STUDY OF LUBRICANT CIRCULATION IN HVAC SYSTEMS

Volume II - Compilation of Program Test Data

**Final Technical Report
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Study of Lubricant Circulation in HVAC Systems

Volume II - Compilation of Program Test Data

SUMMARY

This volume contains all of the program test data essentially as taken from the laboratory dynamic test facility during the sequence of runs.

For the readers' convenience Table 3.1 from Volume I of the report, is included to describe the refrigerant/lubricant test series (six) and the actual chronological test run number. Figures 2.1 and 2.2 from Volume I are also included here for reference.

In the body of this Volume, each of the test series is presented separately, again for the convenience of the reader.

Volume I contains a complete description of the program scope, objective, test results summary, conclusions, description of test facility and recommendations for future effort.

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Relevant Information From Volume I

Table 3.1 Tests Run with Test Number

Refrigerant/ Lubricant Test Series	Actual Chronological Test Run Number			
	Cooling	Cooling Inj.*	Heating	Heating Inj.*
1) R22-3GS	1, 2, 35	41, 42	3, 4, 36, 40	37, 38, 39
2) R407C-3GS	5, 43, 44	45	6, 46, 47	48, 49
3) R407C-1GS	50, 51	†	52	†
4) R407C-SW32	7, 8	9, 10	11, 12, 13	14
5) R407C-SW68	15, 16	17, 18	19, 20, 25, 26	21, 22, 23, 24
6) R407C-RL32S	27, 28	31, 32, 33	29, 30, 34	†
* additional oil injected into compressor				
† no test run

Figure 2.1. Oil Circulation Program Dynamic Test Facility - Cooling Mode

Figure 2.2. Oil Circulation Program Dynamic Test Facility - Heating Mode

Refrigerant/Lubricant Test Series

R22 - Suniso 3GS

SLO 2/23/96

Cooling & Heating Modes - No Oil Injection

System Temperatures

Heat Pump R22-Suniso 3GS Oil Circulation Tests (35&36)

SLO 2/23/96

Cooling & Heating Modes - No Oil Injection

System Pressures

Heat Pump R22-Suniso 3GS Oil Circulation Tests (35&36)

Cooling & Heating Modes - No Oil Injection

SLO 2/23/96

Air Side Temperatures

Heat Pump R22-Suniso 3GS Oil Circulation Tests (35&36)

SLO 2/23/96

Cooling & Heating Modes - No Oil Injection

Oil Flows

Heat Pump R22-Suniso 3GS Oil Circulation Tests (35&36)

Cooling & Heating Modes - No Oil Injection

SLO 2/23/96

Heat Pump R22-Suniso 3GS Oil Circulation Tests (37-39)

Heating Mode - Oil Injection

SLO 2/23/96

System Temperatures

Heat Pump R22-Suniso 3GS Oil Circulation Tests (37-39)

Heating Mode - Oil Injection

SLO 2/23/96

System Pressures

Heat Pump R22-Suniso 3GS Oil Circulation Tests (37-39)

Heating Mode - Oil Injection

Air Side Temperatures

SLO 2/23/96

Heat Pump R22-Suniso 3GS Oil Circulation Tests (37-39)

Heating Mode - Oil Injection

SLO 2/23/96

Heat Pump R22-Suniso 3GS Oil Circulation Tests (37-39)

Heating Mode - Oil Injection

SLO 2/23/96

Heat Pump R22-Suniso 3GS Oil Circulation Tests (40-42)

SLO 2/26/96

Heating (No Oil Injection) & Cooling (Oil Injection) Mode

System Temperatures

Heat Pump R22-Suniso 3GS Oil Circulation Tests (40-42)

SLO 2/26/96

Heating (No Oil Injection) & Cooling (Oil Injection) Mode

System Pressures

Heat Pump R22-Suniso 3GS Oil Circulation Tests (40-42)

SLO 2/26/96

Heating (No Oil Injection) & Cooling (Oil Injection) Mode

Air Side Temperatures

---	TIE1
---	TIE2
---	TII1
---	TII2
---	TOE1
---	TOE2
---	TOI1
---	TOI2

Heat Pump R22-Suniso 3GS Oil Circulation Tests (40-42)

Heating (No Oil Injection) & Cooling (Oil Injection) Mode

SLO 2/26/96

Heat Pump R22-Suniso 3GS Oil Circulation Tests (40-42)

Heating (No Oil Injection) & Cooling (Oil Injection) Mode

SLO 2/26/96

Refrigerant/Lubricant Test Series

R407C - Suniso 3GS

Heat Pump R407C-Suniso 3GS Oil Circulation Test (43)

Cooling Mode - No Oil Injection

SLO 2/28/96

System Temperatures

Heat Pump R407C-Suniso 3GS Oil Circulation Test (43)

SLO 2/28/96

Cooling Mode - No Oil Injection

System Pressures

Heat Pump R407C-Suniso 3GS Oil Circulation Test (43)

Cooling Mode - No Oil Injection

SLO 2/28/96

Air Side Temperatures

—	TIE1
- - -	TIE2
—	TII1
—	TII2
- . - .	TOE1
· · · · ·	TOE2
—	TOI1
—	TOI2

Heat Pump R407C-Suniso 3GS Oil Circulation Test (43)

SLO 2/28/96

Cooling Mode - No Oil Injection

Oil Flows

Heat Pump R407C-Suniso 3GS Oil Circulation Test (43)

Cooling Mode - No Oil Injection

SLO 2/28/96

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (44&45)

Cooling Mode - No Oil Injection & Oil Injection

SLO 2/29/96

System Temperatures

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (44&45)

Cooling Mode - No Oil Injection & Oil Injection

SLO 2/29/96

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (44&45)

Cooling Mode - No Oil Injection & Oil Injection

SLO 2/29/96

Air Side Temperatures

—	TIE1
---	TIE2
—	TII1
—	TII2
---	TOE1
---	TOE2
—	TOI1
—	TOI2

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (44&45)

Cooling Mode - No Oil Injection & Oil Injection

SLO 2/29/96

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (44&45)

Cooling Mode - No Oil Injection & Oil Injection

SLO 2/29/96

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (46&47)

SLO 2/29/96

Heating Mode - No Oil Injection

System Temperatures

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (46&47)

SLO 2/29/96

Heating Mode - No Oil Injection

System Pressures

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (46&47)

SLO 2/29/96

Heating Mode - No Oil Injection

Air Side Temperatures

—	TIE1
—	TIE2
—	TII1
—	TII2
—	TOE1
—	TOE2
—	TOI1
—	TOI2

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (46&47)

SLO 2/29/96

Heating Mode - No Oil Injection

Oil Flows

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (46&47)

SLO 2/29/96

Heating Mode - No Oil Injection

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (48&49)

SLO 2/29/96

Heating Mode - Oil Injection

System Temperatures

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (48&49)

SLO 2/29/96

Heating Mode - Oil Injection

System Pressures

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (48&49)

SLO 2/29/96

Heating Mode - Oil Injection

Air Side Temperatures

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (48&49)

SLO 2/29/96

Heating Mode - Oil Injection

Oil Flows

Heat Pump R407C-Suniso 3GS Oil Circulation Tests (48&49)

SLO 2/29/96

Heating Mode - Oil Injection

Refrigerant/Lubricant Test Series

R407C - Suniso 1GS

Heat Pump R407C-Suniso 1GS Oil Circulation Test (50)

Cooling Mode - No Oil Injection

SLO 3/11/96

Heat Pump R407C-Suniso 1GS Oil Circulation Test (50)

Cooling Mode - No Oil Injection

SLO 3/11/96

System Pressures

Heat Pump R407C-Suniso 1GS Oil Circulation Test (50)

Cooling Mode - No Oil Injection

SLO 3/11/96

Air Side Temperatures

---	TIE1
---	TIE2
---	TII1
---	TII2
---	TOE1
---	TOE2
---	TOI1
---	TOI2

Heat Pump R407C-Suniso 1GS Oil Circulation Test (50)

Cooling Mode - No Oil Injection

SLO 3/11/96

Oil Flows

Heat Pump R407C-Suniso 1GS Oil Circulation Test (50)

Cooling Mode - No Oil Injection

SLO 3/11/96

Heat Pump R407C-Suniso 1GS Oil Circulation Tests (51&52)

Cooling & Heating Mode - No Oil Injection

SLO 3/12/96

Heat Pump R407C-Suniso 1GS Oil Circulation Tests (51&52)

Cooling & Heating Mode - No Oil Injection

SLO 3/12/96

System Pressures

Heat Pump R407C-Suniso 1GS Oil Circulation Tests (51&52)

Cooling & Heating Mode - No Oil Injection

SLO 3/12/96

Air Side Temperatures

Heat Pump R407C-Suniso 1GS Oil Circulation Tests (51&52)

Cooling & Heating Mode - No Oil Injection

SLO 3/12/96

Heat Pump R407C-Suniso 1GS Oil Circulation Tests (51&52)

Cooling & Heating Mode - No Oil Injection

SLO 3/12/96

Refrigerant/Lubricant Test Series

R407C - Castrol SW32

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (7&8)

Cooling Mode - No Oil Injection

THS 2/1/96

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (7&8)

THS 2/1/96

Cooling Mode - No Oil Injection

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (7&8)

Cooling Mode - No Oil Injection

THS 2/1/96

Air Side Temperatures

—	TIE1
—	TIE2
—	TII1
—	TII2
—	TOE1
—	TOE2
—	TOI1
—	TOI2

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (7&8)

THS 2/1/96

Cooling Mode - No Oil Injection

Oil Flows

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (7&8)

THS 2/1/96

Cooling Mode - No Oil Injection

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (9&10)

THS 2/2/96

Cooling Mode - Oil Injection

System Temperatures

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (9&10)

THS 2/2/96

Cooling Mode - Oil Injection

System Pressures

—	PS1
—	PS2
—	PS3
—	PS4
—	PS5
—	PS6

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (9&10)

THS 2/2/96

Cooling Mode - Oil Injection

Air Side Temperatures

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (9&10)

Cooling Mode - Oil Injection

THS 2/2/96

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (9&10)

THS 2/2/96

Cooling Mode - Oil Injection

Oil Flows

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (11&12)

Heating Mode - No Oil Injection

THS 3/4/96

System Temperatures

—	TS1
—	TS2
—	TS3
—	TS4
—	TS5
—	TS6
—	TS7
—	TS8

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (11&12)

Heating Mode - No Oil Injection
System Pressures

THS 3/4/96

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (11&12)

THS 3/4/96

Heating Mode - No Oil Injection
Air Side Temperatures

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (11&12)

Heating Mode - No Oil Injection

THS 3/4/96

Heat Pump R407C - Castrol SW32 Oil Circulation Tests (11&12)

Heating Mode - No Oil Injection

THS 3/4/96

Heat Pump R407C-Castrol SW32 Oil Circulation Test (13)

SLO 2/8/96

Heating Mode - No Oil Injection

System Temperatures

Heat Pump R407C-Castrol SW32 Oil Circulation Test (13)

Heating Mode - No Oil Injection

SLO 2/8/96

System Pressures

Heat Pump R407C-Castrol SW32 Oil Circulation Test (13)

Heating Mode - No Oil Injection

SLO 2/8/96

Air Side Temperatures

---	TIE1
---	TIE2
---	TII1
---	TII2
---	TOE1
---	TOE2
---	TOI1
---	TOI2

Heat Pump R407C-Castrol SW32 Oil Circulation Test (13)

Heating Mode - No Oil Injection

SLO 2/8/96

Heat Pump R407C-Castrol SW32 Oil Circulation Test (13)

Heating Mode - No Oil Injection

SLO 2/8/96

THS 2/29/96

Heating Mode - Oil Injection

System Temperatures

Heat Pump R407C - Castrol SW32 Oil Circulation Test (14)

Heating Mode - Oil Injection

THS 2/29/96

System Pressures

Heat Pump R407C - Castrol SW32 Oil Circulation Test (14)

Heating Mode - Oil Injection

THS 2/29/96

Air Side Temperatures

—	TIE1
- - -	TIE2
—	TH1
—	TH2
—	TOE1
...	TOE2
—	TOI1
—	TOI2

Heat Pump R407C - Castrol SW32 Oil Circulation Test (14)

Heating Mode - Oil Injection

THS 2/29/96

Oil Flows

Heat Pump R407C - Castrol SW32 Oil Circulation Test (14)

Heating Mode - Oil Injection

THS 2/29/96

Refrigerant/Lubricant Test Series

R407C - Castrol SW68

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (15&16)

Cooling Mode - No Oil Injection
System Temperatures

THS 2/29/96

—	TS1
...	TS2
—	TS3
—	TS4
...	TS5
...	TS6
—	TS7
—	TS8

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (15&16)

Cooling Mode - No Oil Injection

THS 2/29/96

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (15&16)

Cooling Mode - No Oil Injection

THS 2/29/96

Air Side Temperatures

—	TIE1
---	TIE2
—	TII1
—	TII2
---	TOE1
---	TOE2
—	TOI1
---	TOI2

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (15&16)

Cooling Mode - No Oil Injection

THS 2/29/96

Oil Flows

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (15&16)

Cooling Mode - No Oil Injection

THS 2/29/96

Heat Pump R407C- Castrol SW68 Oil Circulation Test (17)

Cooling Mode - Oil Injection

SLO 2/8/96

System Temperatures

Heat Pump R407C- Castrol SW68 Oil Circulation Test (17)

Cooling Mode - Oil Injection

SLO 2/8/96

System Pressures

Heat Pump R407C- Castrol SW68 Oil Circulation Test (17)

Cooling Mode - Oil Injection
Air Side Temperatures

SLO 2/8/96

Heat Pump R407C- Castrol SW68 Oil Circulation Test (17)

Cooling Mode - Oil Injection

SLO 2/8/96

Oil Flows

Heat Pump R407C- Castrol SW68 Oil Circulation Test (17)

Cooling Mode - Oil Injection

SLO 2/8/96

Heat Pump R407C - Castrol SW68 Oil Circulation Test (18)

SLO 2/8/96

Cooling Mode - Oil Injection

System Temperatures

Heat Pump R407C - Castrol SW68 Oil Circulation Test (18)

SLO 2/8/96

Cooling Mode - Oil Injection

System Pressures

Heat Pump R407C - Castrol SW68 Oil Circulation Test (18)

Cooling Mode - Oil Injection

SLO 2/8/96

Air Side Temperatures

Heat Pump R407C - Castrol SW68 Oil Circulation Test (18)

Cooling Mode - Oil Injection
Oil Flows

SLO 2/8/96

Heat Pump R407C - Castrol SW68 Oil Circulation Test (18)

Cooling Mode - Oil Injection

SLO 2/8/96

Heat Pump R407C-Castrol SW68 Oil Circulation Tests (19&20)

Heating Mode - No Oil Injection

SLO 2/9/96

System Temperatures

Heat Pump R407C-Castrol SW68 Oil Circulation Tests (19&20)

Heating Mode - No Oil Injection

SLO 2/9/96

System Pressures

Heat Pump R407C-Castrol SW68 Oil Circulation Tests (19&20)

Heating Mode - No Oil Injection

Air Side Temperatures

SLO 2/9/96

Heat Pump R407C-Castrol SW68 Oil Circulation Tests (19&20)

Heating Mode - No Oil Injection

SLO 2/9/96

Oil Flows

Heat Pump R407C-Castrol SW68 Oil Circulation Tests (19&20)

SLO 2/9/96

Heating Mode - No Oil Injection

Heat Pump R407C-Castrol SW68 Oil Circulation Test (21)

SLO 2/12/96

Heating Mode - Oil Injection

System Temperatures

Heat Pump R407C-Castrol SW68 Oil Circulation Test (21)

SLO 2/12/96

Heating Mode - Oil Injection
System Pressures

Heat Pump R407C-Castrol SW68 Oil Circulation Test (21)

SLO 2/12/96

Heating Mode - Oil Injection
Air Side Temperatures

Heat Pump R407C-Castrol SW68 Oil Circulation Test (21)

SLO 2/12/96

Heating Mode - Oil Injection
Oil Flows

Heat Pump R407C-Castrol SW68 Oil Circulation Test (21)

Heating Mode - Oil Injection

SLO 2/12/96

Heat Pump R407C-Castrol SW68 Oil Circulation Test (22)

SLO 2/13/96

Heating Mode - Oil Injection

System Temperatures

—	TS1
---	TS2
—	TS3
—	TS4
---	TS5
...	TS6
---	TS7
---	TS8

Heat Pump R407C-Castrol SW68 Oil Circulation Test (22)

Heating Mode - Oil Injection
System Pressures

SLO 2/13/96

Heat Pump R407C-Castrol SW68 Oil Circulation Test (22)

Heating Mode - Oil Injection

SLO 2/13/96

Air Side Temperatures

Heat Pump R407C-Castrol SW68 Oil Circulation Test (22)

Heating Mode - Oil Injection

SLO 2/13/96

Oil Flows

Heat Pump R407C-Castrol SW68 Oil Circulation Test (22)

Heating Mode - Oil Injection

SLO 2/13/96

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (23&24)

SLO 2/19/96

Heating Mode - Oil Injection

System Temperatures

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (23&24)

SLO 2/19/96

Heating Mode - Oil Injection

System Pressures

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (23&24)

SLO 2/19/96

Heating Mode - Oil Injection
Air Side Temperatures

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (23&24)

SLO 2/19/96

Heating Mode - Oil Injection
Oil Flows

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (23&24)

SLO 2/19/96

Heating Mode - Oil Injection

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (25&26)

SLO 2/20/96

Heating Mode - No Oil Injection

System Temperatures

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (25&26)

Heating Mode - No Oil Injection

SLO 2/20/96

System Pressures

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (25&26)

SLO 2/20/96

Heating Mode - No Oil Injection

Air Side Temperatures

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (25&26)

SLO 2/20/96

Heating Mode - No Oil Injection

Oil Flows

Heat Pump R407C - Castrol SW68 Oil Circulation Tests (25&26)

Heating Mode - No Oil Injection

SLO 2/20/96

Refrigerant/Lubricant Test Series

R407C - ICI RL32S

Heat Pump R407C - ICI RL32S Oil Circulation Tests (27&28)

Cooling Mode - No Oil Injection
System Temperatures

SLO 2/20/96

Heat Pump R407C - ICI RL32S Oil Circulation Tests (27&28)

SLO 2/20/96

Cooling Mode - No Oil Injection

System Pressures

Heat Pump R407C - ICI RL32S Oil Circulation Tests (27&28)

Cooling Mode - No Oil Injection
Air Side Temperatures

SLO 2/20/96

TIE1	—
TIE2	...
TH1	- - -
TH2	- - -
TOE1	- . -
TOE2	...
TOI1	—
TOI2	...

Heat Pump R407C - ICI RL32S Oil Circulation Tests (27&28)

SLO 2/20/96

Cooling Mode - No Oil Injection

Oil Flows

Heat Pump R407C - ICI RL32S Oil Circulation Tests (27&28)

SLO 2/20/96
Cooling Mode - No Oil Injection

Heat Pump R407C-ICI RL32S Oil Circulation Tests (29&30)

Heating Mode - No Oil Injection

SLO 2/20/96

System Temperatures

Heat Pump R407C- ICI RL32S Oil Circulation Tests (29&30)

Heating Mode - No Oil Injection
System Pressures

SLO 2/20/96

Heat Pump R407C- ICI RL32S Oil Circulation Tests (29&30)

Heating Mode - No Oil Injection
Air Side Temperatures

SLO 2/20/96

—	TIE1
---	TIE2
—	TII1
—	TII2
—	TOE1
---	TOE2
—	TOI1
---	TOI2

Heat Pump R407C-ICI RL32S Oil Circulation Tests (29&30)

Heating Mode - No Oil Injection

SLO 2/20/96

Oil Flows

Heat Pump R407C- ICI RL32S Oil Circulation Tests (29&30)

Heating Mode - No Oil Injection

SLO 2/20/96

Heat Pump R407C- ICI RL32S Oil Circulation Tests (31-33)

SLO 2/21/96

Cooling Mode - Oil Injection
System Temperatures

Heat Pump R407C- ICI RL32S Oil Circulation Tests (31-33)

SLO 2/21/96

Cooling Mode - Oil Injection
System Pressures

Heat Pump R407C- ICI RL32S Oil Circulation Tests (31-33)

Cooling Mode - Oil Injection
Air Side Temperatures

SLO 2/21/96

Heat Pump R407C-ICI RL32S Oil Circulation Tests (31-33)

SLO 2/21/96

Cooling Mode - Oil Injection

Oil Flows

Heat Pump R407C- ICI RL32S Oil Circulation Tests (31-33)

Cooling Mode - Oil Injection

SLO 2/21/96

Heat Pump R407C - ICI RL32S Oil Circulation Test (34)

Heating Mode - No Oil Injection

SLO 2/21/96

System Temperatures

Heat Pump R407C - ICI RL32S Oil Circulation Test (34)

Heating Mode - No Oil Injection

SLO 2/21/96

System Pressures

Heat Pump R407C - ICI RL32S Oil Circulation Test (34)

Heating Mode - No Oil Injection
Air Side Temperatures

SLO 2/21/96

Heat Pump R407C - ICI RL32S Oil Circulation Test (34)

SLO 2/21/96

Heating Mode - No Oil Injection
Oil Flows

Heat Pump R407C - ICI RL32S Oil Circulation Test (34)

SLO 2/21/96

Heating Mode - No Oil Injection