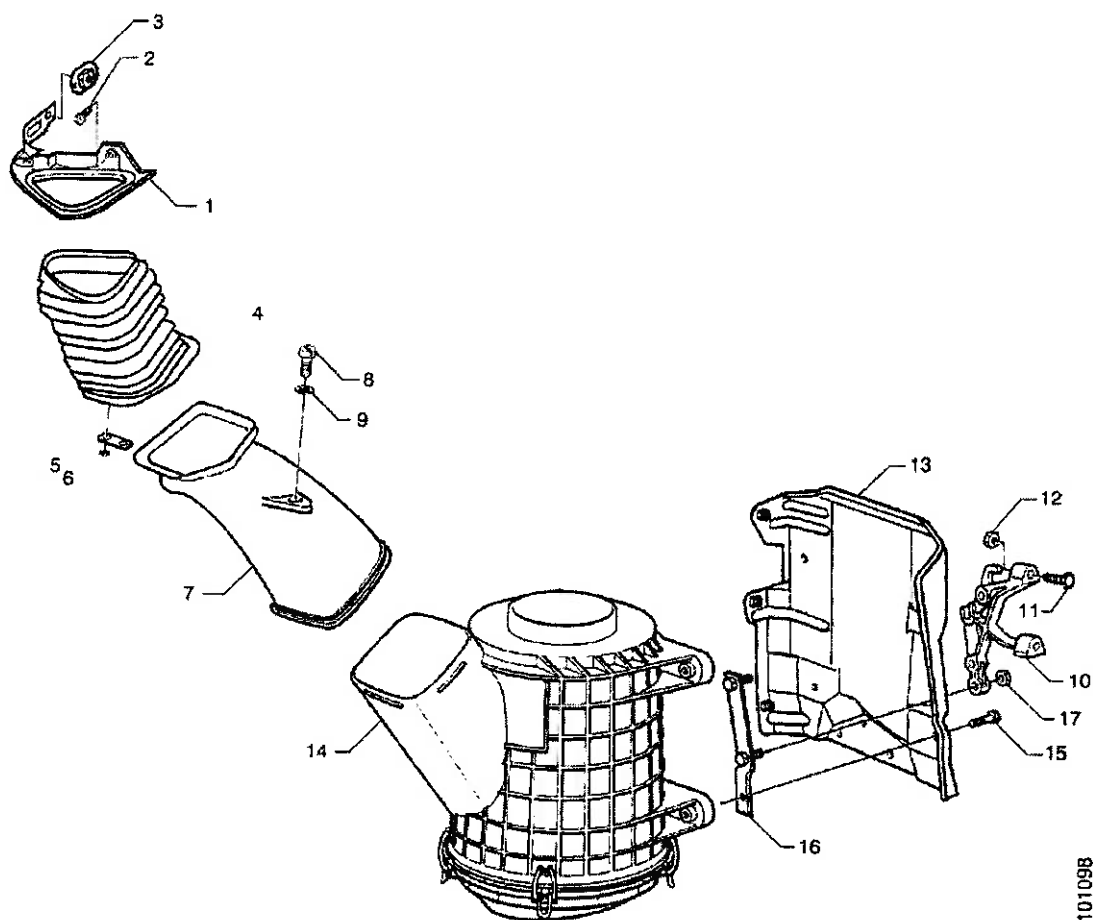
Gr.

Pág.

101098

1-45

1



Motor					Desenho	Gr.	Pág.	
Tomada de ar								
CP								
					101098	1-45	1	
Fig.	Peça N°.		Notas	Qtde.				Descrição
				A	B	C	D	

1	1365602			1				Suporte
2	1306882	M8x15		2				Parafuso com ressalto
3	1310856			1				Placa de porcas
4	1367286			1				Câmara de ar
5	1372381			1				Arruela
6	305086			2				Arruela-trava
7	1363392			1				Tubo
	809741	4x8.5		2				Rebite
8	1366349			2				Parafuso com ressalto
9	319319			2				Arruela
10	333733	(1333733)		1				Suporte
11	815623	M14x60		2				Parafuso
12	815149	M14		2				Porca autotravante
13	1358443			1				Suporte
14		veja : 1-45		1				Filtro de ar
15	814822	M10x30		4				Parafuso sextavado
16	1347899	Assy		1				Placa com parafusos
	814860	M14x45		2				Parafuso sextavado
17	815149	M14		2				Porca autotravante

Motor
Filtro de ar

Desenho

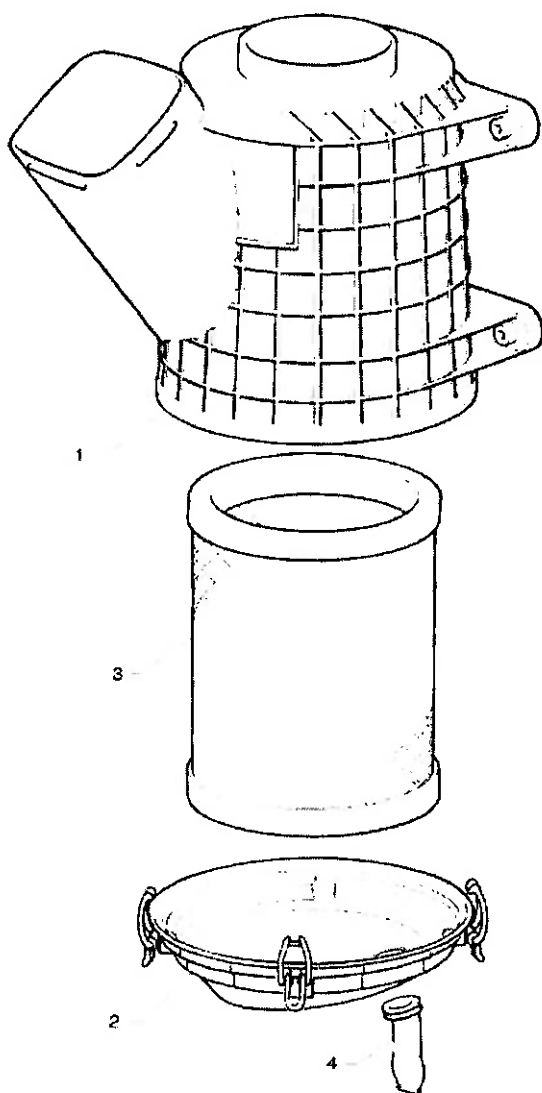
Gr.

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025576

1-45

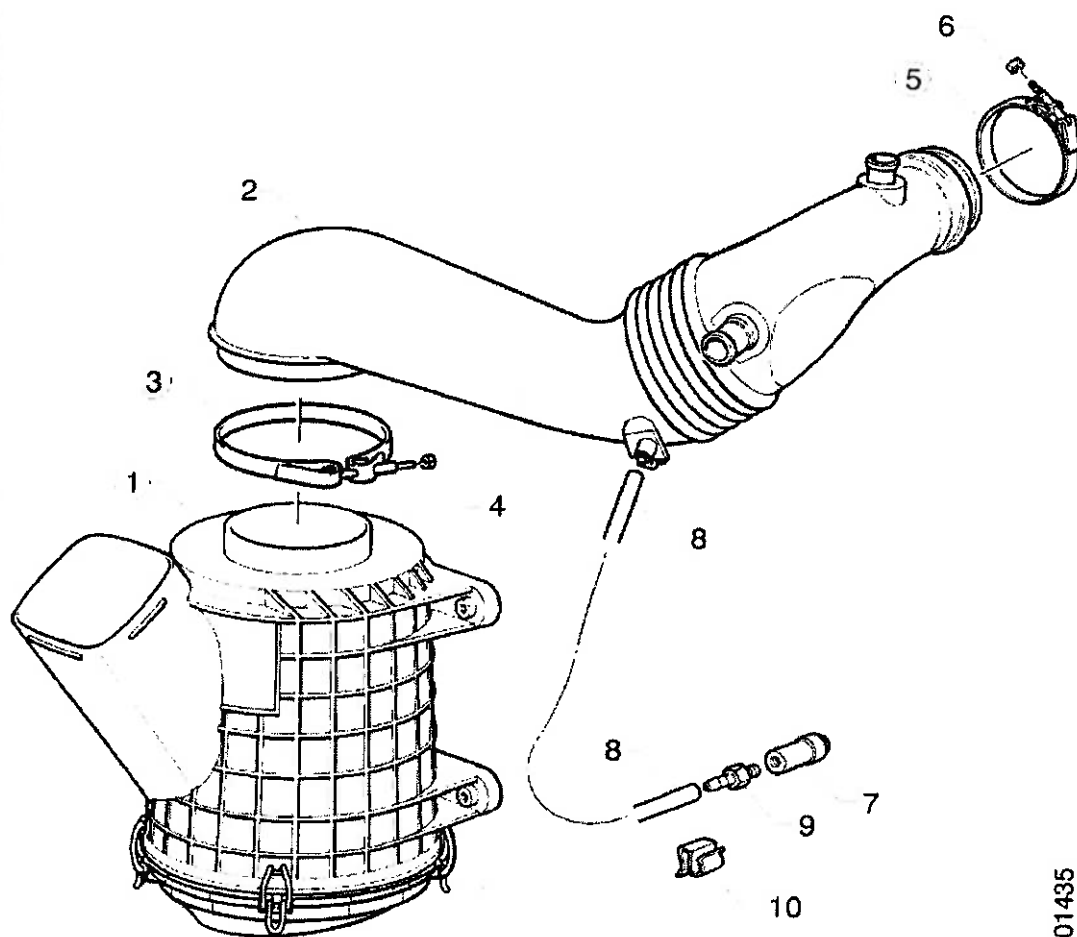
1



25576

Motor
Tubo de ar, motor

Desenho	Gr.	Pág.
101435	1-45	1



101435

Motor					Desenho	Gr.	Pág.
Tubo de ar, motor					101435	1-45	1
Fig.	Peça Nº.	Notas	Qtde.				Descrição
			A	B	C	D	

1		veja : 1-45	1				Filtro de ar
2	1382573	Assy	1				Tubo
3	1355677	Ø188 mm	1				Cinta
4	807351	M6	1				Porca autotravante
5	1355676	Ø107.6 mm	1				Cinta
6	807351	M6	1				Porca autotravante
7	1358837		1				Monitor de pressão
8	1356175	L=950 mm	1				Mangueira
9	1356174		1				União reta
10	301467		3				Clip

Motor

Pré-filtro, tubo do ejeto

CP

Desenho

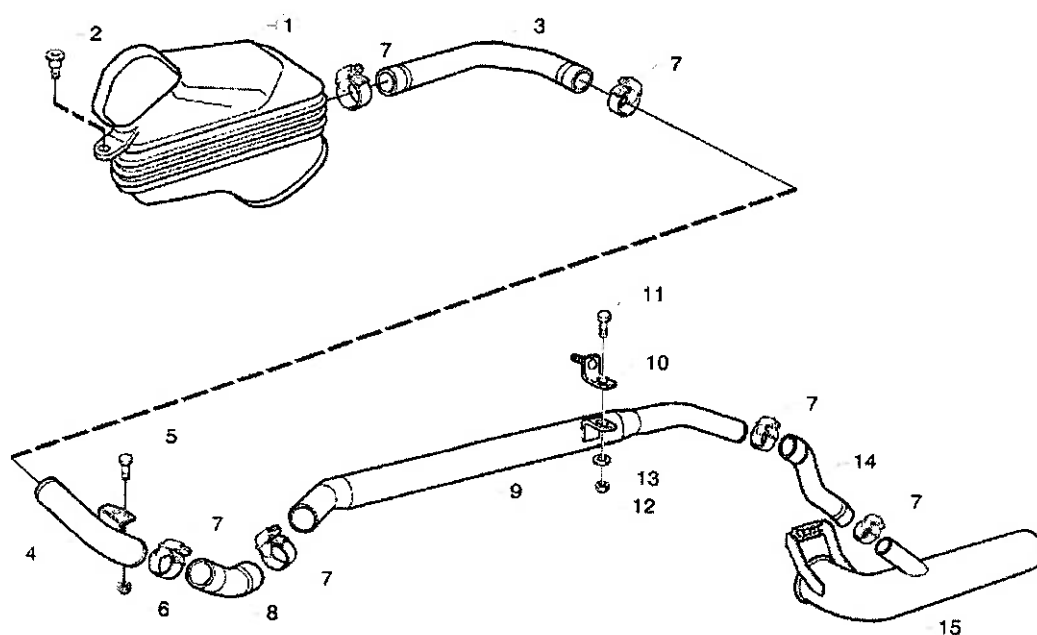
Gr.

Pág.

103501

1-45

1



103501

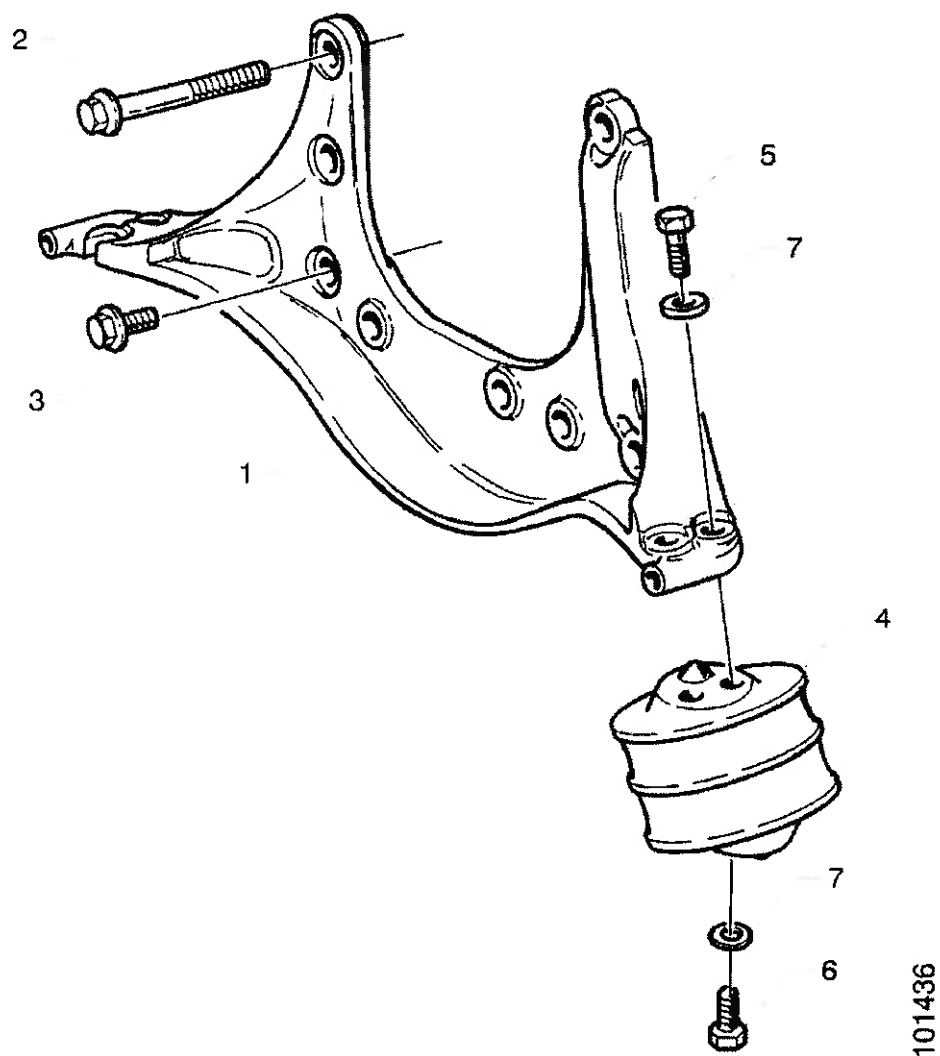
Motor							Desenho	Gr.	Pág.
Pré-filtro, tubo do ejetor									
CP									
A - B - Exhaust outlet down - D -							103501	1-45	1
Fig.	Peça Nº.		Notas			Qtde.		Descrição	
				A	B	C	D		

1	1379320	Assy	1				Pré-filtro
	809741	4x8.5	2				Rebite
2	1379754		2				Parafuso com ressalto
3	1380916		1				Mangueira
4	1375808		1				Tubo do ejeto
5	814822	M10x30	2				Parafuso sextavado
6	815147	M10	2				Porca autotravante
7	796359	Ø 63	6				Braçadeira
8	1375810		1				Mangueira
9	1352975		1				Tubo do ejeto
10	1370487	797)	2				Suporte
11	814822	797) M10x30	2				Parafuso sextavado
12	815147	797) M10	2				Porca autotravante
13	807310	797) 10.5x22	2				Arruela
14	1375821		1				Mangueira
15	1375811	Chassis height: N, H, assy	1				Tubo de escape
	1375817	Chassis height: L, E, assy	1				Tubo de escape
	1375814	8x2, 8x4, assy	1				Tubo de escape

797. Sem retardador.

Motor
Suspensão do motor
DSC9

Desenho	Gr.	Pág.
101436	1-50	1



94

Motor					Desenho	Gr.	Pág.
Suspensão do motor							
DSC9							
Fig.	Peça Nº.		Notas	Qtde.	Descrição		
1	1376173			A B C D			

1	1376173			1				Suporte do motor
2	1368492	M12x110		5				Parafuso flangeado
3	1368493	M12x30		3				Parafuso flangeado
4	1336885	Marked with green colour		2				Amortecedor de vibrações
5	814823	M10x35		4				Parafuso sextavado
6	814821	M10x25		4				Parafuso sextavado
7	807310	10.5x22		8				Arruela

Sistema de arrefecimento

Transmissão por correia

AC

Desenho

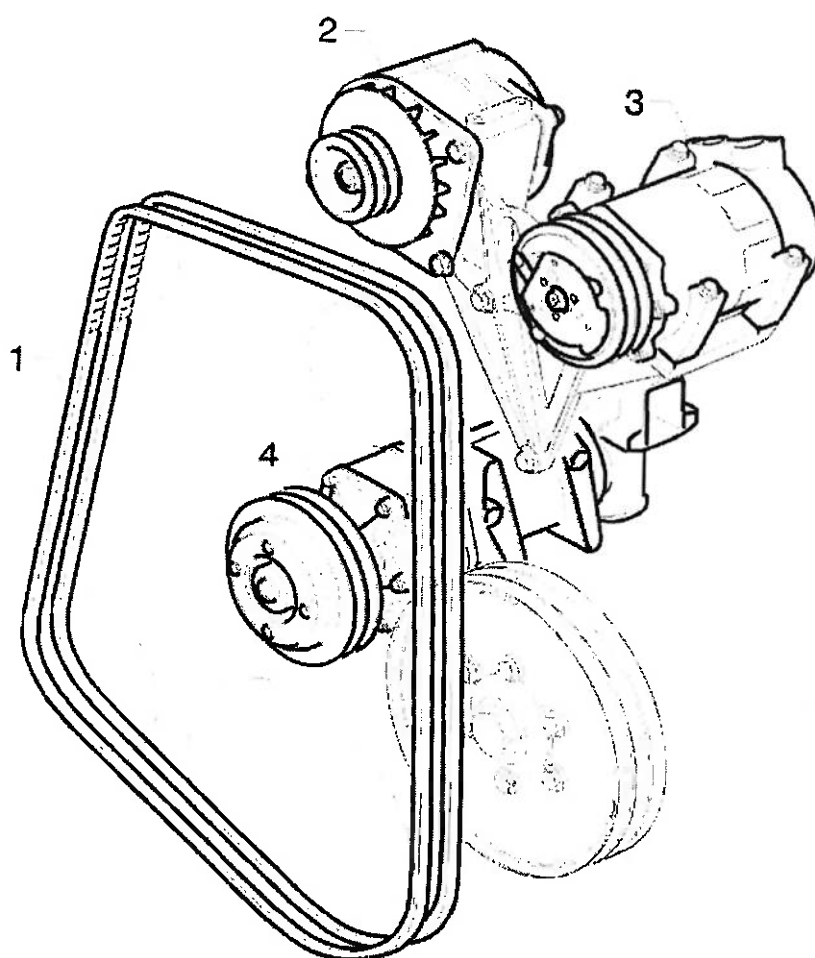
Gr.

Pág.

102805

2-10

1



102805

Ombryngningslinje

Sistema de arrefecimento
Transmissão por correia
AC

Desenho	Gr.	Pág.
102805	2-10	1

Fig.	Peça N°.	Notas	Qtde.				Descrição
			A	B	C	D	

1 1372545 L=1900mm

2

Correia em V
Ar condicionado

2 veja : 16-05

3 veja : 18-75

Alternador

Compressor

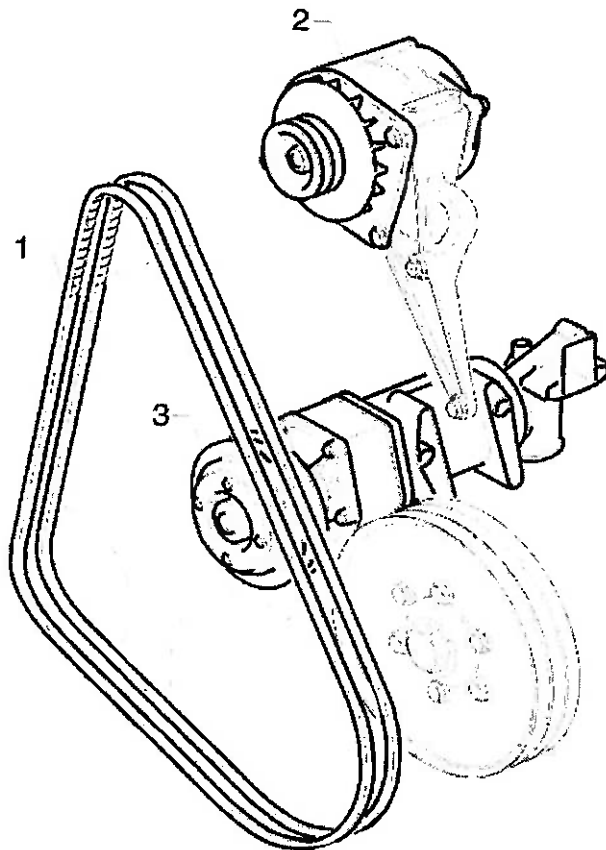
4 veja : 2-25

Ar condicionado

Bomba de água

Sistema de arrefecimento
Transmissão por correia

Desenho	Gr.	Pág.
102806	2-10	1



102806

Ombryhngslng

Sistema de arrefecimento							Desenho	Gr.	Pág.
Transmissão por correia							102806	2-10	1
Fig.	Peça Nº.		Notas		Qtde.		Descrição		
					A	B	C	D	

1 1372544 L=1700mm

2 Correia em V

2 veja : 16-05

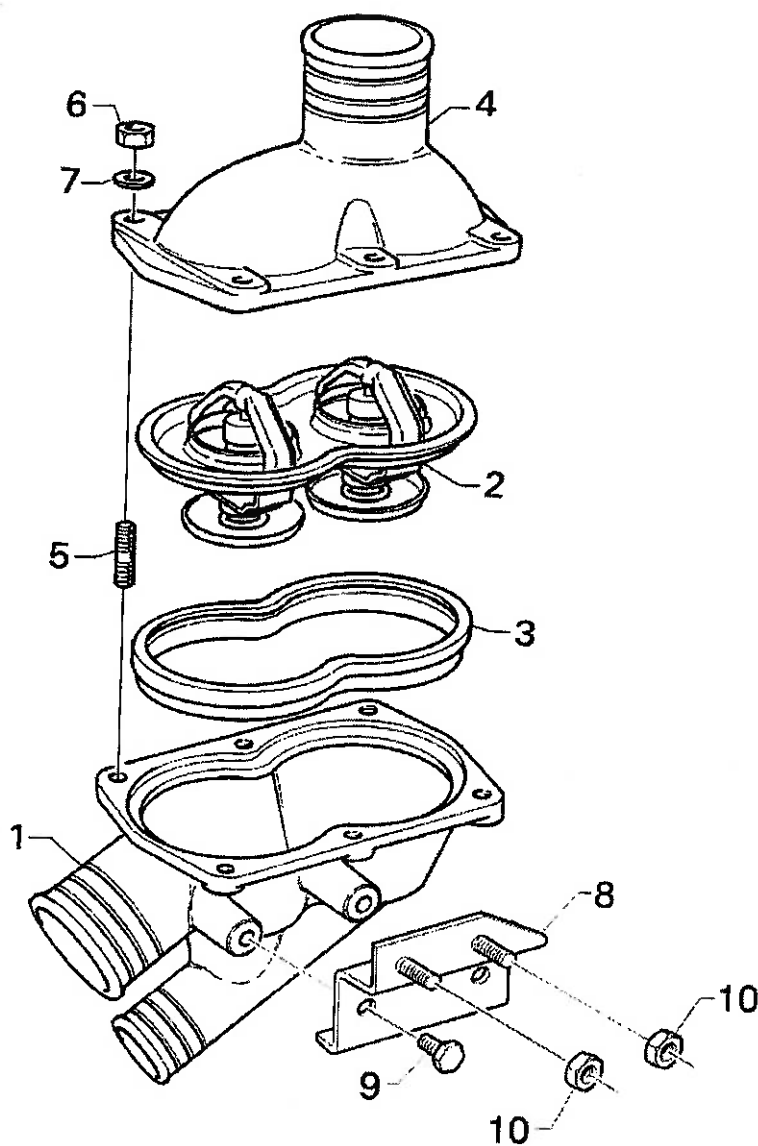
Alternador

3 veja : 2-25

Bomba de água

Sistema de arrefecimento
Carcaça do termostato

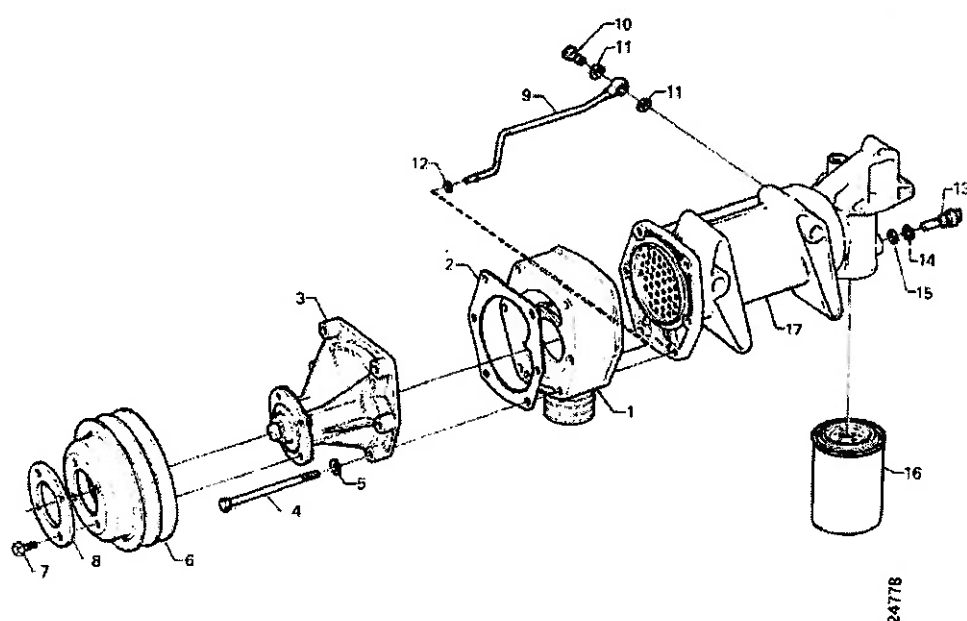
Desenho	Gr.	Pág.
025401	2-15	1



25401

Sistema de arrefecimento
Bomba de água, montagem

Desenho	Gr.	Pág.
024778	2-25	1



24778

Sistema de alimentação e escape

Bomba injetora, tubo de pressão

DSC9 11

Desenho

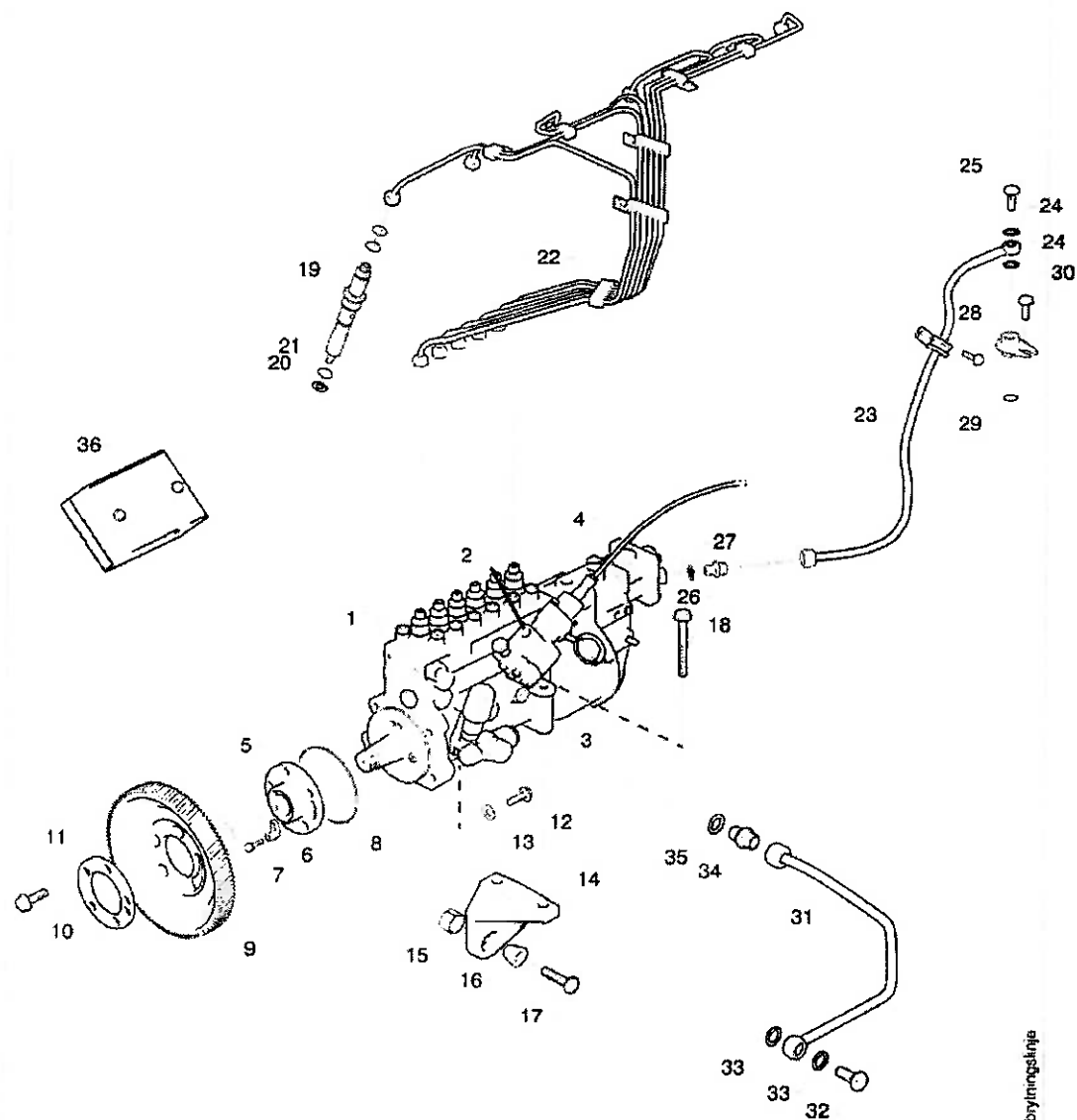
Gr.

Pág.

102626

3-01

1



102626

Ombryttingslinje

Sistema de alimentação e escape
Bomba injetora, tubo de pressão
DSC9 11

Desenho	Gr.	Pág.
102626	3-01	1

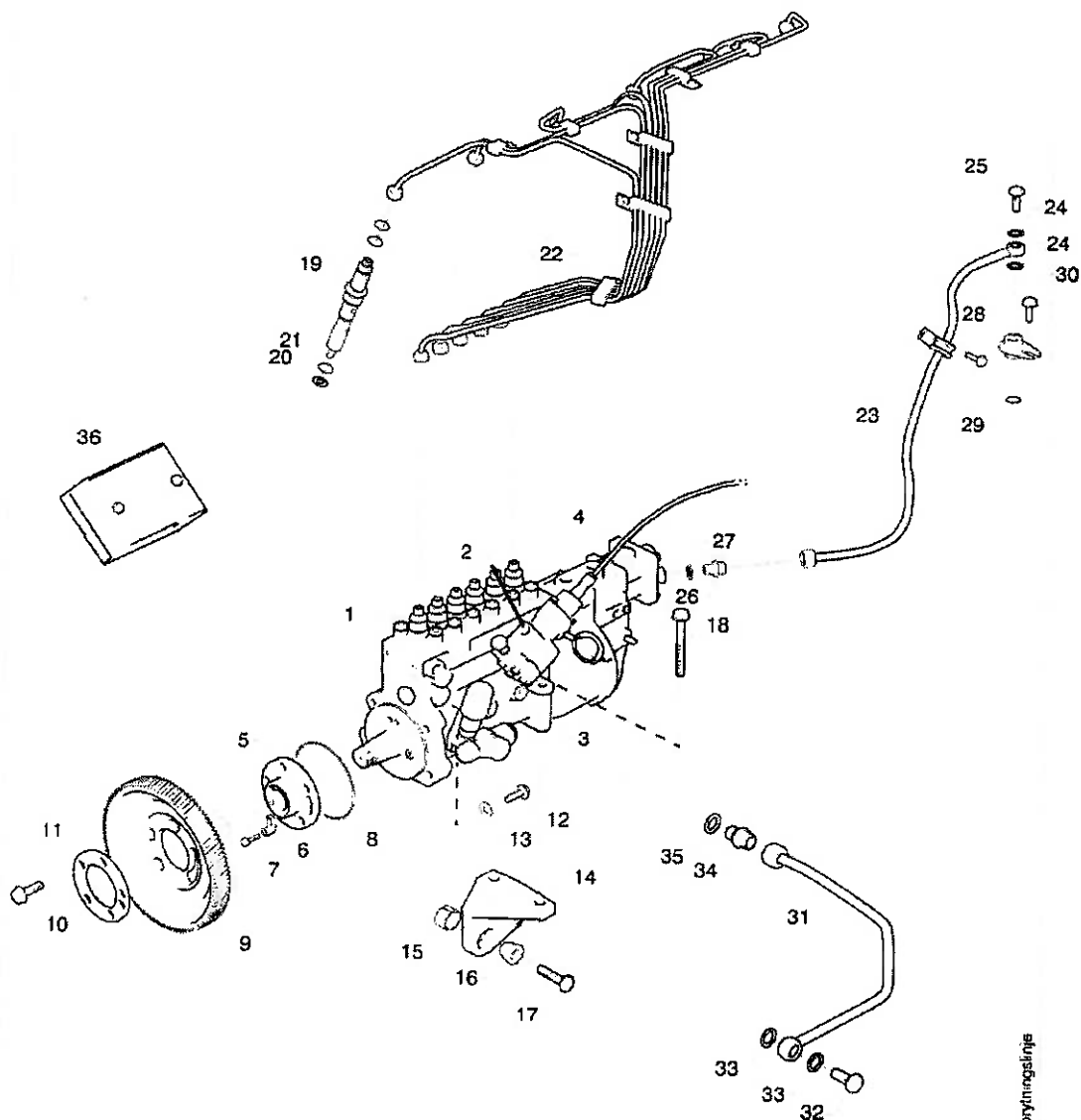
Fig.	Peça N°.	Notas	Qtde.				Descrição
			A	B	C	D	
1	1369545	☐ Assy	1				Bomba injetora
	574186	Assy Exchange unit	1				Bomba injetora
		Nss veja : 3-01	1				Bomba injetora
2	1368171	veja : 3-01	1				Válvula solenóide
	1395941	(1386854)	2				Anel de vedação-O
3		Nss. veja : 3-01	1				Regulador centrífugo
4		Nss	1				Limitador de fumaça
	1375493	Assy	1				Bomba de alimentação
	1384501		1				Bomba manual
5		Assy. nss	1				Cubo
6	1337756		1				Arruela de ajuste
7	812500	M6x12	1				Parafuso flangeado
8	1385350		1				Anel de vedação-O
9	1350720		1				Engrenagem da bomba injetora
10	394587	M12x30	5				Parafuso sextavado
11	1339052		1				Arruela
12	814825	M10x45	4				Parafuso
13	1358193		4				Arruela
14	1380173		1				Suporte
15	1327438		1				Cone
16	1327439		1				Cone
17	815050	M12x40	1				Parafuso flangeado
18	812548	M10x90	2				Parafuso flangeado
19	1383222	☒ Assy	6				Injetor
	574355	Assy Exchange unit	6				Injetor
			6				Suporte
			6				Bico injetor
20	170424	K	6				Junta
21	249928	K	6				Retentor
22	1373854	Assy. EN-5122648 SSS					Tubo de pressão
		EN-4025463 SNL					
		Nss	1				Tubo de pressão
		Nss	1				Tubo de pressão
		Nss	1				Tubo de pressão
		Nss	1				Tubo de pressão

Sistema de alimentação e escape

Bomba injetora, tubo de pressão

DSC9 12

Desenho	Gr.	Pág.
102626	3-01	1



102626

Ombrynnaglinje

Sistema de alimentação e escape
Bomba injetora, tubo de pressão
DSC9 12

Desenho

Gr.

Pág.

102626

3-01

1

Fig.	Peça Nº.	Notas	Qtde.				Descrição
			A	B	C	D	
1	1369528	☐ Assy	1				Bomba injetora
	574187	Assy Exchange unit	1				Bomba injetora
		Nss veja : 3-01	1				Bomba injetora
2	1368171	veja : 3-01	1				Válvula solenóide
	1395941	(1386854)	2				Anel de vedação-O
3		Nss. veja : 3-01	1				Regulador centrífugo
4		Nss	1				Limitador de fumaça
	1375493	Assy	1				Bomba de alimentação
	1384501		1				Bomba manual
5		Assy. nss	1				Cubo
6	1337756		1				Arruela de ajuste
7	812500	M6x12	1				Parafuso flangeado
8	1385350		1				Anel de vedação-O
9	1350720		1				Engrenagem da bomba injetora
10	394587	M12x30	5				Parafuso sextavado
11	1339052		1				Arruela
12	814825	M10x45	4				Parafuso
13	1358193		4				Arruela
14	1380173		1				Suporte
15	1327438		1				Cone
16	1327439		1				Cone
17	815050	M12x40	1				Parafuso flangeado
18	812548	M10x90	2				Parafuso flangeado
19	1379460	☒ Assy	6				Injetor
	574363	Assy	6				Injetor
			6				Suporte
			6				Bico injetor
20	170424	K	6				Junta
21	249928	K	6				Retentor
22	1373854	Assy. EN-5122648 SSS					Tubo de pressão
		EN-4025463 SNL					
		Nss	1				Tubo de pressão
		Nss	1				Tubo de pressão
		Nss	1				Tubo de pressão
		Nss	1				Tubo de pressão

Sistema de alimentação e escape

Bomba injetora, tubo de pressão

DSC9 15

Desenho

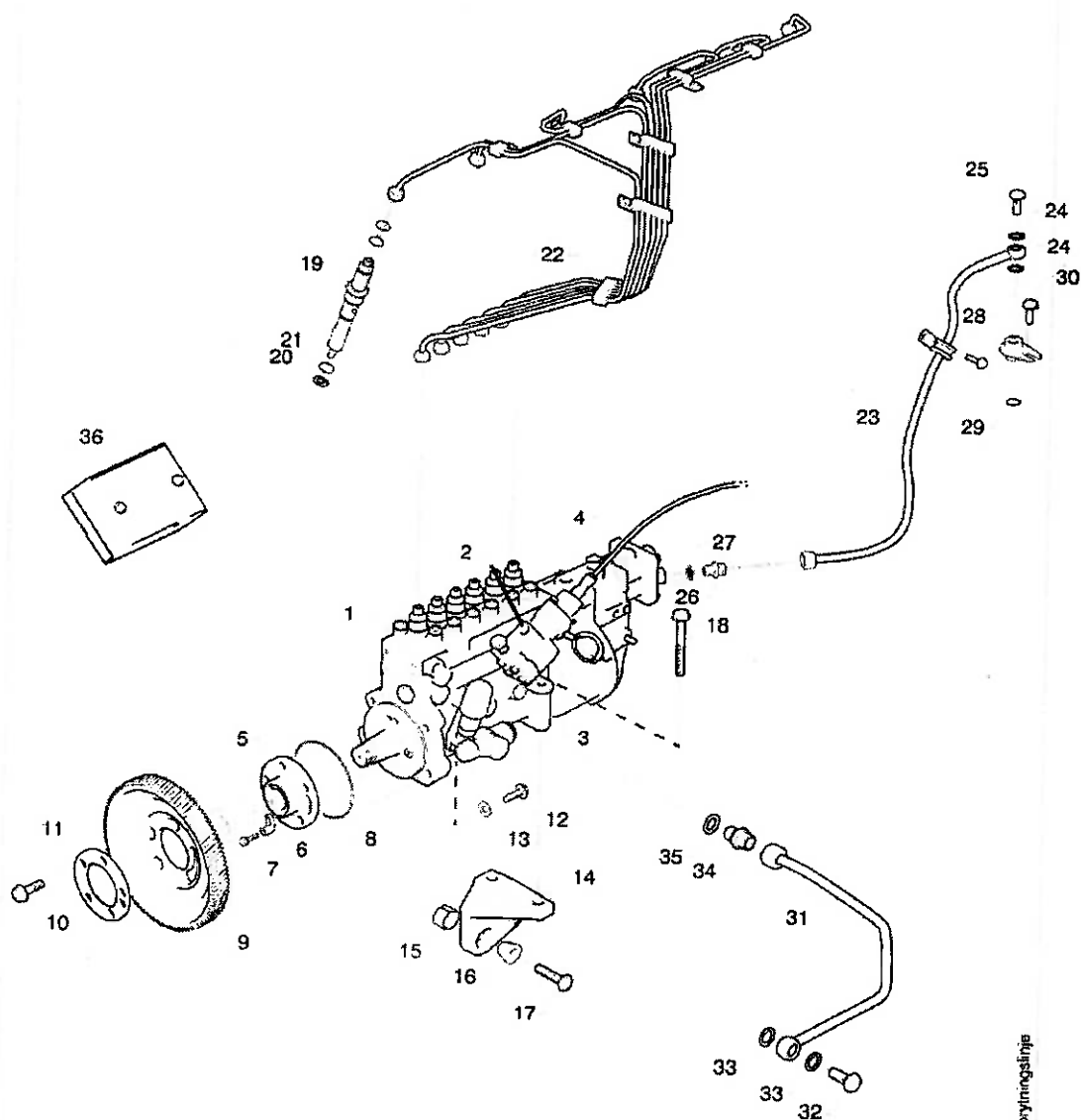
Gr.

Pág.

102626

3-01

1



102626

Ombryningslinje

Sistema de alimentação e escape
Bomba injetora, tubo de pressão
DSC9 15

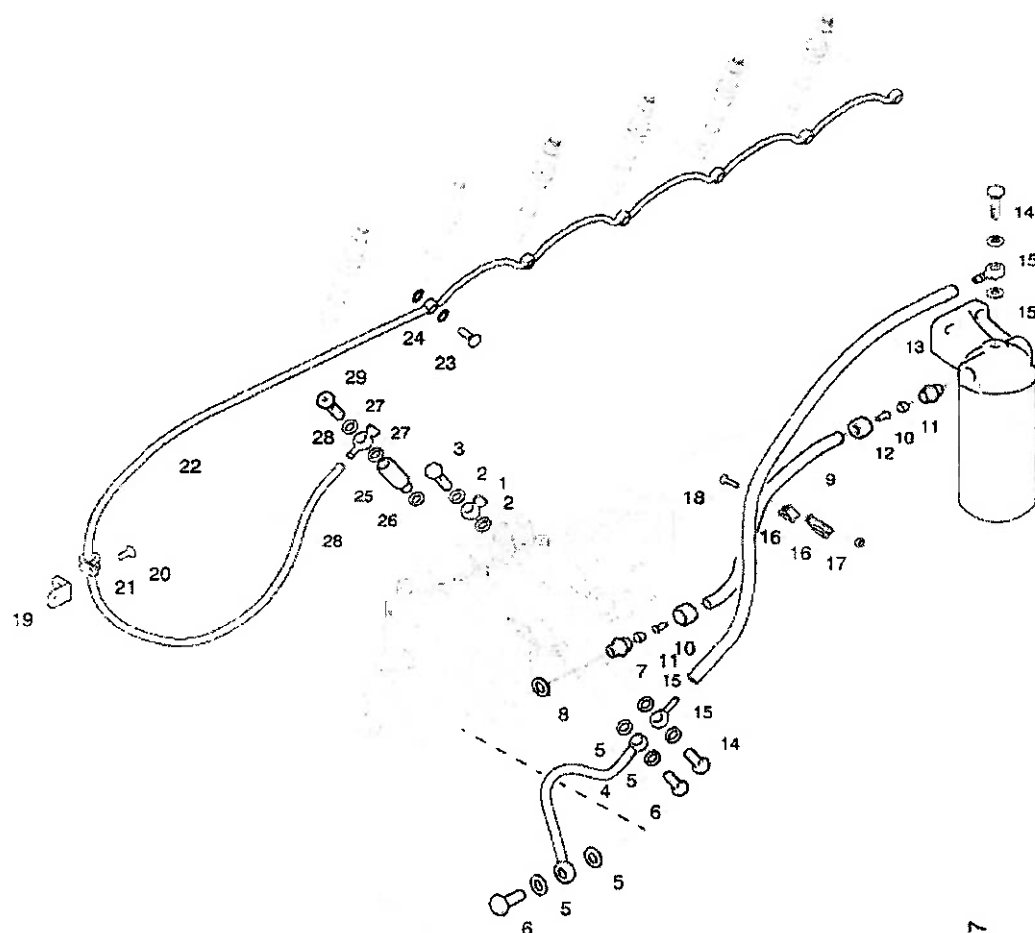
Desenho	Gr.	Pág.
102626	3-01	1

Fig.	Peça N°.	Notas	Qtde.				Descrição
			A	B	C	D	
1	1383494	Assy RS8038	1				Bomba injetora
		Nss veja : 3-01	1				Bomba injetora
2	1368171	veja : 3-01	1				Válvula solenóide
	1395941		2				Anel de vedação-O
3		Nss. RQV250-1000PA1239-3 veja : 3-01	1				Regulador centrífugo
4		Nss	1				Limitador de fumaça
	1375493	Assy	1				Bomba de alimentação
	1384501		1				Bomba manual
5		Assy. nss	1				Cubo
6	1337756		1				Arruela de ajuste
7	812500	M6x12	1				Parafuso flangeado
8	1385350		1				Anel de vedação-O
9	1350720		1				Engrenagem da bomba injetora
10	394587	M12x30	5				Parafuso sextavado
11	1339052		1				Arruela
12	814825	M10x45	4				Parafuso
13	1358193		4				Arruela
14	1380173		1				Suporte
15	1327438		1				Cone
16	1327439		1				Cone
17	815050	M12x40	1				Parafuso flangeado
18	812548	M10x90	2				Parafuso flangeado
19	1339918	☐ Assy	6				Injetor
	574362	Assy	6				Injetor
			6				Suporte
			6				Bico injetor
20	170424	K	6				Junta
21	249928	K	6				Retentor
22	1373854	Assy. EN-5122648 SSS					Tubo de pressão
		EN-4025463 SNL					
		Nss	1				Tubo de pressão
		Nss	1				Tubo de pressão
		Nss	1				Tubo de pressão
		Nss	1				Tubo de pressão
		Nss	1				Tubo de pressão

Desenho	Gr.	Pág.
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Sistema de alimentação e escape
 Conjunto filtro de combustível, tubo de combustível
 DSC9

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102627

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Sistema de alimentação e escape

Conjunto filtro de combustível, tubo de combustível

DSC9

Desenho

Gr.

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102627

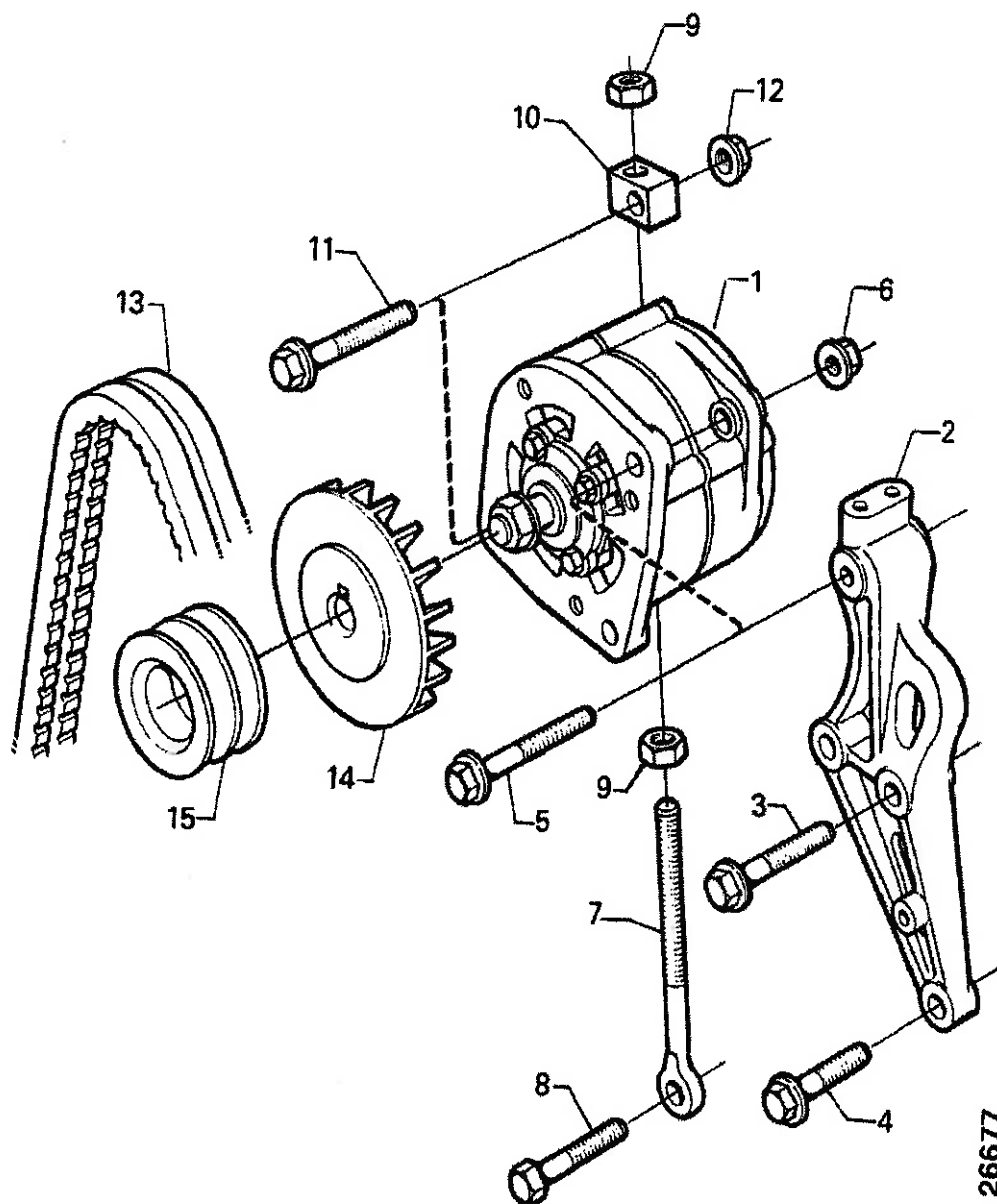
3-05

1

Fig.	Peça Nº.	Notas	Qtde.				Descrição
			A	B	C	D	
1	1351470		1				Nípel banjo
2	1374845	K	2				Vedação
3	812390	M14x1.5	1				Parafuso banjo
4	1370358		1				Tubo de combustível
5	1374845	K	4				Vedação
6	812390	M14x1.5	2				Parafuso banjo
7	1358748		1				União reta
8	1373792	K	1				Vedação
9	813869	L=670 mm Ø12x1.5	1				Tubo de plástico
10	812913	Ø 12	2				Inserto
11	813223	Ø 12	2				Anel de penetração
12	814555	Ø 12	2				Porca de união
13	1341303		1				Tubo de combustível
	1369877		1				Nípel banjo
	1358973		1				Nípel banjo
14	1374042		1				Parafuso banjo
	812391	M16x1,5	1				Parafuso banjo
15	1374845	K	2				Vedação
	1374846	K	2				Vedação
16	293098	Ø12	1				Trinco
17	815132	M8	1				Porca flangeada
18	812516	M8x20	1				Parafuso flangeado
19	1393370		1				Suporte
20	812502	M6x16	2				Parafuso flangeado
21	813933	Ø 6	1				Braçadeira
22	1341301		1				Tubo de retorno
23	17146		6				Parafuso banjo
24	1374842	K	12				Vedação
25	1355724		1				União reta
26	1373792	K	1				Vedação
27	1374845	K	2				Vedação
28	1358742		1				Nípel banjo
29	1358496		1				Válvula de alívio

Sistema eléctrico
Alternador, montagem

Desenho	Gr.	Pág.
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Sistema eléctrico				Desenho	Gr.	Pág.
Alternador, montagem				026677	16-05	1

Fig.	Peça N°.	Notas	Qtde.				Descrição
			A	B	C	D	

1							Alternador
		veja : 16-05					
		veja : 16-05					
2	1390239		1				Suporte
3	815859	M12x140	1				Parafuso flangeado
4	815057	M12x80	1				Parafuso flangeado
5	815733	M10x130	1				Parafuso flangeado
6	815615		1				Porca autotravante
7	374291	M12	1				Parafuso com olhal
8	812549	M10x100	1				Parafuso flangeado
9	815125	M12	2				Porca sextavada
10	338213	M12	1				Tensor
11	812541	M10x50	1				Parafuso flangeado
12	815615		1				Porca autotravante
13	1372544	L=1700mm	2				Correia em V
14	1356608	65A	1				Ventilador
15	333653	2 grooves	1				Polia

Sistema eléctrico
Alternador, montagem
AC

Desenho

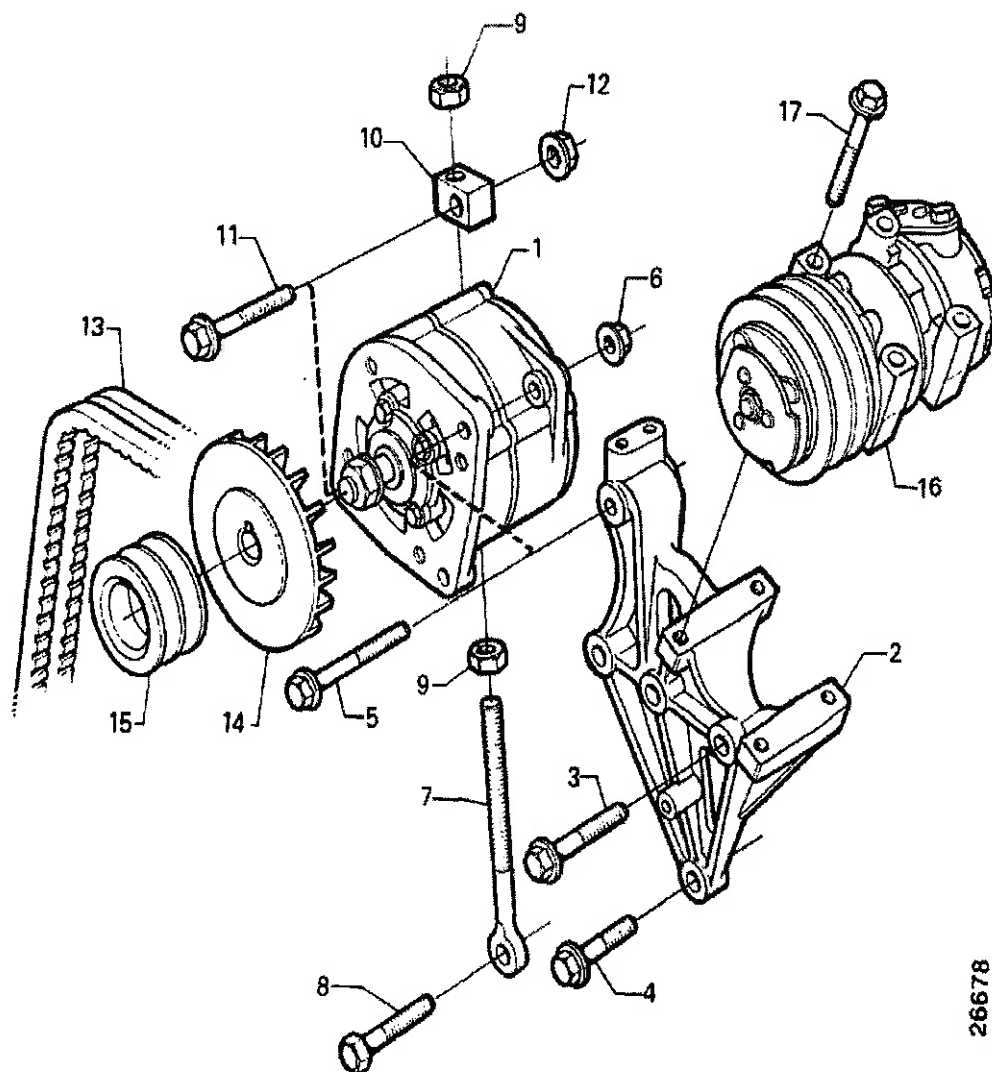
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Sistema eléctrico

Motor de partida, com peças de montagem

Desenho

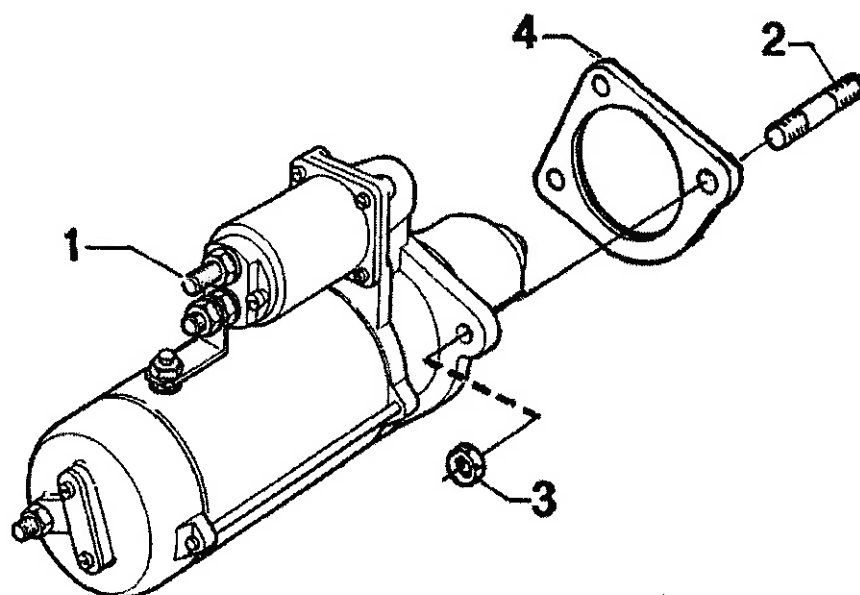
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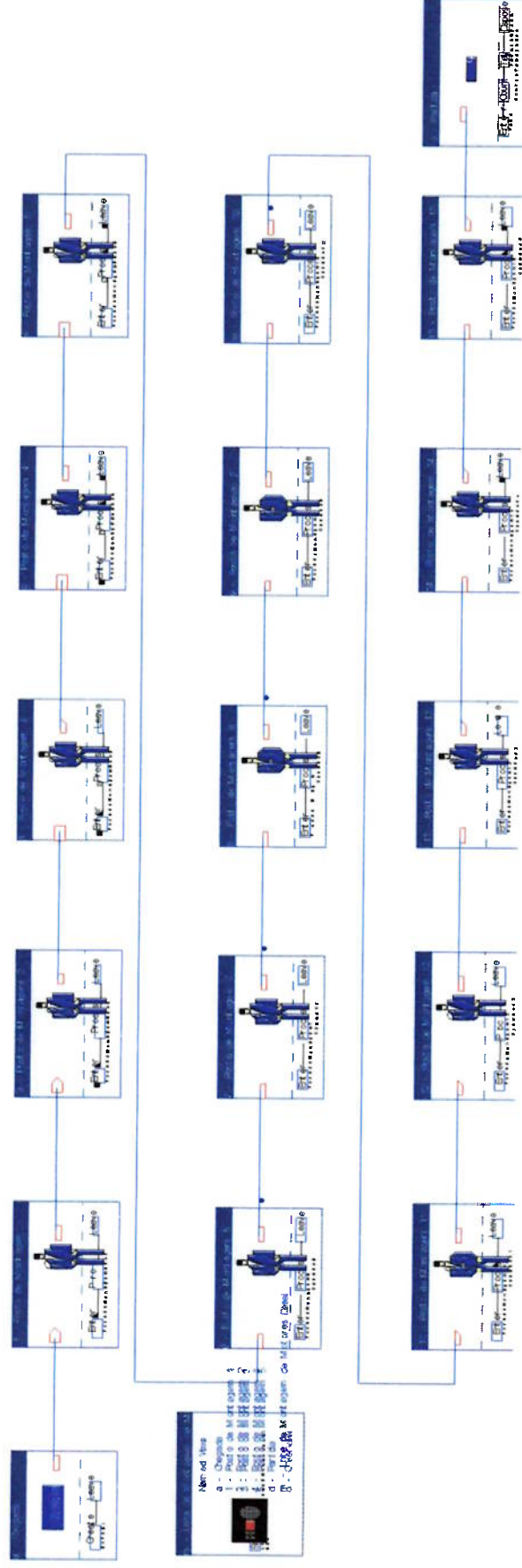
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APÊNDICE 7

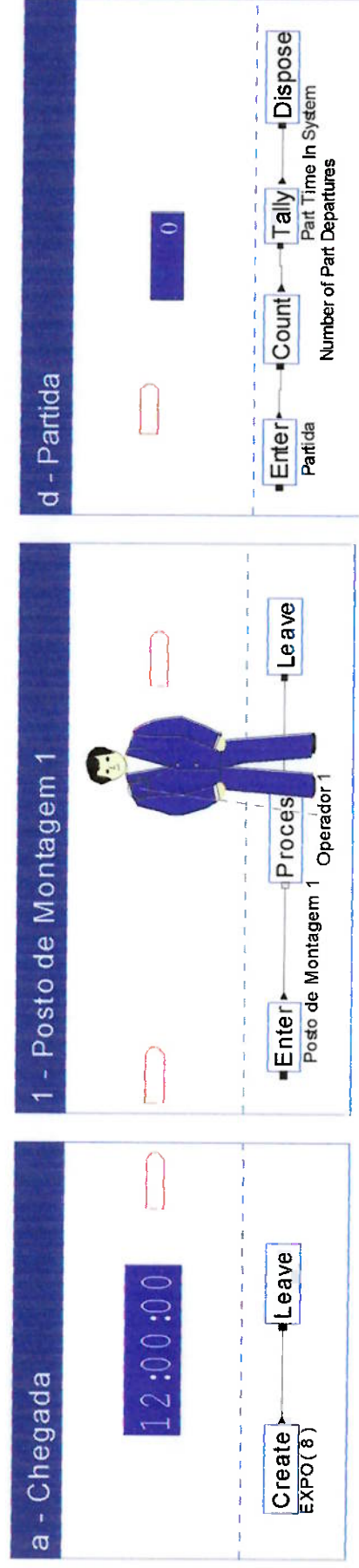
Modelo Funcional - Simulação de Montagem

Modelo Utilizado para Simulação de Montagem através do Programa ARENA

Linha de Montagem de Motores Diesel
Orlton Miro



Blocos Utilizados no Programa ARENA



ARENA Simulation Results
Marco Antonio Infantozzi - License #9400000

Summary for Replication 1 of 1

Project: Linha de Montage Run execution date : 12/19/1998
Analyst: Carlson Marco Model revision date: 12/12/1998

Replication ended at time : 600.0
Statistics were cleared at time: 120.0
Statistics accumulated for time: 480.0

TALLY VARIABLES

Identifier	Average	Half Width	Minimum	Maximum	Observations
Operador 6_Q Queue Tim	2.2410	(Insuf)	.00000	10.212	58
Operador 7_Q Queue Tim	.02631	(Insuf)	.00000	.55233	58
Operador 8_Q Queue Tim	.19173	(Insuf)	.00000	1.9642	58
Part Time In System	163.55	(Insuf)	112.10	227.93	56
Operador 9_Q Queue Tim	2.8503	(Insuf)	.00000	9.3148	57
Operador 1_Q Queue Tim	62.687	(Insuf)	.00000	132.75	60
Operador 10_Q Queue Ti	.31626	(Insuf)	.00000	2.1144	57
Operador 11_Q Queue Ti	.77515	(Insuf)	.00000	3.9097	57
Operador 12_Q Queue Ti	.68159	(Insuf)	.00000	6.1732	57
Operador 2_Q Queue Tim	.01148	(Insuf)	.00000	.26652	60
Operador 13_Q Queue Ti	1.9744	(Insuf)	.00000	6.7352	57
Operador 3_Q Queue Tim	.14644	(Insuf)	.00000	2.6023	59
Operador 4_Q Queue Tim	2.1062	(Insuf)	.00000	9.2255	60
Operador 14_Q Queue Ti	.12538	(Insuf)	.00000	2.0681	57
Operador 15_Q Queue Ti	1.0767	(Insuf)	.00000	6.1305	56
Operador 5_Q Queue Tim	4.6905	(Insuf)	.00000	12.574	60

DISCRETE-CHANGE VARIABLES

Identifier	Average	Half Width	Minimum	Maximum	Final Value
Operador 13 Busy	.93520	(Insuf)	.00000	1.0000	1.0000
Operador 5 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
Operador 6 Busy	.96214	(Insuf)	.00000	1.0000	1.0000
# in Operador 5_Q	.58632	(Insuf)	.00000	2.0000	.00000
Operador 12 Busy	.89362	(Insuf)	.00000	1.0000	1.0000
Operador 4 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
# in Operador 4_Q	.26122	(Insuf)	.00000	2.0000	.00000
Operador 5 Busy	.98712	(Insuf)	.00000	1.0000	1.0000
Operador 4 Busy	.96885	(Insuf)	.00000	1.0000	1.0000
Operador 11 Busy	.89061	(Insuf)	.00000	1.0000	1.0000
Operador 3 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
# in Operador 3_Q	.01800	(Insuf)	.00000	1.0000	.00000

Operador 3 Busy	.73472	(Insuf)	.00000	1.0000	1.0000
Operador 10 Busy	.84403	(Insuf)	.00000	1.0000	1.0000
# in Operador 15_Q	.12561	(Insuf)	.00000	1.0000	.00000
# in Operador 2_Q	.00143	(Insuf)	.00000	1.0000	.00000
Operador 2 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
Operador 1 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
Operador 2 Busy	.75284	(Insuf)	.00000	1.0000	1.0000
# in Operador 14_Q	.01489	(Insuf)	.00000	1.0000	.00000
# in Operador 1_Q	9.0406	(Insuf)	.00000	17.000	12.000
Operador 1 Busy	.99571	(Insuf)	.00000	1.0000	1.0000
# in Operador 13_Q	.23446	(Insuf)	.00000	1.0000	.00000
# in Operador 12_Q	.08094	(Insuf)	.00000	1.0000	.00000
Operador 15 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
# in Operador 11_Q	.09205	(Insuf)	.00000	1.0000	.00000
Operador 14 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
# in Operador 10_Q	.03756	(Insuf)	.00000	1.0000	.00000
Operador 13 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
Operador 12 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
Operador 11 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
Operador 10 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
Operador 9 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
# in Operador 9_Q	.34165	(Insuf)	.00000	2.0000	1.0000
Operador 8 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
Operador 9 Busy	.97345	(Insuf)	.00000	1.0000	1.0000
# in Operador 8_Q	.02317	(Insuf)	.00000	1.0000	.00000
Operador 15 Busy	.91477	(Insuf)	.00000	1.0000	1.0000
Operador 7 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
Operador 8 Busy	.82565	(Insuf)	.00000	1.0000	1.0000
# in Operador 7_Q	.00318	(Insuf)	.00000	1.0000	.00000
Operador 14 Busy	.80485	(Insuf)	.00000	1.0000	1.0000
Operador 6 Available	1.0000	(Insuf)	1.0000	1.0000	1.0000
Operador 7 Busy	.72016	(Insuf)	.00000	1.0000	.00000
# in Operador 6_Q	.29054	(Insuf)	.00000	2.0000	2.0000

COUNTERS

Identifier	Count	Limit
Number of Part Departu	56	Infinite

Simulation run time: 1.08 minutes.
Simulation run complete.