A.J. Elliott

NONFLAMMABLE HYDRAULIC POWER SYSTEM FOR TACTICAL AIRCRAFT

ADP NEWSLETTER

Vol. 3 No. 2 FRIDAY, JULY 14, 1989 Edited by - Jim Sheahan

CTFE, 40 GPM, 8000 PSI, PUMP TESTING

Garrett has completed 25 hours of operation with CTFE as of 7 July. They are making good progress towards solving a wear surface erosion problem. Testing of Abex's latest configuration is expected by mid July. Two Abex AP6VHP 15 gpm variable pressure pumps have been received. The two remaining pumps are expected by 17 July. Vickers test of their latest CTFE configuration is still expected in late July. Lucas Aerospace has received new check valves and are currently finishing up a new barrel with needed strength modifications. Delivery of this pump is expected by the end of Oct. `89.

DELIVERIES & BILLING STATUS

The attached table summarizes items with incomplete delivery and/or billing for ADP suppliers. MCAIR will update this frequently for the next several months until our delivery and billing problems are resolved. If your company has delivered and/or invoiced since the newsletter was published last, please be patient, due credit will be provided in the next newsletter. Delivery reflects recent last promise date. Some promise dates have been missed already.

CTFE TOXICITY RESULTS

The Air Force has drawn some conclusions from toxicity studies of CTFE and other conventional hydraulic fluids. Rodents have been used for most testing and have shown liver damage with CTFE and kidney damage with MIL-H-5606 and MIL-H-83282. It is believed by the Air Force researchers however, that rodent response is not a reliable predictor of human response since CTFE experiments with primates did not produce liver toxicity. The following was taken from an executive summary; "CTFE should not cause a significantly increased hazard compared to other fluids. CTFE and other hydraulic fluids do need to be handled prudently with appropriate industrial hygiene precautions taken to minimize inhalation exposure as well as skin contact."

They further suggest, only as a guideline, that an 8 hour time weighted average (TWA) exposure limit of 2.5 ppm should provide appropriate health protection to exposed personnel. This recommendation could be greatly changed by new data, further scientific review or Federal regulatory action.

THIS NEWSLETTER IS NOT A MEANS OF ADVERTISING

Anything printed in this document is for the sole purpose of aid to and advancement of the NONFLAMMABLE (8000 psi) HYDRAULICS PROGRAM

MAJOR ADP EQUIPMENT STATUS
INCOMPLETE DELIVERY and/or BILLING

COMPANY	COMPONENT	JULY EST'D DELIVERY DATES	% BILLED
APM	FILTER PACKAGE	Delivered	91%
E-SYSTEMS	STABILATOR	Delivered	82%
MOOG	FLAPERON	Shipped 14-July	N/A
	CONVERGENT NOZZLE	21-July	N/A
	DIVERGENT NOZZLE	04-Aug	N/A
CADILLAC GAGE	DIFFUSER RAMP	17-July	100%
ABEX	PUMP, 40 GPM	28-Jul	73%
	HYDRAULIC MOTOR	Delivered 07-Jul	55%
	PUMP CONVERSIONS	14-Jul	25%
LUCAS AEROSPACE	PUMP, 40 GPM	30-Oct	75%
PARKER HANNIFIN	H.I.M.	09-Sep	33%
	4W-3P	05-Aug	37%
	INTENSIFIER	23-Jun ?	50%
	6W-2P	21-July	70%
	RESERVOIR	Del. (2) 7/06 4-Aug	48%
VICKERS	PUMP, 40 GPM	Feb-90	27%
BENDIX ELECTRO.	ROTARY VANE	28-July	62%
PULSCO	HYD. ATTENUATOR	Delivered 26-Jun	100%
GARRETT	PUMP, 40 GPM	28-Jul	100%
SUNDSTRAND	LEADING EDGE FLAP	25-Aug	N/A

CTFE TOXICITY AND MCAIR

A preliminary recommendation for the CTFE exposure limit of 2.5 ppm for an 8 hr. time weighted average (TWA) has been issued. MCAIR has ordered the 3M vapor monitors to help evaluate the exposure levels in our Iron Bird facility and will also be doing the following to insure the health and safety of its employees:

1. When flushing a component, rubber gloves and a splash apron should be worn.

2. In the event of a hot oil spill or vaporization of the fluid (ie. a cloud) the area will be purged by personnel wearing gloves and respirators (1/2 or full face) to clean up any spillage.

Halocarbon Products has provided MCAIR with a Material Safety Data Sheet which outlines various physical characteristics of the fluid, health hazard information and handling procedures & precautions. The data sheet is included in this newsletter a Enclosure I.

Essentially no special handling is going to be used except in the case of hot oil spills or leaks that vaporize the fluid.

ELECTRONIC CONTROLLER INTERFACE REQUIREMENTS

Five controllers have been received and are installed in the control room. We only have sufficient information for the Parker-Bertea Reverser Vane/Arc valve controller to ensure proper interface with the system and to minimize the support we would need in the event of operational anomalies. For the controllers on hand, the following information is required:

Abex 40 GPM Pump Controller -
- o All Schematics and assembly dwgs

HR Textron R/H Rudder Controller-
- o Back panel connector pin out information
- o Card edge interconnection wiring schematic (Card cage assembly wiring diagrams)
- o Actuator assembly dwgs, schematics (elec & hyd), and connector interface

E-Systems R/H Stabilator Controller -
- o All schematics and assembly dwgs
- o All actuator assembly information including the connector wiring and descriptive actuator schematic

Parker-Bertea (LECHT) Controller -
- o Controller dwg 316563-105 and 316670

All suppliers who have not yet delivered controllers should take note of the information we need and supply it with the controller so our lab personnel have it when they open the box.

MCAIR DELIVERIES

Delivery performance of supplier equipment for this program has improved, although several suppliers still have not delivered. Many others (some of whose products are exceptionally critical to our efforts) have resolved most of their problems and are now working on the assembly and test of their hardware.

This assembly must be expedited and the remaining deliveries improved to have any chance of holding to the demonstrator test schedule. Abex pumps (15 gpm) modified for variable pressure, Parker reservoirs, and Pulsco attenuators were required for turn-on and have been received. Our next critical items are the flight control actuators. These need to be tested and delivered no later than the end of July.

SSFAN/HYTRAN MODELING REQUIREMENTS

Only one supplier has responded to our request for component flow model data.

MCAIR is required, under contract, to simulate the steady state and transient performance via hydraulic system programs developed under Air Force contract, The steady state is to be modeled by SSFAN, and the transient response by HYTRAN with the frequency response by HSFR. These simulations are to match actual test data. In order to meet this requirement , we need to update our data base to include actual hardware parameters. All data provided will be treated as proprietary. The actual data sheets that we are requesting should be in Appendix A of the procurement spec. An example of the required data sheets (for a 4-way valve)is enclosed in this newsletter. If you do not have a copy of data sheets applicable to your component(s), please contact your MCAIR engineer who will send you the necessary paperwork promptly.

ROSAN LOANER TOOLS

The Rosan tools for the odd sized porting are loaner tools and are the property of the Air Force. These tools should be returned, at your earliest convienence, to the following:

McDonnell Aircraft Company
Lindberg and J.S. McDonnell Blvds.
Hazelwood MO 63042
c/o Jim Sheahan
mail code: 0341240

COMPONENT AND SYSTEM TEST HISTORY

We are requesting that these records be kept of all testing with the CTFE hydraulic fluid.

These records are needed to better understand test occurrences which may have affected the test fluid properties. The type of information to be recorded includes:

1. Test Circuit Fluid Volume:
2. Test Circuit Fluid Addition: Date
   Quantity Involved
3. Hours of Test Circuit Operation:
4. Test Circuit Temperature - Identify location point
5. All Test Circuit Changes / Modifications:
   Pumps
   Actuators
   Tubing / Hoses
   Filter Elements
   Other Components

   Dates of all changes will be recorded:
   Part Numbers, where available, will be recorded:
6. Date and Time Fluid Samples were Taken:
7. Appearance of Sample
   a. Color
   b. Clarity
   c. Large Particle

   Description
8. Location of Sampling Point in Test Circuit:
9. Test Data Your Company may have Generated on the Fluid Sample:

CTFE SAMPLES

All test programs at the suppliers should submit fluid samples at 50 hour intervals of endurance testing to monitor / maintain fluid integrity. Samples are to be submitted using "ultra-clean clear" Boston round bottles with teflon lined and sealed caps. These bottles and vertical shippers are available through your MCAIR engineering contact if required.

Fluid samples need to be fully identified with the following information:

Company Name and Point of Contact
Test System Identification
Date Sample Taken
Total Number of System Hours
Fluid Description (CTFE-MLO No.)
Location of Sample Port

Samples should be dynamic samples taken at locations away form the reservoir or filters and submitted to:

Wright Research & Development Ctr.
Aero Propulsion & Power Laboratory
WRDC/POOS
Attn: P.G. Colegrove
Wright Patterson AFB, OH
45433

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SPECIAL EDITION FRIDAY, JULY 14, 1989

ENCLOSURE 1

MATERIAL SAFETY DATA SHEET

ENCLOSURE 2

SSFAN / HYTRAN DATA SHEETS

Four-Way

Four-way valves (Figure 26) are the components generally used to control reversible utility functions in aircraft hydraulic systems. As illustrated by the SSFAN operating code, Figure 27, a single four-way valve can be used to command an actuator (or group of actuators) to either extend, retract, or hold their position.

The utility four-way valves that have been modelled in HYTRAN thus far are usually full-trail configuration valves. As such, when the valve spool is in the null position (position = 0.0), the pressure port is blocked and both cylinder ports are connected to return (Figure 28). Such a valve prevents possible hardware damage that can result if pressure is applied to one side of an unequal area actuator before the other side is ported to return, or when thermal expansion or contraction of the subsystem fluid does not have a relief path.

As with the two-way and three-way valves, data presentation for the four-way valve in Figures 29 and 30 consists of data parameters that have been used to model specific F-18 and F-15 valves in HYTRAN and SSFAN. No four-way valve exists in HSFR, but it can be approximated by combinations of two-way valves. See Section 6a for a discussion of two-way valve simulation in HSFR.

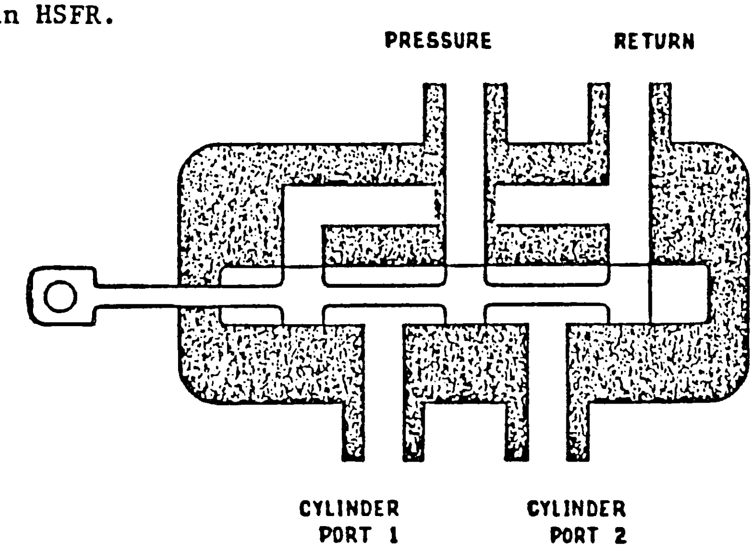
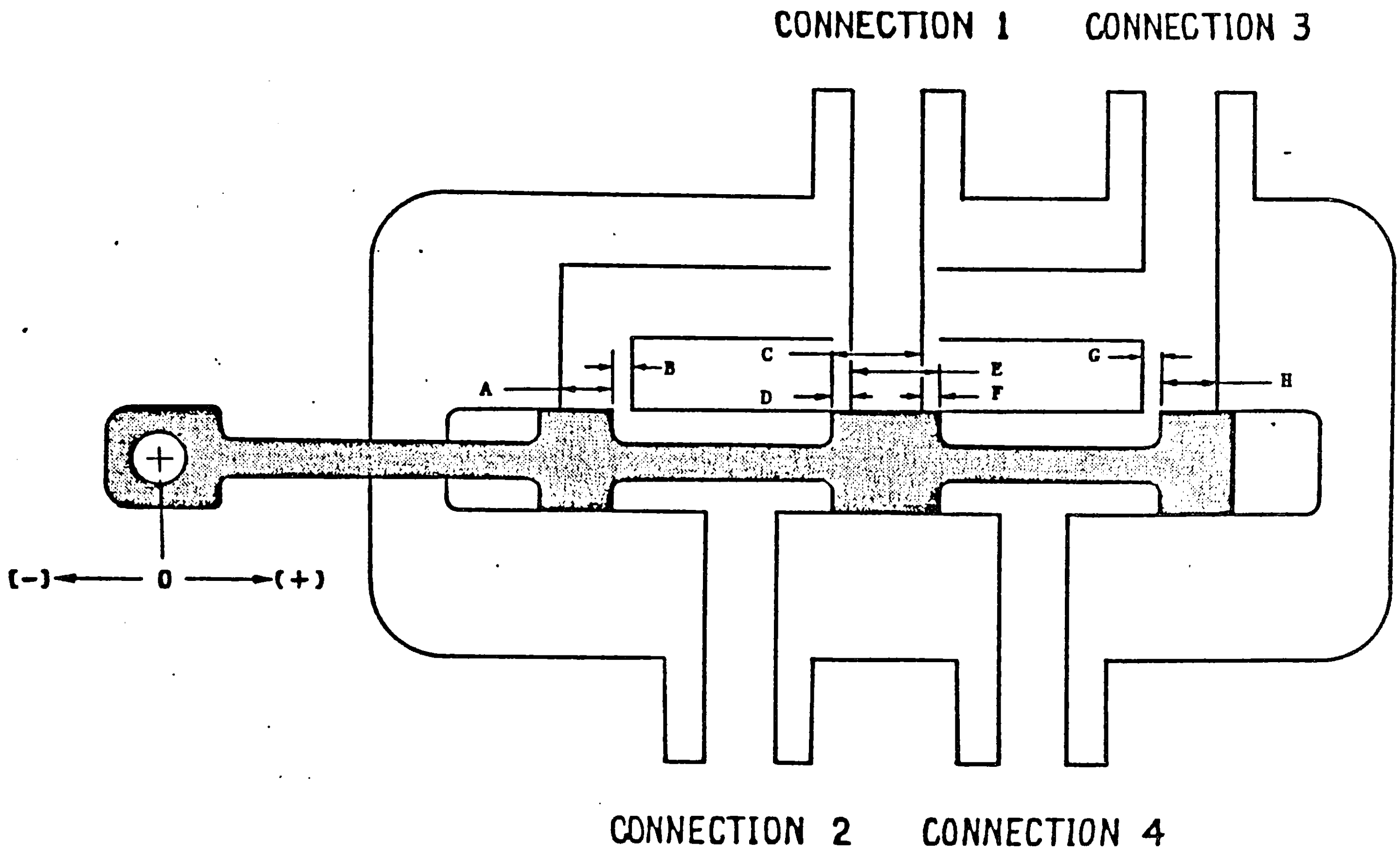


FIGURE 26 ZERO LAP, FOUR-WAY VALVE



	Units
Con. 1-2 Projected Cutoff (D)	IN
Con 1-2 Projected Max. Opening (C)	IN
Con 1-2 Max Effective Valve Area	IN^2
Con 1-2 Characteristic Curvature	-
Con 2-3 Projected Cutoff (B)	IN
Con 2-3 Projected Max Opening (A)	IN
Con 2-3 Max Effective Valve Area	IN^2
Con 2-3 Characteristic Curvature	-
Con 3-4 Projected Cutoff (G)	IN
Con 3-4 Projected Max Opening (H)	IN
Con 3-4 Max Effective Valve Area	IN^2
Con 3-4 Characteristic Curvature	-
Con 1-4 Projected Cutoff (F)	IN
Con 1-4 Projected Max Opening (E)	IN
Con 1-4 Max Effective Valve Area	IN^2
Con 1-4 Characteristic Curvature	-

Figure 30 HYTRAN Four-Way Valve Data

Element Type: Four-Way Control Valve (Continued)

Program	SSFAN		HYTRAN
Element Type	34		22

Data Parameter	Dimensions			
Con #3-4 Max Effective Valve Area	IN^2			
Con #3-4 Characteristic Curvature Coefficient	- 2			
Con #4-1 Projected Cutoff Position	IN			
Con #4-1 Projected Max Open Pos.	IN			
Con #4-1 Max Effective Valve Area	IN^2			
Con #4-1 Characteristic Curvature Coefficient	- 2			
Valve Position Table	IN			1
Valve Time Table	SEC			1

Notes: 1 Dependent on Simulation

2 See Figure 6.22-3

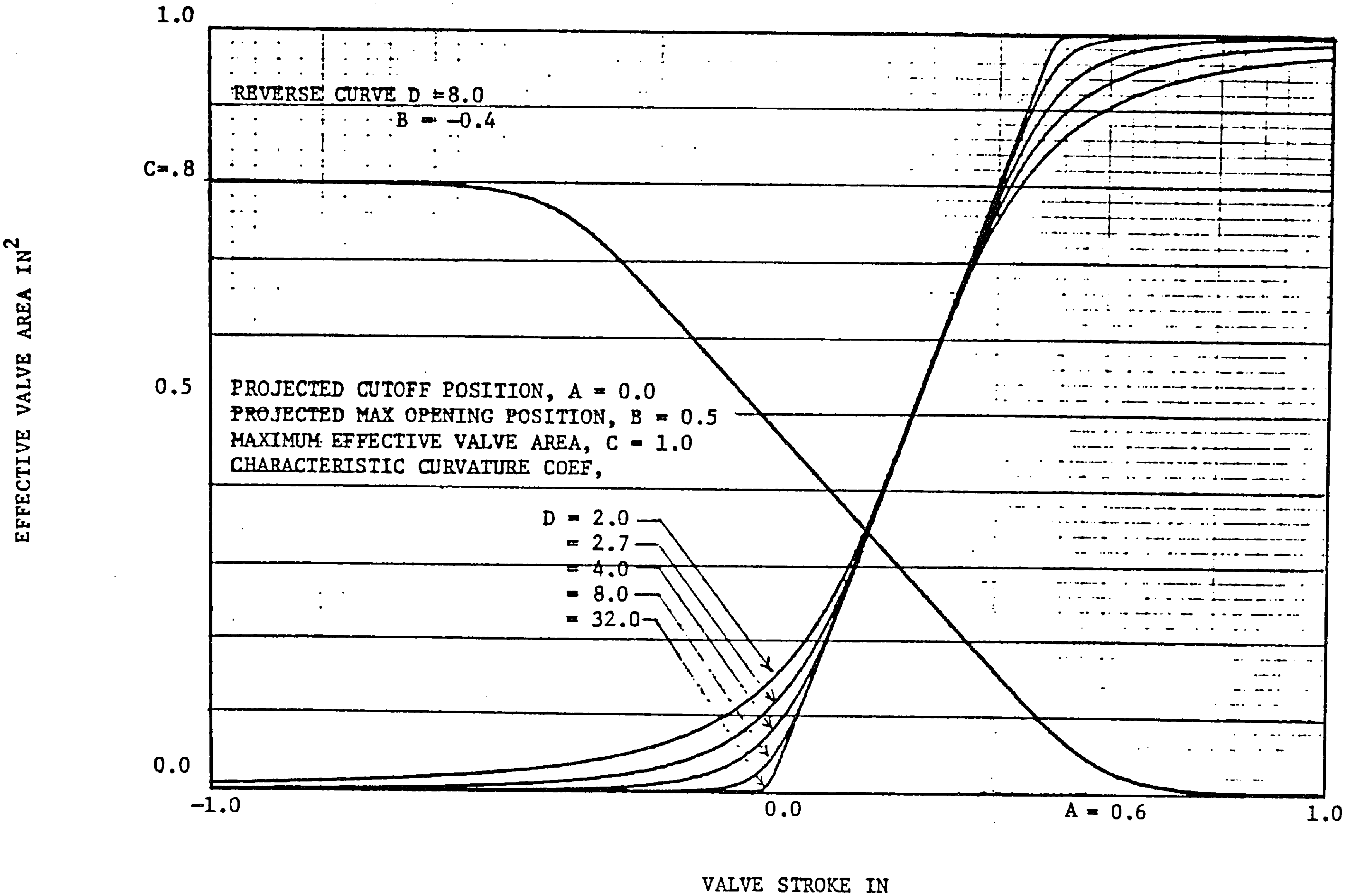


FIGURE 6.22-3
EFFECTIVE VALVE AREA CHARACTERISTICS

Element Type: Four-Way Control Valve

	Program	SSFAN		HYTRAN
	Element Type	34		22
Data Parameter	**Dimensions**			
Pressure Port Size	IN or Dash #			
Return Port Size	IN or Dash #			
Cylinder Port #1 Size	IN or Dash #			
Cylinder Port #2 Size	IN or Dash #			
Rated Flow from "Pressure" to Either "Cylinder" Port	GPM			
Rated Pressure Drop for Rated Flow	PSI			
Fluid Viscosity for Rated Conditions	CENTISTOKES			
Leakage from "Pressure" to Either Cylinder Port (Valve Closed)	GPM			
Pressure Drop for Rated Leakage	PSI			
Operating Control Code	-	△1		
Con #1-2 Projected Cutoff Position	IN			
Con #1-2 Projected Max Open Pos.	IN			
Con #1-2 Max Effective Valve Area	IN^2			
Con #1-2 Characteristic Curvature Coefficient △2	-			
Con #2-3 Projected Cutoff Position	IN			
Con #2-3 Projected Max Open Pos.	IN			
Con #2-3 Max Effective Valve Area	IN^2			
Con #2-3 Characteristic Curvature Coefficient △2	-			
Con #3-4 Projected Cutoff Position	IN			
Con #3-4 Projected Max Open Pos.	IN			

MATERIAL SAFETY DATA SHEET

Halocarbon Products Corporation
82 Burlews Court
Hackensa[redacted]ey 07601

SECTION I. MATERIAL IDENTIFICATION

Name: Chlorotrifluoroethylene Telomer
Trade Name: Halocarbon 3.1 Oil; Safetol® Hydraulic Fluid
CAS No.: 9002-83-9
Formula: $(CF_2CFCl)_n$
Chemical Family: Chlorofluorocarbon

SECTION II. INGREDIENTS AND HAZARDS

Chlorotrifluoroethylene telomer mixture

Under normal conditions of use this is not a hazardous material as defined in 29 CFR 1910.1200C

SECTION III. PHYSICAL DATA

Colorless oil mixture
Vapor Pressure <u>ca</u> 1 mm Hg (70°F)
Solubility in Water Negligible
Specific Gravity $(H_2O=1)$ <u>ca</u> 2.0

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	LOWER	UPPER
None	Not determined	None		

Remove containers from fire area if safe to do so. Thermal decomposition products may be toxic and corrosive. Firefighters should use self-contained respirators if there is danger of leakage. Use extinguishing method suitable for surroundings.

SECTION V. REACTIVITY DATA

Can react with metals such as sodium and potassium.

Avoid contact with aluminum threaded connections where galling and seizure may initiate reaction. Reacts with amines, liquid fluorine and liquid chlorine trifluoride.

SECTION VI. HEALTH HAZARD INFORMATION

Halocarbon oils are non-toxic by acute dermal toxicity studies. Acute inhalation toxicity studies show that the oil is non-toxic at its ambient vapor pressure at 25°C (77°F).

At higher temperatures the oil is subject to thermal cracking. Breakdown begins at 580°F (304°C) and is rapid at 620°F (327°C). Breakdown products in air are toxic, acid substances.

While there are no known conditions or symptoms arising from over-exposure through skin or eye contact, inhalation or ingestion, the following first-aid measures are recommended:

Inhalation:	None normally required
Skin:	Wash with soap and water
Eyes:	Immediately flush eyes with water for at least 15 minutes
Ingestion:	Dilute by drinking large quantities of water. If vomiting occurs, administer more water.

SECTION VII. SFILL, LEAK, AND DISPOSAL PROCEDURES

Spills may be picked up with an absorbent such as vermiculite and held for disposal as solid waste. Cleanup with Freon or Acetone. Disposal may be subject to State or Local regulations.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Use face shield or goggles where splashing may occur. When the oil is heated above 500°F (260°C) for long periods in open vessels, provide adequate ventilation due to the volatility of the breakdown products.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store containers in a cool, well-ventilated area.

REVISED: June 1987