The Ram Cruiser Tank:

An Ambitious Failure

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Abstract

During the early years of the Second World War, Canada was cut off from Britain, its traditional supplier of war materiel. This forced the Canadian Army and the Mackenzie King government to attempt to arm itself using domestic resources as well as those of the then-neutral United States.

One of the results of this policy was the Ram Tank, a design based upon the latest US medium tank in combination with the recent battle experience and expertise of British tank designers. Originally intended to arm Canadian and British formations, the Ram design was outstripped by faster and more responsive American technical innovation in the form of the Sherman tank.

Though the Ram proved adequate for training, for conversion to an armored troop carrier, and gave useful experience for the later manufacture in Canada of self-propelled guns, it was an undoubted failure as a tank. This essay examines the reasons for that failure.

Dedication

To Sharon and Dorothy, and to

all of the secretaries, research library staff, and fellow students

who helped me during the writing of this thesis.

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List of Illustrations

List of Acronyms and Select Terms

a/ (prefix)	Acting
AA	Anti-Aircraft
AD (prefix)	Assistant Director *or* Assistant Deputy
ADAFV(T)	Assistant Director, Armoured Fighting Vehicles (Technical)
ADCGS	Assistant Deputy to the Chief of the General Staff
ADM (M)	Acting Deputy Minister (Militia)
ADOS	Assistant Director of Ordnance Services
ADOS (TS)	Assistant Director of Ordnance Services (Technical Services)
ADOS (GS)	Assistant Director of Ordnance Services (General Staff)
ADQMG (AE)	Assistant Deputy Quartermaster-General (Army Engineering)
AEDB	Army Engineering Design Branch
AFV	Armoured Fighting Vehicle
AQMG (OS)	Assistant Quartermaster-General (Ordnance Services)
BGS	British General Staff
BPC	British Purchasing Commission
CAC	Canadian Armoured Corps
CACTG	Canadian Armoured Corps Training Group
CAFVTC	Canadian Armoured Fighting Vehicle Training Center or Canadian Armoured *Force* Vehicle Training Center
CANMILITRY	Telegraph address for CMHQ, London

CBOD	Canadian Base Ordnance Depot (RCOC)
CD	Contract Demand
CGS	Chief of the General Staff
CIA	Chief Inspector of Armaments
CMHQ	Canadian Military Headquarters, London, England
COO	Chief Ordnance Officer
COS	Chief of Staff
D (prefix)	Deputy or Director
DA (prefix)	Deputy Assistant
DADOS (E)	Deputy Assistant Director of Ordnance Services (Engineering)
DADOS (MT)	Deputy Assistant Director of Ordnance Services (Motor Transport)
DCGS	Deputy Chief of the General Staff
DDEM	Director of Design of Equipment and Mechanisation
DDME	Deputy Director of Mechanical Engineering
DEFENSOR	Telegraph address for NDHQ, Ottawa
DOS	Director of Ordnance Services
DDOS (E)	Deputy Director of Ordnance Services (Engineering)
DG	Director-General
DGM	Director-General of Munitions
D. Mech	Director [or Directorate] of Mechanisation
DM	Director [or Directorate] of Mechanisation *or* Deputy Minister
DMGO or D/MGO	Deputy Master-General of the Ordnance

DMGO (B)	Deputy Master-General of the Ordnance (Ballistics)
DMO & I	Director [or Directorate] of Military Operations and Intelligence
DMS *or* DM&S	Department of Munitions and Supply
DND	Department of National Defence, Ottawa
D of S & T	Director [or Directorate] of Science and Technology
DOS (M)	Director of Ordnance Services (Mechanisation)
DOS (TS)	Director of Ordnance Services (Technical Services)
DQMG	Deputy Quartermaster-General
DSD	Directorate of Staff Duties
DWD	Directorate of Weapons Development
G (SD)	General (Special Duties)
GOC-in-C	General Officer, Commander-in-Chief
GS	General Staff
GSO 1 (SD)	General Staff Officer [Grade] 1 (Special Duties)
I. Tanks	Inspectorate of Tanks
MD 4	Military District 4 HQ (Montreal, Quebec)
MGO	Master-General of the Ordnance
MLW	Montreal Locomotive Works
MT	Motor Transport
NDHQ	National Defence Headquarters, Ottawa
OA	Officer Administering (or Officer Assistant)
OC	Officer Commanding
Q (ops)	Quartermaster Branch (Operations)

RCOC	Royal Canadian Ordnance Corps
SD 3a	Staff Duties 3a [Operations and Coordination]
SDS	Special Duties Staff
TAMT	Technical Advisor Motor Transport
TROOPERS	Telegraph address for UK War Office, London
USA	United States Army
VCGS	Vice Chief of the General Staff
VPE	Vehicle Proving Establishment, Ottawa
WD	War Department (US)
WO	War Office (UK)

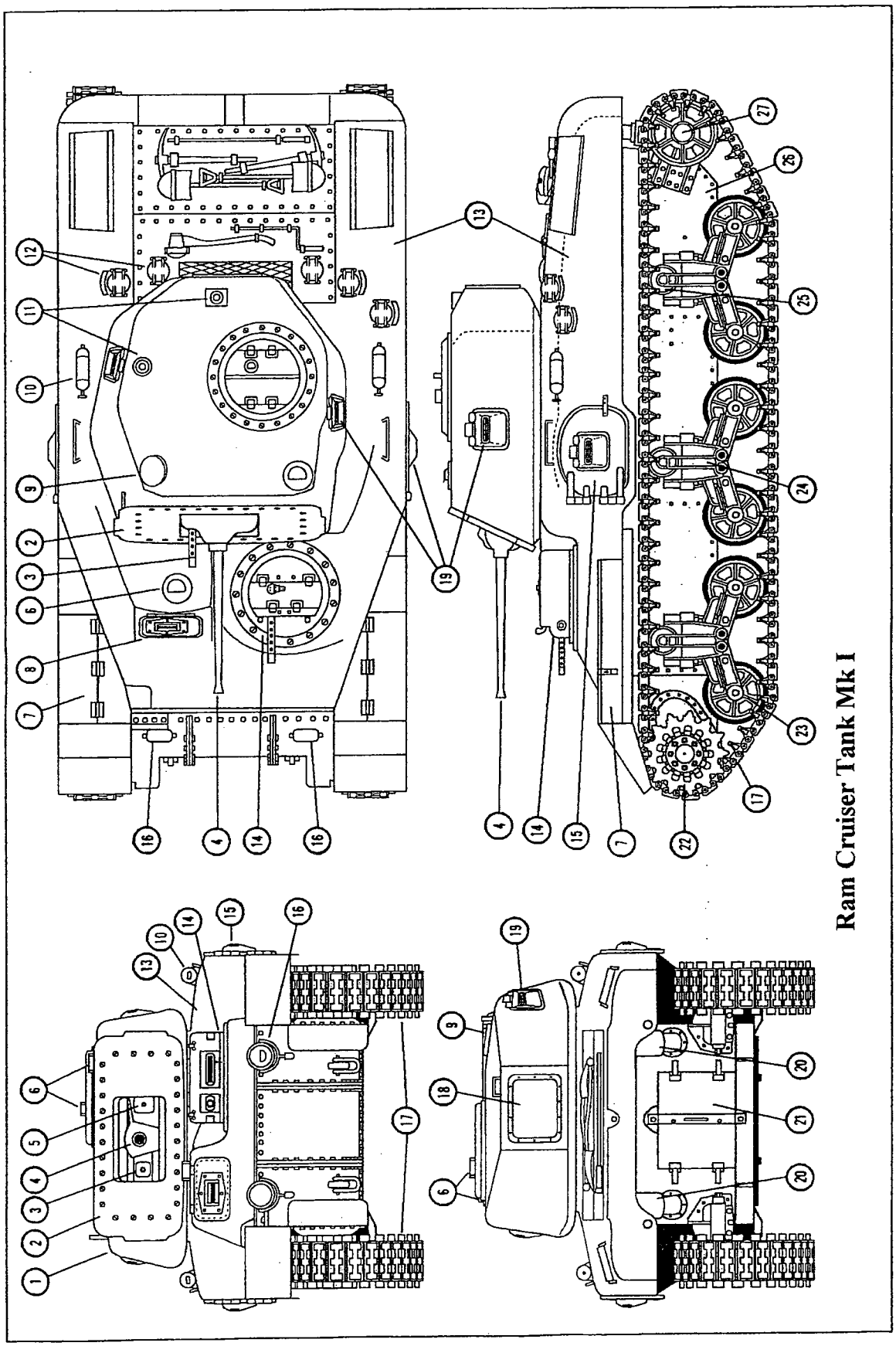
Introduction

During the Second World War, most Canadians were immensely proud of their contribution to the Allied war effort. The first tanks built in Canada for the army began to be publicized as soon as they left the production lines in 1941. But today, few Canadians have even heard of the Ram tank, and those who have might well be embarrassed to think that it was obsolete before it was even manufactured. This thesis examines the complexities of design, bureaucracy, international cooperation (or the lack of it), and sloppy workmanship that plagued Canada's first home-built tank, complexities that ensured that the Ram was never fit to appear on a battlefield in its original role.

Key to Illustration of Ram Cruiser Tank Mk. I

1. Cast Turret
2. Mantlet
3. Coaxial Machine-Gun
4. 2-Pounder Gun
5. Gunner's Sighting Telescope
6. Periscopes
7. Fender Stowage Bins
8. Driver's Vision Slot
9. Turret Ventilator
10. Extinguisher
11. Antenna Mounts
12. Fuel Tank Filler Caps
13. Cast Upper Hull
14. Cupola Machine-Gun Turret
15. Sponson Door
16. Headlight
17. Tracks
18. Turret Rear Access Hatch
19. Vision Slot
20. Exhaust Stacks
21. Engine Compartment Access Doors
22. Drive Sprocket
23. Bogie Wheel and Tire
24. Bogie Spring Suspension Housing
25. Return Roller
26. Riveted Lower Hull
27. Idler Wheel

Illustration redrawn and corrected from drawings by Christopher Johnson in Paul Roberts' *The Ram: Development and Variants, Volume I*, 2002, and by D. P. Dyer in *Bellona Military Vehicles Prints, Series 14 No. 53 CA*, 196-.



Ram Cruiser Tank Mk I

Chapter 1: Beginnings

On the 15th of October 1940, Winston Churchill announced to Britain's House of Commons, "We cannot hope to compete with the enemy in numbers of men, and must therefore rely upon an exceptional proportion of armoured fighting vehicles."[1] On July 3, 1941, an editorial cartoon in the *Montreal Daily Star* entitled "And the Moral Is—" portrayed the Grim Reaper showing a group of people that the "Lesson of Recent Defeats" was that machines, especially tanks and aeroplanes, were now more important in war than the infantry.[2] It may not have been a coincidence that one of the major stories in the previous day's edition of the paper was the rolling-out of the first of the Canadian Cruiser M3 tanks, later to be known as the Ram, from the Montreal Locomotive Works factory in East-end Montreal.

A crowd of dignitaries and politicians were at the June 30th public ceremony, as were many of the workers who had built the tank. It was proclaimed by J. L. Ralston, Canada's Minister of National Defence, to be "...the beginning of the fulfillment of the dream of a Canadian armored division."[3]

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[1] Winston Churchill, *Their Finest Hour* (Boston: Houghton Mifflin, 1949), 462.

[2] *Montreal Daily Star*, Thursday, July 3, 1941, 10.

[3] *Montreal Daily Star*, Wednesday, July 2, 1941, 15. The identical quote appeared on page one of the *Gazette* (Montreal) story on the same event in its Tuesday, July 1, 1941, issue, and many details are the same, suggesting extensive use of either a press release or wire service copy.

The Ram was the product of ideas and supplies from many sources. The ballistically-shaped hull and cast turret were designed by Canadians and Britons; the armament was British and American but manufactured in Canada; the running gear (tracks, idler wheels, bogie assemblies, and drive sprockets) and engine and transmission were from the latest model American medium tank. It was an amalgam of the latest, most modern thought of how a tank should be, at least insofar as British, American and Canadian designers were concerned. Yet the Ram never participated in any battle in the role for which it was designed.

At the outbreak of war in 1939, Britain had not thought of Canada as a source of tanks. Rather, the reverse was true: Prior to the war, Britain had been Canada's source for tanks. But once hostilities began in Europe, it became obvious that all British tank production would be required for British forces on the Continent or elsewhere in the Empire. Canada would have to make do with the few tanks that it had, or find an alternative source of supply.[4]

Other factors, too, worked against the development and integration of war industries in Canada. The British Treasury was not interested in spending vast amounts of monies overseas (in the form of orders for military materiel) to build war-production factories that might never be needed, and that in any case would eventually compete with British ones. Equally, the Canadian government (and Canadian private industry) thought that it would be far too expensive to construct such industrial facilities without an overseas

[4] There were 16 light tanks in Canada at the declaration of war, according to C.P. Stacey, *Six Years of War*, (Ottawa: Queen's Printer, 1955), 20.

buyer, as Canadian military requirements would not provide sufficient orders to make such construction economically sound.[5] For the first nine months of the war, both the British Treasury and the Canadian Government were still treating war-time needs with a peace-time mentality: According to H. Duncan Hall, one of Britain's official historians,

> [O]wing to the combination of a long view on finance and a short view on the value of a munitions potential, Canada continued to be treated during the whole period of 'the twilight war' as a purely marginal source of armaments supply[.][6]

Even though expenditure on armaments was minimal, Canada was still a source of raw materials for Britain. Its importance can be gauged by the swift dispatch of the British Purchasing Commission to Ottawa, where it held its first meeting with the [Canadian] War Supply Board on October 25th, 1939.[7] The two agencies met on a weekly basis, and by the end of August 1940 British purchases of raw materials amounted to just over 23 million Canadian dollars.[8]

Several factors changed this complacency in procurement. One was that the United States, which had an already-existing industrial base, and from where Britain had hoped to get many of its military supplies, was interpreting its Neutrality Act quite strictly.

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[5] H. Duncan Hall, *North American Supply. History of the Second World War, United Kingdom Civil Series, War Production Series* (London: HMSO, 1984), 6.

[6] Ibid., 16.

[7] Library and Archives Canada (hereinafter LAC) Record Group (RG) 28 Vol. 40, Department of Munitions and Supply (DM&S), File 1-1-36-1.

[8] LAC RG 28 Vol. 40, DM&S, File 1-1-36-2. Thereafter British expenses accelerated rapidly, until by the end of March 1941 raw materials and war plant expenditures in Canada had reached nearly $172 million.

Britain could get its war supplies, but no credit would be issued; purchases of American war materiel would have to be made on a cash-and-carry basis. The Neutrality Act had been put in place in reaction to memories of how the United States had become involved in the Great War in 1917. It was a widely-held American belief that the United States would not have entered that War on the side of the British if its investments in the Entente powers had not been so great.

Another factor was British concern about German tank production. Britain's intelligence organizations and, in particular, its Ministry of Economic Warfare (MEW), had attempted to calculate both the numbers of tanks possessed by the German Army and the monthly output of tanks from its factories. There was little hard intelligence on these numbers; estimates of tank strength and production were based on comparing German factory floor space, capacity, and manpower to British equivalents, and then calculating potential tank output from the resulting figures. It was also thought that the Germans would give increased priority to tank and aircraft production because of the impetus of war, and factories would be working either two- or three-shift schedules. The consensus was that German tank production was far exceeding that of Britain and France together.[9]

All of the above assumptions were in error. At the beginning of September 1939 the British thought that the Germans had 5000 tanks, 1400 of them the "medium" Panzer III and IV types, and 3600 the "light" Panzer Is, IIs, 35Ts, and 38Ts. In reality, the German

[9] F. H. Hinsley, E. E. Thomas, C. F. G. Ransom, and R. C. Knight, *British Intelligence in the Second World War, Vol. 1* (London: HMSO, 1979), 226-230.

Army had only 3000 tanks, 300 of them medium, the balance light types.[10] By March 1940 there was an even greater discrepancy between British estimates and German actual tank strength: The War Office estimated German strength at 5,800 tanks, when the true figure was only 2,445.[11] Finally, by June 1940, the British considered that the German Army had between seven and eight thousand AFVs available. This would have meant the Germans had produced an average of 200 tanks per month between September 1939 and June 1940, whereas the true figure was closer to 75.[12]

The other great factor was Dunkirk, and the subsequent fall of France. At one blow the British Army lost most of its vehicles, heavy weapons, and supplies on the Continent, and had lost its main Continental ally as well. Only 13 tanks made it back from the Continent with the BEF.[13] Winston Churchill later wrote that there were only 469 tanks in the United Kingdom, mainly in training schools.[14] Another estimate sets the total at 340 modern tanks and armoured cars available to repel a German invasion in June 1940, along with a few "scout cars, carriers, and obsolete training machines"[15]. Factories were

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[10] Ibid., 62.

[11] Ibid., 134. At the same date, the French Deuxième Bureau [Military Intelligence] was estimating German tank numbers at 7,000 to 7,500 and, as Hinsley notes, "...this gigantic estimate cannot but have had an inhibiting effect on French dispositions."

[12] Ibid., 230.

[13] David Fletcher, *The Great Tank Scandal: British Armour in the Second World War, Part I* (London: HMSO, 1989), 34. Another source, A. J. Smithers' *Rude Mechanicals* (London: Grafton, 1989), states on page 73 that twenty-five tanks had returned from Cherbourg, and that of those that had remained in Britain "there was little enough available and most of the runners were unfit for combat."

[14] Winston Churchill, *The Second World War* (New York: Mariner Books, 1985), 128.

[15] Fletcher, op. cit., 34.

constructing tanks virtually by hand, and their aggregate output was only about sixteen per month[16].

In fact, the British tank industry was in severe disarray. Until 1937 there were only two manufacturers of tanks in Britain, The Royal Carriage Factory (Woolwich Arsenal) and Carden-Loyd (Vickers).[17] The subsequent addition of other manufacturers, all building their own tanks without the benefit of consultation with any of the others, resulted in much wastage and duplication of effort.[18] Also, because of changes to the administrative agencies and because of the bureaucracy of the War Office, the various design bureaux that had worked on tanks were broken up and dispersed to separate locations in Britain, eliminating the close working relationships between departments that had earlier been achieved.[19]

Britain was desperate for tanks and vehicles from any source; and it was this that really began the British investment in Canadian war production. Canadian automobile manufacturers were already being used for the production of military vehicles, and it was thought that railway companies, with their experience in handling heavy metal castings and parts, would be well-suited to the production of tanks. The Treasury, in concert with the Canadian Government and the Canadian Pacific Railway Company, "...proposed to

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[16] Ibid., 34. However, Smithers in *Rude Mechanicals*, op. cit., 76, states that "by mid-summer [1940] Valentines were coming out at about forty a month."

[17] G. MacLeod Ross and Major-General Sir Campbell Clarke, *The Business of Tanks, 1933 to 1945* (Ilfracombe, Devon: Arthur H. Stockwell, 1976), 70.

[18] This point is extensively discussed in Smithers, op. cit., 40-52 and 78-87.

[19] This is discussed in detail in Beale, *Death By Design,* op. cit., 146-165, and in M.M. Postan, *British War Production* (London: HMSO, 1975), 188-195.

create capacity for the construction of infantry tanks [in Canada] at the rate of two per week."[20] Earlier in the year, on 6 February 1940, an inspection party from the Canadian Government and the British Supply Board arrived at the CPR's Angus Shops in East-end Montreal to evaluate its production capacity, and issued a favourable report on the Shops' suitability for tank construction.[21] A preliminary order for tanks was issued, but then cancelled in April when it was considered that deliveries would only start in 1941.[22] Nonetheless, the CPR had begun the process of looking for the specialized supplies and subcontractors needed for tank construction.[23] This preparatory work was not wasted, however, as a firm British order for 300 tanks came in June 1940.[24]

Thus the first tank to be built in Canada was the British-designed Valentine. Small, underpowered, undergunned, and underarmoured, it was nonetheless mechanically reliable and one of the most recent British designs.[25] It was arranged that blueprints and construction drawings be hurriedly shipped to Canada to allow its production, to be followed by one or two tanks for tests and study.

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[20] Hall, op. cit., 14.

[21] Anonymous, "Canadian Pacific Ry. Munitions Manufacture," *Canadian Transportation* (July, 1942) : 378.

[22] L.R. Cameron, "Tank Production in Canada," Report No. 38, Historical Section (G. S.), Army Headquarters, 27 Jul [19]50, 2, accessed February 6, 2009 at http://www.cmp-cpm.forces.gc.ca/dhh-dhp/his/rep-rap/doc/ahqr-rqga/ahq038.pdf.

[23] Anonymous, "Canadian Pacific Ry. Munitions Manufacture," *Canadian Transportation* (July, 1942): 378.

[24] Cameron, op. cit., 2.

[25] "Whatever its faults, the Valentine had one unique and compensating virtue. It was the only British tank of the day that could be trusted not to break down in moments of crisis." Smithers, op. cit., 41-42.

The initial order of 300 Valentines issued to the CPR by the British was to be delivered between February and August 1941; an additional 488 tanks ordered by the Canadian General Staff were to be delivered for Canadian Army use by February 1942.[26] (Eventually 1,420 were to be constructed in Canada, many going to Russia under the provisions of Lend-Lease.[27]) Preliminary construction of the Valentine got underway at the CPR's Angus Shops, but various delays slowed its production. Blueprints and drawings were slow to arrive, and many of those that did were illegible.[28] The Engineering Section of the shops had to re-draw many of the plans and, in some cases, had to wait until the tank arrived from England so that it could be stripped and its parts could be removed, measured, and drawn.[29] These problems and the subsequent slow pace of production caused the British and Canadians to look around for other sources for their tanks.

The Joint Committee on Tank Development was formed in late August 1940 to act as a liaison between the Department of National Defence which would detail its requirements, the Department of Munitions and Supply which would procure the materials needed to fulfill those requirements, and Canadian industry representatives who would be

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[26] Hall, op. cit., 221, and LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, "Report of Meeting Held at 729, Fifteenth Street, Washington. Friday 20th September, 1940," n.d. There is no record of who recorded the meeting but a Captain T. Newton-Dunn was listed as "In Attendance".

[27] There is some confusion in official sources over this figure. This figure of 1,420 comes from Cameron, op. cit., 1, but Hall in *North American Supply*, 223, quotes a figure of 3,556. Ross and Clarke, op. cit., put the number of Valentines at 4,452. It appears that these last two contain a conflation of figures for the Valentine and the initial orders of the Ram.

[28] Anonymous, "Canadian Pacific Ry. Munitions Manufacture," *Canadian Transportation* (July, 1942) : 379.

[29] Ibid.

manufacturing the needed weapons.[30] Major M. Evans of the Ordnance was seconded to the Department of Munitions and Supply as Chief of the Tank Division. Evans' experience, both in the Tank Corps and as the Assistant Chief Engineer of General Motors of Canada, gave him unique qualifications for the post.[31] Two other key Committee members were Colonel E.L.M. Burns and Colonel F.F. Worthington, veterans of the Great War and members of the Permanent Active Militia (as the Canadian Army was known at the time) during the interwar years. As captains, both had contributed to the Canadian Defence Quarterly, a journal that, as its name implies, was devoted to writings on military subjects. Several of Burns' articles discussed possible future doctrines for tank warfare. In one article, "A Division That Can Attack," he contended that the slow-moving tanks then known as "I" (Infantry) tanks should no longer have a place in the Canadian order of battle.[32]

The function of the "I" tank was to accompany the infantry forces to help them break into—and through—the enemy's lines. Because the infantry would only be moving at a walking pace, it was thought necessary to give the "I" tank heavy armour because its slow pace would be subject it to a sustained volume of antitank fire from the enemy. This heavier armour, in turn, would handicap the tank and keep its maximum speed as little more than 3 to 5 miles per hour.

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[30] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 1, G.K. Sheils to W.F. Drysdale, "Tank Committee," 29 August 1940.

[31] LAC RG 24 Vol. 2596, File H.Q.S. 3352-4, DM&S Joint Committee on Tank Development with the Department of National Defence, "Proceedings of the First Meeting," 30 August 1940.

[32] *Canadian Defence Quarterly* Vol. 15, No. 3 (April, 1938), 291-2.This led to a spirited exchange of further articles between Burns and Guy Simonds, then a Captain but later a Corps Commander. Simonds' articles propounded an all-arms formation for attack and defence, not just one containing armour.

Burns thought that it would be better to have troops accompanied by general-purpose Cruiser tanks, which might be more vulnerable to enemy fire but that certainly could exploit a breakthrough of, or breakout from, the enemy lines, relying on speed rather than armour for their defence. They would be accompanied by light tanks, which would fulfill the former cavalry tasks of reconnaissance and screening.[33]

Burns, however, did not devote as much thought to the armament needed for the Cruiser tanks to fulfill the breakout function. There was no discussion of the need for a tank to have a dual-purpose gun, good against both "hard" targets (other armoured vehicles and defensive works) and "soft" targets (personnel and unarmoured vehicles). Had he done so, realizing the need to mount ever-larger weapons into tanks, the story of the Ram might have been very different.

Worthington's writings, by contrast, dealt mainly with the use of machineguns in modern warfare and the use of films and miniature ranges for troop training. His articles on the use of the machinegun in defence and in attack built on his experience in the Great War in armoured cars of the Machine-Gun Corps, and in the Canadian Machine Gun Brigade after that. Lessons on the effective siting, concealment and operation of the machinegun were imparted in the form of an imaginary dialogue between a somewhat naïve author-interviewer and the experienced Colonel of a machinegun battalion, whose unit the author was visiting.[34]

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[33] Ibid., 292.

[34] See *Canadian Defence Quarterly* Vol. 9, No. 1(October 1931), "Machine Guns in Attack," 49-61, and Vol. 9, No. 2 (January 1932), "Machine Guns in Defence," 224-232.

Worthington's article on training troops through the use of terrain models stemmed from the financial limitations of the inter-war years, when the Depression caused a succession of cash-strapped federal governments to withhold funds from the military. Since there was no money for full-scale training in field manoeuvres, Worthington devised several schemes in which infantry troops could build and use miniature models of different types of terrain to learn the lessons of fieldcraft and how to plan defences and attacks in varying situations. He noted that the practice range was in use four nights per week in his regiment's armoury.[35] Likewise, his advocacy of using films for training was intended to liven up lectures as well as to illuminate lessons with filmed examples, such as showing troops how to advance in open country.[36] Worthington went on to become the Commandant of the Canadian Armoured Fighting Vehicles Training Centre [CAFVTC] at Camp Borden, Ontario, and his use of miniatures was later expanded with the RYPA simulator that was used for the training of tank crews.[37] The simulator moved in a realistic way, duplicating the roll, yaw, pitch and alteration of course that a tank traversing open ground would encounter, and it also reproduced the views that tank crewmen would see through the vision devices of their tanks. The RYPA was primarily used to teach the principles of acquiring, tracking, and shooting accurately at a target, as

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[35] *Canadian Defence Quarterly* Vol. 10, No. 4 (July 1933), "The Miniature Battle Practice Range as an Aid to Training," 489-497. Worthington's regiment was the Princess Patricia's Canadian Light Infantry (P.P.C.L.I.), based in Winnipeg at the time.

[36] *Canadian Defence Quarterly* Vol. 10, No. 1 (October 1932), "The Motion Picture as an Aid to Teaching," 87-92.

[37] Larry [Clara E.] Worthington, *Worthy: A Biography of Major-General F.F. Worthington, C. B., M.C., M. M.* (Toronto: The Macmillan Company, 1961); there, the acronym is said to stand for the Canadian Armoured *Force* Vehicle Training Center.

well as those of deflection and indirect fire.[38] Worthington's experience in evaluating tank design had been called upon when he attended the Hempstead, New York trials of a Christie Light Tank in 1938. He noted that it was fast, smooth-riding and had a good gear-box. But he criticized its lack of a turret with all-around traverse, and thought that its 2-man crew was inadequate. In his opinion, it was "not recommended in its present form" for Canada.[39]

The Dewar [later, the British] Tank Mission arrived in New York in July 1940.[40] Its members had the experience needed to assess the suitability of tank designs; it was led by Michael Dewar (head of British Timken Ltd, with experience in the Great War's Ministry of Munitions), and also boasted Mr. L. E. Carr (a Mechanisation Board tank design expert) and Brigadier Douglas H. Pratt, who had recent battle experience from commanding 1st Army Tank Brigade (4th RTR and 7th RTR) at Arras in France.[41] The Mission immediately began to meet with American manufacturers and American Army officers regarding the construction of tanks for Britain. Britain had wished to have American firms build British designs—not simply because of a chauvinistic pride, but from a desire for the standardization of types of war materiel. This would ease supply problems as well as ensure that all of the Empire / Commonwealth forces could be

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[38] Major M.R. McNorgan, "The Royal Canadian Armoured Corps School History," http://www.army.forces.gc.ca/Armour_School/histor-eng.asp , accessed June 16, 2009.

[39] LAC RG 24 Vol. 2588, File H.Q.S. 3352 Vol. 2, Worthington to NDHQ, "Report on Christie Light Tank Trials carried out Hempstead, L.I., 29-30 September, 1938," 1 Oct 1938.

[40] Hall, op. cit., 170.

[41] Fletcher, op. cit., 88. British Timken was a Birmingham-based manufacturer of ball- and roller-bearings. RTR is the abbreviation for Royal Tank Regiment.

similarly equipped and thus obviate differences in training, doctrine, and the like.[42] The Dewar mission was informed that the US authorities would prefer that Britain purchase American tank designs, rather than have US companies tool up to produce British designs.[43] The chief tank design that was on offer was the new M3 Medium tank currently being engineered for the US Army. Though its design had not yet been completed, the M3 was more powerful than anything the British currently had in existence or even in development, while its large 75 mm sponson-mounted gun gave it a greater potential on the battlefield. (A sponson-mounted gun is carried in the hull of a tank, rather than in the turret. This makes it possible to mount a larger gun in the tank, but it limits the traverse available to the gun. As a result, to aim the gun the M3 tank had to be pointed at its target, and it had to be "hull-up", exposing much more of its superstructure to possible return fire.)

The British Tank Mission viewed trials of the M3 medium tank at Aberdeen, Maryland, at the end of July 1940, and placed orders for the British Army. (The Treasury authorized the purchase of 1250 tanks, but Dewar initially ordered over 3000, considering that "...the British General Staff consistently underestimated the number of tanks needed."[44]) The need to purchase other urgently needed war materiel (and a squeeze on US dollar reserves) forced the Tank Mission to trim its orders, but by the end of 1940 Britain had ordered 2,086 M3 tanks from the United States, to be manufactured by the Pullman

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[42] Hall, op. cit., 180-181. See also the discussion of this in H. Duncan Hall and C.C. Wrigley, *Studies of Overseas Supply*. (London: HMSO, 1956), 47-48.

[43] Fletcher, op. cit., 88-89.

[44] Ibid., 89-90.

Standard Manufacturing Company, the Pressed Steel Car Corporation, the Baldwin Locomotive Works and the Lima Locomotive Works.[45] In the British models of the M3, later to be called the Grant, changes were made to reconfigure the tank to benefit from Britain's recent combat experience.[46] The most obvious of these changes was a slight lowering of the tank's silhouette by the removal of a cupola-mounted machine-gun, and the relocation of the radios to a redesigned and enlarged turret, where the tank commander would have control of them.

Even with these modifications, however, the British and Canadians were not happy with the US M3 tank. It was still too high, measuring 123 inches (10 feet 3 inches) from ground level to the commander's cupola on the top of the turret, and had to expose too much of itself to fire its main gun, mounted in the hull sponson.[47] It had been learned in the interwar years that, in the presence of enemy tanks or anti-tank weapons, the best thing for a tank to do was to hide and try to stalk its opponent by stealth. For this purpose, a low silhouette was useful in order to allow the tank to use folds in the ground to camouflage its moves.

A joint British-Canadian working group, made up from members of the British Tank Board and the Canadian Tank Production Committee, was formed to suggest changes to be incorporated in the next US tank design. It was hoped that this successor model,

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[45] Hall, *North American Supply,* op. cit., 291. On page 215 of the same volume, the figure of 2,085 – one tank less – is quoted, possibly omitting the prototype.

[46] Ibid., 181.

[47] Dimensions are from Peter Chamberlain and Chris Ellis, *M3 Medium (Lee/Grant) AFV 11*, (Windsor, Berks.: Profile Publications, 196-), n.p.

dubbed the "modified M.3" or M.4, would be built in Canada; but it was necessary to wait for the Americans to finalize the M3 design before any modifications could be made to it.[48]

Since more information was obviously needed, it was recommended (at a 14 September 1940 meeting of the Tank Production Committee in Ottawa) that Major M. M. Evans of the Ordnance branch be sent to the USA and temporarily attached to the Dewar Mission to get more information on the US M3 Medium tank.[49] Evans turned out to be an excellent observer; upon his return to Ottawa he reported what he had found out in a 4-page, single-space typed memo.[50]

Evans arrived in Washington in time for a 20 September meeting between members of the Dewar Mission (Brigadier-General D. H. Pratt, Mr. Michael Dewar, and Mr. L. E. Carr) and Canadian representatives (Mr. E. P. Taylor of the Department of Munitions and Supply and Colonel F. F. Worthington of the Canadian Army General Staff). The attendees discussed the orders for Valentine tanks as well as potential orders for the US M3 and "modified M.3" tanks. Various manufacturers were suggested as possible production centres for a British/Canadian version of the new US M3 Tank, among them

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[48] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1.

[49] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, P.A. Chester, M.G.O., to A.D.M.(M.) [Acting Deputy Minister (Militia)], 16 September 1940. Evans was to leave before 21 September.

[50] LAC RG 24, Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Major M.M. Evans to D.O.S.(M.), Ottawa, "Report of a Visit to the United States Primarily With Reference to the Design and Procurement of Cruiser Tank M.3," 1 October 1940. Evans reported on much more than the US M3; he relayed information on other new tracked, half-tracked, and wheeled vehicles in development, obtained their photographs and specifications, and discussed differences between the British and US reconnaissance doctrines.

the Montreal Locomotive Company, the National Steel Car Company, the Dominion Steel and Coal Company, and the Dominion Bridge Company. It was thought that production capacity could be on the order of 4 tanks per day (to be split between Canadian and British requirements) and Taylor put forward the D.M.&S. view that Canada and the UK would each pay half of the cost of capital expenditure on this plant.[51]

If Canada were to purchase the American high-hull design, Colonel Worthington wanted the British-designed 6-pounder (57 mm) cannon installed to replace the M3's sponson-mounted 75 mm gun, as it had a more rapid rate of fire and a higher muzzle velocity, with a consequent flatter trajectory for its shot. It was also established that Canada would provide No. 9 wireless sets for all of the British-ordered tanks built in the USA.[52] The balance of the afternoon was taken up with discussions regarding M3 design details with Mr. L.E Carr, "the engineer of the Dewar Mission."[53]

The following week was a busy one for the Canadians and the members of the Dewar Mission. On the next morning (Saturday, 21 September 1940), Colonel Worthington and Major Evans were at the British Purchasing Commission in New York City, arranging to have obsolete 6-ton training tanks [WW I Renaults] shipped from Rock Island Arsenal,

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[51] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, "Report of Meeting Held at 729, Fifteenth Street, Washington. Friday 20th September, 1940," op. cit.

[52] Ibid.

[53] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Major M.M. Evans to D.O.S. (M.), October 1, 1940, op. cit.

Illinois, and Fort Mead, Maryland, to the CAFVTC at Camp Borden.[54] (The tanks had been about to be sold for scrap; Worthington arranged their purchase (as scrap metal) at the rate of $20 per ton, and got thirteen spare engines and 45 tons of spare parts from an obliging US Army for no extra cost. The shipment was consigned to the "Camp Borden Iron Foundry" as a way of avoiding any unpleasantness with the US Neutrality Act.[55])

That same afternoon, Evans met with Mr. Fraser of American Locomotive Company (ALCO) and the Montreal Locomotive Works to discuss production problems regarding M3 tanks. Fraser informed Evans that ALCO had a contract with the US War Department for the construction of 685 tanks, and their experience in tooling up for M3 production would be helpful if and when an order was placed with the Montreal Locomotive Works.[56]

Evans spent much of Monday, 23 September, at the Aberdeen Proving Grounds in Maryland, examining an incomplete wooden mock-up of the M3. As of this date, the design of the turret and its traverse gear was still unfinished, as were some internal arrangements.[57]

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[54] Ibid. Both of these sites are listed as sources for the Renault tanks, but it is possible that they only came from the Rock Island Arsenal. See LAC RG 24 Vol. 2588, File H.Q.S. 3352, Vol. 3, letter from Colonel H. DesRosiers, Acting Deputy Minister (Militia) to O.D. Skelton, Undersecretary of State for External Affairs, 15 June 1940.

[55] Worthington, op. cit., 167.

[56] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Major M.M. Evans to D.O.S. (M.), October 1, 1940, op. cit. ALCO was the parent company of the Montreal Locomotive Works.

[57] Ibid.

The next day he was back in Washington in discussions with Canadian and US Military officers and with Mr. Sheehan of the General Steel Castings Corporation on the feasibility of having cast armour for both the hull and the turret of the Canadian version of the tank. (The American M3 was also to have a cast turret, but its design had not yet been finalized.)[58]

Further talks with Colonel Worthington clarified the points that Evans would bring back to Ottawa regarding the M3; it would not be possible to develop definite Canadian design changes until the US tank design was "frozen" (complete), so close contact would have to be maintained between Canada, the US War Department and the Dewar Tank Mission to ensure that Canadian proposals could go forward at the earliest possible time. These changes included the re-design of the tank hull, lowering its silhouette and placing the main gun in a fully-rotating turret atop the hull. Worthington added that the Montreal Locomotive Works, as a subsidiary of ALCO, was the logical facility for producing the modified M.3 in Canada. Also, Mr. Dewar felt "confident" that his Mission could obtain the necessary engines and transmissions for made-in-Canada tanks from US suppliers.[59]

One major problem was still the US Neutrality Act. American War Department officers were eager to help the Canadians but were constrained in what they could offer by way of "free interchange". Negotiations would have to take place at a higher level to allow the

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[58] Ibid.

[59] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Major M.M. Evans to D.O.S. (M.), October 1, 1940, op. cit.

exchange of plans, specifications and production drawings so that the tank could be built in Canada.[60]

The Montreal Locomotive Works would face a daunting task when it came time to start tank production. When its design was finalized, the American M3 required the efforts of 197 engineers working for 4 weeks "under pressure" to translate 186 lbs. of blueprints into production drawings needed for the factory floor and for the many subcontractors. Each part of the tank had first been made in wood (as part of a full-scale mock-up) to ensure that the components would fit together properly.[61]

Further changes in the M3 were discussed at a 27 September meeting at the Department of Munitions and Supply between representatives of the DM&S, the DND and the British Technical Mission and the BPC. The British appeared to be very enthusiastic about using 6-pounder guns as the main armament in their Canadian-built Cruiser tanks, as well as about adopting the gun as their standard carriage-mounted antitank gun. It was agreed that, if necessary, the M3 Cruiser's turret would be redesigned to accommodate the 6-pounder, and a mounting for the gun would be adapted or designed by Canada in conjunction with the BPC.[62]

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[60] Ibid.

[61] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, information from "the Whaley-Eaton letter—a Washington dope-sheet on political and other subjects", attached to personal letter from Bill Davidson, British Purchasing Commission, to Maj. Max Evans, DM&S, 25 September 1940.

[62] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, Colonel E.L.M. Burns to General H.D.G. Crerar, 27 September 1940.

Another British delegation was at Aberdeen Proving Grounds in October. On October third, R.H. Fowler (the Scientific Attaché at the British High Commission in Ottawa), British Army Lt.-Colonel F. C. Wallace, and Canadian Army Colonel H. F.G. Letson (the Military Attaché at the Canadian Legation in Washington) examined the latest US tank designs, especially the M3 Grant.[63] All of these men had been seconded to the Tizard Mission, a British delegation sent to North America to arrange the exchange of scientific and technical information between Britain and the United States.[64]

A further visit was made to Aberdeen a week later, this time by members of the Tank Mission. Again, emphasis was placed on the need to lower the silhouette of the M3 tank in its revised British version. Suggestions included the replacement of the tank commander's cupola by an all-round-vision periscope, removing the 75 mm main gun from the hull sponson to the turret, and changing the gearing of the propeller shaft from the engine to the transmission; this last change would allow its radial engine to be mounted at a flatter angle and thus lessen the height of the rear hull of the tank.[65]

Other practical recommendations learned from recent battle experience were the need to replace the tank commander's top-mounted machine-gun with another that had greater elevating ability for anti-aircraft use; a protectoscope to eliminate a blind spot (and

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[63] David Zimmerman, *Top Secret Exchange,* (Montreal: McGill-Queen's University Press, 1996), 126-127.

[64] When Tizard went down to the United States three Canadians were attached to his mission: C.J. Mackenzie, head of the National Research Council in Ottawa; Air Vice-Marshal A.V. Stedman, R.C.A.F. research chief; and Colonel H.E. Tabor, Master-General of the Ordnance. Zimmerman, op. cit., 161.

[65] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1. "Record of Visit to Aberdeen Proving Ground on 9th October, 1940," Appendix II.

possibly a pistol port) was required on the left of the turret; and seats should be modified for the easier removal of wounded or dead crew, with easily-accessible escape hatches.[66]

Dewar forwarded these suggestions to the Ministry of Supply. He also wished to adopt a cast hull for the British version of the tank, because casting the hull would result in savings in production time (by reducing the need for machining and assembly) as well as improve the ballistic protection afforded by the hull. (Ainsworth, another member of the Tank Mission, confirmed this from his experience manufacturing tanks with the Hotchkiss arms combine in France.)[67] Another factor was the evidence of Colonel Martin-Frevel, a leading tank designer of the French Army who was now in North America. He had worked on the French Somua, a tank that was largely made from cast-metal components, and had brought along enough working drawings to demonstrate how the same techniques could be used for tanks produced in North America. Using this method of casting armour would utilize those facilities that could only cast metal, and free up rolling steel mills to make armour needed for other uses.[68] The Ministry, with minor caveats, agreed with Dewar's recommendations.[69]

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[66] Ibid.

[67] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1. "M3 U.K. Tank Production in U.S.A. Memo No. 1," Appendix A, 27 November 1940.

[68] LAC RG 24 Vol. 2596, File H.Q.S. 3352-4, Department of Munitions and Supply Joint Committee on Tank Development with the Department of National Defence, "Proceedings of the First Meeting," 30 August 1940.

[69] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, "Record of Visit to Aberdeen Proving Ground on 9th October, 1940," Appendix III.

There was still discussion in late October 1940 among senior Canadian Army officials and the government regarding the purchase and use of tanks being manufactured in Canada. Colonel E.L.M. Burns laid out the current choices in an information letter to General Crerar, then the Chief of the Canadian General Staff (CGS).

As of the 21st of October, 488 Mark 3 Infantry [Valentine] tanks and 1157 M3 Cruisers had been ordered, with delivery of both to Canadian units anticipated around August, 1941. Current cost estimates for each model were that the Valentine tank would cost about $75,000 per unit, with the Cruiser costing about $50,000 (though it was recognized that these were only preliminary estimates at best). Burns noted that the discrepancy was mainly due to the need for additional labour in the case of the Valentine, because of a lack of mass-production economies in its original British design and construction. These tanks had been ordered at a time when it seemed that they would be the only tanks available for Canadian use, and so they were a case of making the best of a bad situation. But under the current Canadian Table of Equipment and Organization, there was no place for the Valentine tanks (except as training tanks) unless an Army Tank Brigade was established.

Burns suggested that if the M3 Cruiser turned out to be significantly cheaper, it might be a good idea to reexamine Canadian orders for the Valentine and switch CPR production over the manufacture of Cruiser tanks. A handwritten note in the margin from Crerar noted that until both production lines were up and running, there was insufficient

information upon which to base a decision and so production of the two tanks for Canadian use would be continued until there was a firmer basis for a decision.[70]

The day after this letter was sent, H. J. Stevenson (D.O.S.(M)) and Major M. M. Evans were authorized to fly to Washington on 22 October to meet with US Army officers and the Dewar Commission regarding "design problems of the M3 Cruiser Tank".[71] Despite these ongoing problems with the design, two three-way contracts were signed on 23 October between the Department of Munitions and Supply, the Montreal Locomotive Works, and the American Locomotive Company (ALCO). The first contract was to "Construct a plant for 5.5" Gun Carriages or M.3 Cruiser Tanks"; the second, to "Produce 5.5" Gun Carriages or M.3 Cruiser Tanks."[72]

At this point, the design of the M3 tank was "frozen" by the US Ordnance, to allow the tooling-up for its construction to begin. The M3 as initially designed had a crew of seven men, more than most other countries' tanks, and had a very high profile, much higher than most of the Axis tanks it might face in combat. From the ground to the top of the main hull it measured 7' ½", and its total height, including the tank commander's cupola atop the turret, was 10' 3". The turret contained a high-velocity 37 mm gun and a .30 caliber coaxial machinegun, but the main armament was contained in a sponson on the front right side of the main hull. The 75 mm gun in the sponson had a limited traverse of

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[70] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, Colonel E.L.M. Burns to C.G.S. [Crerar], 21 October 1940.

[71] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Major G.L. Frawley, for D. of S. & T., to D.O.S. (M), reply to letter from D.O.S.(M). Their flight transport warrant was 48713.

[72] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1. Both contracts are in the same File docket.

fifteen degrees off the centerline of the tank, which meant that to hit its target the entire tank had to be pointing in the direction in which it was firing. An additional .30 caliber machinegun was in the commander's cupola atop the turret, and two fixed forward-firing .30 caliber machineguns were set in the glacis plate just above the transmission housing on the front of the hull, operated by the driver.[73]

The tank was 8' 11" wide at its widest point and its overall length was 18' 6". Motive power was provided by a Continental Motors R-975 9-cylinder radial engine in the rear of the hull. The tank drove on two 16 ½" wide caterpillar tracks, one on each side of the hull. The suspension consisted of six road wheels in three bogie assemblies (two wheels to each bogie), three return rollers (one atop each bogie) and a drive sprocket and idler wheel for each track. There were four large escape hatches for the crew, one on each side, another on the upper surface of the hull behind the main gun sponson, and a final one atop the turret for the tank commander.[74]

Now that contracts had been signed between the Canadian government and ALCO, and because the design of the M3 tank had been frozen by the US authorities, it became possible for blueprints and construction drawings of the M3 to have "free interchange" between ALCO and the Montreal Locomotive Works. Captain Coventry of the British Purchasing Commission informed Colonel G. B. Howard (the Chief Inspector of Armaments) that drawings of the M3 would be sent to Howard's department "as they

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[73] These dimensions, apart from the height of the main hull, come from R.P. Hunnicutt, *Sherman* (Novato, CA: Presidio Press, 1978), 528. The height of the hull is from Mr. Charles Lemons, Curator at the Patton Museum, Fort Knox, Kentucky; personal communication, 13 July 2009.

[74] Ibid.

become available". They also discussed the free interchange of M3 drawings between ALCO and Montreal Locomotive Works.[75] Howard, in turn, requested that Major Max Evans, the Director-General of Munitions, arrange courier services between Canada and the US for the transport of the drawings.[76] All of these details (including the port of exit for the drawings, so that US Customs could clear them as rapidly as possible) were sorted out between ALCO, MLW and the Chief Inspector of Armaments by the 5th of November, 1940.[77]

By this point, production capacity was being found for the two types of tanks, with an eye to switching the Valentine lines over to producing Cruisers when practicable. It appeared that the Valentine was nearing the limits of its design potential, whereas the Cruiser Tank still could be improved.[78] The Joint Committee on Tank Development projected that the M3 Cruiser Tank could be produced at the rate of 2 per day, rising to a maximum of 3 per day in 1941, and with a further rise to 5 per day "as soon as circumstances would permit"; also, design work to change the M3 would be put into effect at the end of 1941.[79]

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[75] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Major Max Evans, for the Director General of Munitions, to Colonel G.B. Howard, Chief Inspector of Armaments, Ottawa, 30 October 1940.

[76] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Colonel G.B. Howard to Major Max Evans, 5 November 1940.

[77] LAC RG 24 Vol. 6294, File H.Q. 38-72-261 Vol. 5, cover letter "Re: Drawings for MIII Cruiser Tank" and 3 letters between ALCO, the D.G.M., and the Chief Inspector of Armaments, 5 November 1940.

[78] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, J.L. Ralston to C.D. Howe, 25 October 1940.

[79] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, "4th Meeting of the Joint Committee on Tank Development," 8 November 1940. It is not apparent if the reference "end of 1941" is a misprint for "end of 1940."

To keep up with this projected five-tanks-per-day demand, armour production would have to increase in Canada. The Steel Company of Canada was building a new mill which would add capacity by February 1941. Heat-treating apparatus had not yet been installed, however, because there was no definitive agreement on the needed capacity between Steel Company of Canada and the Department of Munitions and Supply. Burns, in a letter to the Associate Minister of National Defence, noted that several manufacturers were still reluctant to invest in additional war production capacity for their plants, worried that it would create a surplus problem after the war. He urged that the Department of Munitions and Supply create a Tank Division, headed by a man experienced in heavy manufacturing, to ensure the confidence of everyone associated with the M3 project.[80]

A meeting of the key British, Canadian and American tank experts was held at the Willard Hotel in Washington on November 13, 1940, "...To Discuss Questions of Demarcation Between Material To be Supplied to Tank Erectors and Material which They will have to provide for themselves."[81] Discussions were held on the production of the M3 in both the United States and in Canada, and it was arranged that all of the engineering drawings needed by MLW for the construction of the M3 would be passed to Canada via the BPC; this would ensure that all of the companies building the M3 were building the "same" M3, current with one another in every respect. It was noted that the

[80] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, E.L.M. Burns to the Associate Minister of National Defence, 10 December 1940.

[81] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1. "Minutes of a Meeting Held in the Willard Hotel on Wednesday, November 13th, at 10 A.M. To Discuss Questions of Demarcation Between Material To be Supplied to Tank Erectors and Material which They will have to provide for themselves."

design drawings were to be ready for duplication and distribution by early December. Mr. Dewar, for the British, put forward the idea that it was more efficient to have a single subcontractor supply the same component for all the tank manufacturers than to have the duplication of effort involved in all of the erectors making the same part; for instance, all the tank engines would come from Continental, all of the transmissions would come from Chrysler, and so on. He thought that this would save on machine tool needs as well.[82] Also, following a suggestion by Mr. Kent, representing the US National Defence Advisory Committee, the main contractors expressed an interest in forming a joint purchasing combine, based on a similar one already formed by aircraft constructors.[83] (Such a combine was formed, and a document was later drawn up that listed over 110 suppliers for equipment carried in or built onto the M3.)[84] The Dewar Mission took on the task of ensuring that engines, transmissions and other non-Canadian components would be delivered to the Canadian M.3 assembly lines; it was believed that the transmissions would be the hardest items to procure, compared to other parts. Dewar also requested that Canada supply a "resident (technical and production) Tank Liaison Officer" to his mission (something thought "highly desirable" by the memo's author, Major M.M. Evans).[85]

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[82] Ibid., 6.

[83] Ibid.

[84] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Lt.-Colonel Edmond L. White, U.S.A., to J.H. Bradshaw Jr., BPC, "Sources of Equipment for Medium Tank, M3," 11 June 1941.

[85] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1. Memorandum, Major Evans to DMGO, DND, Ottawa, "M3 Anglo-American Cruiser Tank Design," November 12, 1940.

Among many other topics discussed that day, a key one was to determine what improvements were desired for the M3's successor, designated as the M.4 for discussion purposes.[86] Most of the major improvements had already been discussed by the Tank Committee. The M.4 should have its main armament (the 75 mm or the 6-pounder gun) in a fully-rotating turret, and the hull profile should be lowered as much as possible and its armour thickened. Both the new upper hull and the turret should be made of cast armour, for quicker production time, and the turret would have sufficient space for the No. 19/24 wireless radio so that the tank commander had easy access to it.[87] The idea was put forward that because these changes above would require shop facilities for design, experimentation and construction, a design staff should be assembled at the MLW to fulfill that function.[88] In its report to the MGO the Tank Committee agreed, emphasizing that the "starting point of the new design must be an established model [M3]"; the Committee hoped that the experts of the British Tank Mission would act as advisors.[89]

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[86] There are three different reports in the archives relating to this meeting. It appears to have been an ad hoc group of many of the concerned parties and not a formally-constituted one, such as the Tank Committee. All of the reports are in LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1.

[87] The most modern wireless set at the time, the 19 Set had a 12 mile range, when equipped with a 6 ft aerial; the range of the 24 Set was 400m in flat country. See LAC RG 24, Vol. 2597, File H.Q.S. 3352-11 Vol. 1, "Wireless Set 19/24," 8 November 1940.

[88] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Major Evans to DMGO, DND, Ottawa, "M3 Anglo-American Cruiser Tank Design," November 12, 1940.

[89] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Col. E.L.M. Burns (ADCGS) to D/M.G.O., 19 November 1940.

Chapter 2: Design Commences

Originally, it was thought that Canada would start producing M3 tanks at the same time as did the US factories; at least 300 were expected to be produced at the MLW before changing over to any newer design.[1] However, it transpired that production would actually start somewhat later in Canada, and there would also be a lesser capacity on the Canadian assembly line. These factors, combined with British/Canadian dissatisfaction with the M3 design, instead led to the idea that tank production in Canada might start with the new Canadian design of the M4.[2] Mr. L.E. Carr, at the request of the Department of Munitions and Supply, began developing designs for the new M4 hull, lowering its silhouette as much as possible and incorporating all of the other changes desired by the British.[3] In this he was aided by Dr. R.E. Jamieson, a Canadian civil engineer with expertise in the casting and welding of metals.[4] Jamieson had served with

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[1] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, W.F. Drysdale, Director General of Munitions, to Wm. Morris, Vice-President, Montreal Locomotive Works, December 13, 1940.

[2] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1. E.P. Taylor (Director General for Munitions Production) to Michael Dewar (BPC), "Re: Anglo-American M3 Cruiser Tanks and Armament," November 26, 1940; see also "Minutes of a Meeting held in Washington, Saturday, January 4th, 1941, at 4:00 PM in Mr. Michael Dewar's Office," in the same box and File.

[3] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, "Minutes of a Meeting held in Washington, Saturday, January 4th, 1941, at 4:00 PM in Mr. Michael Dewar's Office." See also Fletcher, op. cit., 94.

[4] Noted in Ross and Clarke, *The Business of Tanks, 1933 to 1945*, op. cit., 202. At the time, Jamieson had left his position as the William Scott Professor of Engineering at McGill University in Montreal to work for the National Research Council. Later in the war, he served as Director-General of the Supply Branch of the Department of Munitions and Supply.

the Canadian Siege Artillery in the First World War and had experience in both gunnery and armour strength.[5]

Though a final decision was yet to be made on whether to build the US M3 or the "Modified Canadian M.4", the various erectors chosen to build the tanks were still able to work together to coordinate the ordering of components. Despite the marked difference in the upper hull designs of the two tanks, the running gear, engines and transmissions were the same, allowing common parts to be ordered for both designs.

The British continued to observe the progress of the American M3 with interest. A group from the Dewar Mission returned to Aberdeen on 28 November 1940, where they watched (as well as participated in) a trial of gyro-stabilized gun firing on the Aberdeen range. Impressed by the results, Dr. Fowler of the British High Commission in Ottawa and Lt.-Col. Wallace of the British Army both urged the adoption of the gyro-stabilizer for British tank guns.[6]

There was still uncertainty over whether Canada would build the standard American M3 or the Modified Canadian Cruiser M3 in mid-December. W.F. Drysdale, the Director-General of Munitions, had authorized tank production at the Montreal Locomotive Works on the understanding that the first 300 tanks to be constructed there would be identical to the American M3 being made for the British at ALCO's Schenectady workshops.

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[5] From http://www.archives.mcgill.ca/resources/guide/vol2_3/gen01.htm#JAMIESON, ROBERT EDWARD, accessed December 14, 2007.

[6] Zimmerman, op. cit., 127. Footnote 38 quotes Fowler, "Report on a Visit to Aberdeen Proving Ground 28 November 1940," National Archives (UK) File PRO AVIA 10/2.

Drysdale urged Mr. William Morris (the MLW Vice-President in charge of the Tank Programme) to inform his office of any difficulties they might have in obtaining parts or US export permits, so that the Dewar Mission could in turn be informed and take remedial action.[7]

By mid-December the new "U.K. Design" cast turret for the American M3 was available for inspection by the British and Canadians. The cast armour turret was considered to be easier to make, and to have a thirty percent lower production cost, than a comparable turret of equivalent strength made from armour plate. Unfortunately, once the turret was fitted to the tank it appeared that, in the words of Major W. Mavor, "The result was disappointing. From an appearance point of view the Tank was very top heavy[.]" A final judgement on the design was reserved until the finished turret, with all its guns and other equipment installed, was ready to be inspected. This was tentatively scheduled to take place at Aberdeen on Monday December 30th by Colonel Burns, Colonel Worthington and Major Evans, the best Canadian tank experts available.[8]

The British had also commissioned the fabrication of a one-piece upper hull casting that closely followed the original design of the US M3 tank. Cast and machined at the General Steel Castings foundry in Philadelphia (the same plant that had cast the new turret), the casting *qua* casting was considered an excellent job, and its adoption would

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[7] LAC RG 24 Vol.2597, File H.Q.S. 3352-11 Vol. 1, W.F. Drysdale, Director General of Munitions to Wm. Morris, VP, Montreal Locomotive Works, December 13, 1940, op. cit.

[8] LAC RG 24 Vol.2597, File H.Q.S. 3352-11 Vol. 1, Major W. Mavor to Major Evans, Mr. Drysdale, Colonel Burns, Brig. Letson, and Mr. Carswell, "Tank Programme Memo No. 4," 16 December 1940.

result in savings in both labour and armour plate.[9] (The Baldwin Locomotive Company, one of the constructors of the M3 tank, held a controlling ownership in General Steel and this was at least one of the reasons why it had been chosen by the British.[10])

Casting had the advantage of being faster and easier to produce than complex hull shapes made from straight armour plate, once initial tooling had been created. Another advantage of having a cast hull was that there were no vulnerable joins between armour plates, or rivets that could be hit by an attacker's shot and turned into lethal fragments ricocheting around inside the tank.

On the other hand, casting has a disadvantage in that it is extremely difficult to ensure that the "grain" of the metal alloy is aligned as the cast piece cools. It is this alignment that gives metal much of its strength, although some of this can be achieved later through a process known as "face hardening".[11]

Based on the successful British attempt, it was considered that the hull of the Canadian version of the tank should also be made of cast armour steel. The British had made a large monetary investment in General Steel Castings, and there would be no need for additional capital expenditure in order to fabricate the "Canadian" hulls. There was also

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[9] Ibid. Interestingly, these cast hulls, which were later designated with the model number M3A1, had side doors identical to those on the Ram. See the drawing and picture in Jim Mesko, *M3 Lee/Grant in Action* (Carrollton, TX: Squadron/Signal Publications, 1995), 6 and 22.

[10] Albert Churella, "Corporate Response to Technological Change: Dieselization and the American Railway Locomotive Industry During the Twentieth Century," *Business and Economic History* 25, No. 1 (Fall 1996), 28.

[11] John W. Schaefer, from a discussion on http://yarchive.net/mil/ww2 _tank_armor.html, June 11, 1996, accessed January 10, 2006.

the fact that rolled armour plate was needed for other uses, and a cast hull would be both cheaper and equally effective against antitank fire. The final decision was left to the Joint Committee on Tank Production.[12]

On New Year's Eve of 1941, Major Evans drew up the estimate of how many of the new tanks were to be needed for Canada's sole Armoured Division. The Division was made up of two Armoured Brigades, with three Regiments to each Brigade. Based on the Division's Table of Organization, 304 Cruiser tanks and 36 "Close Support" (CS) tanks would be required: 10 Cruisers were allocated to each of the two Armoured Brigade Headquarters, 46 Cruisers were allocated to each of the six Armoured Regiments, and a further 8 Cruisers were earmarked for the Headquarters of the Armoured Division. The 36 CS tanks were to be equally divided among the Armoured Regiments, at 6 apiece.[13]

Calculations of "War Wastage" vastly increased these numbers, meaning that many more tanks would need to be built than this. A wastage rate of 14% per month (or 168% per year) was assumed by Evans, based on the best estimates available at the time. This translated into a total of 815 Cruisers being required, rather than the original 304, and a need for 97 of the CS version of the tank, close to two-and-a-half times the original figure of 36. A further 245 Tanks "in excess of establishments" was added to make a total of

[12] LAC RG 24 Vol.2597, File H.Q.S. 3352-11 Vol. 1, Major W. Mavor to Major Evans, Mr. Drysdale, Colonel Burns, Brig. Letson, and Mr. Carswell, "Tank Programme Memo No. 4," 16 December 1940, op. cit.

[13] LAC RG 24 Vol.2597, File H.Q.S. 3352-11 Vol. 1, Evans to ADCGS [Burns], NDHQ, December 31, 1940.

1157 tanks.[14] Two days later, a memo from Victor Sifton, the Master General of the Ordnance to Ralston, the Defence Minister, set out the contract cost for the tanks as $57,850,000. This, however, turned out to be optimistic. In a handwritten addendum to the letter, initialled several days later by H.D. [Crerar], it was noted that the total value of the Contract Demand, signed on January 8, 1941, had already risen to $138,840,000.00.[15] Evans, in a January 8 letter to the Department of Finance, confirmed that the 1157 Cruiser Tanks M3 had been ordered on Contract Demand #283 of 1940-1941 at a price of approximately $120,000 each.[16] The formal approval by the War Committee of the Cabinet for the purchase was issued on 29 January 1941.[17]

On January 4th Colonels Burns and Worthington, and Major Evans, attended a meeting in Washington following their visits to the Aberdeen Proving Grounds and to General Steel Castings in Philadelphia. Their brief had been to assess how the US Army had revised the M3 Cruiser Tank in line with the design changes proposed by the British Purchasing Commission. At the meeting, the attendees (members of the BPC and the Tank Mission) discussed the new Canadian/UK M4 tank design, to be built at the

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[14] Ibid.

[15] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, V. Sifton to Minister of Defence Ralston, January 2, 1941.

[16] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Evans to W. Smellie, Clerk of Estimates, Department of Finance, 8 January 1941.

[17] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1. L.M. Breen, Asst. Private Secretary, to C.G.S., M.G.O., and D.M. at D.N.D., 3 February 1941.

Montreal Locomotive Works in place of manufacturing the M3.[18] It was again thought that there would be no difficulties in getting supplies of engines and transmissions from the US, because total Canadian requirements were projected at only two per day once production got under way (as opposed to total US and UK requirements of between 24 and 29 daily).[19]

Another reason that engine and transmission supply was not thought to be a problem was the similarity of the Canadian/UK design to the forthcoming US M4 tank, whose redesign (incorporating many British suggestions for improvement) was due to begin in February. But in a January 7 meeting with Brigadier-General Barnes of the US General Staff, the Canadians and British were informed that the US might not supply the parts for the tanks if they did not like the design.[20] Cooperation was key between Britain, Canada and the U.S., as

> Canada would be dependent on the U.S. for engines and transmissions and possibly other components and we should not wish to run the risk of having deliveries of these components restricted, as the U.S. authorities might possibly do if they were doubtful as to the soundness of the design of the armoured fighting vehicle in which it was proposed to incorporate them. [21]

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[18] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1 "Minutes of a Meeting held in Washington, Saturday, January 4th, 1941, at 4:00 PM in Mr. Michael Dewar's Office." Evans had been sent along by the A.D.C.G.S. specifically so that he could learn, and report back upon, technical proposals regarding the manufacturing of tanks in Canada.

[19] Ibid.

[20] LAC RG 24 Vol.2597, File H.Q.S. 3352-11 Vol. 1, Major Evans to DND, "Memorandum of a discussion held at the U.S. War Department 7th January 1941," dated 13 January 1941.

[21] Ibid.

The US view was that the parts were too valuable, and in too short supply, to be wasted on substandard designs. From now on it would be necessary to have US approval for Canadian tank design and production. Barnes noted that the US General Staff had no objections to the Canadian arrangements with General Steel Castings to produce hulls at the rate of two per day, as this was not anticipated to interfere with any American production requirements.[22]

Further conferences took place on January 9th and 10th regarding the decision to build the Canadian/UK pattern cast hull. It was again pointed out that the original American M3 design appeared lop-sided and top-heavy, did not have a fully traversing turret and had a "prevalence of vertical surfaces" that were highly vulnerable to antitank weapons. In three meetings held over these two days, it was ultimately determined that 1100 lower-silhouette cast hulls would be fabricated by General Steel Castings Corporation, at a total cost to be determined later, and that a mock-up of this hull design (built at the Montreal Locomotive Works) should be available for inspection by January 16th, when it would be evaluated for "the adequacy of the design from the fighting angle."[23] Mr. Carr suggested that this full-scale mockup was the best way of showing the Americans how to make improvements in their own design, and also to ensure that they would see the Canadian

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[22] Ibid.

[23] LAC RG 24 Vol.2597, File H.Q.S. 3352-11 Vol. 1, A.F. Gill, DM&S, "Department of Munitions and Supply, Armour for M3 Cruiser Tank," undated but probably between January 10 and 16, 1941. The reason for the discrepancy between the contract demand for 1157 tanks and the figure of 1100 hulls noted here is not known.

Cruiser as a feasible project and release the necessary components for its assembly.[24]

Upon completion, the mock-up of the new cast upper hull was examined, especially with reference to how the hull fit over the internal arrangements of the fighting compartment. It had been necessary to reposition the main drive shaft, gearbox, and to lower the driver's and gunner's seats from their original placement within the higher M3 hull. After some minor adjustments had been made to the mock-up, the go-ahead was given to prepare final working drawings of the hull, with the "casting thicknesses to be decided on by Mr. Carr with the advice of Colonel Worthington and General Steel Casting Company." It was estimated that the final weight of the hull would be approximately 10,500 lbs and would provide a minimum 30% ballistic improvement over an equivalent-thickness hull made with rolled armour plate. As a part of the manufacturing arrangement, General Steel Castings would design the escape hatches on the hull but the hatches themselves would be cast by another supplier.[25]

Once the plans had been finalized, 2 prototype hulls were cast. One, unfinished, was eventually sent to Valcartier to be used for ballistics tests.[26] The second was to be completely machined, for use as the first finished sample tank. The unfinished hull would be ready between the 1st and the 15th of March; the finished hull would be available by

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[24] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 1, Department of Munitions and Supply Joint Committee on Tank Development with the Department of National Defence, "Proceedings of the Seventh Meeting," 31 January 1941.

[25] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Major Evans, "Report of the Meeting held at the Works of the Montreal Locomotive Company, Montreal, January 17th 1941."

[26] Kennedy, J. de N. *History of the Department of Munitions and Supply: Canada in the Second World War. Vol. I. Production Branches and Crown Corporations* (Ottawa: King's Printer, 1950), 64.

the 1st of May. Both samples would be cast at General Steel Casting's Eddystone Plant, but the production runs would probably take place at their Granite City Plant. It was also agreed that Carr would provide direction to General Steel Casting for the engineering work on the new turret, which would contain the No.9 or No.19/24 Wireless Radio Set.[27]

On January 19th 1941, the War Committee of the Cabinet "approved, in principle, the purchase of 1,157 cruiser tanks" for use by the Canadian Army.[28] In the terms of the contract (signed on the 30th of January), MLW was to accept the offer of General Steel Castings Corporation of Eddystone, PA "to manufacture and sell to His Majesty 1,157 cast armour tank top hulls [...] in connection with production contract No. 1053, dated October 23rd, 1940".[29] These were to be delivered as part of requisition Q-855-O, Order Q-12676 (Ordnance),

> fully machined and weighing approximately ten thousand five hundred (10,500) pounds, each conforming in design to your drawing number 53018 and manufactured in accordance with and passing the tests prescribed by U.S. Army Ordnance Specification AXS-499, exclusive of paragraph F.1.C. (providing for radiographing).[30]

The price of each hull casting was set at $6,650.00 US dollars.[31]

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[27] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Major Evans, "Report of the Meeting held at the Works of the Montreal Locomotive Company, Montreal, January 17th 1941," op. cit.

[28] LAC RG 24 Vol.2597, File H.Q.S. 3352-11 Vol. 1, Minister of National Defence [Ralston] to CGS, MGO, DM, 3 February 1941.

[29] LAC RG 28 Vol. 432, File 20-LV1A-1, 30 January 1941. Production contract No. 1053 had originally been for the manufacture of cast hulls for the British variant of the M3, the Grant tank.

[30] Ibid.

[31] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, MLW to the bankers J. P. Morgan & Co., 26 February 1941.

As the tank took shape in the design stage, responsibilities for the supply of all the components needed were established for the construction of tanks at the Montreal Locomotive Works. Major components, such as the Continental 9-cylinder engine and the Mack Truck Company transmission, were to be supplied complete and "Free Issue"* by the manufacturers. The same applied to the gun mounts, all optical equipment, and the tank's radio sets and antennas; however, MLW was to supply the exterior antenna mount on the tank, and the wiring from the interior turret bustle to that mount. MLW also informed the Department of Munitions and Supply that it would not be able to machine armour plate for the hull and expected to receive all plate and castings "completely machined and processed ready for erection." Possibly because of Carr's British background, Montreal Locomotive Works asked for and received assurances that U.S. rather than Whitworth [British] threads would be used on all components in the tank.[32]

It was further agreed that the Montreal Locomotive Works would make the turret traversing ring in one piece, and that it would be based on a 60-inch diameter ring, a larger diameter that that used on contemporary British tanks. This larger diameter meant that the speed of the turret traverse would be reduced from the original British

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* "Free Issue" in this context means that the Government would pay for the items and arrange their delivery to the Montreal Locomotive Works production lines, rather than have Montreal Locomotive Works order and pay for them, thus avoiding any surcharges that might be incurred by Montreal Locomotive Works.

[32] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Major M.M. Evans (M.G.O. (Tanks)) to multiple addressees, "Minutes of a Meeting held at the Montreal Locomotive Works on Friday, February 7, 1941." Two different meetings were held at the MLW this day but, confusingly, they were both written up by Major Evans and they both have the same title, though one is much longer than the other. The long one concerns itself with many details about the tank, and the short one only discusses the dimensions of the No. 9 Wireless Set, and the need to fit it into the turret of the Canadian Cruiser M3. The information in this paragraph comes from the longer document.

requirements, a design change agreed to by Carr.[33] However, it was this single decision that rendered the new tank design as obsolete before its time.

The larger a turret ring, the larger a gun that can be fitted into the turret. By restricting the diameter to 60 inches, the Ram-to-be could only be upgunned to the 6-pounder, as there would be insufficient space to fight a larger weapon (such as a 75 mm cannon or a 17-pounder) within the same ring. The Germans, farther ahead in tank doctrine, had already grasped this fact. Their Panzer III and Panzer IV tanks (designed in 1935-36) had from the outset been provided with turret rings far larger than their current armament had required.[34]

It is not clear how or why the 60-inch diameter turret ring was chosen. In his biography, F.F. Worthington is quoted as saying that he wanted the largest possible turret ring, 72" at least, so that the tank could be upgunned if necessary, but the Committee decided otherwise. According to the argument recounted in the book, the largest contemporary British turret ring was 54", and some of those tanks had 2-pounder (40 mm) guns in their turrets, so it is not clear why a 60" ring was thought necessary.[35] (Another source points

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[33] Ibid.

[34] The Panzer III had a turret ring diameter of approximately 60 inches, and the Panzer IV had one of approximately 64 inches. The Panzer III ultimately became obsolete, but it had a much longer career than the Ram as a gun tank, and its chassis (like that of the Ram) eventually served as the basis for several designs of self-propelled guns and other specialist vehicles. See Bruce Culver, *PzKpfw III In Action* (Carrollton, TX: Squadron/Signal Publications, 1988), 4, for the Panzer III data, and LAC Microfilm T-17473, File 1/AFV Guns/1, Department of Tank Design, information from examination of captured Panzer IV #813, 2 December 1941.

[35] Worthington, op. cit., 166.

out that even the 6-pounder could fit inside a 54" turret ring.)[36] No reason is given for not making the largest diameter ring possible, though it may have been a lack of machine tools available that were capable of handling the job. In his autobiography, E.L.M. Burns (then the General Staff member on the Tank Production Committee) glosses over whoever was responsible for the decision, saying

> We decided that the Canadian tank should embody the British turret principle, and considered mounting a 75 mm. gun, but this proved impossible because of certain mechanical difficulties. [...] If we could have placed the 75 mm. gun into the turret, we should have produced precisely the "Sherman" tank with which eventually American, British and Canadian armoured troops were equipped, and which contributed so much to winning the war on land.[37]

Unfortunately Burns never mentions what those "certain mechanical difficulties" were, and there is no mention of any size-limiting difficulties in the minutes of the February 17th meeting. (This shortcoming seems to only have been recognized in January 1942, when DND authorized the procurement of machine tools to produce a 69" turret ring, meant to be used on the Grizzly, the Canadian version of the Sherman.[38])

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[36] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 1, Mr. L.E. Carr, BPC, to Major W. Mavor, DND, 21 April 1941.

[37] E.L.M. Burns, *General Mud: Memoirs of Two World Wars* (Toronto: Clarke, Irwin & Company, 1970), 104-5. One possible reason for Burns not mentioning too much about this period, or not giving the reasons behind decisions, was that at the time he was having an affair with a married woman in Montreal and trying to see her as often as he could. See J.L. Granatstein, *The Generals: The Canadian Army's Senior Commanders in the Second World War* (Toronto: Stoddart, 1995), 128.

[38] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, R.E. Jamieson, "Tanks Committee Meeting," 31 March 1942. The notes are not numbered, but this was either the fourth or fifth meeting of the Committee.

British and American tank design was still lagging behind that of Germany and the Soviet Union. Both of these countries' tank designers had recognized the need to install the largest turret rings possible in their tanks, to allow them to be up-gunned if necessary. The Germans had 50 mm main guns (roughly equivalent to the British 6-pounder, though of higher velocity) in their Mark III and Mark IV tanks, and the need to replace them with 75 mm guns had already been recognized by German tank crews. The Soviets had started out with 76.2 mm main guns in their KV-1 and T-34 tanks, which (when used correctly) could defeat any German armour. Both countries also had recognized that additional armour protection would be needed against an adversary's up-gunned tanks, and had begun to develop face-hardened and appliqué armour for the more vulnerable frontal surfaces of their tanks.[39]

Production schedules were being drawn up for the new tank even as its design was being finished. General Steel Castings was to pour the first Canadian M3 hull on March 21st, with the second one following two weeks later.[40] It was anticipated that the first "Cruiser Tank M3 (modified)", complete with its armament, would be delivered to the Army by October 1st, 1941, and that the full production rate of two tanks per day would be attained within 30 to 45 days after that date.[41]

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[39] For discussions of turret ring size, upgunning, and appliqué armour see Bruce Culver, *PzKpfw III in Action* (Carrollton, TX: Squadron/Signal Publications, 1988), pages 4, 15, 21, and 23; Bruce Culver, *PzKpfw IV in Action* (Carrollton, TX: Squadron/Signal Publications, 1975), pages 4-5, 15-21, and 27-29; and Steven Zaloga and James Grandsen, *T-34 in Action* (Carrollton, TX: Squadron/Signal Publications, 1983), pages 7-8, 17, 32, and 36-37.

[40] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 1, Department of Munitions and Supply Joint Committee on Tank Development with the Department of National Defence, "Proceedings of the Eighth Meeting," 18 February 1941.

[41] LAC RG 24 Vol.2597, File H.Q.S. 3352-11 Vol. 1, G.K. Shiels, DM&S, to Victor Sifton, M.G.O.,

As part of the effort to convince the American Ordnance department that the recent British battle experience had given them better insight into the tactical handling of armour, a meeting was held February 27 and 28 in Montreal between Canadian, British and US Army officers to discuss matters relating to tank construction and internal arrangements, with an emphasis on radios and communications. Specialist officers from the Signals Branch of all of the armies were invited to attend, as well as their superiors. It was emphasized that the meeting was in no way official:

> The object of the meeting is to have a frank and free round-table conference on tank design and production, and, if possible, to iron out any misunderstandings, real or imaginary, which may now exist.[42]

Nonetheless, Major Mavor and Brigadier Letson were instructed to prepare an agenda that would put across Canadian and British concerns to the Americans.[43]

On the first day of the meeting, the conference attendees visited the Valentine III production line at the Angus Shops in the morning. The Montreal Locomotive Works, with its nascent tank production line and the mock-up of the cast M3 (Modified) hull, was toured in the afternoon. As hoped, specialist officers in signals and tank design from all three nations attended, as did senior officers from Ottawa and Washington, including Generals Crerar and Burns of the Canadian General Staff. Informal discussions took place that evening over supper and drinks at the Mount Stephen Club in downtown

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4 February 1941.

[42] LAC RG 24 Vol. 2615, File H.Q.S. 3352-25, Letson to Burns, 19 February 1941.

[43] LAC RG 24 Vol. 2615, File H.Q.S. 3352-25, Burns to Letson, 22 February 1941.

Montreal, and the formal meetings of the conference took place there on the following day. The Canadians, who provided the minutes of the meeting, ensured that their views predominated.[44]

In the minutes, it was emphasized that the curves of the cast upper hull of the Canadian M.3 Modified Cruiser Tank gave better ballistic protection than vertical armour plate, and that a cast hull also reduced tank production time in both assembly and machining. It was pointed out that proper annealing of the casting in the production process should remove any "shrinkage strains" within it, a problem not found in armour plate. The horizontal plate that wedded the upper and lower hull halves was to be riveted to the lower half and welded to the upper. (The lower hull was constructed of plate because of the multiple openings and machining operations required by the tank suspension.)[45]

The wooden mock-up M.3 Modified hull that had been shown to the American and British officers at the Montreal Locomotive Works was waiting only for one part (the driver's periscope) before finalization of the production design, and had an anticipated completion date of March 14th. The design of the hull casting was based on an overall 60 mm thickness, and had the 60-inch turret ring with the 2-pounder gun installed in the fully-rotating turret. The turret's power traverse enabled it to turn at three-and-a-half revolutions a minute, and a gyro-stabilizer was to be installed on the main gun.[46]

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[44] LAC RG 24 Vol. 2615, File H.Q.S. 3352-25, Burns to Letson, 26 February 1941.

[45] LAC RG 24 Vol. 2615, File H.Q.S. 3352-25, "Minutes of a Meeting at the Mount Stephen Club, Montreal, February 28, 1941."

[46] Ibid.

Some of the attendees went away from the meeting thinking of other matters: General Crerar wrote a memo to C. D Howe, the Minister at the Department of Munitions and Supply, to complain of the slow construction of the tank assembly building at the Montreal Locomotive Works. This was apparently due to a lack of structural steel allocated to the project, and he asked Howe if more steel could be made available for the building.[47]

General Burns wrote a memo detailing the problems still to be solved for the "M4C" tank, including the final main turret design, and detail work on the auxiliary machine-gun cupola. He noted that sources still had to be secured for optical equipment such as sights, protectoscopes and periscopes, and that technical manuals were desperately needed for shop workers and end-users both, and would have to be prepared.[48] Mr. C.I. Evans of the Department of Munitions and Supply recognized this as well, and consequently asked Major Max Evans to prepare and produce an instruction book for the "M3 Modified Cruiser Tank".[49] Major Evans, also looking towards the future, noted that the

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[47] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Crerar to Howe, 1 March 1941.

[48] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Burns to DM&S, 3 March 1941.

[49] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Mr. C.I. Evans to Major Max Evans, 28 March 1941. Interim Ram servicing manuals were only issued in March 1942; they were copies of the "USA M3 Medium Instruction Book No. TM 9-750", dated 1 October 1941, with exceptions and additions noted on an attached sheet. Because of the similarities between the M3 and the Ram, it could be used to instruct on the operation and maintenance of everything except the armament. As late as June 1942, a final instruction book for the Ram was still lacking, as were information sheets that described maintenance schedules and requirements. This was more than two months after the tanks had been issued to Canadian troops and to the UK authorities for testing, and more than five months since the War Office had asked for details about the tank. See LAC RG 24 Vol. 9364, File 38/Arm Veh/28, A.S. Ellis (T.A.M.T.) to Captain Gibbons, A.F.V.1.(b), W.O., 26 March 1942, and LAC RG 24 Vol. 2600, File H.Q.S. 3352-11 Vol. 8, Ellis to AEDB, "Manufacturing and Service Information – Ram Tanks," 2 June 1942.

maintenance demands of this tank would require not only greater instruction but also better-trained people in the service echelons to keep it working in battle.[50]

Another delegation arrived from the United States in March to examine the "Canadian Cruiser" mock-up at the Montreal Locomotive Works. Among the visitors were Colonel J.B. Christmas of the U.S. Ordnance Corps, Aberdeen Proving Ground, Major A.V. Goldring, the British Assistant Military Attaché in Washington, and Mr. L.E. Carr, the man who had done most to design the hull and turret of the tank.[51] All were experienced tankmen, and it was understood that they would be submitting reports back to their governments about the Canadian efforts.

During the delegation's visit, Colonel E.L.M. Burns spoke with Major Goldring regarding possible improvements for the "M4C Tank", based on Goldring's experience in the British Army's Tank Design Department, as well as his part in designing the Matilda Mk. II Infantry Tank. Goldring suggested that the Canadian Cruiser M3's escape hatches should be hinged from the inside for greater crew safety; and also that the glacis in front of the driver be modified to prevent bullet splash from penetrating the hull through his visor and entering the tank. He also emphasized that trials of the finished prototype should ensure that the auxiliary machinegun in the cupola worked well under simulated combat conditions. Goldring noted that in the field, maintenance would be held to the

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[50] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Maj. M.M. (Max) Evans for D.O.S. (M). to D./M.G.O., "Visit to American Locomotive Company, Schenectady, U.S.A.", 22 April 1941.

[51] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Brigadier H.F.G. Letson, Military Attaché (Canadian Legation, Washington) to the Deputy Chief of the Defence Staff, NDHQ, Ottawa, date unknown but internal evidence suggests between 12 February and I March, 1941. The visit was to take place 21 March, 1941.

minimum amount possible and parts that were well-lubricated on trials would probably be much harder to move or turn in action. His own experience with the cupola in the British A12 Tank showed that an auxiliary traversing mechanism, operated by hand, would probably be needed. Finally, Goldring pointed out that the proper installation of the No. 9 Wireless Set in the turret was critical, as even the slightest variation in the wiring and positioning of the wireless set and its connections within the tank would probably result in lessened performance and a painstaking re-adjustment of the set.[52]

It was also suggested that Canada should establish a "Tank Design Organization" to produce new type variants and improvements in the tanks presently being manufactured. Goldring thought that the UK Ministry of Supply could second to Canada a senior draftsman from its Tank Design Branch "if a sufficient inducement were offered."[53] Another possibility was that the Dewar Mission's designers might be made part of this Canadian design staff should the British Purchasing Commission be reduced in size.[54]

Even as Goldring proposed this, a Canadian Design Staff was already being created, with the transfer of the Design Branch for Motors and Tanks from the DND to the Department of Munitions and Supply, as part of an effort to consolidate Design and Production within DM&S and avoid misunderstanding and duplication between departments working on

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[52] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Col. E.L.M. Burns, DND to W.F. Drysdale, DG of Munitions Production, DM&S, 24 March 1941.

[53] Ibid.

[54] Ibid.

similar projects.[55] By late May, office space for some 75 technicians had been requested and the wrangling for accommodation between the Department of Munitions and Supply and the Ministry of Public Works went on for several months.[56] At one point Public Works suggested that there was considerable vacant space available in the Temporary Buildings on Wellington Street and that it just needed consolidating to provide space for the incoming technicians. J.S. Reynolds of the DM&S's Personnel and Equipment Branch noted that this was incorrect, and that "...In fact yesterday we were forced to put an important gentleman coming to work with Mr Turnbull in a woman's restroom [...] on account of the lack of space."[57] It was clearly realized that the Design Branch was needed to keep pace with developments, as well as to outpace those of the enemy. In the words of Victor Sifton, the Master General of the Ordnance, to Defence Minister Ralston,

> It is true that some original and very satisfactory work has been done with respect to the development of the Cruiser Tank, but with this exception, we have been satisfied, strictly speaking, to duplicate British designs as nearly as possible in this country.[58]

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[55] LAC RG 28 Vol. 59, File 1-1-127-1, C.D. Howe to J.L. Ralston, 2 April 1941. Ralston agreed, on the condition that the personnel be transferred from DND to Department of Munitions and Supply premises, as well, to free up office space for other DND projects. By September 27th , it was established that the Design Branch would be established in the new Temporary Building 4, at Ottawa's LeBreton Flats. See Ralston's reply to Howe in the same file, 4 April 1941 and see also J.H. Barry (Technical Advisor, DM&S) to G.K. Shiels (DM&S), 27 September 1941.

[56] LAC RG 28 Vol. 59, File 1-1-127-1, G.K. Shiels, Deputy Minister, DM&S, to J.B. Hunter, Deputy Minister of Public Works, 19 May 1941.

[57] LAC RG 28 Vol. 59, File 1-1-127-1, J.S. Reynolds to A.J. Martin, Department of Public Works, 22 May 1941.

[58] LAC RG 28 Vol. 59, File 1-1-127-1, Sifton to Ralston, 30 May 1941. This letter also notes that Mr. Garfield Evans is Director of Tank Production.

From Maryland, Colonel Worthington sent back a report on the firing trials conducted upon the experimental cast hull designed for the British Lee/Grant M3 Medium tank. Shots were fired at the hull from both 75 mm and 37 mm guns. Though the armour was sometimes gouged by the impact of the projectiles, the only penetration of the armour came from some 37 mm fire at close range and high velocity. Subsequent examination of the hull led to the conclusion that equal protection was achieved for plate and cast armour at thicknesses above one-and-a-half inches.[59]

The design of the Canadian cruiser tank prototype, now unofficially known as the Ram, was finalized on schedule in the last half of March 1941. The running gear of the tank (the tracks, bogies, road wheels, etc.) was virtually identical to that of the M3, but in contrast to the original M3 design, the hull was much lower, not only because the tall sponson housing the 75 mm gun had been removed but also because the driver's and co-driver's seats were now positioned behind, rather than above, the transmission of the tank. This reduced the total height of the tank to 8 feet 9 inches, 18 inches lower than the original American M3 design. The new cast hull had a rounded-edge shape that seemed to flow up in a curve from the suspension of the tank. The main armament, a 6-pounder gun, was mounted atop the hull in a turret that had a full 360 degrees of traverse. (The mount for the 6-pounder gun was not ready in time for the initial production run, so the first 50 tanks were equipped with a 2-pounder gun in a slightly different turret face plate and designated as the Ram I, with the 6-pounder models given the name of Ram II. Both designs had a coaxial machine gun beside the main gun which moved in synchronization

[59] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, Colonel Worthington to NDHQ, "Report on Firing Trials – Cast Hull M III," 24 March 1941.

with it.) The machine-gun cupola (that had been on top of the M3 turret) was relocated to the left-front hull of the Canadian tank and its .30 calibre machinegun was used by the co-driver for close-in defence. Five large hatches afforded access and escape routes for the crew: one in the bottom of the hull, two large ones in the sponsons above the tracks on each side of the tank (which increased the width of the Canadian Cruiser M3 by several inches over that of the M3), one above the machine-gun cupola, and one for the tank commander. Finally, the crew had been reduced in number from the M3's seven to five: The driver, a co-driver/machine-gunner, a loader and a gunner for the main gun, and the tank commander.

Chapter 3: Production Begins

As noted above, plans of the hull and turret had been sent to General Steel Castings for manufacture even as other parts began to arrive at the Montreal Locomotive Works to construct the first Ram I Tanks. Each individual cast hull required close to two weeks to produce, because of the various processes required to give the armour of the hull its correct properties. After the hull was released from its mold and the machining around hatches and critical-tolerance areas was finished, the heat treatment of the hull took place in four stages. During the first stage, known as "homogenizing", the hull was heated to a temperature of 1850° to 2000° Fahrenheit and "soaked" (kept at that temperature) for 6 to 10 hours, and then allowed to air-cool slowly, a process which increased the strength and hardness of the armour. The second stage, "annealing", heated the hull to 1100° - 1250° F. for 4 to 6 hours and again allowed it to air-cool; this process reduced any brittleness in the metal and made the hull easier to weld if any repairs or fittings were needed. The third stage was "hardening", where the hull was again heated to 1500° - 1700° F., but this time for only 2 to 6 hours, and then it was rapidly cooled by "quenching" it in a water bath. The final and fourth stage was "tempering" the metal, heating it to 1000° - 1250° F. for 4 to 10 hours, and allowing it to air-cool. This last step

was vital to ensuring the uniformity of hardness throughout the armour.[1] The first M3 Cruiser upper hull was to be sent to MLW on May 3rd, to be mated to a lower hull to form the prototype tank. The second cast upper hull was to go to Aberdeen "for testing to destruction," but the destination was later changed to Valcartier. The first cast turret was expected to arrive at MLW on 25 May, and it was thought that the first finished tank should be ready sometime in June, with small-scale production thereafter, gradually increasing. (Full production could not be expected until September-October, upon completion of the new tank assembly hall.)[2]

In Montreal, rolled armour plate for the lower hulls of the tanks, "annealed, cut to shape, heat treated and straightened", came from Dominion Foundries and Steel Ltd. of Hamilton, Ontario to be assembled on the production line.[3] Heavy transmissions used for the US M3 tanks were ordered from the Iowa Transmission Company because the weight

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[1] The above data applied to Ram hulls that were produced up to "sometime in May 1942". After this date, "Low Alloy" hulls (with a different metal mixture) were produced under contract #Q.12676, with these changes in heat treatment:

Temperature	Hours Rise	Hours Soak (Cooling)	Coolant
1950°	10	10	Air
1250°	10	4	Air
1575°	12	4	Water
1150°	12	4	Air

These two treatments resulted in equivalent ballistic protection for both types of hull. See LAC RG 24 Vol. 9365, File 38/Arm Veh/28/3, D.D.E.M. (D.Q.M.G., C.M.H.Q.) to D.D.O.S.(E) (C.M.H.Q.), "For the attention of Major Relyea", 22 January 1943.

[2] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 1, Department of Munitions and Supply Joint Committee on Tank Development with the Department of National Defence, "Proceedings of the Tenth Meeting," 17 April 1941.

[3] LAC RG 28 Vol. 432, File 20-LV1A-11, Contract [unnumbered] with Dominion Foundries and Steel Ltd. of Hamilton, Ontario, for the "Manufacture of Sets of Rolled Armour Plate for M3 Cruiser Tanks", 17 July 1941.

of the Ram exceeded the operating limits of any Canadian-made transmission.[4] Co-axial gun mounts for the 2-pounder gun, with their attached 65mm armour shield, were coming from the York Safe and Lock Company of New York City, and Continental Motors had the tank's R-975 engines, fittings, and spares on order at their Ohio factory.[5] Many other parts for the initial production run of tanks were arriving from US manufacturers because so many components of the Ram's running gear, fighting compartment, and engine compartment were identical to those of the US M3 Lee (and the UK M3 Grant) tanks; the list of items and suppliers for these parts ran to six single-spaced legal-sized pages.[6] Later on, for the Ram II model, Canadian manufacturers would produce many of the same designs under license.

Often, these parts arrived in advance of the formal signing of contracts. The Dominion Foundries contract was signed in July of 1941; the contract for gun mounts with York Safe was finalized in October of the same year.[7] Other contracts were only agreed to well after the production of the tanks was underway, many of them being modified as specifications and parts requirements changed.

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[4] LAC RG 28 Vol. 432, File 20-LV1A-1, "Letter of Intent to Iowa Transmission Co.," 3 April 1941. This Letter was later superseded by US Government Contract DA-W-271-ORD-137.

[5] LAC RG 28 Vol. 432, File 20-LV1A-1-17, Contract Canada No. 171 with the York Safe and Lock Co., dated 15 October 1941, and File 20-LV1A-1 in the same box, Contract Canada No. 193 with Continental Motors Corporation, dated 28 November 1942.

[6] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1, addendum to "Minutes of Meeting held at Willard Hotel – November 13, 1940," dated 14 November 1940.

[7] LAC RG 28 Vol. 432, File 20-LV1A-11, Contract [unnumbered] with Dominion Foundries and Steel Ltd., op. cit., and File 20-LV1A-1-17 in the same box, Contract Canada No. 171 with the York Safe and Lock Co., op. cit.

The expansion of the works at MLW to construct the Montreal Tank Arsenal was covered by a contract for $200,000 US to be paid to ALCO for its "General and Administrative Expenses and Direct Charges" over the period of 23 October 1940 to 31 December 1941.[8] Further sums would be paid out over the course of the production programme, but this was the figure for the initial investment at MLW. Later on in the year, several tracts of land adjoining the Arsenal were expropriated to create a testing ground for the tanks, simulating the conditions that they could be expected to face in action.[9]

On 22 April 1941, Lt-General Taber, Brigadier Carr, Colonel Morrison, and Major Evans visited the ALCO plant at Schenectady, New York, not only to examine the plant and its production methods, but also to attend the ceremonial roll-out of the first production US M3 Lee. The tank was essentially an olive-drab-painted shell, lacking radios, much of the inside wiring, internal stowage, vision devices, and correct gun mounts, but it had been mocked-up sufficiently to look complete for the press cameras at the presentation ceremony.[10] Within two weeks, the first M3 tanks emerged from the other US production lines at the Baldwin Locomotive shops in Eddystone, Pennsylvania, and the Detroit Tank Arsenal; however, something that was not revealed to the press was that the same single transmission assembly powered the first two tanks out into public view. The shortage of parts was so acute that no sooner had the first M3 returned inside the factory

[8] LAC RG 28 Vol. 432, File 20-LV1A-1, Contract [unnumbered] between ALCO and DM&S, 4 September 1942.

[9] LAC RG 28 Vol. 432, File 20-LV1A-1, various notices dealing with property expropriation through the offices of the City of Montreal. The expropriated land was returned to the owners on 20 December 1945.

[10] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Maj. M.M. (Max) Evans for D.O.S. (M). to D./M.G.O., "Visit to American Locomotive Company, Schenectady, U.S.A.", 22 April 1941.

at Schenectady than its transmission was unbolted from the chassis and hurriedly shipped to Baldwin for the public presentation of that factory's first M3 tank.[11] Another transmission arrived in time to power the Detroit tank, but transmission supply problems would continue to plague the tank production programmes in both the US and Canada for months.

A breezy article from an issue of *Time* Magazine for the period is clipped into the DND files, describing the debut of the M3 pilot model at the Aberdeen Proving Grounds and the trials that photographers and reporters were allowed to see. The article also compared two different hulls planned for the M3 chassis, the present one made of bolted-together armour plate and a cast armour type. To compare the two, *Time* reported, "... [the bolted, armour-plate] M3's hull took 1,100 man-hours to fabricate. The experimental hull, cast as a simple piece of armor, was completed in 100 man-hours."[12]

The first machined and finished cast hull of the Modified Canadian M3 tank was shipped to Montreal from General Steel Casting Corporation via the Delaware and Hudson Railroad on Saturday, 3 May.[13] During an 8 May meeting of the Joint Committee on Tank Development, it was noted that the upper hull had arrived at MLW and had been welded and bolted to the lower hull being assembled there. The first tank was estimated

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[11] Noted in Peter Chamberlain and Chris Ellis, *M3 Medium (Lee/Grant) AFV 11*, (Windsor, Berks.: Profile Publications, 196-), np.

[12] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, clipping from Time magazine, "Army M3", dated April 14, 1941.

[13] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, W. Mavor, BPC, to Maj. M.M. Evans, 2 May 1941. Mavor, the Canadian technical representative at the BPC, urged Major Evans to notify Canadian Customs of the shipment to ensure that it could be cleared through to MLW as soon as possible.

at seventy percent complete (less the turret) and its completion was anticipated for sometime in June, 1941. Also at the meeting, Major Evans and Mr. L.H. Carr reported that they had investigated the possibility of casting the lower hull of the tank, but there appeared to be no time or labour savings involved in having a cast lower hull in place of the already-designed rolled plate one, so it was agreed to continue with the flat-plate version. Headlamps were to be of the same type as were installed on the Universal Carrier, and Vickers periscopes might be installed instead of the ones used on the US M3. Evans and Carr also thought that, if necessary, they could develop a mount for the 6-pounder gun, as there was so much delay in getting the British to supply plans for the assembly.[14]

In England, at the same time, now-Brigadier Worthington was speaking with the Director of Tank Design at Egham, trying to instil a stronger sense of purpose into the design and fabrication team creating the new 6-pounder gun mount for tanks. He reported to Canada that the 6-pounder mounting design was coming along but the task was handicapped on two counts: First, because the designers did not have an actual 6-pounder gun to work with, as the first pre-production batch of 12 were still being produced by hand at the Woolwich Arsenal. Second, because full-scale production of the gun was not to start until October, "no great urgency" was perceived on the British end to finish the job on the mounting.[15]

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[14] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 1, Department of Munitions and Supply Joint Committee on Tank Development with the Department of National Defence, "Proceedings of the Twelfth Meeting," 8 May 1941.

[15] LAC Microfilm T 17885, Worthington to DM&S, "Report No. 6," 21 May 1941.

Worthington had gone to the UK as part of a Canadian "Special Mission" that was assigned on 12 April and was in the UK from 23 April to 7 June, 1941. The Mission was intended to "familiarize [itself] as quickly as possible with the basic features of tank design and problems connected with production and supply," and was made up of Worthington, Major S.E. Morres, and D. McKay Loomis, a Technical Advisor seconded from the Department of Munitions and Supply.[16] Among the suggestions that Worthington sent back to Canada was the UK opinion that the metal of a cast hull could be thinned as its slope approached the horizontal, because most anti-tank projectiles would be traveling parallel to the ground and the greater slope of the armour would compensate for its thinness; he advised the Department of Munitions and Supply that this was a possible line of inquiry.[17] (The Russians had already exploited this principle in the sloped hull of their excellent T-34 tank, and the Germans would later copy it in their Panther PzKpfw V.) In other despatches he enclosed plans and drawings of new splash-proof pistol ports that had been designed for the new British A22 Tank (later known as the Churchill), recommending that they be used in Canadian tanks as well.[18] (New models of armoured vehicles would undergo "splash tests" at the earliest feasible production stage. These were trials in which various sized projectiles were fired at the tank to see how much punishment the armour can take, as well as to assess how vulnerable the hatches, vision devices, and turret ring were to bullet and shell fragments ("splash") entering the tank through gaps in the armour at these vulnerable points.) More

[16] LAC Microfilm T 17885, Worthington to Senior Officer, CMHQ, "Special Mission," 10 June 1941.

[17] LAC Microfilm T 17885, Worthington to DM&S, "Report," 15 May 1941, and "Notes on Armour Protection for AFV's," n.d. but probably between 23 May and 5 June, 1941.

[18] LAC Microfilm T 17885, Worthington to DM&S, "Report," 15 May 1941, "Report No. 8," 23 May 1941, and "Report No. 13," 5 June 1941.

information on a new way of minimizing bullet splash (with full descriptions and drawings) was sent back to Canada by Worthington, and he added the suggestion that Canadian designers should follow British practice and put an escape hatch in the underside of the tank's hull (an idea that was adopted early on in Ram production).[19]

While the first Canadian Cruiser M3 was nearing completion, the first example of the other tank being constructed in Canada rolled off the CPR production line at the Angus Shops in Montreal. On 22 May 1941, in the presence of an estimated 2,000 onlookers, the first Valentine III tank to be produced outside of Britain was driven out of the shops and showed off its capabilities to the crowd. The tank was commanded by a veteran of the Royal Tank Regiment, Corporal Colin Stirton, and driven by Mr. J.A. Chisholm, an assistant foreman. In a brief ceremony that was recorded for later broadcast on the CBC, Mr. D.C. Coleman of the CPR formally handed over the tank to C.D. Howe, the Minister of the Department of Munitions and Supply, who in turn handed it over to Minister of Defence J.L. Ralston. All of these men spoke of their admiration for the achievements of the CPR in making the tank, and Ralston added that "the Canadian army is ready to receive just as many as they can produce and just as fast as they can produce them."[20]

The ceremonial roll-out of the first Canadian Cruiser M3 duly took place at the Montreal Locomotive Works on the 30th of June. As was the case with the Valentine, it was a

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[19] LAC Microfilm T 17885, Worthington to DM&S, "Report," 15 May 1941.

[20] Anonymous, "First Tank Produced at CPR Angus Shops," *Canadian Transportation* (July, 1941) : 371-372. As noted above, this did not happen. Most of the 1420 CPR-produced Valentines went to Britain and Russia under Lend-Lease. Only the first 30 were kept by the Canadian Army, and those solely for training and evaluation. See B.T. White, *Valentine, Infantry Tank Mk III, AFV 6* (Windsor, Berks.: Profile Publications, 196-), np.

spectacle staged for the staff of the Works as well as for the cameras of the local newspapers, with the tank bursting dramatically through "a huge poster depicting M3's advancing into battle." Corporal Stirton of the RTR was again present, this time acting as the driver of the tank, and many media accounts emphasized that he had been a veteran of the Dunkirk fighting and evacuation. Many of those involved in the tank production programme were there to see the tank's debut, including Mr. L.E. Carr, Brigadier N.O. Carr, Mr. G.L. Evans, Dr. R.E. Jamieson, Lt-Colonel W. Mavor, and Colonel H.E. Taber C.D. Howe and J.L. Ralston were there as well, representing their respective departments.[21]

Howe, in his speech to the crowd, said that this was only the first of many tanks to come and noted that there were already several other partially constructed tanks on the Works production line. Concerned about complacency in Canadian industry, he went on to warn that

> Continued production can only be achieved by a steady flow of components from all parts of central Canada. A strike in any one of 20 plants would stop this production line. Both workmen and management must see to it that nothing will occur that will cause delay to the production of these tanks. I have every confidence that the flow of components of this plant will not be interrupted by any cause whatsoever.[22]

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[21] Leslie C. Powell, "Steel Monster Makes Its Debut At Montreal Locomotive Works," *The Gazette* (Montreal), 1 July 1941, 1 and 15, Anonymous, "Big Cruiser Turned Over To Ralston and Howe," *The Montreal Daily Star*, 2 July 1941, 15, and Anonymous, "Montreal Locomotive Works Producing Cruiser Tanks," *Canadian Transportation* (August, 1941): 435-436.

[22] Quoted, at least partially and word-for-word, in each of the above-mentioned stories in *The Gazette*, *The Montreal Daily Star*, and *Canadian Transportation*, suggesting that all article writers took it from an official press release.

In his speech, J.L. Ralston congratulated the plant workers for their dedication in getting the first tank out nearly two months ahead the date specified in the contract.[23]

The Canadian Cruiser M3 prototype did not stay in Montreal for too long after its unveiling. On 14 June 1941, a request had come from the US Ordnance Department for the loan of the prototype "Cruiser M3" tank (upon its completion), for trials at the Aberdeen Proving Grounds in Maryland.[24] The Tank Development Committee had approved the request on the 19th of June, considering that it would be a good opportunity for the US to test British and Canadian design ideas, as well as to get constructive criticism from the trials.[25] On the 12th of July, only two weeks after its roll-out from the Montreal Locomotive Works, the Cruiser M3 was shipped from Montreal to Maryland. The tank crewmen who were to demonstrate the tank went down as well. As the United States was still officially neutral, the tankmen had to have passports with US visas and wear civilian clothes to cross the border, carrying their uniforms in their luggage to wear at Aberdeen. Initial trials began on the 21st of July, lasting into the next month.[26]

During the Aberdeen tests, the Americans requested that the Cruiser M3 be allowed to undergo further trials at the US Armor School at Ft. Knox, Kentucky. R.A. Macfarlane (of the Directorate of Mechanization) gave permission for moving the tank "to wherever

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[23] Anonymous, "Montreal Locomotive Works Producing Cruiser Tanks," *Canadian Transportation* (August, 1941): 436.

[24] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, R.A. Macfarlane, D. Mech to the Military Attaché, U.S. Legation, Ottawa, "Canadian M-3 Modified Cruiser Tank," 13 August 1941.

[25] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Crerar to Ralston. 4 July 1941.

[26] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Mavor to Macfarlane, 7 July 1941.

US Ordnance wants", only asking in return that the Canadian Legation in Washington be kept informed of the whereabouts of the Cruiser M3 and its crew.[27] After its stay at Ft. Knox, the tank was returned to Aberdeen for armour and splash tests.[28]

The tank was returned by rail from Aberdeen to Montreal in early November, having set out on the 21st of October.[29] Even before its return, a report on the first set of tests at Aberdeen had been sent back to Canada by Corporal C. Stirton, the senior member of the tank crew. These trials had tested the running and operation of the tank, not its armament. Generally good results were obtained from the tests, and various improvements were suggested for the fighting compartment, especially a "driver's body belt" that would help the driver to stay in his seat when the Cruiser M3 was going down steep slopes. The sole negative note in his report was that of an engine fire that occurred near the end of the testing. Fire extinguishers in the tank's engine compartment failed to function and Aberdeen's local fire department had to be called in; it took them 10 minutes to arrive but they quickly put out the fire. (When tested later, the extinguishers worked; it appeared that the handles were not pulled hard enough to activate them the first time.) Damage to the tank was minimal, mainly scorching of the paintwork around the engine compartment. The apparent cause of the fire was that the "near side" [left]

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[27] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, R.A. Macfarlane, D. Mech to the Military Attaché, U.S. Legation, Ottawa, "Canadian M-3 Modified Cruiser Tank," 13 August 1941, op. cit.

[28] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, C.G.S. to Canadian Military Attaché, Washington, D.C., 2 September 1941.

[29] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, D. Mech to K. Ault, Tank Production Department, 21 October, 1941.

muffler had fallen out of position and blew hot exhaust gasses back over the engine, igniting spilled gasoline there.[30]

A Canadian Army representative, Captain H.W. Steel, also attended the Aberdeen and Ft. Knox trials and reported his findings (to Ottawa as well as to Dr. Jamieson and Mr. G.I. Evans at the Montreal Locomotive Works) upon his return to Canada in November with the tank.[31] Steel's report was more detailed than Corporal Stirton's had been, the test results itemized on a form that the US Ordnance Department had created for testing its own tanks. Most of the observations about the tank were graded as either "satisfactory" or "very satisfactory", but the perceived shortcomings of the tank were listed in detail.[32]

The report noted that the vision devices on the tank were inadequate, especially for the driver. When his armour hatch was closed, his field of view was very restricted, a small slit in the hatch allowing him only limited vision to the front of the tank; when the hatch was opened, it was far too large and the driver was unprotected, even by a sheet of glass, from dust and debris. Also, the driver had no side-vision slots or rear-view mirror, so he would have to depend heavily on the tank commander for directions on any alteration of course. Other flaws that affected the driver were that the clutch and transmission, located near his legs, would overheat his compartment during moderate and prolonged use and

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[30] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, enclosure report by Cpl. C. Stirton in letter from K. Ault, Tank Production Department, D.M.S., to Lt. F.W. Findlay, D.N.D., October 3, 1941.

[31] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Dr. R.E. Jamieson, Department of Munitions and Supply, to J.V. Young, D/M.G.O., November 1, 1941. In the letter Jamieson misspells Steel as "Steele".

[32] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Capt. H.W. Steel to Lt.-Col. Mavor, D.O.S.(T.S.), Ottawa, 12 November 1941.

that on one occasion it burned his leg when he leaned it against the transmission housing. It was also found that the seats of the driver and the co-driver/cupola gunner were badly located, interfering with the movements that they would be expected to make in combat, and that the driver's steering rods needed to be repositioned to avoid being fouled (interfered with) by the co-driver's feet. The pistol ports were difficult to operate and the side hatches were not adequately armoured against bullet splash. And the official opinion of the US Ordnance observers was that the tank definitely needed to have a gyro-stabilizer fitted to the main gun, to allow it to fire while the tank was on the move. [33]

In field trials, the vibration set up by the tracks while traveling on roads caused the main turret to traverse from side to side on its ring, and a lock for the traverse mechanism was suggested as a remedy. The tank was comparatively inconspicuous by day, its low silhouette allowing it to use folds in terrain and other ground cover for greater concealment; but by night, its exhaust system gave off flashes of light that clearly signaled its location. Also at night, the external lighting on the tank was too weak to be used by the crew for driving, and it was considered that a siren would be better suited to the tank than the low-volume automobile horn currently fitted.[34]

In the engine compartment, the fuel lines tended to vibrate loose from their fittings, and more insulation against heat was needed over the gas tanks. Both mufflers were

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[33] Ibid.

[34] Ibid.

considered to be badly placed and, as noted earlier, one of them had come loose and caused an engine fire.[35]

Overall it was considered that there were many shortcomings in the tank, but that was to be expected in a prototype vehicle, and most of them were easily fixable. The main goal now was to incorporate the fixes into the plans for the subsequent production vehicles, while ensuring that these fixes did not result in further problems. There are no records of the 2-pounder gun having been tested while in the United States, which speaks of a strange complacency on the part of Canadian authorities—unless the knowledge that "war" versions of the M3 were going to be equipped with the 6-pounder gun made them think it unnecessary.

Construction of Canadian Cruiser M3s continued while the prototype was being evaluated in Aberdeen. Scheduled production was projected as 4 M3s in September 1941, 8 in October, 16 in November and 24 in December, for a total of 52 (excluding the prototype) by the end of the year.[36] But in early August, one of the events that had so concerned C.D. Howe in his speech—a labour strike at a parts supplier—had come to pass. It was a United States supplier: A strike at the Mack Truck Company temporarily stopped the shipment of tank transmissions to Canada. The Canadian Military Attaché in Washington was asked to get the War Department to maintain deliveries on time, diverting transmissions to Canada from another manufacturer if necessary.[37] In the event,

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[35] Ibid.

[36] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, D. Mech to D.S.D., 17 September 1941.

this measure was needed because the strike ended on August 18th. But it starkly demonstrated how vulnerable Canadian tank construction was to elements beyond the control of the constructors, and even of the Canadian government.

Also in August, the second prototype hull arrived from the United States and was sent to Valcartier, Quebec, for firing range trials. In reports, the hull casting was considered to be free of flaws and well-finished. It was subjected to 2-pounder fire at various ranges and offered comparable protection to armour plate of the same thickness. The most vulnerable area of the hull appeared to be the lower part of the casting, as this was where it was at its thinnest, only 1 ½" thick. Mr. J.M. Ireton, the Inspection Officer for Tanks, said, "All shots at normal showed good petalling effect on the face of the casting, and very little tendency to spalling on the back."[38] This meant that the armour was fulfilling its role, sacrificing itself through flaking (petalling) on the outer surfaces, yet not separating into layers and fragmenting on the inside face of the armour (spalling). Of 41 shots fired at the hull with 2-pounder armour-piercing shot (solid) rounds, most only caused surface damage to the armour. Six shots caused the armour to crack, but did not penetrate; four shots resulted in pinhole penetrations, holing but not entering the tank;

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[37] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Brig. Stuart (V.C.G.S.) to the Military Attaché, Canadian Legation, Washington, D.C., 14 August 1941.

[38] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Inspector-General of the Inspection Board of the U.K. and Canada to Colonel G.P. Morrison, Director of Research, Ottawa, "Firing Trial Reports on Hull #2 and Turret of Cruiser Tank M3," 29 August 1941. One of the cast turrets was sent as well, but though there is a summary sheet referring to it, the file does not contain any information referring to what firing trials were performed on it.

and only 5 shots resulted in penetration, piercing the armour through.[39] This was deemed to be an excellent result; but on the Axis side, the standard German antitank guns were now the 50 mm PaK 38 and the 75 mm PaK 40, with shot weights of 4 pounds 9 ounces and 15 pounds respectively, both with much higher penetrating power than the British 2-pounder shot.[40] Both shots would be able to punch through the M3's armour with ease.

In late September 1941, War Supplies Limited (the Crown Corporation set up for selling war materiel to Allied countries) received a request for an M3 Modified Cruiser Tank hull casting from AMTORG, the Soviet trading organization. By now, War Supplies had plenty of the hulls available, and asked the Department of Munitions and Supply if there were any objections to the sale. The Department of Munitions and Supply in turn asked the Master-General of the Ordnance if the hull was a secret weapon; also, if the Soviets liked the hull and wanted to buy more, would their request for additional hulls put a strain on US production?[41] Ultimately, the MGO said that if the United States (as the producer) had no objection to the sale, then Canada did not.[42] Unfortunately, there does not appear to be any further correspondence in the files, so the outcome of the Soviet request is not known.

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[39] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Inspector-General of the Inspection Board of the U.K. and Canada to Colonel G.P. Morrison, Director of Research, Ottawa, "Firing Trial Reports on Hull #2 and Turret of Cruiser Tank M3," 29 August 1941, attachment.

[40] For a discussion of these weapons, see http://www.lonesentry.com/articles/50mm/index.html and http://www.lonesentry.com/articles/ttt07/pak40.html , both accessed 4 September 2009. See also Bruce Culver, *PzKpfw III in Action* (Carrollton, TX: Squadron/Signal Publications, 1988), 23 and 33, for the early adoption dates in tanks of the German 50 and 75 mm guns. PaK is an acronym for *Panzerabwehrkanone*, anti-tank gun.

[41] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Beamish (DM&S) to Young (D/M.G.O.), 27 September 1941.

[42] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Young (D/M.G.O.) to Beamish (DM&S), 8 October 1941.

Plans were also being made for modifications to future models of the Canadian Cruiser Medium Mk 3, in accordance with British War Office (WO) plans. The decreed policy of the WO was that ten per cent of tanks in armoured formations were to be dedicated to Close Support (CS) work with the infantry, and as such needed to be equipped with a dual-purpose gun (a gun that could fire both antitank and antipersonnel ammunition). To conform to this requirement, the CS Cruiser Mk 3s would be equipped with either the US 75 mm gun or the UK 3-inch howitzer, when the tanks and the guns became available. Each of the guns was able to fit inside the 60-inch turret ring of the tank, though the larger size of the gun meant it would be a tight fit for the crew if the turret were not redesigned and enlarged.[43] This requirement for CS-gunned tanks was ultimately dropped by the WO, but not before a great deal more correspondence was exchanged on the matter.

By mid-October the first 12 tanks in the production run had successfully been "joined" (had the upper and lower hull halves welded and bolted together) but the only tank that was actually complete was Hull #1, still at Aberdeen under test. All of the other tanks still lacked full equipment, and none were ready to be passed for inspection or to be issued to troops.[44] The first 10 tanks off of the production line were to be sent to A8 CACTC in Ontario for training; the balance of the first order was to go to the 5th Canadian Armoured Division, training in southern England.[45]

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[43] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Canmilitry to Defensor, 12 August 1941.

[44] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, Montreal Locomotive Works to MGO, "Progress Report No. 1 – M3 Modified Cruiser Tank," 14 October 1941.

[45] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, D.S.D. to D. Mech, 2 October 1941.

Around the same time, General H.D.G. Crerar sent a personal letter to Lt-General A.G.L. "Andy" McNaughton, commander of the Canadian forces in England, keeping him informed about the progress of Canadian tank manufacture and the tests that the tank had been undergoing in both Canada and the United States. He told him that the US War Department trials had revealed some minor problems, but otherwise the tank was considered to be structurally and mechanically sound. He went on to add:

> The U.S. War Department have now produced a pilot model of the M.4 Cruiser. This model is a development of our Canadian M.3. It has a cast upper hull which is an improvement on our present hull, and a cast turret. It has a 69-inch turret ring in place of the 60-inch ring in the Canadian M.3. The turret can take either a U.S. 75 mm. or a 6 pdr. This new model is now under order at certain of the U.S. plants producing to British and U.S. order. As this new model has been accepted by the U.S. and the British and as it is a better fighting tank than the Canadian M.3, the General Staff has agreed to accept it provided production is not unduly impeded. Department of Munitions and Supply state that the change over will not impede production and they hope to introduce the change over at Montreal Locomotive after production of about the 150th M.3 Canadian Cruiser.[46]

In late October 1941, official word went out that the tank variously known as the M3 Modified Cruiser Tank or the Medium Tank M3 (Canadian) would henceforth be known as the Ram. The Ram I designation was reserved for tanks armed with the 2-pounder

[46] LAC RG 24 Vol. 9364, File 38/Arm Veh/11, personal letter from "Harry" [H.D.G. Crerar], C.M.H.Q. to "Andy" [Lt-General A.G.L. McNaughton], 17 October 1941. Ultimately, it took far longer than was anticipated for the production line to change over, and even then the M4 production run was brief. After only 188 examples of the Canadian M4 (the "Grizzly") had been produced, its production was halted to allow the manufacture of the Sexton self-propelled gun.

gun, and the Ram II for those armed with the 6-pounder gun.[47] The American designations for the tanks recognized their advance from the M3 model and instead placed them within the M4 Sherman series. The Ram I received the model number M4A3, and the Ram II was to be known as the M4A5.[48]

During the same month the new Tank Arsenal building next to the MLW shops was finished. Two separate main assembly lines ran most of the length of the 800-foot-long building; sub-assembly lines ran parallel to these, terminating at the points where their completed assemblies would be mated up with the tank hulls.[49] Each of the main lines was nearly 200 feet wide and they were separated from one another by a row of offices down the middle of the building.

Production of each tank began on the main assembly lines where precut armour plates were joined to form the lower hull. The cast upper hull was then lowered onto this assembly and the two were welded and bolted together. The suspension components (idler wheels, springs, housings, bogies, and return rollers) were attached at this stage. At the first subassembly installation point, parts of the electrical harness were put in, gas tanks and fire extinguishers were installed in the engine compartment, and ammunition

[47] LAC Microfilm T-12181, memo from War Office to Director of AFVs and many other recipients, 28 October 1941.

[48] LAC RG 24 Vol. 2601, H.Q.S. 3352-11 Vol. 9, Maj. L.M. Hart, Canadian Army Staff, Washington, DC, to Maj. E.D. James, Director of Mechanization, Ottawa, "Specifications and Photographs: Ram I and Ram II Tanks," 4 September 1942.

[49] The information in this and the following two paragraphs comes from Anonymous, "Montreal Locomotive Works Tank Production," *Canadian Transportation* (November, 1942), 625-627.

stowage racks and the steering and control systems were installed in the fighting compartment.

Next came the transmission, secured at the front of the fighting compartment within its heavy bolted cover, followed by the front-side fenders with their external stowage bins. The motors were then installed, and also the driveshaft connecting the transmission to the main engine.[50] This was followed by the fitting of the turret basket and the turrets, and at the very end of the line the tracks were installed. The tank would then be driven out of the factory on a short test run to check that everything was operating as it should. (A purpose-built Tank Testing Ground which duplicated that of the Aberdeen Proving Ground was created near the Arsenal the following year, to assess the tanks more realistically.)[51] The tank would then return to the Arsenal, any faults discovered would be corrected, and it would be painted and have its guns installed prior to being handed over to the Army.

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[50] The main engine and the auxiliary generator were both in the engine compartment, but the motor that powered the turret was attached to the turret ring, inside the fighting compartment.

[51] LAC RG 28 Vol. 432, File 20-L1VA-1, "City of Montreal," 1 December 1941. Land expropriated "for the purpose of a Tank Testing Ground" on 1 December 1941 was returned to the owners (or their estates) on 20 December 1945. .After the City of Montreal, the Montreal Industrial Land Co. Ltd. and the Canadian National Railways owned the bulk of the land, with a handful of individuals owning smaller plots—see the blueprints and contracts in other files in this series dated 5 December 1945.

Chapter 4: Growing Pains

With the new Tank Arsenal building complete, it was anticipated that the output of tanks from the plant would speed up considerably. In mid-December 1941, as part of a measure to ensure greater control over the construction process, the Department of Munitions and Supply took over all of the contract arrangements for the manufacture of tanks. The ad hoc methods that had prevailed up to that time, with contracts let by the DND as well as by the Department, were discarded and the new sole responsibility of the DM&S was formalized by the Privy Council and the Treasury for greater accountability.[1]

One reason for this stemmed from problems in production at MLW. Soon after the DM&S takeover, a report on MLW detailed a lack of urgency and a seeming indifference towards efficient tank production until that time. The Master-General of the Ordnance noted that there had been continued delays in finalizing the tank's stowage arrangements and construction drawings. He complained that MLW had frequently missed deadlines, and tanks that were to be ready by the end of August had had their completion date pushed back to the 4th of October, and then delayed again (as of the report's writing) until the new year [1942]. It was strongly urged that the Department of Munitions and Supply use its new powers to exercise more control over tank construction at MLW.[2]

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[1] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 5, Internal Treasury Office Memorandum "Re: Montreal Locomotive Works tank contract, your file HQ CTO 296," dated 17 December 1941. The discussions had begun in July; see LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 5, D.K. Sheils, Deputy Minister, DM&S, to Col H. DesRosiers, Deputy Minister, DND, 25 July 1941, plus subsequent letters in the file.

[2] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, M.G.O. to DM&S, 22 November 1941.

In addition to production delays, faults in assembly were found in tanks that did get despatched from MLW. Reports were made of a number of potentially serious errors in the installation of fittings within the fighting compartment. In one tank, a smoke bomb holder was installed so that it blocked the right-side escape door. Ammunition racks were incorrectly sited because overlarge angle iron was used in their mounting; access to 2-pounder ammunition was impeded by the wrong positioning of an ammunition box bracket and the radio spares box; and turret hatch catches were installed in reverse, protruding into the tank interior. In many cases it seemed as if plans were not being used as instructions to be followed exactly in the tank's construction, but rather were mere suggestions, leaving it up to the workers at MLW to put together the tanks as they wanted.[3]

All of these problems raised concerns within the DND, and Defense Minister Ralston sent a questioning memo to C.D. Howe about the Locomotive Works' competence to build tanks. In his response, Howe admitted "for once that the DM&S has fallen down" but he added that because of the recent reorganization at MLW, it was hoped that tank production and delivery would work more smoothly from then on.[4]

But another difficulty arose that would continue to trouble Ram production for much of the following year. The delivery of engines and transmissions from the United States, originally thought to have been of no concern by the members of the Dewar Mission

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[3] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, M.G.O. to MLW, 2 December 1941.

[4] LAC RG 24 Vol. 2598, File H.Q.S.-3352-11 Vol. 3, Howe to Ralston, "Ram I and Ram II Cruiser Tanks," 2 December 1941.

when designing the tank around these components, was a source of worry at the Department of Munitions and Supply.[5] Projected delivery schedules of these two components were going to fall short of requirements as tank production increased over the next year at MLW.

One reason for this was the enormous demand being placed on American industry. President Roosevelt, with a brief declaration in September 1941, had doubled the planned output for tanks for the next year.[6] As a dramatic gesture made in response to the German invasion of Russia, it was fine political theatre. But at the time there was insufficient American production capacity to keep up with his new requirements, and this was recognized by industry if not in the political world.

> The public and most Congressmen simply do not understand the time element in industrial production of munitions. They must be told again and again until they do understand why it takes time to build tanks, guns and planes. They must realize that wars are won in factories years before the conflict in the field.[7]

A second and more serious reason was that the War Department in the US was allocating a lower priority of deliveries to MLW, due to a perceived slowness of production at the

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[5] LAC RG 24 Vol. 2597, File H.Q.S. 3352-11 Vol. 1. "Minutes of a Meeting Held in the Willard Hotel on Wednesday, November 13th, at 10 A.M. To Discuss Questions of Demarcation Between Material To be Supplied to Tank Erectors and Material which They will have to provide for themselves," op. cit., 8.

[6] Harry C. Thomson and Lida Mayo, *United States Army in World War II: The Technical Services: The Ordnance Department: Procurement and Supply* (Washington, DC: Superintendent of Documents, 1955), 232. Roosevelt did this against the advice of his technical advisors, but they were bound by his decision.

[7] *Factory Management and Maintenance*, n.d., quoted in *Time* Magazine, "Production: Facts without Fooling," October 21, 1940. Accessed 18 August 2009 at http://www.time.com/time/printout/0,8816,777437,00.html .

Canadian shops. Major J.R.K. Taylor, the Canadian Army Procurement Officer in Washington, DC, requested that Canada remedy this by asking the US for a larger supply of engines and transmissions. He also noted that, "As pointed out in our letter of yesterday, the U.S. tank manufacturers report a tank completed *as soon as the work on the runner tank only is finished*, and add the armament, optical instruments and fittings, afterwards."[8] [Italics added.] By contrast, in Canada a tank was only considered complete when everything had been installed and it had been issued with an Inspection Receipt Voucher by the Inspection Board. Discussions on this difference between national practices followed between the Department of Munitions and Supply and Montreal Locomotive Works, and finally the Director of Mechanization asked if Canada should change its policy to conform to that of the United States.[9] It was proposed that two sets of books be kept, one for the Americans and one for Canadian use, but this was eventually dismissed as being too unwieldy and likely to cause confusion.[10] As a stop-gap solution, a section of the Montreal Locomotive Works was roped off so that tanks which conformed to American standards could be placed there and reported to the US as "delivered".[11] Ultimately it was decided that Canada would continue its current practice, but she would make sure that the United States understood the reason for the apparent

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[8] LAC RG 24 Vol. 2598, File H.Q.S.-3352-11 Vol. 3, Major J.R.K. Taylor to Colonel R.W. Johnson, DM&S c/o MLW, "Transmissions and Engines for Canadian Cruiser (M3 Modified) Tanks," 13 November 1941.

[9] LAC RG 24 Vol. 2598, File H.Q.S.-3352-11 Vol. 3, R.A. Macfarlane (D. Mech) to B.D. Beamish, Director of Tank Production, DM&S, 27 November 1941.

[10] See the following documents in LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 3: Major J.R.K. Taylor, Army Procurement Officer, Washington, to Col. R.E. Johnson, Technical Officer, Montreal, 12 November 1941; E.D. James to D/MGO, 24 November 1941; and Kingsley Ault, DM&S, to Lt. C.L. Fraser, D. Mech, 4 December 1941.

[11] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 1, "Minutes of the Staff Meeting, Washington Representatives of Canadian Government," Meeting No. 23, 24 December 1941.

discrepancy in output figures between MLW and the various tank production plants in the United States.

A further meeting held in Washington noted that the problem was by no means solved. Canada was allocated only 12 transmissions in December, even though the Iowa Transmission Company was producing from 75 to 80 per month. Also, Canada was allocated 6 tank engines for the entire month of November, but Continental was producing 20 of them per day. Apparently, the different standards regarding when tanks were deemed "completed" had not yet been communicated to the US War Department. Major Taylor asked if some War Department officials could be invited to Canada to see how well the Ram programme was going, and thus get them to release the supplies.[12] It should be noted here that American tank assembly plants were not immune to parts shortages. During one 19-day period in September 1941, Chrysler's Detroit Tank Arsenal received only four engines from Wright, an event noted as "disturbing" by its vice-president of operations, H.L. Weckler.[13]

Meanwhile, design work was proceeding on the Ram II prototype, with field trials being carried out at Petawawa Military Camp. The new 6-pounder gun was test-fired (with Canadian-made ammunition) in a mock-up mount and found to be "highly satisfactory"

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[12] LAC RG 24 Vol. 2598, File H.Q.S.-3352-11 Vol. 3, "Minutes of the Staff Meeting, Washington Representatives of the Canadian Government," Meeting No. 18, 21 November 1941. The problem of perceived inadequate tank output at MLW continued to be discussed into 1942. See LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, "Minutes of the Staff Meeting, Washington Representatives of Canadian Government," Meeting No. 30, 26 February 1942 for more discussion of Canadian worries on this matter.

[13] Wesley W. Stout, *Tanks are Mighty Fine Things* (Detroit: Chrysler Corporation, 1946), 36. Accessed November 26, 2009 at http://imperialclub.com/Yr/1945/46Tanks/Page036.htm .

by senior officers.[14] In the course of these trials, recommendations were made on redesigning the turret basket to give more room to the tank commander and the gunner in action, as well as permitting the gunner faster access to ready-use ammunition. Further suggestions discussed the repositioning of various control wheels and levers to be within easier reach of the gunner and the loader, as well as to lower the driver's seat by 3 inches.[15] On the outside of the tank, a redesign of the upper hull for better protection of the turret ring was considered a prerequisite before further production was started.[16] One other outcome was the proposal that a User's Committee be formed that would evaluate a full-scale wooden model of the tank, made from design drawings prior to production. By examining this mock-up from the point of view of the crew's comfort and convenience, the Committee could pass on its recommendations to "the Tank Design people" so that flaws in the design could be caught and fixed before any metal had been cut or cast.[17]

For the Canadian Army, it was an unfortunate fact of life that heavy dependence on US sources of supply meant that American approval of the Ram II design was necessary in order to procure parts from American manufacturers. By the 2nd of December, 1941, the Ram mockup was ready for viewing by United States Ordnance representatives, but

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[14] LAC RG 24 Vol. 10039, File 13/AFV Ram/1, Major J.M. McAvity to various recipients, "Report on Visit to Petawawa", 7 November 1941.

[15] LAC RG 24 Vol. 10039, File 13/AFV Ram/1, Major J.M. McAvity to various recipients, "Report on Observations of Ram 2 – M.3 (Modified) Cruiser Tank – Trials held at Petawawa Camp, 3 Nov 41", 5 November 1941, and LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 3, J.A. McCann, "Report on No.2 Cruiser Tank M3 (Canadian) at Petawawa Camp – Ont", 6 November 1941.

[16] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 3, Victor Sifton, M.G.O., to B.D. Beamish, DM&S, "Ram II Tanks", 12 November 1941.

[17] LAC RG 24 Vol. 10039, File 13/AFV Ram/1, Major J.M. McAvity to various recipients, "Report on Visit to Petawawa", op. cit. The User's Committee eventually came into being later on, but usually only managed to make its suggestions after equipment had been designed, making it necessary to retrofit tanks with their improvements rather than introduce them before production.

repeated delays prevented this from happening until late in January, 1942.[18] Nonetheless, production of major Ram II components such as the turrets and upper hulls had continued to be made at and shipped from American foundries, and Ram IIs began to emerge from the Montreal Locomotive Works in early 1942.

In December, further reports on the Ram's Aberdeen trials arrived from Captain H.W. Steele and the US Ordnance, both confirming Steele and Corporal Stirton's original reports (described above) that the tank was generally good, but could be improved in many ways.[19] It was noted that this was only to be expected in a prototype, especially for a tank that was constructed in haste by an inexperienced workforce. The Army Engineering Design Branch (A.E.D.B.) had asked for two specific improvements, the first being more protection against splash around the turret ring (as noted above), and the second requesting a greater degree of depression for the main gun. Dr. Jamieson, on behalf of D. Mech and the MGO, responded that because only about 20% of the turret ring could be protected (and that in an unproved manner), the effort of such protection was not worth proceeding with. However, main gun depression was deemed an issue worthy of consideration. A maximum depression of "as near to 15° as possible" was desired in both frontal and broadside firing, but the actual maximum achieved in those

[18] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 3, Colonel R.B. Gibson, D.M.O. & I., to Brigadier H.F.G. Letson, Military Attaché, Canadian Legation, Washington, 25 November 1941, and LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 4, Major E.D. James, D. Mech, to B.D. Beamish, DM&S, 9 January 1942. Most of these delays were caused by the sudden entry of the United States into the war.

[19] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 2, H.W. Steel, CAC, Camp Borden, to Lt-Col. W. Mavor, D.O.S.(T.S.), Ottawa, "Report on Performance Tests of Ram I at Aberdeen Proving Ground," 12 November 1941. See also LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, Department of Munitions and Supply Joint Committee on Tank Development with the Department of National Defence, "Proceedings of the Twenty-Fifth Meeting," 11 December 1941, and LAC RG 24 Vol. 9364, File 38/Arm Veh/28/3, Letson to Secretary, DND Army, "First Report on Canadian Medium Tank M3," ca. 12 December 1941.

directions was only 10°. When firing the gun to the rear, the high silhouette of the rear hull limited depression in that direction to a theoretical maximum of 7° 30', and in practice even less because of interference by rear-deck stowage. D. Mech hoped that AEDB could come up with a better place than the rear deck to stow the tank's camouflage nets and tarpaulins. At any rate, greater overall gun depression could only be increased through a major redesign of the hull and turret.[20] (Splash tests were later performed on the sponson doors (but not the turret ring) of a production Ram I hull. Standard .30 caliber ball ammunition was fired from 25 feet away by a Browning M.1919 A4 machine-gun; these tests were conducted on both an unmodified tank, and (later) on the same tank which had been equipped with a supplementary 5/8" mild steel ring around the inside of the sponson hatches. In many places, the ring improved the protection against bullet splash and would have prevented injury to the crew.[21]) Further splash tests were performed on a different Ram I at Valcartier with the same type of machine gun and ammunition, but this time from a range of only 10 to 12 feet. Bullet splash was more severe in these tests, possibly because of the closer positioning of the machine-gun to the tank. Its effect was most marked at points where the armour joined or was compromised in some way, among them the pistol ports, the machine-gun cupola face, the driver's vision door, the top edge of the mantlet and its machine-gun air vent, and the upper turret

[20] LAC RG24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, D.S.D. to C.G.S., 2 January 1942, and LAC RG24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, D. Mech to the Director-General of the Army Engineering Design Branch, 8 January 1942.

[21] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 4, V.W.G. Wilson, A.E.D.B., to Major E.D. James, M.G.O., "Splash Proofing of Side Doors Ram II Tanks," 20 January 1942, and LAC RG 24 Vol. 9365, File 38/Arm Veh/28/3, Major J.L. McAvity, M.G.O. Experimental Committee, to various recipients, "Splash Trials of Sponson Doors Ram Tanks," 6 February 1942.

hatch, especially where the two hatch halves met in the middle. It was estimated that all of the crew would have become casualties from the splash.[22]

Following the satisfactory firing trials of the 6-pr. gun at Petawawa, a contract was let with the Canadian Car and Foundry Company for the manufacture of 1,107 6-pr Tank Gun Recoil Systems. Deliveries were to start on the first of February, 1942 "at the best rate possible", and would increase to an eventual rate of 50 per week until all were delivered.[23] The contract was issued despite the fact that the existing design of the 6-pounder elevating gear, and its proposed re-work, still did not permit the incorporation of the gyro-stabilizer, and it did not allow the gunner to use his telescopic sights while elevating or traversing the gun. Major J.L. McAvity of the Department of Munitions and Supply suggested redesigning the elevating gear by using a similar mechanism to that of the 37 mm gun mounted in the US M3 turret, which had already been worked out and found satisfactory.[24]

In response to the Japanese attack on Pearl Harbor in December, war production in Canada and the United States was integrated to higher levels. On 16 December 1941, it was decreed that Rams were to have US War Department numbers as well as Canadian

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[22] LAC RG 24 Vol. 9365, File 38/Arm Veh/28/3, Major J.L. McAvity, M.G.O. Experimental Committee, to various recipients, "Bullet Splash Trial Ram I Tank," 20-21 February 1942. These tests were carried out on Ram I 41-1-3609 .

[23] LAC RG 24 Vol. 2598, File H.Q.S.-3352-11 Vol. 3, G.I. Evans, Director of Tank Design to R.E. Jamieson, "Test of the Six Pounder Gun and Mount in the No. 2 Cruiser Tank M-3," 12 November 1941, and LAC RG 28 Vol. 432, File 20-LV1A-1, Contract M.P. 111 between DM&S and Canadian Car and Foundry Ltd. for 6-pdr. Recoil Systems, issued 1 December 1942.

[24] LAC RG 24 Vol. 2598, File H.Q.S.-3352-11 Vol. 3, Major J.L. McAvity to J.V. Young, DMGO, "Elevating Gear 6-pdr Ram Tank," 3 December 1941. Young repeated this letter verbatim to Beamish, 10 days later.

Department of National Defence numbers. The WD numbers [T38781 to T40980 inclusive] would be stamped on the manufacturer's nameplate mounted inside each tank, and the DND numbers were to be painted on the hulls.[25]

Throughout December 1941 and January and February 1942, discussions were taking place over the relative merits of the Ram and the new M4 Sherman design. These comparisons were undertaken because the Canadians would soon have to decide whether to proceed with construction of the Ram II or to switch production over to the Sherman. Informal discussions regarding these two options had convinced R. A. Macfarlane, the Director of Mechanization, that the better option was to switch over to the M4. In his opinion,

> The facilities now at the disposal of the Department of Munitions and Supply are so limited that it is impossible for them to keep up with normal production changes such as are occurring daily. As a consequence, it is impossible for the Army Engineering Design Branch to keep up with design as it progresses in the United States and Great Britain. The result is that whereas we are now building a tank which is considered equivalent to the United States design, in a year or two we will have dropped behind because of the lack of design facilities, and will be producing an out-moded tank.[26]

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[25] LAC RG 24 Vol. 9364, File 38/Arm Veh/28/3, J.V. Young D.M.G.O. to Dr. R.E. Jamieson, DG, A.E.D.B., "Serial Number – Ram Tanks," 16 December 1941. If the tank were to be shipped overseas, the DND number would be painted out and the War Department number used instead on all documents. The WD tank numbers are listed in a letter from Hoare to Jamieson, 3 December 1941.

[26] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 4, R.A. Macfarlane, D. Mech, to M.G.O., 26 January 1942.

He went on to point out that Americans would continue to develop the M4 Sherman and, because of their greater research and testing capabilities, it would soon improve faster and more steadily than the Ram II. Also, the Canadian Army planned to eventually employ Shermans in the Close Support role, because its larger turret ring allowed it to mount the 75 mm gun that could fire both solid shot and high-explosive shell. This would result in the armoured divisions having a mix of Rams and Shermans, similar but not identical tanks, with potential difficulties in logistics and repairs for both. In Macfarlane's opinion, it would be far better to standardize production on the M4 and phase out the construction of Rams as soon as possible. He suggested that, to disrupt tank production as little as possible, the Montreal Locomotive Works begin working on a parallel production line for M4s so that the changeover could be made smoothly.[27] Others involved in its production supported the Ram, noting that it was more heavily armoured and should be able to stand up to combat better than a Sherman. Armour on the Ram averaged 75mm in thickness, whereas plans for the Sherman showed a 60mm thickness overall in its cast hull.[28] Also, production of the new M4 tank would require several 84-inch or 100-inch boring mills, very large machine tools which would take approximately 5 months to build in Canada if they could not be obtained from a US source. A decision on their acquisition was desired soon because otherwise, it was noted, "we shall certainly require an additional run of the Ram II tanks in order not to lose production while boring mills are being built."[29]

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[27] Ibid.

[28] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, Department of Munitions and Supply Joint Committee on Tank Development with the Department of National Defence, "Proceedings of the Twenty-Fifth Meeting," 11 December 1941.

[29] LAC RG 24 Vol. 2598, File H.Q.S. 3352-11 Vol. 3, Beamish to Jamieson, 2 December 1941.

At the December meeting of the Joint Committee on Tank Development, it was estimated that, with the heavier 6-pounder gun and mounting plate, the Ram II would weigh 64,000 pounds, fully loaded. Among the more prosaic matters on design changes dealt with was a scheme for improved internal stowage in the Ram II turret. This could be achieved by blocking an escape hatch but, because the right-hand sponson door had already been blocked by the installation of a new ventilating fan, this would mean the elimination of two escape routes for the crew. Final say on this design alteration would be left to the DND.[30] In the short term, no decision was made on acquiring the boring mills, and Ram II production would continue. However, because of this uncertainty, the General Staff only authorized the construction of 700 of the original 1157 tanks at this time.[31]

The public began to see the Ram in press releases, the first publicity since the tank's initial roll-out. The Toronto Evening Telegram ran a photo of tank 41-1-3600 in December, accidentally breaking a DND embargo on pictures taken during an NFB publicity shoot at Camp Borden. Following a minor fuss, more photos from the same shoot were released to the media.[32] Later, publicity photos of a Ram tank that had been

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[30] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, Department of Munitions and Supply Joint Committee on Tank Development with the Department of National Defence, "Proceedings of the Twenty-Fifth Meeting," op. cit. At the end of this meeting the Joint Committee on Tank Design disbanded, it being thought that its functions could now be taken over by future cooperation "between Army authorities, the Army Engineering Design Branch, and the Production Branch." Its responsibilities were assumed by the Tanks Committee, which began meeting in February 1942. See LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, R.E. Jamieson, "Tanks Committee Meeting," 12 February 1942. Several of the members of the first committee retained their seats in the second one.

[31] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 4, Major E.D. James, D. Mech, to B.D. Beamish, Director of Tank Production, DM&S, 15 January 1942.

[32] RG 24 Vol. 2598, File H.Q.S.-3352-11 Vol. 3, DMO and I for CGS to E.L.M. Burns, Officer Administering, Canadian Armoured Corps, "Photographs Ram I Tanks," 11 December 1941. The tank had its main armament installed but none of its machine guns were fitted.

fitted with an engraved plate reading, "Donated by the Citizens of Kitchener and Waterloo, Ontario", were distributed to news outlets.[33]

By now, preparations for transporting the first 40 Rams to England were being undertaken on both sides of the Atlantic. London cabled Ottawa asking for the outside dimensions of the new tanks, so that the War Office could supply transport for them when they landed in England.[34] This information was crucial for logistics purposes. Because of the damage that tank tracks can do to civilian roads, and more importantly (from a military standpoint) because of the damage that excessive travel can inflict on a tank's tracks, tanks are usually transported to a battle zone on railway flatcars or on special road trailers. For the Ram, as for most tanks, both methods were used. The vehicles were loaded onto railway flatcars and transported to the railhead nearest to their destination, and then transferred to road hauliers for final delivery. The dimensions of the tanks were needed because British railway lines could only handle loads that measured a maximum of 114 inches (9 feet 6 inches) wide at their widest point, due to clearance restrictions between train carriages where the railway tracks ran side-by-side. When both trains on parallel tracks had cars or loads of maximum width, the distance between passing trains was two inches.[35] If the tanks would not fit onto rail cars, arrangement would have to be made for more road transport and thus more petrol expenditure. Eventually the answer came back that the Ram I measured 9 feet 3 inches at

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[33] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 4, DM&S to D. Mech., 4 February 1942.

[34] LAC RG 24 Vol. 2600, File H.Q.S. 3352-11 Vol. 8, Canmilitry to Defensor, 10 November 1941.

[35] LAC RG 24 Vol. 10039, File 13/AFV Ram/1/2, CMHQ to Captain D. E. Magnus, Canadian Planning Staff, War Office, 31 October 1942.

its maximum width, and so could fit on UK rail flatcars.[36] It was hoped that all 40 of the Ram I tanks destined for England would be shipped in the month of January, but ultimately this goal was not achieved. Only 28 were despatched by January 27th, with the last 12 scheduled to follow as soon as shipping was available.[37] All 40 had arrived in the UK by the end of February.[38]

The hostile environment that the tanks would face in transit to England called for exacting instruction in how they were to be prepared for the voyage. Until the Longue Pointe Ordnance Depot (in east-end Montreal, near the site of the Montreal Locomotive Works) became operational, responsibilities for the safe delivery of the tanks were divided up and explained by the Master-General of the Ordnance in an exactingly detailed letter. MLW was to ensure the stowing and sealing (waterproofing) of each tank (with the exception of the left-hand sponson door, which was to be padlocked but not sealed), under the supervision of the Inspection Board, and was to give the Board seven copies of the tank's packing list, which detailed any shortages or deficiencies in that tank.[39]

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[36] Ibid.

[37] LAC Microfilm T-17883, Cable (extract) from Stuart to McNaughton, 9 January 1942; LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 4, DND to DM&S, 26 January 1942; and (in the same file) D. Mech. to Chief Ordnance Officer, Longue Pointe Ordnance Depot, Montreal, 27 January 1942.

[38] LAC Microfilm T-17883, Lt.-Colonel W.J. Megill, GSO 1 (Staff Duties) at CMHQ, to BGS, 28 February 1942.

[39] LAC RG24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, Victor Sifton, M.G.O., to Mr. W.M. Townsend, Montreal Locomotive Works, 26 January 1942.

The Inspection Board in turn was to check the tank seals, ensure that the tank was properly fitted out with authorized equipment, and make sure that it was tied down properly on railway flatcars for shipping. It was also to pass on paperwork to Ordnance that showed the status of the tank (including any deficiencies) and also to pass on one key to the padlock on the unsealed sponson door and two copies of the "Instructions for Entering Tank". Ordnance representatives would then place the paperwork in the tank turret, have MLW lock and seal the left sponson door, and supervise MLW's rail shipment of the tank to its destination.[40] Once there, the tanks would have to be carefully handled in transshipment from their rail cars to the decks of their sea transports, and secured on board with their protection against salt water corrosion intact.

The demand for tanks meant that the pressure was on MLW to produce them as quickly as possible but, as seen above, this meant that quality control suffered on the production line. To remedy this Mr. Victor Sifton, the M.G.O., sent a letter to Mr. Berry, the Director-General of the Automotive Production Branch, which detailed several of the flaws in Ram I construction in the hope that they would not be duplicated in the Ram II. Earlier, in an effort to get as many "runners" (tanks that could move under their own power, but were incomplete in some way) as possible, the Director of Tank Production had allowed tanks to be shipped out with over twenty individual defects, ranging from running gear problems to improperly grounded radios.[41] But from this point on, Sifton announced that Department of National Defence policy would be

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[40] Ibid.

[41] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 4, letter, Victor Sifton (M.G.O.) to Mr. Berry, Director-General, Automotive Production Branch, 9 February 1942.

> (a) A tank shall be considered complete when all items of equipment are included as determined by the "Table of Tools and Equipment" issued by the Director-General, Army Engineering Design Branch. Deviations and shortages will only be permitted when notified to this Department in writing and agreed to in writing by us. [...]
>
> (b) The Inspection Board must be satisfied with all items and no such lists as "Unsatisfactory Items" will be allowed.[42]

This policy followed the already-established practice used with "B" vehicles (unarmoured army vehicles such as trucks and automobiles), which had been in production in Canada since the start of the war. Sifton added, no doubt with the wish father to the thought, that "It is well known that if this policy is followed strictly, greater efforts will be put forth by all concerned in the production of the tanks as was the case with the "B" vehicles."[43]

R.A. Macfarlane backed up the M.G.O.'s argument that many faults had been accepted in production Ram tanks in the search for quantity over quality:

> A study of the defects of Ram I Tanks already produced by Montreal Locomotive Works reveals a number of points to which inspection took exception, but which were overlooked in order that a good production showing could be made. A number of these defects were minor, but unreasonable when it is considered that each tank costs between $50,000 and $100,000. In short, the Ram I tanks already produced are not, at present, fighting tanks but would require considerable modification before they would be in a fit condition to fight.[44]

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[42] Ibid.

[43] Ibid.

[44] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 4, Macfarlane to M.G.O., 12 February 1942.

Macfarlane went on to repeat his earlier recommendation that the production lines at MLW prepare to switch over to Sherman Tank construction at the earliest possible date and thus benefit from advances made in the design by the Americans. Otherwise, he said, "Under present conditions, much time and effort is being directed toward trying to improve the Ram in directions which have already been covered by U.S. Ordnance."[45]

Trying to defend itself against accusations of delays in production and deliveries, the Montreal Locomotive Works accused the Inspection Board of unnecessarily holding up its approval of completed Ram IIs. In response, the Board documented the results of an inspection performed on the second of March. 14 tanks produced in the previous week had been "passed as complete" by MLW at a noontime production meeting. At the conclusion of the meeting, Board inspectors singled out three of the vehicles and examined them closely. W.L. Auchinclose (the Inspector of Tanks) stated that, "To complete the inspection on these three machines, it took until 8.30 p.m. due to Montreal Locomotive's staff having so much work to do on what was presented to us as completed machines."[46]

He noted that one examiner was not able to inspect "his" tank because MLW employees were still working in it from 12.30 p.m. until 4.30 p.m., despite its having been passed for inspection. Another tank had 21 specific faults listed, including defective tires, missing interior stowage racks, and an interior that had not been cleaned before inspection and

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[45] Ibid.

[46] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, W.L. Auchinclose to DM&S, 4 March 1942, with enclosures.

which was littered with "matches, cigarette boxes, paper, welding material, chips, etc." Auchinclose attached a report which itemized the deficiencies in the inspected vehicles, with the comment, "It would appear that the statement which Montreal Locomotive has made during the last ten days, to the effect that they have a number of vehicles ready to ship pending our inspection, is a mis-statement of facts which is born out by the above."[47]

Even when parts were available, the suppliers were often unfamiliar with military packing procedures. In January 1942 Camp Borden complained to D. Mech that machine guns and cannons for their Rams were arriving with light coatings of rust because the manufacturers were not shipping them packed in mineral jelly (used as a preservative). The Inspection Board reacted quickly and suppliers were notified of the proper procedures before the end of the month.[48] Camp Borden added that they had not yet received the official Issue Vouchers for the nine Rams they had received for troop training.[49]

In early January 1942, production at the Montreal Locomotive Works switched over to the Ram II, even though the final design of the turret was not available because the main guns and their mounts had not yet had their designs frozen.[50] However, the demand for

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[47] Ibid.

[48] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 4, HQ CAC Camp Borden to D. Mech, 1 January 1942.; in the same file, DND to Inspector-General, Inspection Board of the U. K. and Canada, 16 January 1942, and Inspection Board to DND, 26 January 1942.

[49] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 4, HQ CAC Camp Borden to D. Mech., 27 January 1942

[50] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 4, handwritten memorandum from Victor Sifton to D. Mech, 6 January 1941.

tanks was such that even unarmed Rams would be useful for training tank troops in the mechanical care needed for their new armoured force, and so production went ahead. Other than the heavier armament of the 6-pounder, several changes had been made that distinguished this model from the Ram I. (Most of these were not easily apparent from the outside, as the hull casting remained basically unchanged until hull number 40101 did away with the sponson doors later in 1942.) Beginning with the first Ram II (hull CT-39831), an exhaust fan replaced the pistol port in the right-hand sponson door, the internal storage of the turret was rearranged, and a redesigned turret basket was installed.[51] While January would see few tanks produced, the Works reached its projected production rate of 36 tanks per month for both February and March of 1942.[52]

Stuart cabled to General McNaughton that 80 Ram IIs would be produced up to March 1942, but they would still be missing guns and mounts. Despite McNaughton's desire to have as many tanks as possible in England to train his troops there, Stuart had to tell him that 60 would be kept in Canada to train the 4th Armoured Division.[53]

General McNaughton soon had a chance to see the parlous situation of tank production for himself. He was brought back from his post as GOC (General Officer Commanding) of the Canadian forces in England on a six-week publicity tour to rally support for the war in Canada. On his first day in Montreal, among other activities, he visited the

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[51] The new turret basket was cylindrical rather than conical in shape and gave the gunner, loader and tank commander more room in which to move about.

[52] LAC Microfilm T-17883, Lt.-Colonel W.J. Megill, GSO 1 (Staff Duties) at CMHQ, to BGS, 28 February 1942.

[53] LAC Microfilm T-17883, Cable (extract) from Stuart to McNaughton, 9 January 1942.

Valentine and Ram production lines in Montreal and the Dominion Engineering Works in Longueuil, where he saw the manufacture of 6-pounder guns for the Ram II.[54]

While the 6-pounder guns were being manufactured in quantity, the mounts for them were not. The designs of the mantlet, the mantlet/mount adaptor plates, and the recoil mechanisms had taken longer to finalize than had the gun, and production of these pieces was only expected to begin around the 19th of March.[55] The first of these off the line were not examples of mass production. Because of difficulties in the manufacturing process, each of the first 110 mantlets produced was matched to a particular adapter plate, rather than being interchangeable with others.[56]

By this time 50 Ram II tanks had been shipped overseas, less their 6-pounder guns and mounts, which were to follow later. General Staff meetings in Ottawa determined that no further tanks were to be shipped to the UK without their armament, so the balance of the unfinished tanks destined for overseas were to stay at MLW until the mantlets and guns

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[54] John Swettenham, *McNaughton: Vol. 2, 1939-1943* (Toronto: Ryerson Press, 1969), 196. Another of McNaughton's goals was to organize Canadian war production on the basis of the needs of the troops. To do so, McNaughton proposed the establishment of a Weapons Development Committee in Ottawa, to take suggestions from the fighting troops and design weapons according to their needs. His arguments were found to have such merit that the committee was running before McNaughton returned to Britain, with Victor Sifton and R.E. Jamieson among its members. Ibid., 197-198.

[55] LAC RG24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, Meeting No. 32, "Minutes of the Staff Meeting, Washington Representatives of Canadian Government," 12 March 1942.

[56] See LAC RG24 Vol. 2600, File H.Q.S. 3352-11 Vol. 7, D.Mech (Major B.A. Gunn) to E.C. Perley, DM&S, 18 June 1942, and M.C. Perley to Mr. W.M. Townsend, Works Manager, MLW, 2 July 1942.

had been fitted.[57] Tanks intended for training the Armoured Divisions in Canada could still be sent out and 47 unarmed Ram IIs were promptly dispatched to the 4th Armoured Division at Debert, Nova Scotia.[58] Soon after, 49 more Rams were sent to Canadian destinations for familiarization and training—two to the Canadian Army Trade School in Hamilton, one each to the Army bases at Kingston and London, 15 to Camp Borden and an additional 30 to the 4th Armoured Division.[59] A sufficient number of 6-pounder guns and mounts were expected to arrive at MLW in April to equip another 50 Ram IIs due to be shipped to troops in England that month.[60] Depending on the supply of guns and mantlets, the situation would be reviewed by the Chief of the General Staff on the 31st of May.[61]

Soon after the first Ram IIs began to be received in England, a design change to the hull showed the necessity for the designers to consult with the end-users. The Ram I hull, as noted above, was only 9 feet 3 inches wide, and thus was within the load limits of 9 feet 6 inches of British railways. But because of the new ventilator louvre in the right-hand

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[57] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, "Shipment, Ram Tanks," Major E.D. James (D. Mech) to Chief Ordnance Officer, Longue Pointe, 14 March 1942. NFB pictures dated 10 September 1942 show rows of unfinished tanks parked under tarpaulins outside the Tank Arsenal at MLW, that testify to a continuing lack of mantlets and guns. There are at least 82 tanks visible in the photos, and probably more that were not photographed during the NFB visit. Photos are numbered e000760835 to e000760855, located at http://collectionscanada.gc.ca, accessed July 16, 2006.

[58] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol.5, D. Mech to Chief Ordnance Officer, Longue Pointe Ordnance Depot, 27 March 1942.

[59] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, DM&S to D. Mech, 8 April 1942, and D. Mech to C.O.O., Longue Pointe, 8 April 1942.

[60] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, Meeting No. 34, "Minutes of the Staff Meeting, Washington Representatives of Canadian Government," 2 April 1942.

[61] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 5, Telephone memo between Lt.-General Stuart and Young re Ram distribution March-August 1942, 18 March 1942.

sponson door, this brought the overall width up to 9 feet, 6 and 5/8ths inches, over the maximum. A plaintive telegram to Ottawa noted,

> May be able arrange rail transport depending on how many this type to be received. Presume from DCI tank 2 [an earlier telegram] that tank 350 will be less doors. Cable overall width Ram 2 without doors and state probable lot number of first tank.[62]

A return cable from Defensor stated that the Ram II without any side doors was still in its design stage and that the width of that model was still not known. In the meantime, other alterations to the Ram hull were going to make life more difficult for transport officers in the UK. The first 149 Ram IIs, numbered CT-39831 to CT-39980, had (as noted above) a ventilator in one sponson door and the original pistol port in the other. The 150th hull, and the one hundred and eighteen hulls that followed [CT-39981 to CT-40100], had fans in both sponson doors, resulting in an overall width of 9 feet, 9 and ½ inches (117 ½ inches).[63]

The solution that was eventually hit upon by CMHQ was to have one or both of the sponson doors of the Ram removed prior to shipment overseas, and seal the opening(s) with weatherproof plywood inserts, the removed door(s) being stored inside the tank.[64] Ultimately, a redesign of the Ram II hull that eliminated the sponson doors also

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[62] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, Canmilitry to Defensor, 16 April 1942.

[63] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, R.E. Jamieson, "Tanks Committee Meeting T-7," 21 April 1942.

[64] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, Canmilitry to Defensor, 16 May 1942.

repositioned the ventilation louvers further inside the tank, bringing its overall width back down to the maximum UK railway limit of 114 inches.[65]

The louvres had been installed because gun-firing trials had shown that propellant fumes built up rapidly in the fighting compartment. The fan in the right-hand sponson door was implemented with the first Ram II, hull number CT-39831. The problem remained and Jamieson wrote to Young proposing that a second ventilation fan replace the unneeded pistol port in the left sponson door.[66] This change, as noted above, came into effect with the 150th Ram II hull, CT-39981.[67]

Trials at the Farnborough (UK) test track revealed several major problems with the Ram I tank that had been sent there for evaluation. The periscopes in the turret were badly placed, the eyepieces being mounted too high and thus leaving insufficient clearance between the crew's helmeted heads and the inside of the turret roof of the tank. It was also noted that the 8500 lb suspension springs were severely overloaded. They were measured as being within one-quarter inch of being fully compressed under normal circumstances, meaning that the suspension system was almost at the limits of its load with no play remaining for severe march conditions. The rubber tires on the bogie

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[65] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, R.E. Jamieson, "Tanks Committee Meeting T-11," 2 June 1942.

[66] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, R.E. Jamieson, A.E.D.B., to J.V. Young, D/M.G.O., "Re: Ventilating Fan – Ram Tank," 13 February 1942.

[67] Paul Roberts, *The Ram: Development and Variants, Vol. 1* (Ottawa: Service Publications, 2002), 21-23.

wheels were distorting under this load, and one had failed completely at the 250-mile mark.[68]

The same suspension springs that equipped the Rams were also failing on Lee tanks in US service.[69] CMHQ hoped that these springs could be replaced by the new 12,000 lb springs that were going into the new Sherman tanks, as they would fit within the same suspension assemblies without modification.[70] But there were problems with the suspension assembly castings themselves. The castings on the first 90 Rams despatched to the UK were found to be "defective or liable to be defective."[71] The Department of Munitions and Supply responded with a request that only castings known to be defective be replaced, not all of them; but D. Mech's response was that all were defective and all needed replacement.[72] A compromise was reached, wherein faulty suspension castings

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[68] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, R.W. Morris, Experimental Wing, Tank Design Department, Farnborough, to Brigadier C.R Stein, DND, "Ram I [Trials]," 27 April 1942. In this file, as well as several others, there are multiple references to bogie tire failures, almost always those supplied by the Dominion Rubber Company. In correspondence between CMHQ and Dominion Rubber, the company said that something occurring subsequent to the tires' manufacture was the cause of the failures. A sample tire was sent to the U.S. Rubber Company to test. LAC RG24 Vol. 9364, File 38/Arm Veh/28/2, Ellis to D.A.D.O.S. (MT), CMHQ, "Ram Bogie Wheel Tires – Dominion Rubber Co.," 30 September 1942.

[69] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, Defensor to Canmilitry, 21 March 1942.

[70] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, Canmilitry to Defensor, 14 April 1942. The Lees were later fitted with a spring that was 30 percent "stiffer" and 5/8" longer, and it was hoped to replace the Ram springs with these. See LAC RG 24 Vol. 9364, File 38/Arm Veh/28, A.S. Ellis (T.A.M.T.) to Major J.J. Johnson, D.A.D.O.S. (E), "Tanks Ram I and Ram II," 13 June 1942.

[71] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, D. Mech to Department of Munitions and Supply, "Suspension Castings," 10 April 1942.

[72] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, Department of Munitions and Supply to D. Mech , "Re: Suspension Castings," 27 April 1942, and D. Mech to DM&S, "Re: Suspension Castings," 30 April 1942.

would be replaced if or as they failed during training, but the castings would be entirely replaced if the tanks were needed for active service.[73]

Other quality control problems continued to affect the Ram programme. A routine inspection showed that some of the oil filters in the Rams had accidentally been installed in reverse. This error restricted the flow of oil and could cause the engine to burn out its bearings. A bulletin was hastily issued to check the filters to ensure that they were correctly oriented, or reinstalled if necessary, before the tanks were issued to the troops.[74] Ram crews in England found that the lubrication guns supplied with the tank kits did not have nozzles that allowed them to lubricate the tanks' bogie wheels or turret fittings. Correct-size replacement nozzles and adaptors for the guns were to be sent "soon" to Bordon (UK) for use and distribution.[75] New Ram IIs received at Camp Borden (Ontario) had problems with deposits in the fuel lines, possibly due to leftover flux from the soldering of the gas tanks. The deposits were fouling strainers and made them useless, and Borden hoped that the Inspections Officer at MLW would investigate the matter.[76] Also at Camp Borden, the transmissions on two Ram tanks broke down after less than a mile of travelling from their transport flatcar to the Camp. The Synchro-Mesh

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[73] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, Brigadier C.R Stein, Chairman of the A.F.V. Users Committee, D.N.D., to T.A.M.T., D.Q.M.G., C.M.H.Q., "Suspension Castings Ram Tanks," 28 April 1942.

[74] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, A.S. Ellis (T.A.M.T.) to A.Q.M.G. (O.S.), "Assembly of Ram Tanks at Canadian M.T. Depot," 20 March 1942.

[75] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, A.S. Ellis (T.A.M.T.) to Lt-Colonel J.A.W. Bennett, C.M.H.Q., "Tank – Lubrication Gun Modifications," 23 March 1942.

[76] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, D. Mech to Inspection Officer, Tanks, MLW, 30 April 1942.

assembly within the transmission was assumed to be the problem.[77] A litany of 18 "Minor Defects" (including burnt-out switches, leaks, breaking levers and cables, and sticking parts) was sent to CMHQ by the Experimental Wing at Camp Borden. It was considered that most defects could be remedied by modifying the defective parts before installation on the production line, or by refitting tanks that were already with the troops.[78]

The 4th Armoured Division, training at Camp Debert, NS, suggested that the workmanship evident in the construction of the Ram was so poor that it could be termed sabotage, and requested that an engineer from MLW go down there to be on hand to help when troubles were found with the tanks.[79] Three days later, the Inspection Board at MLW despatched two of their men to investigate the charges.[80] While the engineers were still en route to Debert, Major-General Worthington (commanding the 4th Armoured) had sent an amplifying letter on the poor quality of the tanks to the Department of National Defence. He reported that steel and iron filings had been found contaminating the lubrication system of the tank, and that "many other evidences of poor workmanship in installation" were severely limiting the service lives of the tanks. This

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[77] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, Kingsley Ault (Captain for I. Tanks) to Mr. J.H. McNulty, 2 May 1942.

[78] LAC RG 24 Vol. 18212, War Diary, Experimental Wing, C.A.C.T.G., entry headed "Appendix "E", Minor Defects On Ram Mark I And II Tanks," dated 15 June 1942.

[79] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, 4th Armoured Division (Debert, NS) to Victor Sifton c/o Defensor, 7 May 1942.

[80] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, D.Mech to Debert, 8 and 9 May 1942.

was despite the fact that the tanks were being "nursed" along by the trainees and generally travelled only on level ground during exercises.[81]

Finally, a misunderstanding about a design flaw in the new turret basket caused a spirited exchange between Ottawa and London, culminating with the 5th Armoured Division declining acceptance of any more Ram IIs until the problem had been fixed.[82] It was discovered that the weight of the 6-pounder gun and mantlet on the Ram IIs overloaded the attachment of the basket to the turret ring, causing the bolts holding the basket to the ring to shear off when the turret traversed. Steps had already been taken to correct this during production, and modification instructions were issued quickly.[83] Unfortunately, the initial reports from Ottawa to field commands had not mentioned that this only occurred when the guns and mantlet had been fitted, and that unarmed tanks could still be used for training purposes.[84] When this was explained, the 5th Armoured Division apologized for its ultimatum; but there were still so many problems with the Ram (among these, persistent overheating of the transmission oil cooler) that the Division's frustration could easily be understood.[85]

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[81] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, Major-General Worthington (HQ 4th Armoured Division) to the Secretary, DND, 9 May 1942.

[82] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Canmilitry to Defensor, 15 May 1942.

[83] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, Defensor (MGO) to Canmilitry, 4 April 1942, and LAC RG 24 Vol. 9364, File 38/Arm Veh/28, A.S. Ellis (T.A.M.T.) to users (2nd Armd. Bde., #2 R.C.O.C. M.T. Depot, 5th Cdn. Div.), "Defect in Ram Basket," 16 April 1942.

[84] See LAC RG 24 Vol. 9364, File 38/Arm Veh/28, Defensor to Canmilitry, 15 May 1942, and LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Defensor to Canmilitry, 19 May 1942

[85] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, Canmilitry to Defensor, 23 May 1942.

In the midst of these problems, one vindication of the design of the Ram came through. The United States ordered 1300 Rams and 13 sets of spare parts on its Lend-Lease account, for use by British armoured units. They were to be armed with the 6-pounder gun and to have the same layout (i.e., with right-hand drive) as Canadian Rams.[86] Because deliveries of the original 1,157 Rams (and their accompanying 12 sets of spares) from the first contract were still being made, these Lend-Lease tanks would start being delivered to ALCO only after the first 1,000 Canadian tanks had been produced. At that point, the Canadians would take 2 of the tanks produced each day at the Arsenal, with the Americans receiving the balance.[87] Within approximately three months of the re-equipment of the Arsenal, ten tanks per working day were to be delivered to ALCO, with one set of spare parts being produced for every 100 tanks. Deliveries were projected to begin in November 1942 and end in July 1943.[88]

The Directorate of Mechanization had wanted to make sure that the Canadian Army would get all of its Rams before the fulfillment of the US Lend-Lease contract, but the eventual delivery schedule was a compromise among all of the negotiators.[89] Three further Canadian contracts were let for additional Rams, as it was realized that more

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[86] LAC RG 28 Vol. 432, File 20-LV1A-1-2-4, Memorandum of Agreement between DM&S and the American Locomotive Company, dated 11 August, 1942. The Agreement refers back to the original contract of 23 October 1940 to build and equip the Tank Arsenal. The cost of re-equipping the Arsenal for the new contract was estimated at $250,000.00. The estimated cost of each tank was $54,555.55, plus a fixed fee surcharge of $1,455.00 US per tank "for the use of the facilities furnished by His Majesty". The estimated cost of each set of spare parts was $636,363.30.

[87] Ibid., see also LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, B.D. Beamish, DM&S, to Major E.D. James, D. Mech., "Re: Canadian Requirements Ram Tanks", 13 May 1942.

[88] Ibid.

[89] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, Major E.D. James, D. Mech, to Director General of Tank Production, "Canadian Requirements – Ram Tanks," 9 May 1942.

would be needed to equip the Armoured Divisions as well as two new Tank Brigades. The new contracts were for a total of 2929 Rams, on top of the original 1157 of the first contract, and even with this there still would be a shortfall of 605 tanks in the Canadian Forces estimates.[90] It was foreseen that at some point the Ram would be superseded by an improved model or a different tank altogether, but for the moment it was the Ram that was on order with MLW.

Efforts to improve the Ram continued. The first major redesign of the Ram hull was implemented with Hull 321, serial number CT-40101, based on experience gained from the earlier hull design as well as suggestions from the AFV User's Committee. The sponson side doors were removed and replaced by a new escape hatch fitted in the floor of the tank, a position that would give the crew more protection if they had to abandon the tank under fire. Welded-on armoured ventilator fan "bumps" and revised internal stowage occupied the places where the side doors had been, and new splash beading was installed around vulnerable hatch openings. The turret was modified as well, having its armour thinned in places where it was thought that the original thickness needed had been over-estimated.[91] Additional turret and cupola ring splash protection was incorporated

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[90] The original contract for 1157 was C.D.L.V. 283. The new contracts were:

C.D.L.V.	558	for 1351	Ram IIs
C.D.L.V.	1540	for 628	Ram IIs
C.D.L.V.	1554	for 950	Ram IIs

Sometime between August 2nd and September 15th, 1942, the last two contract numbers were dropped and the first amended so that C.D.L.V. 558 was for the complete order of 2929 tanks. The total number of tanks needed at full wastage rates was 4691. See LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 9, V. Young, M.G.O., to Minister of Defence Ralston, "Tank Production," 2 August 1942, op. cit., and (in the same file) "Master Production Schedule No. 11, Tank: Ram", 15 September 1942, attached to letter from B.D. Beamish, DM&S, to V. Young, M.G.O., 15 September 1942.

[91] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, A.S. Ellis (T.A.M.T.) to Lt-Colonel B.H. Darwin, AFV Advisor's Committee, "Revisions in Production to Ram Tanks," 12 June 1942.

into the Ram II from Hull 340 on. Retrofitting this protection to earlier tanks was "not feasible", and considered unnecessary because the turret ring had been impervious to small-arms fire during tests conducted in Canada.[92] The AFV Users Committee replied that it still wanted those tanks fixed, because their tests in England had shown the area was vulnerable.[93] The discrepancy in results between the two sets of tests may have been that the turret rings of early Ram Is had not been machined with tolerances fine enough to eliminate splash, but the problem appeared to be resolved in later-produced tank hulls.[94] AEDB responded that it was not possible to add the protection to the first 319 tanks, though whether this was because of the hull design or the hull composition was unclear.[95]

An endurance test ground, similar to the one used at the Detroit Tank Arsenal to improve the tank's mechanical reliability, was surveyed to be built on CNR-owned land near the Locomotive Works.[96] Located in easy proximity to the Valentine tank works at the CPR's Angus Shops as well as the Tank Arsenal, it contained various types of terrain to duplicate battlefield conditions. A two-mile-long roadway was planned as well, to test

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[92] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, Defensor to Canmilitry, 27 March 1942.

[93] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, Canmilitry to Defensor, 18 April 1942.

[94] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, A.S. Ellis (T.A.M.T.) to various addressees at DND, 2 June 1942. The turrets of the Ram I tanks tested in both the United States and England had exhibited "shivering", or excessive turret traverse and oscillation, from the vibration of road travel during those tests. This shivering seemed to indicate ill-fitting parts in the turret race, and it was thought that closer machining and finishing of those parts would remedy the situation. See LAC RG 24 Vol. 9364, File 38/Arm Veh/28/2, Ellis to Forsyth, Secretary of the AFV Committee, 14 July 1942.

[95] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, Defensor to Canmilitry, 27 April 1942. This response did not mention anything about hulls 320-339.

[96] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, R.E. Jamieson, "Tanks Committee Meeting [T-15]," 21 July 1942.

the tanks' endurance and speed runs capabilities.[97] In this way it was hoped that any problems would show themselves during the test, and be fixed on their return to MLW before the tanks were sent on to the troops.

R.E. Jamieson suggested that Canada follow a new US practice and weld together (rather than rivet) the lower hulls of Ram Tanks to accelerate production, as long as testing showed that the welds were "good" and the ballistic properties of the armour were uncompromised.[98] Tests on the welding procedure confirmed this and it was approved on 10 April 1942, less than 2 weeks later.[99] A Capital Expenditure Contract was let on 22 April with General Motors of Canada in Oshawa to acquire and install the necessary tools, including arc welders, dies and fittings "to weld lower hulls for Ram II Tanks at the rate of Ten (10) per day when in full production," which was anticipated commencing in August 1942.[100]

The accelerating pace of production of the Ram II meant that more Canadian companies were becoming parts suppliers, supplanting the original American ones. In the period

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[97] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, R.E. Jamieson, "Tanks Committee Meeting," 31 March 1942. Two blueprint plans of the proposed test track, showing its path from the intersection of Viau and Sherbrooke Streets to a point near where present-day Jean-Talon and Langelier Boulevards meet in Saint-Leonard, are in LAC RG28 Vol. 432, File 20-LV1A-1, "Formal Agreement of Contract and Lease between Canadian National Railway Co. and H.M. the King" dated 22 January 1945. Plan 'A' is undated, Plan 'B' dated 31 October 1941.

[98] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, DM&S to MGO, "Re: Lower Hulls Ram Tanks," 1 April 1942.

[99] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, D/MGO to DM&S, "Re: Lower Hulls Ram Tanks," 10 April 1942.

[100] LAC RG 28 Vol. 510, File 51-M-4, Capital Expenditure Contract M.P.1096 between MLW and General Motors of Canada, 22 April 1942. The initial contract was "not to exceed $291,173.00" and by 6 November 1942 an amendment requesting an additional $166,250.00 to the above for more tools was ready for signature.

from April to June, 1942, MLW let contracts worth over $1.4 million with just four firms. In addition to the above contract with GM, similar capital expenditure contracts were signed with the Robert Mitchell Company of Montreal, the Massey-Harris Company of Toronto, and Dominion Rubber in Kitchener. All were to build additional plant capacity and to tool up for making suspension components. The Robert Mitchell Company was to build track assemblies, Massey-Harris was to manufacture end connectors for the tracks, and Dominion Rubber was to fabricate pins and wedges for the tracks and then assemble Ram tracks with the components from the other two contractors. Dominion Rubber also had a contract to make the bogie wheels that ran on the tracks.[101]

Victor Sifton continued to worry that the Ram program was not advancing technologically as quickly as that of the Sherman. He suggested to Crerar that in the interest of standardization, Ram production should be discontinued as soon as possible and that the M4 (US) be built instead; the primary argument against this decision was that the Ram had superior crew protection due to its thicker hull armour.[102] In his response, Crerar agreed to the changeover proposal on the conditions that there be no loss in tank production, and that the M4 would use the "new Ford" engine that developed more

[101] All contracts are contained in LAC RG 28 Vol. 510, File 51-M-4. Capital Expenditure Contract M.P. 1538 "not to exceed $10,991.00" between DM&S, MLW and the Robert Mitchell Company Limited, Montreal. 27 June 1942; Capital Expenditure Contract M.P. 1203 "not to exceed $596,654.00" between DM&S, MLW and the Massey-Harris Co. Ltd., Toronto, 16 May 1942 (an amendment to the above dated 19 August 1942 details increased costs of $125,392.00); Capital Expenditure Contract M.P.1552 "not to exceed $402,423.00" between DM&S, MLW and the Dominion Rubber Company, 10 June 1942; and Capital Expenditure Contract M.P.1205 "not to exceed $140,818.00" between DM&S, MLW and the Dominion Rubber Company, 16 May 1942, with later amendments and additional costs of $45,991.00.

[102] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, M.G.O. (Sifton) to C.G.S. (Crerar), 2 April 1942.

power.[103] (This seems a curious choice, as it would introduce a new engine and thus added complexity to the supply of parts for the Armoured Corps.)

Upon further investigation, it was found that ensuring a smooth transition, with minimal loss of production, would require approximately 8 months lead time. During that period, MLW would re-tool with larger boring mills to fabricate the 69-inch turret ring that could provide the space needed for the 75 mm gun. General Steel Castings would also need to re-tool, both to make the moulds for a new hull casting and to rejig machine tool setups for cutting and finishing new access hatch locations in those hulls.[104] GSC further reported that the new M4A1 hull would be more difficult to machine than that of the Ram II.[105]

A DM&S report to Ottawa from Washington explained that engine and transmission spares were scarce because most spares were being sent overseas to combat areas, and the balance were going straight into tanks on the assembly lines. US Ordnance would not stop production by ordering more spares, preferring to ship complete units—that is, tanks.[106] As an earlier DND cable had noted, "We fully realize necessity providing detailed stocks for repair and overhaul transmission engines etc but we are absolutely

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[103] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, C.G.S. (Crerar) to M.G.O. (Sifton), 4 April 1942.

[104] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, B.D. Beamish, Director-General, Tank Production Branch, to M.G.O. (Sifton), 15 April 1942.

[105] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Beamish to Young, 10 July 1942.

[106] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, DM&S (Washington) to DM&S (Ottawa), 28 April 1942.

dependent on U.S. Production and supply stop U.S. will not release parts for these items stop."[107]

This lack of spare parts had a domino effect through the Canadian training establishment. General McNaughton cabled Ottawa that spare parts were desperately needed in Britain to facilitate the repair and overhaul of Ram transmissions, engines, and other components. He noted that it was bad for the troops' morale for their equipment to have too many breakdowns, or for them to have to wait too long for repairs.[108] If the Armoured Divisions were going to war in these tanks, they would have to know that they would not let them down mechanically at a crucial time. Likewise, spares problems were occurring at training camps in Canada as well. A message from Camp Debert to DND HQ in Ottawa noted that tanks were breaking down more frequently and troops were resorting to "cannibalization", taking parts from immobile tanks to repair ones that were still running. The message reported that training was suffering, as the troops could not train as a group in larger formations due to breakdowns.[109] The Camp Borden War Diary noted that

> Mr. Hisscock, D. of M. & S., called with District Spare Parts Officer. Discussed the question of spare parts for tanks and stressed the fact that in many cases tanks urgently needed for training were immobilized for weeks

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[107] LAC RG 24 Vol. 2599, File H.Q.S. 3352-11 Vol. 6, Defensor to Canmilitry, 23 April 1942.

[108] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Canmilitry (McNaughton) to Defensor (C.G.S. and M.G.O.), 8 May 1942.

[109] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Camp Debert to Ottawa, 14 May 1942. This problem persisted over a year later, as a Canadian Grenadier Guards War Diary entry shows: "Reports are being received that certain units are stripping tks before evacuation. This practice will cease forthwith." LAC RG 24 Vol. 14259, War Diary, 22 Cdn Armd Rgt, Part 1 Orders, "Cannibalization – Ram Tk 1," entry for 5 June 1943.

> for lack of a small part. Mr. Hisscock advised that as the output of parts was only in line with tank productions, it was almost impossible to get spare parts and these that were available were urgently needed Overseas. He further stated that every effort was being made to get them.[110]

The Minister of Defence, J.L. Ralston, sent a message to C.D. Howe asking if the fact that many Rams were missing vital equipment (especially their 6-pounder guns) would delay the 5th Armoured Division from being included in the Canadian Order of Battle on its scheduled date of the first of August.[111] Howe replied that Ralston had no need to be worried; the target date of August first would be met by the Department of Munitions and Supply.[112] For some reason neither Howe nor Ralston knew that the 5th Armoured Division was only to be in the Order of Battle as of September, 1942, because a shortage of shipping space delayed the Rams' delivery to the UK, not delays in production.[113]

Just about two-thirds of the way through the first production run, the Ram II hull and turret castings were modified again for easier manufacture. In the hull, the ventilation fan "bumps" were now an integral part of the casting rather than being welded on afterwards, keeping the width of the hull within the loading gauge of the British railways. As well, additional splashproofing was placed around the base of both the turret ring and the machine-gun cupola ring. The turret casting was changed to incorporate new pistol ports that were less vulnerable to splash. This new casting also eliminated an access hatch

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[110] LAC RG 24 Vol. 18212, Camp Borden War Diary (H.Q., Canadian Armoured Corps Training Group), entry for 5 June 1942.

[111] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Ralston to Howe, 10 April 1942.

[112] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Howe to Ralston, 13 April 1942.

[113] LAC RG 24 Vol. 9364, File 38/Arm Veh/13, Canmilitry to Defensor, 6 March 1942.

located in the turret rear, originally meant to allow the removal and replacement of the main gun without removing the mantlet. It had been found, in practice, that it was actually easier to remove the mantlet and gun assembly together from the front of the turret, rather than try to thread the gun back through the rear hatch without damaging it (or any of the fitters) in the process.[114]

However, problems with Rams continued to make themselves known, usually only after they had left the factory. At Debert seven Rams needed replacement engines due to damage from their oil supply running low, because they lacked a telltale light to alert the driver that the oil pressure had dropped.[115] At Borden, battery switches were burning out from a combination of dust build-up and "faulty design".[116] In the UK, transmission oil coolers were breaking and the wireless sets in many tanks were working intermittently, if at all.[117] The voltage regulators frequently failed during firing training, and there were recurrent troubles with booster coils.[118] During training in both countries, mud build-up in the space between the suspension and the return rollers of the Ram was causing the tank to "throw" its tracks, immobilizing the tank until the crew could re-mount the tracks

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[114] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, A.S. Ellis (T.A.M.T.) to Lt-Colonel B.H. Darwin, AFV Advisor's Committee, "Revisions in Production to Ram Tanks," 12 June 1942. Ellis says that the changeover for the turret will come at Hull 758 / CT-40538, but Roberts, *Ram*, op. cit., lists both the turret and the hull changing on the same tank, Hull 768 / CT-40549. In this case, Ellis is probably the more reliable source.

[115] LAC RG 24 Vol. 2600, File H.Q.S. 3352-11 Vol. 7, Major E.D. James to the Director-General, Army Engineering Design Branch, "Ram Tank Engine Failures," 11 June 1942.

[116] LAC RG 24 Vol. 18212, Appendix "B" Letter from Experimental Wing, Canadian Armoured Corps to H.Q. C.A.C., appended to War Diary, Experimental Wing, C.A.C.T.G., 6 June 1942.

[117] LAC RG 24 Vol. 9378, T.A.M.T. War Diary, entries for 9 May 1942 and 19 May 1942.

[118] LAC RG 24 Vol. 9364, File 38/Arm Veh/28/2, Ellis to O/C 5th Div. Sigs, 1st Cdn Army, "Voltage Regulator – Ram Tanks," 6 Aug 1942.

onto the running gear. To repair this meant that the crew had to unfasten the track, put it back into its correct position using the tank's tow cables, and then connect the track ends together again, a strenuous job at the best of times. This flaw was remedied by installing a small spacer plate under the return rollers, which raised them just enough to keep the mud from accumulating. This was a relatively simple repair, but it meant that six spacer plates had to be fabricated for and installed on each tank.[119]

Battle experience also resulted in changes. Reports from fighting in the Middle East noted that the ammunition stowage racks in Lee tanks were vulnerable to penetrating fire and shell splinters. Because of the similarity between the Lee and the Ram, 6 mm of hardened armour was added to surround the stowage racks in the Ram.[120] None of these problems were fatal or insoluble in and of themselves, and most were solved relatively quickly, but there were so many of them that they frustrated designers and users alike.

On June 1st, 1942, R.A. Macfarlane, the Director of Mechanization, wrote a very angry letter to Victor Sifton, the Master-General of the Ordnance. Macfarlane noted that over 300 Ram tanks had been produced and there were still very basic problems with their production. The greatest problem was still the lack of spare parts, but there were other

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[119] LAC RG 24 Vol. 9364, File 38/Arm Veh/11, "D.M.E. Modification Circular No. A-574," 10 June 1942. Since each track shoe weighed about 18 lbs and even the easiest repair job entailed lifting multiple shoes to reconnect the track, such a repair was hard work for the crew. (Track shoe weight comes from LAC RG 28 Vol. 432, File 20-LV1A-1-4, Formal Agreement [between] Montreal Locomotive Works, Limited [and] Fahralloy Canada Limited, 15 March 1943.)

[120] LAC RG 24 Vol. 2600, File H.Q.S. 3352-11 Vol. 7, Major E.D. James to the Director-General, Army Engineering Design Branch, "Ammunition Racks - Ram Tanks," 30 May 1942.

difficulties, especially a lack of communication between suppliers, producers and design staffs.[121]

One example of this was that new engines being supplied by Continental (that ran on 80-octane rather than scarce 91-octane gasoline) had turned out to have different dimensions from the original Wright engines provided for the Rams. As a result, the Ram engine compartment had required a redesign to accommodate the different plumbing and wiring on these engines. The situation was made more complicated because some tanks had the older engine and compartment, some had the new engine with the redesigned compartment, and others had the new engine but with mountings that allowed it to fit the older engine spaces. Apparently the Chief Engineer at MLW had known about the engine changeover for over two months but had failed to pass on the information to the Design Branch or the Production Department. In addition, the oldest model engines were now out of production, so no spare parts were going to be available for them in the future.[122]

Another problem was that the first production run of 110 adapters and mantlets for the 6-pounder gun of the Ram II had been made to fit each other in specific sets, rather than being completely interchangeable. They were stored at MLW until the 6-pounder guns became available from Dominion Engineering in Longueuil months later. When these guns were eventually installed in the Rams the need to match the specific adapters and

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[121] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, D. Mech (R.A. Macfarlane) [actually dictated by E.D. James, his deputy] to M.G.O. (Sifton), 1 June 1942.

[122] Ibid.

mantlets had been forgotten, with the result that many of the guns could not reach their full depression or elevation. All of the different agencies involved blamed one another for the lack of communication.[123]

Sifton passed on much of this information in a letter to Defence Minister Ralston on June 3rd. He added that discussions were held with Minister Howe of the DM&S and it was decided to halt the Ram production line to accommodate the redesign and rebuild of the engine compartments, call back tanks already produced to retrofit them as necessary, and to send work drawings overseas to allow modifications to be done there. It was also agreed to track down and correctly pair off all of the 6-pounder guns to their proper mantlets at Canadian Army ordnance workshops. Finally, to ease the burden on Armoured Division workshops, Howe agreed that complete engines could be broken down for distribution as spare parts.[124]

The same day as the above, B.D. Beamish (Director-General of the Tank Production Branch) wrote a letter to Howe that minimized the problems in the tank construction programme, and then essentially disclaimed much of the responsibility for them, placing the blame on others—US Ordnance for not supplying engines, transmissions and spares, MLW for working too slowly, and the Inspection Board officials for not catching errors before the tank left the plant.[125] Howe replied to Sifton five days later, enclosing Beamish's letter to him. He expressed his opinion that any changes needed seemed

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[123] Ibid.

[124] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, MGO (Sifton) to Ralston, 3 June 1942.

[125] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Beamish to Howe, 3 June 1942.

minor, and that they could easily be effected in the field.[126] Beamish, perhaps not knowing that Howe had forwarded his letter, also wrote to Sifton the same day repeating many of his same explanations to Howe, trying to deflect blame still further away from the Tank Production Branch.[127]

Sifton replied directly to Beamish in a very stiff letter on the 15th of June. He refuted several of Beamish's claims, and insisted that the Tank Production Branch had to take some responsibility for actually producing tanks. He further informed Beamish that all tanks must be delivered complete from then on, lacking nothing that would make them battle-worthy, and that the supply of spare parts had to be improved.[128]

Ralston summarized the various problems listed above in his reply to Howe and laid most of the blame for them on the MLW, the Design Branch, and the Inspection Board. In his opinion none of them were catching faults that needed correction, and that MLW in particular was working at too slow a pace. He added, perhaps ironically, "It probably does not give the true picture to say that not one of the 300 tanks produced is fit for action."[129]

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[126] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Howe to Sifton, 8 June 1942.

[127] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Beamish to Sifton, 8 June 1942.

[128] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Sifton to Beamish, 15 June 1942. Sifton emphasized that spares could not be more than 50 tanks in arrears; for example, if the spares were not available for the 301st tank shipped, the 351st tank would not be accepted by the DND.

[129] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Ralston to Howe, "Re: Ram Tank Production", 11 June 1942.

Eventually, it was considered that the deficiencies in Rams arriving in the UK were too numerous to be dealt with by the Army Workshops there. Cable QMG 2342 was sent to Canada asking for permission for British civilian firms to perform the work.[130] Jack Olding & Company Ltd. of Hatfield, a heavy machinery supplier, was chosen to undertake the job of bringing them all to a single up-to-date standard. "Oldings" was already performing this function on "soft-skinned" (unarmoured) vehicles for the Canadian Army, and agreed to extend the existing contract between them and the Ministry of Supply to include Canadian tanks and AFVs.[131] The contract was approved by June 20th and the first Rams were en route to them for modifications ten days later.[132] Soon after, A.S. Ellis of the Motor Transport branch noted that 43 modifications were being performed on Rams in England as a result of user suggestions or modifications recommended by Canada. He also noted that there had been at least 177 design changes on the Canadian production line, ranging "from changing the material specification of a bolt to a complete change of the upper hull casting."[133]

Two technicians from Continental Motors flew to England at the end of July to work on problems that were occurring on Ram engines, accompanied by Ernest Whittick, Chief

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[130] LAC RG 24 Vol. 9378, T.A.M.T. War Diary, entry for 17 June 1942.

[131] LAC RG 24 Vol. 2600, File H.Q.S. 3352-11 Vol. 8, Canmilitry to Defensor, 8 July 1942.

[132] LAC RG 24 Vol. 9378, T.A.M.T. War Diary, entries for 20 June and 25 June 1942.

[133] LAC RG 24 Vol. 9365, File 38/Arm Veh/28/2, A.S. Ellis (T.A.M.T.) to Captain W.D. Smith, A.D.O.S., 5th Canadian Armoured Division, "Modifications to Ram and General Lee Tanks," 16 July 1942.

Inspector of the Montreal Locomotive Works.[134] They obtained the UK equivalents to the greases and sealants needed from the RAF (as the specific US products normally used on the engines were not available), and ensured a steady supply of these for Canadian Army maintenance echelons.[135] The technicians visited the "assembly plant" at Jack Olding & Company as well as tank units in the field during their instruction tour, and set up maintenance training programmes at No. 1 CBOW.[136] Whittick spent much of his time in England in "Design and Provisions" meetings at Oldings and returned to Canada in the last week of August, carrying plans and drawings for the Ram modification programme in the UK as well as a list of Ram field modifications.[137]

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[134] LAC RG 24 Vol. 9365, File 38/Arm Veh/28/2, Defensor to Canmilitry, 24 July 1942. The technicians were Earl B. Byard Jr. and J.L. Edrington, hired on contract PC/1/5997 dated 10 July 1942.

[135] LAC RG 24 Vol. 9365, File 38/Arm Veh/28/2, Ellis to D.A.D.O.S.(E.), 8 August 1942.

[136] LAC RG 24 Vol. 9365, File 38/Arm Veh/28/2, Ellis to E.D. [Doug] James, D. Mech, Ottawa, 11 Aug 1942.

[137] LAC RG 24 Volume 9378, T.A.M.T. War Diary, 23 August 1942.

Chapter 5: Bypassed by Events

While manufacture of the Ram continued, its fate as a main battle tank was determined at a meeting of the London offices of the Department of Munitions and Supply on July 25th, 1942. General McNaughton, the G.O.C.-in-C., said that he felt that standardization was the most important consideration for war production work in North America, and thus the adoption by the Canadian Army of the M4 Sherman with its 75 mm gun (replacing the Ram and the 6-pounder) would be especially beneficial in simplifying the jobs of supply officers and maintenance demands throughout the Allied forces.[1] In addition, the 75 mm gun could fire both armour-piercing shot and high-explosive (HE) shell (for use against infantry and "soft" vehicles); the 6-pounder gun could fire both kinds of projectile as well, but the smaller size of its HE shell rendered it "almost useless" in the opinion of British tankers.[2] Unfortunately, McNaughton's ideal of standardization contributed to the Canadians (and possibly the Allies) having an armoured force that on the whole had inferior armament to that of its enemies, as the Sherman's 75 mm gun had inadequate striking power by the time Canadian troops landed in Europe.

The Allies did have three better guns in development at this time (the American 76 mm and 90 mm, and the British 17-pounder), but complacency among higher commanders about the effectiveness of the 75 mm gun would lead to the fiery deaths of many Allied

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[1] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, "Minutes of Meeting Held at Department of Munitions and Supply, 28 St. James Square, London, S.W.1, on July 9th, 1942."

[2] Quoted in Beale, op. cit., 105.

tank crews.[3] The Canadian AFV User's Committee (through the Directorate of Mechanization) recommended to US Ordnance that the 76 mm gun be adopted for the Sherman, but only a few tanks were eventually so equipped.[4] Another opportunity was missed when McNaughton disapproved of trying to fit the 3" 17-pounder gun into the Sherman, saying that it "was an impossible gun to fit into tanks".[5] This cavalier dismissal was much regretted later, when a comparatively few Shermans were hurriedly equipped with enlarged turrets and 17-pounder guns and put into battle as the "Firefly", one of the few tanks able to take on German panzers on roughly equal terms.[6]

Accordingly, it became Canadian policy that the Sherman would become the main battle tank in Canadian formations. Within weeks, Major James was to be in a meeting in Washington to discuss the successor to the Ram with Colonel Christmas of the US

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[3] Months later, in November 1942, General Bernard Montgomery would say "the 75mm gun is all we require" and his prestige as the only winning British general to the time would make his view gospel in the British (and Commonwealth) Armies. See Beale, op. cit., 97.

[4] LAC RG 24 Vol. 9365, File 38/Arm Veh/29, "M.4 Tank Design Requirements," Lt.-Col. W.W. Goforth, a/D.S.D.(W), to D. of Mech., 21 September 1942, and Bruce Culver, *Sherman in Action* , (Carrollton, TX: Squadron/Signal Publications, 1977), 41-47.

[5] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, "Minutes of Meeting Held at Department of Munitions and Supply, 28 St. James Square, London, S.W.1, on July 9th, 1942." It is curious that McNaughton, an artillery man by training, would think that the 17-pounder could not be used in a Sherman. Perhaps he depended too much on the bad advice of "experts", or possibly was carrying the idea of standardization too far, imagining chaos from introducing another weapon into the supply chain. See also LAC RG 24 Vol. 9364, File 38/Arm Veh/28/2, personal letter from Major E.D. James (D. Mech) to S.E. (Sid) Swallow, T.A.M.T., C.M.H.Q., 27 July 1942. James said, "We were disappointed to hear that General McNaughton did not favour the 17-pounder as it was our idea without ever seeing the gun but this might prove to be the real tank killer".

[6] The deadliness of the 17-pounder gun was recognized by the Germans, who responded by concentrating their tanks' fire on the distinctive long-barrelled Fireflies as soon as one was seen on the battlefield. These tanks were initially crewed by officers, but casualties swiftly became heavy enough that the officers were replaced with sergeants, and a Firefly would only be brought into battle when a difficult target or position had to be overcome. See Lt.-Col. H.M. Jackson, *The Sherbrooke Regiment (12th Armoured Regiment)*, (Sherbrooke, Qc: The Sherbrooke Regiment, 1958), 127.

Ordnance Department, since "the Ram tank was, of course, now superseded by later U.S. types".[7] Despite this, and despite being eliminated as a gun tank, it was decided that the Ram made an excellent chassis for the Command/Observation Post tank variant needed by the Armoured and SP Artillery Divisions. Command/OP tanks had their 6-pounder gun removed, along with the ammunition, the ammunition stowage bins, and the turret traverse motor. The space that was freed up in the turret was occupied by an additional crew member, map boards and two additional radios for better communications with higher commands as well as accompanying infantry. A hollow tube welded to the turret mantlet made it appear to be an ordinary gun tank. An initial order of 40 Command/OP tanks increased to 64 in September 1942 when the allocation of tanks per battalion was changed.[8] Eventually 145 were built in Canada, and more were converted in the UK from Ram stocks held there.[9] Supply and repair problems were minimized in the artillery regiments because the Ram OPs shared a common chassis with the 25-pounder Sextons that they accompanied.

Also in July, in sharp contrast to the fuss occasioned by a photograph of the Ram appearing in a Toronto newspaper seven months earlier, a Ram and a Valentine from Camp Borden were used to help advertise Lux soap. Four Troopers posed with two

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[7] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 9, R.E. Jamieson, AEDB, to Department of Munitions and Supply, "Meeting at Montreal Locomotive Works Aug 14/42," 19 August 1942.

[8] LAC RG 24 Vol. 9365, File 38/Arm Veh/31, Telegram from Canmilitry to Defensor, 23 September 1942. Initially there were contracts for two different but similar OP vehicles, the "Command" variant and the "Armoured" variant, but by the time the tanks were being manufactured they were all generally known as Command/OP vehicles.

[9] The 145 Canadian vehicles were built on three separate contracts. See Roberts, *The Ram: Development and Variants, Vol. 1*, op. cit., 9-10 and 21.

female models and two child models.[10] On a more warlike note, in August, "National Film Board representatives started shooting film on Demonstrations of and Tactical employment of A.F.Vs."[11]

Though he was determined that military needs would come before those of industry, McNaughton never lost sight of the fact that he had to be supportive of Canada's industrial war effort. As C.D. Howe noted in his journal during his visit to England in September-October 1942,

> "Motored to GHQ and lunched with McNaughton and everyone in the Canadian Army with the rank of Brigadier and up...After lunch McNaughton held a conference to discuss Canadian production and Canadian weapons. The ram tank is the best tank that has reached England; in fact, McNaughton made the general statement that all Canadian equipment is the best that they have received".[12]

MLW continued to turn out Rams for training use. In addition to the new production, 100 tanks from General Worthington's 4th Armoured Division in Nova Scotia were returned to MLW for rebuilding before being sent overseas. These tanks each had from 2500 to 3000 miles of use, but the rebuild process essentially returned them to "new" condition. 6-pounder mountings were still in short supply; the Daily Production Report

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[10] LAC RG 24 Vol. 18212, Camp Borden War Diary (H.Q., C.A.C.T.G.), entry for 8 July 1942. The pictures were taken on the authority of Military District No. 2. The men each received five dollars for their work.

[11] LAC RG 24 Vol. 18212, Camp Borden War Diary (H.Q., C.A.C.T.G.), entry for 18 August 1942.

[12] LAC RG 28 Vol. 5, DMS History Minister's Office. "Diary of Visit to London From Ottawa 26th September 1942" by C.D. Howe, datelined Dorchester Hotel, London, Oct. 3rd Saturday, 4.

from MLW for July 27, 1942 showed that 217 Ram IIs were in Montreal waiting for gun mounts.[13]

Canadian authorities even proposed that the CPR start manufacturing Rams or M4s when Valentine production was finished at the Angus Shops, but this idea was vetoed by the US Ordnance Department. They considered that the Montreal Locomotive Works still had unused production capacity (of up to 20 tanks per day) and to divert work to the CPR facility would be a waste of resources.[14] Accordingly, preparations for Ram/M4 production at the CPR were cancelled and all files and drawings returned to MLW.[15]

Despite the fact that the Ram was no longer in consideration as a main battle tank, the Ram II hull was redesigned yet again to eliminate a shot-trap behind the cupola machine-gun, replacing the assembly with a ball-mounted machine-gun in the bow plate of the tank.[16] A wooden mockup of the new design was completed by August 27, and this hull would be incorporated into the next (and, as it turned out, final) production run of Ram IIs.[17] With the addition of minor modifications against bullet splash for the co-driver's hatch and a re-fairing of the armour around the new ball-mount MG, the plans were duly

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[13] LAC RG 24 Vol. 9364, File 38/Arm Veh/28/2, personal letter from Major E.D. James (D. Mech) to S.E. (Sid) Swallow, T.A.M.T., C.M.H.Q., 27 July 1942.

[14] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 9, Maj.-Gen. James V. Young, MGO, to Minister of Defence Ralston, "Tank Production," 2 August 1942.

[15] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, R.E. Jamieson, "Tanks Committee Meeting T-17," 11 August 1942.

[16] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, Defensor to Canmilitry, 4 June 1942.

[17] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, E.D. James (D. Mech) to D.S.D., 26 August 1942.

approved by a senior General Staff representative on August 29th.[18] CMHQ was informed that the production of these new hulls would be delayed until November 1942 (starting with the 101st tank of the second contract, CT 159502) because General Steel Castings reported that new hull hatch designs had caused some unforeseen machining problems.[19] A contemporary journal article estimated that this simplification of the hull saved approximately $930,000 in materials and labour and more than 88,000 man- and machine-hours of manufacturing.[20]

This final hull redesign essentially made the tank into a modified M4, and it was thought that the first 700 tanks of the US contract production run might have Ram II hulls and the balance have M4 hulls.[21] It was stipulated that in any tank production subsequent to the US Ordnance order the hull was to have a 69-inch turret ring diameter, which essentially meant that MLW would be manufacturing the Sherman instead of the Ram by July 1943.[22] Major James of the Department of Mechanization noted that

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[18] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Captain (G.S.) Chas. Sale, D.S.D. to D. Mech, 29 August 1942.

[19] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Defensor to Canmilitry, 1 September 1942, and LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 9, R.E. Jamieson, A.E.D.B., to DM&S, "Meeting at Montreal Locomotive Works Aug 14/42," 19 August 1942. All of the Ram upper hulls and turrets had been cast by the second week of February, 1943. See LAC RG 24 Vol. 2602, File H.Q.S.3352-11 Vol. 14, Defensor to Canmilitry, 13 February 1943.

[20] Figures from J.R. Petrie, "Business Efficiency in the Canadian War Effort," *The Canadian Journal of Economics and Political Science*, Vol. 9, No. 3 (Aug. 1943), 363. The estimates were based on an annual production figure, and included a saving of 2,232,000 pounds of steel. However, since this article was written in wartime and was meant to project and reinforce an image of efficiency, it probably should not be taken as definitive.

[21] LAC RG 24 Vol. 9364, File 38/Arm Veh/28, Defensor to Canmilitry, 4 June 1942.

[22] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 9, Mr. W.M. Townsend, MLW Works Manager, "Minutes of a Meeting held at Montreal Locomotive Works, Limited, August 14th , 1942, Concerning Change in Design of Tank to be Produced."

> in all probability we will change the Montreal Locomotive Works to build the M4A1 tank exclusively and exactly the same as the one being produced in the United States. There is one thing to remember on the standardization program and that is if we adopt the U.S. design 100% we will be tied down to their ideas and will only be able to get changes into effect when we can persuade Washington that this should be done. When the Overall North American Tank Program is taken into consideration this is no doubt a good idea as we can interchange information and be talking about the same thing. At the present, the U.S. Ordnance looks upon us much as an orphan and lets us go our own way sometimes to our detriment.[23]

As part of the effort that Major James outlined, a Directorate of Mechanization memo of 21st September 1942 listed over 50 improvements to the final M4 Sherman design that Canada should suggest to the US authorities. Among these recommendations were that the new 76 mm gun was preferred over the 75 mm or the 6-pounder, cast hulls were considered preferable to welded hulls, there should be improved splash protection and instrument reliability, and that the weight of the tank should not exceed 60,000 pounds.[24]

In early October of 1942, the United States cut the allocation of transmissions by 40 percent throughout the entire North American tank production programme without any warning. This immediately affected delivery schedules at MLW, to the point that the delivery of the 1,000th Ram would now occur in the middle of December, rather than in October as originally scheduled. Canadian production was disproportionately affected by the cut and, instead of producing 200 tanks per month during October, November, and

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[23] LAC RG 24 Vol. 9365, File 38/Arm Veh/28/2, personal letter from Major E.D. James (D. Mech) to S.E. (Sid) Swallow, T.A.M.T., C.M.H.Q., 27 July 1942.

[24] LAC RG 24 Vol. 9365, File 38/Arm Veh/29. "M.4 Tank Design Requirements," op. cit.

December, MLW predicted that only 167 new Rams would be built over the same three-month period. It was hoped that part of the shortfall could be made up by bringing older tanks back to MLW and reconditioning them, not only maintaining the supply for overseas but also keeping valuable workers employed on the lines. It was still unknown at this point how the production of the Canadian Sherman, or the new SP gun chassis known as the Sexton, would be affected by this order.[25]

In the meantime, further problems continued to be found with Rams. Oil cooler failures in the UK were attributed to corrosion from exposure to sea air in transit, and the solder on those cooler connections was melting because of the high temperature of the oil.[26] Bogie tires failed repeatedly.[27] Some radio sets were wrongly positioned and failed to work.[28] Further bullet splash trials and chemical-warfare tests showed that increased protection was needed, especially around the driver's periscope, direct-vision slots, and the turret ring.[29] And the integrity of some of the tank hulls was in question. During

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[25] LAC RG 24 Vol. 2602, File H.Q.S. 3352-11 Vol. 12, Defensor [Brigadier T.D. Switzer, for Master-General of the Ordnance] to Canmilitry, 12 October 1942, and LAC RG 24 Vol. 2601, Maj.-Gen. James V. Young, MGO, to Minister of Defence Ralston, "Tank Production," 2 August 1942.

[26] LAC RG 24 Vol. 9365, File 38/Arm Veh/28/3, D.D.E.M. (D.Q.M.G.) to D.D.O.S.(E) (C.M.H.Q.), "Ram II Transmission Oil Cooler," 23 October 1942 and, in the same file, letters from Jack Olding & Co. to C.M.H.Q., "Ram I Transmission Oil Cooler," 6 October 1942, and to Mr. Wolford, Chief Chemist, London Passenger Transport Board, "Ram Tanks Intermission Oil Cooler," 14 October 1942.

[27] LAC RG 24 Vol. 9365, File 38/Arm Veh/28/2, Ellis to D.A.D.O.S. (MT), CMHQ, "Ram Bogie Wheel Tires – Dominion Rubber Co.," 30 September 1942.

[28] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, R.E. Jamieson, "Tanks Committee Meeting T-26," 1 December 1942.

[29] For bullet-splash trials, LAC RG 24 Vol. 9365, File 38/Arm Veh/28/3, D.D.E.M. to D.D.E.M. [that's what it says], 4 December 1942 and, in the same file, Lt.-General A.G.L. McNaughton (G.O.C-in-C., 1st Canadian Army) to Maj.-General A.W.C. Richardson (Director A.F.V., W.O.), 9 December 1942. For the chemical-warfare tests, LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, Brigadier DCGS to DMGO (B), 31 August 1942.

repairs to tank number #227 several holes had to be drilled into the metal. One part of the hull was found to be extremely hard, while another area drilled with no more difficulty than if it were mild steel. An Ordnance Corps officer speculated that some Ram hulls may have had inadequate heat treatment in places, and urged the Directorate of Mechanization to greater efforts at quality control and inspection of the hulls.[30]

Engine fires in Rams were commonplace enough for an order to be issued that a man with an extinguisher be stationed behind the opened engine-bay doors of the tank whenever an engine was started in cold weather.[31] Prior to the issuance of this order, on December 7th, 1942, Ram 42-1-661 had become bogged down near Camp Borden with one side four feet lower than the other. The tank was towed to level ground and an inspection failed to find any fuel or oil leaks, but when the tank was re-started a fire erupted in the engine compartment that required some 15 to 20 portable extinguishers to put out, as the tank's own extinguishers and carbon dioxide suppression system failed to do the job.[32] One possible reason for the ineffectiveness of so many of the extinguishers was that the carbon tetrachloride they contained was an extremely effective cleaner as

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[30] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 9, Captain B.D. Irvin, O.C. No. 1 Proving Ground Detachment, R.C.O.C., D.N.D., Ottawa, to Lt-Colonel James, D. Mech, "Ram Tank Hulls," 10 September 1942. Further tests on the armour in January 1943 found that its Brinell [hardness] number was not as high as it should have been, registering a maximum of 225 rather than 270. Despite this, the tanks were considered to be adequately protected. See LAC RG 24, Vol. 10039, File 13/AFV Ram/1/3, C.M.H.Q. to H.Q. 1st Cdn Army D.D.M.E., "Cast Armour—Ram," 25 January 1943.

[31] LAC RG 24 Vol. 10039, File 13/A.F.V. Ram/1/3, A.S. Ellis, D.D.E.M., C.M.H.Q., to D.D.O.S.(E), C.M.H.Q., "Fire Hazards in Ram Tanks," 31 December 1942.

[32] LAC RG 24 Vol. 2602, File H.Q.S. 3352-11 Vol. 12, report from Driving & Maintenance Wing to the Officer Commanding, No. 2 Det. R.C.O.C., [both at Camp Borden, Ontario], "Ram Tanks," 8 December 1942. Engine fires had been frequent in the M3 Grant/Lee tanks, as well. See Norris H. Perkins and Michael E. Rogers. *Roll Again Second Armored: Prelude to Fame 1940-1943* (Surbiton, UK: Kristall Publications, 1988), 93 and 103.

well as a fire suppressor.[33] George G. Blackburn, in his memoir *Where the Hell Are the Guns?*, stated that the men in his Artillery unit had a tendency to drain off the carbon tetrachloride to clean their uniforms, and refill them to their proper weight with another fluid that would not freeze—petrol. This in turn rendered the extinguishers somewhat worse than useless for fighting fires.[34]

The AFV User's Committee met at Oldings to discuss the modifications being performed on Rams in the UK. The modifications were classified into three groups, (a), (b), and (c). The (a) level modifications were those needed to make the tank fit for training purposes, (b) modifications were those needed to make the tank fit for battle, and (c) modifications were those that were not contained in (a) or (b) and which were deemed desirable but not essential for either purpose. All new tanks arriving in the UK were to be refitted by Oldings, with priority given to those destined for the 4th and 5th Armoured Divisions and Reinforcement Units.[35]

In Canada, too, expenditures had to be made on the testing, maintenance and repair of various components of the Rams. Engines and transmissions required overhauls and bogie wheels had to be replaced, among many other parts, and it was again considered

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[33] In the dry reportese of Lt.-Col. J.W. Bishop, the "suspected misuse of the carbon tetrachloride content of the hand extinguishers no doubt accounts for the quantity expended". LAC RG 24 Vol. 9365, File 38/Arm Veh/28/4, Lt.-Col. J.W. Bishop, H.Q. 5 Cdn Armd Div to DDOS(E), CMHQ, "Fire Hazards in Ram Tanks," 27 January 1943.

[34] George G. Blackburn, *Where the Hell Are the Guns?* (Toronto: McClelland and Stewart Inc., 1997), 351-352.

[35] LAC RG 24 Vol. 10039, File 13/AFV Ram/1/2, Major H.L. Forsyth, "Minutes of Fifteenth Meeting, Canadian A.F.V. User Committee, Held at J. Oldings Ltd. at 1400 hours, 30 Oct 42", 30 October 1942.

more efficient to contract this work out to civilian firms than to occupy the time that troops could be using in battle training.[36] For tanks that were still building, further contracts were let to Canadian and American companies for parts for the Ram, especially those comprising the suspension and running gear. Many of the parts ordered were common to other vehicles that Canada would build, such as the Sherman/Grizzly and the new SP gun built on the Ram chassis, and would still be usable should Ram production cease.[37] This was fortunate, as Sherman tank production had increased to the point at which it appeared that there would be sufficient numbers to equip all of the Allied combatants.[38]

A direct result of this enormous Sherman production was the cancellation of the 1300-tank "American" Ram II order on December 28th 1942.[39] To minimize the cancellation and penalty charges for all of the parties concerned, the contract was cut back to 792 Ram II Tanks, "to be produced and delivered against the 2929 vehicles called for on CD 558."

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[36] For examples see LAC RG 28 Vol. 432, File 20-LV1A-1-19/2, Contract M.P. 1238 between DM&S and Canadian Wright Ltd. [for the overhaul, repair, and re-condition of Ram tank engines], originally dated 11 November 1942 (plus three subsequent amendments), LAC RG 28 Vol. 509, File 51-M-4, Formal Agreement [to recondition transmissions of Ram tanks] between Mid-Town Motor Sales Ltd. Montreal and MLW, 30 September 1942 and LAC RG 28 Vol. 510, File 51-M-4, Capital Expenditure Contract M.P. 2638 between MLW and Dominion Rubber Company to test Ram Tank Bogie Tires, 21 October 1942, (plus two subsequent amendments).

[37] For examples see LAC RG 28 Vol. 509, File 51-M-4, DM&S Capital Expenditure Contract No. M.P. 2757 for the Manufacture of Bogie Tire Assemblies for Ram II and/or M4 Tank Track between DM&S, MLW, and The Goodyear Tire and Rubber Company of Canada Limited, 13 November 1942, (same file) DM&S Capital Expenditure Contract No. M.P. 2890 for Canadian Dry Pin Track Shoes for Tanks between DM&S, MLW, and The Hull Iron and Steel Foundries Limited, 4 December 1942, and LAC RG 28 Vol. 432, File 20-LV1A-1-4, Formal Agreement [for manufacture of 500 sets of CDP Tracks] between MLW and Fahralloy Canada Limited, 15 March 1943.

[38] Eventually, over 46,000 Shermans in various marks and models would be produced by 10 heavy manufacturing plants in the United States. See Culver, *Sherman in Action*, op.cit., 4.

[39] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 10, "Meeting re 1300 "American" Tanks, Detroit, December 28th, 1942", dated 4 January 1943.

In addition, MLW was to produce 84 25-Pdr. Self-Propelled Gun Mountings, and 24 Armoured Observation Posts, for a total of 900 hulls on the rewritten contract.[40] Tools originally meant to be used on the American order were to be returned to the US from MLW, or they could be switched to working on goods needed for Canadian or US accounts.[41]

Rams continued to be shipped to the Canadian troops training in the UK. As of December 19, 1942, there were 562 Ram IIs in England. 329 were with the 4th and 5th Canadian Armoured Divisions, 30 were in workshops or under repair, 10 were loaned to British forces for various trials, and another 193 were awaiting delivery to the Canadian forces.[42] 64 Rams were known to have been lost to enemy action in transit from Canada to the U.K., with a further 86 "assumed still on ocean" and 139 in Canada either waiting in port for transhipment or were en route to their embarkation port.[43] CMHQ reported in January 1943 that 150 Rams were available for overseas shipment per month from then onward.[44]

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[40] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 10, "Meeting re 1300 "American" Tanks, Montreal, 6th January, 1943," and in the same file, E.C. Perley (Director of Tank Production) to Mr. W. M. Townsend, MLW, "Re: Ram II and/or M4A1 Tanks – Schedules CD LV 558," 5 January 1943.

[41] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 10, "Meeting re 1300 "American" Tanks, Detroit, December 28th, 1942," op. cit., and "Meeting re 1300 "American" Tanks, Montreal, 6th January, 1943," op. cit.

[42] LAC RG 24 Vol. 10039, File 13/AFV Ram/1/2, Canmilitry to Defensor, 16 December 1942.

[43] LAC RG 24 Vol. 2601, File H.Q.S. 3352-11 Vol. 11, M.G.O. [J.V. Young] to DND [Ralston], "Tank State in England," December 19, 1942.

[44] LAC RG 24 Vol. 10039, File 13/AFV Ram/1/3, Defensor to Canmilitry, 22 January 1943.

Despite its thickness, the Ram's cast armour was not invulnerable. During a practice shoot at Beachy Head by the Perth Regiment, Tank CT 40195 (of the Headquarters Squadron, 2nd Canadian Armoured Brigade) was towing a target when it was mistaken for the target itself and fired on by a 2-pounder anti-tank gun from approximately 300 yards range. The solid shot went through 2 ¾" of armour, penetrated the turret basket to wound the gunner in the leg and then ricocheted off the far wall of the tank, ending up under the driver's seat. There was no flaking on the inside of the hole and "very little petalling" on the exterior and interior hull. The shot entered the left side of the tank about 15° off normal [right angle], roughly mid-way between the cupola turret and the hull side ventilator.[45] This (or a similar incident) was referred to by Montrealer Bernard Finestone in a postwar interview.

> Then the Canadians developed the Ram tank which we hated because the first time we used it on the range, some guy made a mistake and, instead of firing at the target, fired at the tank and drilled a hole two inches wide right through it. We looked at that and said, "We're going into action in that damned thing!" But we liked it because it had a 6-pounder gun.[46]

This penetration of the hull at short range "was to be expected" in the opinion of Mr. Rendall of the Department of Tank Design Armour Section.[47] But over six months earlier, 2-pounder shot fired head-on in tests against face-hardened German Panzer III

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[45] LAC RG 24 Vol. 10039, File 13/AFV Ram/1/3, H.Q. 5 Cdn Armd Div to 1st Cdn Army, "Armour – "A" Vehs," 6 January 1943. The accident occurred on or before 29 December 1942. The time required to repair the damage to the hull and tank interior was 11.5 hours. See LAC RG 24 Vol. 10039, File 13/AFV Ram/1/3, H.Q. 5 Armd Div to D.D.O.S. (E.), C.M.H.Q., 22 January 1943

[46] Bernard Finestone interview, quoted in Patricia Burns, *They Were So Young: Montrealers Remember World War II* (Montreal, QC: Vehicule Press, 2002), 116.

[47] LAC RG 24 Vol. 10039, File 13/AFV Ram/1/3, Major J.R. Johnson, S.D. 7, "Report of Examination of Damage to Ram II No. 40195 by 2-Pr.," attachment to the above entry.

frontal armour plate failed to penetrate it at ranges in excess of 100 yards. Even at that range, there was only some shatter penetration (penetration by broken-up shell fragments) into the tank.[48] The 2-pounder did, however, manage to penetrate the (non-face-hardened) thinner flank armour of the Panzer III at comparable ranges.[49]

But the Ram's importance was rapidly becoming eclipsed; as of the 9th of March, 1943, self-propelled 25-pounder gun mounts (Sextons) and Armoured Command [OP] Vehicles were to have manufacturing priority over Ram IIs, per General Staff instructions.[50] Tooling was also being set up at MLW to build the Ram's successor, the Grizzly I.[51] As the last of the Rams were being produced, the production line was not working at full capacity. To maintain the labour supply until Grizzly production started, MLW undertook to recondition earlier Ram tanks at a minimum of 10 per week, needing a continuous supply of tanks from Canadian training camps to keep the reconditioning line in efficient operation. There was a concern at MLW that a lessening of demand would cause men to be reassigned to other tasks, "...and once a move of this type is made it is very difficult to return these men to their original work."[52] As they were reconditioned, improvements were made to the Rams to bring them up to the latest standard being

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[48] LAC Microfilm T-17472, Lt.-Col. D.M. Mycroft, A.D.A.F.V. (T)., Near East Command, "A.F.V. (T.) Experimental Report No. 4," 20 May 1942. All such reports were circulated to all British and Commonwealth commands.

[49] LAC Microfilm T-17472, Lt.-Col. D.M. Mycroft, A.D.A.F.V. (T)., Near East Command, "A.F.V. (T.) Experimental Report No. 5," 24 May 1942.

[50] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, R.E. Jamieson, "Tanks Committee Meeting T-32," 9 March 1943.

[51] Ibid.

[52] LAC RG 24 Vol. 2602, File H.Q.S. 3352-11 Vol. 14, E.A. Hankin, Automotive & Tank Production Branch, to Major B.A. Gunn, Directorate of Mechanization, "Reconditioning Program," 27 April 1943.

turned out on the new production line. Many "early" Ram IIs were subsequently equipped with the heavier suspension springs and trailing return rollers that were identical to those used on Shermans.[53] But certain aspects of the repair program remained in some disarray for months. An April 1943 cable from London to Ottawa plaintively stated, "Reconditioned Rams arrived less Sponson doors. Advise if shipped."[54]

A further meeting on tank policy took place on the 4th of June, 1943, resulting from uncertainties about where Canada was going to source its Shermans. Following a review of the capabilities of the Ram II, McNaughton thought that it could be considered battleworthy if it could be upgraded to carry the 75 mm gun. Accordingly, it was proposed that 600 Rams be equipped with 75 mm guns right away, to be run-in and then reserved for future use in battle. A further 1000 Rams, armed with the 6-pounder gun and with sufficient modifications to bring them up to battle standard, were to be made available for training, but without subsequent use in battle. Finally, another 100 Rams would be equipped with 75 mm guns for use in formation training and on firing ranges. These too would not be used for battle.[55]

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[53] Roberts, *The Ram: Development and Variants, Vol. 1*, op. cit., photos and captions on pages 10-17.

[54] LAC RG 24 Vol. 9365, File 38/Arm Veh/28/4, Canmilitry to Defensor, 10 April 1943.

[55] LAC RG 24 Vol. 2602, File H.Q.S. 3352-11 Vol. 16, Lt.-Colonel D.C. Spry, P.A. to G.O.C.-in-C., "Minutes of Conference held at HQ First Canadian Army, 1600 Hours 3 Jun to Discuss Future Tank Policy," 4 June 1943, 2-3.

The 600 Ram IIs to be reserved for battle would be considered "modified and fit for operational purposes."[56] They would also be exempted from becoming training tanks.[57] But second thoughts about the use of the Ram as a battle tank must have prevailed, because three days later a cable was sent to all Ram users from First Canadian Army HQ stating that all Ram II tanks were to have a large letter "T" painted on their hulls after the WD number, to denote their status as training tanks.[58] This did not signify the end of the 75 mm Ram; in August, 100 Rams were listed as "Training Firing" tanks to be equipped with 75 mm guns, and conversions were started in the Base Ordnance Depot.[59] Fitting the larger 75 mm gun into the space meant for a 6-pounder involved many problems and progress was slow, with only 29 tanks modified before the program was halted in December, 1943.[60] It was determined that Sherman Tanks were now available in sufficient numbers for gunnery training and range practice with field units, and therefore Ram IIs equipped with the 75 mm gun were no longer required for this purpose by the 1st

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[56] LAC RG 24 Vol. 10039, File 13/AFV Ram/1/4, D.O.S. C.M.H.Q. to O.C. No. 4 Sub Depot 1 CBOD, 6 July 1943.

[57] LAC RG 24 Vol. 10039, File 13/AFV Ram/1/4, D.O.S. C.M.H.Q. to O.C. No. 4 Sub Depot 1 CBOD, 6 July 1943. The document is smudged, and the word "exempted" may be "excepted". [Though sent on the same day between the same parties as the above document, this is a different memo.]

[58] LAC RG 24 Vol. 10039, File 13/AFV Ram/1/4, First Canadian Army to multiple recipients, 9 July 1943.

[59] LAC RG 24 Vol. 10039, File 13/AFV Ram/1/4, D.D.M.E. to A.D.O.S. (M.T.), "Ram II Tanks," 27 August 1943. Tests performed in September in the first converted tank showed that there were problems with the turret traverse on slopes, and that when moving over bumpy ground "[t]he hardness of the tank suspension [...] causes excessive movement of the gunner's body and head with consequent blacking out and inability to use the [gun] sights." A new heavier browpad was recommended for the gunner. LAC RG 24 Vol. 10039, File 13/AFV Ram/1/5, Lt. Col. F.D.W. O'Rorke, Experimental Wing, A.F.V. School, Lulworth Camp, Dorset, Report E.O. No. 1/5/21, "RAM II With 75mm. (36.5 cal) Gun," 20 September 1943.

[60] LAC RG 24 Vol. 10039, File 13/AFV Ram/1/5, A.D.O.S. (M.T.) C.M.H.Q. to O.C. No 4 Sub Depot 1 CBOD, 16 December 1943.

Canadian Army; however "E" Group CRU requested them for training, and they would be sent there.[61]

Minister of Defence Ralston solicited the opinions of various officers concerned with tank production at a 22 July 1943 meeting. The consensus view was that the Ram had been a good tank when designed, because it had combined American mechanical prowess with British fighting experience. But by mid-1943, it was clear that the Sherman was capable of improvement at a faster rate than the Ram. One of the participants, Brigadier R.B. Gibson, noted that the Rams were not a total loss, because they could still be used for training.[62]

The opinions section of the meeting's minutes ended with, "Meeting unanimous. We should abandon [tank] production in Canada" and use the same Sherman models with which the U.K. forces were being supplied.[63] Production would concentrate on the manufacture of self-propelled Sexton gun carriages for Britain and Canada. The document pointed out that most of the Ram components came from the US, and that the "manufacture" of the tank was essentially "an assembly job with some machining and welding."[64] Of course, this was largely true of the Sexton, as well.

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[61] LAC RG 24 Vol. 10039, File 13/AFV Ram/1/5, HQ 1st Cdn Army to Q (Ops), "Ram Tks Equipped with 75mm Gun," 20 December 1943.

[62] LAC RG 24 Vol. 2602, File H.Q.S. 3352-11 Vol. 16, "Tanks: Meeting of July 22, 1943," 8.

[63] Ibid., 9.

[64] Ibid., 12.

The above conversation had taken place in Canada, but it appeared not to have been communicated to London. A week later, Canadian policy regarding the manufacture of tanks in Canada was still being discussed. The Sherman/Grizzly slated to replace the Ram on the MLW production lines was now considered to be inferior to the M4A4 Sherman model that Chrysler was manufacturing. The DQMG asked if it would be better to skip the Sherman entirely and tool up to make the T20 series currently being developed by US Ordnance because

> [t]he conditions that obtained when Canada first considered the manufacture of tanks have completely changed, due to the great increase in USA production and the allocation of large numbers to the British account.[65]

As it eventually turned out, the Canadian Sherman (the "Grizzly") had a short production run. Only 188 out of an anticipated 2937 Grizzly I tanks were made before all of the efforts of the Montreal Locomotive Works were concentrated on making the Sexton.[66]

As its future as a gun tank receded, the Ram began to be considered for other roles. It had already been used as a test bed for a 25-pounder SP gun carriage and a 3.7 inch antiaircraft gun carriage. The 25-pounder gun carriage would eventually evolve into the highly successful Sexton, but the 3.7 inch gun ended its days at the School of Artillery in the UK after trials were completed.[67] It was tried out as an AVRE vehicle, but that role

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[65] LAC RG 24 Vol. 9365, File 38/Arm Veh/36, Brig. J.R. MacQueen, DQMG, CMHQ to Mr. C.A. Banks, DM&S, London, "Policy re Manufacture of Tanks in Canada," 28 July 1943. Only a few of the T20 tanks were produced, as they were rapidly superseded by the T26 Pershing.

[66] LAC RG 24 Vol. 2602, File H.Q.S. 3352-11 Vol. 14, "Armoured Fighting Vehicles, C.D.'s raised by D. of Mech.," 15 March 1943. 2137 Grizzly Is were contracted for on Contract Demand L.V. 558, and a further 800 were contracted for on Contract Demand L.V. 1742.

eventually went to the more heavily-armoured Churchill.[68] Other conversions were made in small numbers, such as the Armoured Recovery Vehicle, the Beach Armoured Recovery Vehicle, and the Ram searchlight, none of which saw action.[69]

The Command/OP variant has already been described above, and was so successful that it soldiered on with Canadian formations till the end of the war. Originally the use of Ram OP tanks had been viewed as a temporary measure, because the War Office had said Shermans would be available to replace them from UK stocks in June or July of 1944.[70] But the Canadians considered that the Ram was better suited for use as a Command/OP tank than was the Sherman. This was because it had many parts in common with the Sexton SP guns with which it would operate; it had heavier frontal armour than the Sherman; and, perhaps most important, it would not take away any Sherman gun tanks from the Allied forces.[71]

The Skink, designed for antiaircraft defence, suffered from both the lack of a clear role in armour doctrine as well as a dearth of enemy aircraft to defend against. Its development was hampered because its turret and gun mounts had to be redesigned to take four 20 mm

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[67] LAC RG 24 Vol. 10039, File 13/AFV Ram/1/4, from C.M.H.Q. to various recipients, "25 Pr Ram S.P.", 30 April 1943. The Ram 25-pounder was to go to the School of Artillery complete, as was the 3.7" gun for use as an AA Trainer; the Ram chassis was retained at Bordon.

[68] The AVRE (Armoured Vehicle Royal Engineers) was a specially-adapted tank that was developed to deal with fortifications, armed with a short-range gun that could blast through thick concrete walls. The low silhouette of the Churchill gave it a marked advantage in this role.

[69] Roberts, *The Ram, Development and Variants, Volume I*, op. cit., 10-21.

[70] LAC RG 24 Vol. 9365, File 38/Arm Veh/31, Brig. M.H.S. Penhale, GS, CMHQ to DDEM, CMHQ, "OP Tanks," 20 March 1944.

[71] LAC RG 24 Vol. 9365, File 38/Arm Veh/31, Ellis (D.D.E.M., D.Q.M.G.) to Lt-Colonel J.A. Johnston, S.D.S., "OP Tanks," 15 March 1944.

Polsten cannons rather than the prototype's Hispanos, and the different gun and magazine connections needed slowed its production. Only three were ever completed and only one was shipped overseas.[72] It was attached to the No. 1 Tank Demonstration Unit and fought with six different Canadian armoured regiments over a five-week period, and then in an antipersonnel role. However, the four cannons were found to be extremely effective in house-to-house fighting, as their high volume of fire and mix of explosive and incendiary shells drove German troops out of their defences.[73]

Also known as the Armoured Ammunition Carrier, the "Wallaby" was converted from Ram IIs, and used to transport additional ammunition for armour and artillery units. The turret and turret basket were removed, and the turret ring plated over with 14 mm armour. A large square hatch in the plate allowed access to the interior. The wireless set and batteries were moved to the sponsons to make room for ammunition stowage. 76 were ordered for the First Canadian Army, with the conversion estimated to take 10 days to complete.[74]

Several Rams were converted to "Ram Towers" in much the same way as the Wallaby, with the addition of a hook on the rear hull to tow 25-pounder guns.[75] These were intended to replace Crusader gun tractors, but it was soon found that the Towers were not

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[72] See Roger V. Lucy, *The Skink in Canadian Service* (Ottawa: Service Publications, 2005), 6-20.

[73] Ibid., 23.

[74] LAC RG 24 Vol. 9366, File 38/Arm Veh/42, ARMD DCGS to ADOS (MT), "Provision of Armd Carriers," 10 August 1944.

[75] LAC RG 24 Vol. 10039, File 13/AFV Req Gen/1, Major D.D. Campbell, SD 3a, "Minutes of Meeting at CMHQ on 8 Apr 44 to estimate the delivery of AFV's and certain "B" vehicles to Field Units," 2.

needed and they went into storage in England until they were used in another role, as Kangaroos, below.[76]

The Ram Kangaroo was probably the best-known variant of all Rams. Kangaroos were Armoured Personnel Carriers (APCs) that were otherwise "surplus to requirements", equipped to transport infantry into battle in relative safety. The first Kangaroos were converted from M7 Priest SP gun carriages, but it was then realized that Rams would be even better at fulfilling this task.[77] 100 were taken from late-model Ram stocks in the UK and modified by removing the turret, turret ring and basket, moving the tank's batteries into the sponson, and installing the No. 19 Wireless Set inside the left-hand sponson within reach of the co-driver.[78] So converted, a "Ram Kangaroo" (the new name for these vehicles) with its 2-man crew could carry a section (10 men) into battle. An additional 25 Ram APCs were requested on the 16th to act as a reserve, bringing the total needed to 125.[79]

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[76] Ibid. See also LAC RG 24 Vol. 9366, File 38/Arm Veh/42, Lt. Gen. P.J. Montague, C.O.S., C.M.H.Q. to G.(SD), H.Q. First Cdn Army, "Conversion Ram 17 Pr Towers to Armd Personnel Carriers", 13 December 1944, and Roberts, *The Ram: Development and Variants, Volume I*, op. cit., 20.

[77] Roberts, ibid. The M7s had been replaced by Sextons in the artillery formations. To convert them to Kangaroos, their guns were removed and the gaps in their superstructure plated over with mild steel. In this role, they were also dubbed "Defrocked Priests".

[78] LAC RG 24 Vol. 10075, File 13/Tanks Armd Pers/1, Deputy Chief of the General Staff, C.M.H.Q., to A.D.O.S. (M.T.), D.Q.M.G., C.M.H.Q., 10 August 1944. They were initially supposed to be in France by the 24th of August, but, because gun tanks had a higher priority, shipping of the APCs only began around August 29th. See LAC RG 24 Vol. 9366, File 38/Arm Veh/42, SD Main 1st Cdn Army to SD (W) CMHQ, 21 August 1944.

[79] LAC RG 24 Vol. 10075, File 13/Tanks Armd Pers/1, A.D.Q.M.G.(A.E.) to Commandant, 1 Cdn COD, 16 August 1944.

More Kangaroos were required by December, the original supply having been reduced in number by both battle and mechanical losses. The 17-pounder Ram Towers in storage were sent to workshops for refit as Kangaroos. All of the towers had been converted from early-model Ram IIs equipped with the machine-gun cupola, and the inner hull contours did not permit positioning of the No. 19 wireless in the left-hand front sponson. However, it could be (and was) mounted to the right of the co-driver, over the transmission that ran down the centre of the tank.[80]

The Badger was developed to replace the Wasp, a flamethrower mounted upon a Universal Carrier (a small, lightly-armoured tracked vehicle) that was extremely vulnerable to enemy small-arms fire and mines. The same model flamethrower was installed in place of the machine-gun in a turretless Ram II hull and trials showed that its heavier armour afforded far greater protection for the crew and allowed it to approach its targets more closely. The last models of the Badger had the main turret ring plated over with a surplus machinegun cupola turret mounted atop the plate, to afford protection for the commander as well as close-in defence for the crew.[81] The Badger, like the Kangaroo, took its place in the assault formations of the Canadian Army.

After the Second World War ended, Rams were no longer needed. On the 18th of September, 1946 the (re-named for peacetime) Department of Supply ordered that all Ram tanks were to be scrapped as soon as possible because of a shortage of steel needed

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[80] LAC RG 24 Vol. 9366, File 38/Arm Veh/42, Lt. Gen. P.J. Montague, C.O.S., C.M.H.Q. to G.(SD), H.Q. First Cdn Army, "Conversion Ram 17 Pr Towers to Armd Personnel Carriers", 13 December 1944.

[81] Roberts, *The Ram: Development and Variants, Vol. 1*, op. cit., 19.

for other purposes. Any items common to the Grizzly were to be salvaged before scrapping.[82] Little thought was given to the historical significance of the Ram in the Canadian Army. Indeed, the original Ram I upper hull which had been used for firing tests on the Valcartier range had already been scrapped in mid-1943.[83] However, a week later a request was issued that two Rams, one Ram I and a Ram II, were to be kept for the "Foreign Materiel Section Collection".[84] One other reprieve was given, but a pyrrhic one: 30 Rams were requested to be retained for use as range targets for tank guns and PIATs.[85]

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[82] LAC RG 24 Vol. 2604, File H.Q.S. 3352-11 Vol.19, Col. W.G. Denney, Department of Supply to A.D.O.S. (T.S) and A.D.O.S.(G.S), 18 September 1946.

[83] LAC RG 24 Vol. 2596, File H.Q.S. 3352-3 Vol. 2, R.E. Jamieson, "Tanks Committee Meeting T-37," 25 May 1943.

[84] LAC RG 24 Vol. 2604, File H.Q.S. 3352-11 Vol.19, Lt-Col J.R. Johnson to D.O.S., 25 September 1946. In a handwritten comment by someone at DWD, 2 Rams were to be kept for the V.P.E. [Vehicle Proving Establishment], Ottawa.

[85] LAC RG 24 Vol. 2604, File H.Q.S. 3352-11 Vol.19, DWD to DCGS, 4 January 1947. The British PIAT ("Projector, Infantry, Anti-Tank") was roughly equivalent to the American Bazooka and the German *Panzerfaust*, a close-range weapon for infantry to use against tanks.

Chapter 6: Conclusion

It could be argued that the Ram was an enormous waste of resources, in that the Ram was never used for its intended purpose. However, a counterargument could be made that the Ram program suited the needs of Canadian troops during the period in which it was built. The Rams were used for training, for experimentation as new weapons test beds, and as the basis of several specialized designs that were used in battle. Ultimately the Ram and its variants only accounted for about one-quarter of one percent of wartime Canadian vehicle production.[1]

It could also be argued that the experience of building the Ram and learning how to troubleshoot the problems involved in its construction lead to the relatively trouble-free construction of the Sexton, which used many of the same parts. Or, at least, there are far fewer reports of dissatisfaction in the archives.

Lest the Ram be thought of as an isolated failure or an example of useless manufacture, Peter Beale in *Death by Design* notes how obsolete tanks continued to be manufactured in Britain, even though it was well known that they could not stand up to the rigours of battle. Of all of the British main battle tanks produced in 1943, he estimates that over 48% had no value as gun tanks, 26% were obsolescent, and only about 25.5% were

[1] LAC RG 28 Vol. 19, Army Engineering Design Branch, DM&S, "Post War Military Vehicle Design in Canada," September 12, 1945, 32. Ram I and II tanks comprised 0.23 percent of production, with Ram Command/OP tanks comprising another 0.01 percent.

capable of being up-gunned and taking part in battle with a chance of survival.[2] Even Germany had the 200-ton-plus Maus super-tank as an example of badly-utilized resources.[3]

The American Sherman had its problems too. It was outclassed by many of the German tanks that it faced, and the crews knew it soon after entering battle. In the words of one veteran, "...until you get into action and the enemy starts filling you full of holes, you don't realize how bad the equipment is."[4] Only the vast numbers of Shermans available to the Allies allowed them to continue to operate large armoured formations.

The Ram went from design to prototype in less than seven months, yet its subsequent development was glacial. It took a further six months for the first fifty tanks to be built, and improvements never kept up with production in subsequent production. Flaws that became evident in tanks with the same design heritage, such as the suspension problems found on American Lees, were not remedied in Canada until long after they had been fixed in the United States. And the failure to design a tank with a larger turret ring so that could easily be up gunned is still an open question.

Among the reasons for the Ram's slow progress was that it lacked a single coordinating body to push it through from design to battlefield. Responsibility was split between the

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[2] Beale, op. cit., Table 5.1, 124.

[3] The weight of the Maus varied from 160 to 207 tons depending on its armament and point of development. This information is from a reprint US War Department *Intelligence Bulletin* at http://www.lonesentry.com/articles/maus/index.html , accessed February 17, 2008.

[4] Bernard Finestone, quoted in Patricia Burns, op. cit., 116.

Department of Munitions and Supply and the Department of Defence and their multiple agencies and ad hoc advisory bodies, all of which at times jealously defended their own areas and fiefdoms, contributing to the Ram's glacial pace of development. Add to these troubles a semi-skilled workforce with insufficient supervision and an Army with no clear idea of tank doctrine, and it is not so surprising the Ram was considered unable to survive on a contemporary battlefield against its adversaries.

Much of the job of producing the Ram was simply assembling the parts that arrived at the Montreal Locomotive Works, and yet this assembly never reached the level of efficiency that it could have attained. Part of the blame for this lies with supply problems, but more lies with a lack of urgency and, again, the lack of a clear demarcation of responsibilities. The entry of the United States into the Second World War in some ways contributed to the slowdown in Ram production, because of supply shortages and increased American supervision and interference in the Canadian tank programme. Also, the emergence of the M4 Sherman as the main battle tank of the Allies may have contributed to the lack of urgency in the development of the Ram. Some men in positions of responsibility, such as R.A. Macfarlane and General McNaughton, recognized that the efforts spent on producing the Ram would be better off diverted into other war production. But bureaucratic inertia, misplaced pride, and a parsimonious government all contributed to keeping the Ram in production past the time when it was useful.

The story of the Ram can be read as a demonstration of the enormous difficulty of developing a weapon in a time of rapidly changing technology, as well as in a time of

rapidly changing doctrines of warfare. A lack of domestic resources, combined with inflexibility in planning and production, meant that it took almost the entirety of the Second World War for Canada to develop a tank that had no place on the battlefield as a tank. Even so, the Ram was only feasible because of American supply. While its fighting design owed a great deal to Canadian and British sources, the Ram would have remained a paper project without the manufacturing capacity of the United States.

The history of the Ram tank suggests that, for many years now, weapons systems have become so expensive that only the richest states can afford to develop them. This in turn suggests that smaller states are doomed to dependence on these nations when engaging in conventional warfare. Canada, for example, uses American and NATO-member military hardware and is essentially a client state of these suppliers. What does this mean for our government and our military? May we only wage war when our allies deem it desirable? We might wish for independence in foreign policy, unfettered by the constraints of others, but we could not wage war for long without resupply from outside sources.

In retrospect, it was fortunate that the Germans and the Soviets (the two combatants possessing the best tanks of the time) fought each other on the Eastern front, with few German tanks managing to be spared to fight the Western allies. Given the battlefield loss ratio of three to five Shermans, Cromwells or Churchills when put up against single or multiple Panthers, Tigers or Sturmgeschutzes (self-propelled assault guns), only the Allied superiority in materiel allowed victory.

References and Select Bibliography

Primary Sources

Library and Archives Canada, Record Group Files as noted in the text.

The *Gazette* (Montreal).

The *Montreal Star.*

Anonymous. *Anti-Tank Gunnery: Military Training Pamphlet No. 59.* HMSO, 1943.

_____. *Booby Traps and Tank Traps: Field Engineering Pamphlet No. 9.* HMSO, 1941.

_____. *Design Record Canadian Developed Vehicles World War II – Volume III, Tanks and Tank Type Vehicles, December, 1945.* Ottawa: Department of Munitions and Supply Publication, 1945.

_____. *The Industrial Front: Department of Munitions and Supply.* Ottawa: King's Printer, 1944.

_____. *Royal Armoured Corps Weapons: Military Training Pamphlet No. 35: Part 14: Ordnance Q.F. & S.A. 6-Pr. Gun.* War Office, 1942.

Books

Anonymous. *Canadian Military Vehicles Series Profile No. 2. Tank, Cruiser RAM I and II.* Rockwood, ON: Canadian Military Historical Society, 1981.

_____. *German Tank Maintenance in World War II.* Washington, DC: Center of Military History, 1988.

Bond, Brian. *British Military Policy between the Two World Wars.* Oxford: Clarendon Press, 1980.

Bothwell, Robert, and William Kilbourn. *C.D. Howe: A Biography.* Toronto: McClelland and Stewart, 1979.

Broadfoot, Barry. *Six War Years, 1939 – 1945.* Toronto: PaperJacks, 1976.

Chamberlain, Peter, and Chris Ellis. *AFV 11, M3 Medium (Lee/Grant).* Windsor, UK: Profile Publications, 196-.

Cooper, Belton Y. *Death Traps: The Survival of an American Armored Division in World War II.* Novato, CA: Presidio Press, 2000.

Culver, Bruce. *Sherman in Action.* Carrollton, TX: Squadron/Signal Publications, 1977.

Deighton, Len. *Blitzkreig.* London: Jonathan Cape, 1979.

Dunn, Hunter. *Memoirs of a WWII Armoured Officer.* n.p.: Hunter Dunn, 2005.

Ellis, Chris, and Peter Chamberlain. *AFV 13, Ram and Sexton.* Windsor, UK: Profile Publications, 196-.

Fairfax, Ernest. *Calling All Arms.* London: Hutchinson and Co., 1945.

Fletcher, David. *The Great Tank Scandal: British Armour in the Second World War Part 1.* London: HMSO, 1989.

_____. *The Universal Tank. British Armour in the Second World War Part 2.* London: HMSO, 1993.

Granatstein, J. L. *The Generals. The Canadian Army's Senior Commanders in the Second World War.* Toronto: Stoddart, 1995.

Gregg, W. A., ed. *Blueprint for Victory: The Story of Military Vehicle Design and Production in Canada from 1937 – 45.* Rockwood, ON: Canadian Military Historical Society, 1981.

_____. *Canada's Fighting Vehicles: Europe 1943 – 45*, 2d ed. Rockwood, ON: Canadian Military Historical Society, 1980.

Guthrie, Steve. *The Sherman in Canadian Service.* Ottawa: Service Publications, 2002.

Hall, H. Duncan. *North American Supply.* London: Longman's Green Company, 1955.

Hall, H. Duncan, and C. C. Wrigley. *Studies of Overseas Supply.* London: Longman's Green Company, 1956.

Hancock, W. K., and M. M. Gowing. *British War Economy. History of the Second World War, United Kingdom Civil Series.* London: HMSO, 1975

Hinsley, F. H., E. E. Thomas, C. F. G. Ransom, and R. C. Knight. *British Intelligence in the Second World War, Vol. 1.* London: HMSO, 1979.

Hunnicutt, R. P. *Sherman: A History of the American Medium Tank.* Novato, CA: Presidio Press, 1978.

Hurstfield, J. *The Control of Raw Materials.* London: HMSO, 1984.

James, R. Warren. *Wartime Economic Cooperation: A study of Relations between Canada and the United States.* Ryerson Press: Toronto, 1949.

Jarymowycz, Roman. *Tank Tactics: From Normandy to Lorraine.* Boulder, CO: Lynne Rienner Publishers, 2001.

Kennedy, J. de N. *History of the Department of Munitions and Supply: Canada in the Second World War. Vol I. Production Branches and Crown Corporations.* Ottawa: King's Printer, 1950.

_____. *History of the Department of Munitions and Supply: Canada in the Second World War. Vol II. Controls, Services and Finance Branches, and Units Associated with the Department.* Ottawa: King's Printer, 1950.

Knight, Doug. *The 6-Pounder Anti-Tank Gun in Canadian Service.* Ottawa: Service Publications, 2004.

Law, Clive M. *Making Tracks: Tank Production in Canada.* Ottawa: Service Publications, 2001.

Lucy, Roger V. *The Skink in Canadian Service.* Ottawa: Service Publications, 2005.

Perkins, Norris H., Major (Ret.), and Michael E. Rogers. *Roll Again Second Armored: Prelude to Fame 1940-1943.* Surbiton, UK: Kristall Productions Ltd., 1988.

Postan, M. M. *British War Production.* London: HMSO, 1975.

Quarrie, Bruce. *Panzers in the Desert.* Tucson, AZ: AZTEX Corporation, 1981.

Roberts, Paul. *The Ram: Development and Variants, Volume 1.* Ottawa: Service Publications, 2002.

_____. *The Ram: Development and Variants, Volume 2.* Ottawa: Service Publications, 2004.

Ross, G. MacLeod, in collaboration with Major-General Sir Campbell Clarke. *The Business of Tanks, 1933 to 1945.* Ilfracombe, Devon: Arthur H. Stockwell, Ltd., 1976.

Smith, John Owen. *All Tanked Up – the Canadians in Headley during World War II.* Headley Down, UK: J.O. Smith, 1994.

Schneider, Wolfgang. *Panzer Tactics: German Small-Unit Armor Tactics in World War II.* Translated by Fred Steinhardt. Mechanicsburg, PA: Stackpole Books, 2005.

Smithers, A. J. *A New Excalibur: The Development of the Tank 1909-1939.* London: Grafton, 1988.

_____. *Rude Mechanicals: An Account of Tank Maturity During the Second World War.* London: Grafton, 1989.

Spielberger, Walter. *AFV 2, Panzerkampfwagen III.* Great Bookham, UK: Profile Publications, 196-.

Stacey, C. P. *Arms, Men and Governments; the War Policies of Canada 1939-1945.* Ottawa: Queen's Printer, 1971.

_____. *The Canadian Army 1939 – 1945: An Official Historical Summary.* Ottawa: King's Printer, 1948.

Tonner, Mark W. *The Kangaroo in Canadian Service.* Ottawa: Service Publications, 2005.

White, B. T. *AFV 6, Valentine Mark III.* Windsor, UK: Profile Publications, 196-.

Worthington, Larry [Clara E.]. *'Worthy', a Biography of Major-General F. F. Worthington, C. B. M. C. M. M.* Toronto: Macmillan Company of Canada, 1961.

Articles

Anonymous. "American Locomotive." Fortune 25 (February 1942): 78-122.

_____. "The Armoured Corps Story." *Sentinel* 2, No. 5 (June 1966): 30- 33.

_____. "Canadian Pacific Ry. Munitions Manufacture." *Canadian Transportation* (July 1942):

Broad, Graham. "'Not competent to produce tanks': The Ram and Tank Production in Canada, 1939-1945." *Canadian Military History* 11, No. 1 (Winter 2002): 24-36.

Websites

Anonymous. "Canada's Tank Cruiser, Ram Mk I, Mk II (USA's M4A5)." Available at http://www.wwiivehicles.com/canada/ram.html, accessed June 2, 2005.

_____. "Canadian Armour." Available at http://mailer.fsu.edu/~akirk/tanks/can/Canada.htm, accessed June 1, 2005.

_____. "1st Canadian Armoured Carrier Regiment Association." Available at http://www.1cacr.org/index.html, accessed June 3, 2005.

_____. "Juno Beach Centre—Canadian-built Tanks." Available at http://www.junobeach.org/e/4/can-tac-arm-can-e.htm, accessed June 1, 2005.

_____. "New Zealand Artillery—Southern Gunners—Live Firing." Available at http://livefiring.ashst.com/artillery_heritage/ordnance/25pr.htm, accessed June 3, 2005.

Cameron, L. R. "Report No. 38, Historical Section (G.S.), Army Headquarters: Tank Production in Canada." Available at http://www.forces.gc.ca/dhh/downloads/ahq/ahq038.pdf, accessed June 3, 2005.

Connors, Chris. "90mm Gun Motor Carriage M36." Available at http://afvdb.50megs.com/usa/90mmgmcm36.html, accessed June 3, 2005.

Martin, H. D. "Report No. 43, Historical Section (G.S.), Army Headquarters: Training of the 4th and 5th Canadian Armoured Division in the United Kingdom, October 1941-July 1944." Available at http://www.forces.gc.ca/dhh/downloads/ahq/ahq043.pdf, accessed June 12, 2005.

Oglesby, R. B. "Report No. 57, Historical Section (G.S.), Army Headquarters: A Summary of Major Changes in Army Organization, 1939-1945." Available at http://www.forces.gc.ca/dhh/downloads/ahq/ahq057.pdf, accessed June 12, 2005.

Spoelstra, Hanno. "1st Canadian Armoured Carrier Regiment." Available at http://www.mapleleafup.org/histories/1cacr/index.html, accessed June 3, 2005.

_____. "New Life for a Ram Kangaroo." Available at http://www.mapleleafup.org/vehicles/restorations/restore7.html, accessed June 3, 2005.

_____. "Sherman Register—Serial Numbers." Available at http://web.inter.nl.net/users/spoelstra/g104/serial.htm, accessed June 3, 2005.

Stacey, C. P. "Report No. 42, (dated 13 Aug 41), Visit to Canadian Army Tank Brigade." Available at http://www.forces.gc.ca/dhh/downloads/cmhq/cmhq042.pdf, accessed June 3, 2005.

Winnington-Ball, Geoff. "The Canadian Ram Cruiser Tank." Available at http://www.mapleleafup.org/vehicles/cac/ram.html, accessed June 3, 2005.