

DOCKET NO: SA-510

EXHIBIT NO: 9AA

**NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.**

**PRESENTATION MATERIALS
MANFRED RUNKEL**

HYDRAULIC FLUID CONTAMINATION

PARTICULATE CONTAMINATION

SOURCES

SIZE COMPARISON

CLASSIFICATION

FILTER RATINGS

CONTAMINATION LEVELS

CONTAMINATION EFFECTS

JANUARY 1995

PARTICULATE CONTAMINATION

PARTICLES VARY IN:

- SIZE** - APPROXIMATELY 300 μm MAX.
- MATERIAL** - PLASTIC, METALS, SAND, OR CLOTH
- QUANTITY** - GENERALLY INVERSE TO SIZE
- SHAPE** - SPHERES TO FIBERS

SOURCES OF PARTICLES

- **BUILT IN TO COMPONENTS DURING FABRICATION**
- **WEAR - SLIDING / ROTATING MOTION**
- **STORAGE / TRANSFER OF FLUIDS**
- **OTHER MAINTENANCE ACTIONS**

TYPICAL SIZE COMPARISONS

FEATURE	<u>Inch</u>	<u>µm</u>
HUMAN HAIR DIAMETER (REF)	.0040	100
CONTROL VALVE SPOOL CLEARANCE	.0002	5
PUMP / PISTON CLEARANCE	.0010	25
ACTUATOR / PISTON CLEARANCE	.0040	100
T-VALVE ORIFICE	.0060	150

CLASSIFICATION OF CONTAMINATION

(NO. OF PARTICLES / 100 ml)

Size μm	CLASS (PER AS 4059)*				
	4	6	8	10	12
>5	4,860	19,500	77,900	311,000	1,250,000
>25	152	612	2,450	9,800	39,200
>50	26	106	424	1,700	6,780
>100 REF	4	16	64	256	1,024

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- NOTES:
- * STANDARD PER AS 4059 (OR NAS 1638)
 - SUPERSEDES NAS 1638
 - ACTUAL DISTRIBUTION BETWEEN SIZE RANGES VARIES

TYPICAL SYSTEM FILTER RATINGS (ABSOLUTE)

COMMERCIAL AIRCRAFT

PRESSURE : 15 μ m

RETURN FILTER : 15 μ m

PUMP CASE DRAIN : 25 μ m

ACTUATOR (T-VALVE) : 25 μ m

(REF. - MILITARY: 5 μ m)

ABSOLUTE: LARGEST SPHERICAL SHAPE PASSED THRU FILTER

CONTAMINATION LEVELS (TYPICALLY SUGGESTED)

	Class
FLUID AS RECEIVED MIL-H-XXXX	4 to 6
FLUID AS RECEIVED PHOSPHATE ESTHER TEST STANDS (ARP 810 - MIL-H-XXX)	5 to 7
COMPONENT SPECIFICATIONS	7 to 8
SYSTEMS - COMMERCIAL	6 to 8
SYSTEMS - MILITARY (MIL-H-5440)	8
SYSTEMS - SPACE (AIR 1918)	8
	4 to 7

INCREASED CONTAMINATION EFFECTS

WEAR: ABRASION, EROSION, SCORING

**INCREASED FRICTION
EXTERNAL LEAKAGE
INTERNAL LEAKAGE**

ACCUMULATION: SILTING, PLUGGING

**INCREASED OPERATING FORCES
PERFORMANCE CHANGES
INTERNAL LEAKAGE**

RESULT: SHORTER COMPONENT LIFE